

Springs Coast Comprehensive Watershed Management Plan



2001

Southwest Florida
Water Management District



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SPRINGS COAST COMPREHENSIVE WATERSHED MANAGEMENT PLAN



Prepared by
the Southwest Florida Water Management District

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SPRINGS COAST COMPREHENSIVE WATERSHED MANAGEMENT (CWM) TEAM

Since this CWM Plan is a continuing process, there will no doubt be many participants who have or will contribute time and effort to the success of this initiative. To date, there have already been many people from various organizations, government agencies and private industries, who have met, shared ideas and information, reviewed and edited this document, and basically put forth a concerted effort to establish a plan for the betterment and preservation of the Springs Coast watershed. The following list includes the current members of the **Springs Coast Comprehensive Watershed Management Team**:

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AOR=Area of Responsibility

EXECUTIVE SUMMARY

The Springs Coast watershed encompasses parts of Pasco, Hernando and Citrus counties and includes a diverse variety of hydrologic and ecologic features. The eastern and central portions of the watershed are dominated by the Brooksville Ridge, a sandy remnant of previous higher sea levels, characterized by its karst geology with scattered sinkhole lakes and depressional wetlands. The watershed is also underlain by the Floridan aquifer, the primary source of potable water for residents in and out of the watershed. The watershed's karst geology and the generally unconfined nature of the Floridan aquifer combine to provide a connection between surface and groundwater resources. This combination also results in a high susceptibility for ground-water contamination which must be addressed through appropriate resource management programs and land use considerations.

The Crystal, Homosassa, Chassahowitzka, Weeki Wachee and Pithlachascotee rivers and associated coastal aquatic resources are dominant features of the watershed and provide recreational opportunities for area residents and tourists. Significant limerock mining operations are located northwest of Brooksville. Agricultural areas of the watershed previously developed for cattle grazing and citrus, are slowly converting to low density residential and other uses. Of paramount concern is the need to maintain the quality and biological health of the waters and aquatic resources within the watershed to ensure their continued use and enjoyment for current and future residents.

Several areas within the watershed are rapidly developing particularly the New Port Richey, Spring Hill and Crystal River/Homosassa Springs areas. Continued population growth in the watershed, fueled by the development of the Suncoast Parkway, will continue to create issues between land use and water resource planning. As much of this urbanization of the watershed is of relatively recent occurrence, a number of resource assessments and planning initiatives necessary to effectively manage the resources of the watershed have yet to be undertaken.

Given the above considerations and review of currently available information the following issues and actions, by District area of responsibility, were identified by the Springs Coast watershed team as top priorities for the next one to five years:

WATER SUPPLY

1. Assess water supply availability and seek establishment of minimum flows and levels
- Efforts currently underway to establish additional groundwater monitoring sites in the northern portion of the Southwest Florida Water Management District (the District) in anticipation of a Water Resource Assessment Project. Schedule established for setting minimum flows and levels for those counties in the watershed.

2. Prevent groundwater contamination through appropriate land use siting and development practices - Hernando County has developed and implemented a wellhead protection program. Development of similar programs in Pasco and Citrus counties will be pursued. Continue to assist local governments with appropriate land use siting and development practices to protect groundwater resources.
3. Address concerns about potential water supply development and export - Continue to review water resource development within the context of "local sources first".
4. Conservation of existing groundwater resources - See Water Supply Issue #1.

FLOOD PROTECTION

1. Continue to pursue local government partnerships in the District's Flood Protection Coordination (FPC) effort - Implement projects identified in the Flood Protection Coordination document adopted with Hernando County and continue to partner on identified projects and initiatives. Identify potential flood protection coordination opportunities with Pasco and Citrus counties and develop draft FPC for their review and consideration.
2. Implement local building codes and ordinances to address potential coastal flooding damages.
3. Develop regulations for discharge of stormwater into sinkholes in karst sensitive areas.
4. Establish education and awareness programs for the operation and maintenance of stormwater management systems.

WATER QUALITY

1. Reduce nitrate concentrations in spring discharge - Interagency workgroup has formed to address increasing trends in ground water and spring nitrate levels; Nitrate Symposium held at Saint Leo College in May of 1999 provided opportunity for dialogue and public discussion of the issues related to nitrate trends; Workgroup will continue to pursue opportunities to mitigate/reverse trends through various efforts.
2. Develop a water quality monitoring network to address data gaps and monitoring needs - District staff has identified what data is currently being collected and what additional data/distribution needs remain.

3. Develop and implement restoration plans for surface water bodies with poor water quality and preservation plans for the protection of water bodies with good water quality. Continue implementation of the Crystal River/Kings Bay Surface Water Improvement and Management Plan.

NATURAL SYSTEMS

1. Limit the destruction and fragmentation of natural systems - Complete a natural area core and corridor mapping analysis which will identify and inventory historical habitat distribution to determine habitat loss, evaluate/determine areas of high habitat value and viable linkages, and coordinate land acquisition and other conservation efforts among all programs in the watershed.
2. Continue efforts to control/eradicate invasive exotic plants - Provide for the effective management of aquatic and terrestrial invasive exotic plants for the protection and preservation of natural ecosystems.
3. Address declining ground water and lake levels - See Water Supply Issue #1.
4. Management of publicly-owned lands - Actively manage publicly-owned preserve lands to maintain their natural resource values.

CHAPTER I

INTRODUCTION AND WATERSHED DESCRIPTION

This document is the Springs Coast Watershed Management Plan, developed as part of the Southwest Florida Water Management District's (District's) Comprehensive Watershed Management (CWM) Initiative. The CWM Initiative integrates a variety of water resource management activities within each of the District's 11 watersheds. In 1994, the District's Governing Board made CWM a Strategic Initiative and directed staff and funding resources to this project. In addition, a majority of the District's Basin Boards have also made Watershed Assessments a priority for future cooperative funding proposals and projects.

The Comprehensive Watershed Management (CWM) initiative has been established to improve the management of water and related natural resources within the Southwest Florida Water Management District (SWFWMD or District). This initiative employs a watershed-based approach to resource management. Staff from a variety of disciplines and departments make up "watershed teams" that have been assigned to eleven primary watersheds (Figure 1). Local governments and other stakeholders within each watershed are also significant partners on these teams. The goals for the teams include:

- Collect, integrate and analyze the existing information pertinent to each watershed and create a data base for analytical purposes;
- Identify and prioritize existing and future water resource management issues relating to water supply, flood protection, water quality and natural systems (District Areas of Responsibility or "AORs");
- Develop preventative or remedial management actions to address these resource management issues;
- Identify funding sources and partnerships to support action plan projects;
- Implement and monitor the effectiveness of selected actions and the overall process and recommend potential revisions.

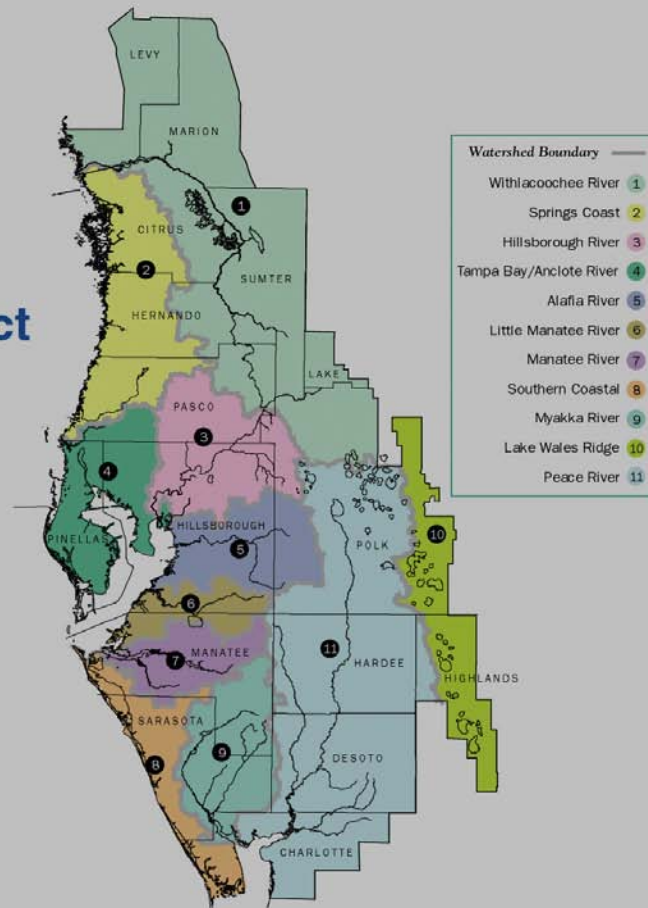
CWM represents an evolution in direction for the District, providing the opportunity to enhance coordinated action between the District, local governments and others. It is a science-based approach, including the application of Geographic Information System technology and other modeling tools within each watershed.

Each team has been charged with the development of a watershed management plan reflecting the results of this process. The CWM watershed plans are complex in the breadth and variety of issues that they encompass, but simple in intent and design. They analyze

Figure 1

CWM Watersheds in the Southwest Florida Water Management District

The watershed boundaries were delineated by the Comprehensive Watershed Management (CWM) teams based on a United States Geological Survey, Water Resources Division delineation. The original delineation was obtained from the Florida Department of Environmental Protection, Tallahassee, Florida in 1994.



the wealth of information available in each area, identify issues and recommend specific actions to address these issues. The fundamental elements of the plans are the chapters that identify issues in each of the District's four AORs. Specific and realistic actions to address each issue are presented within each AOR. Completed CWM plans become a part of the District Water Management Plan through incorporation by reference. These plans reflect a "snapshot-in-time" for the watershed and will be updated on a periodic basis.

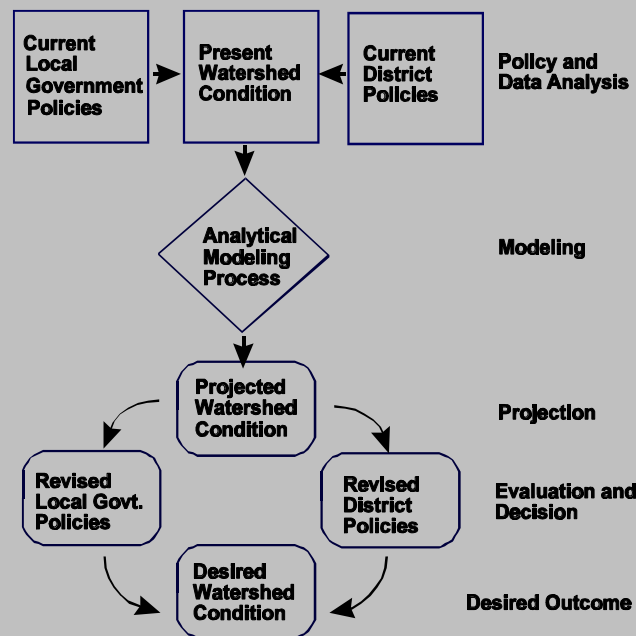
Coordination With Local Governments and Other Agencies

A significant element of the CWM initiative is the active involvement of the local government(s) together with the District within a watershed. The District and local governments share the premise that resource management incorporates the desire for sustainability. Consequently, the need to revise their respective policies from time to time is on a parallel tract. Scientific knowledge serves as the backbone to this process and allows us to achieve the desired watershed condition (Figure 2). Local governments have

the greatest influence over future growth through their comprehensive plans and associated land development regulations. Partnering with local governments is essential to the success of the CWM initiative. Each CWM team will have active participation by the local government(s) within their watershed. This will include involvement in issue identification, development of preventative or remedial strategies and coordinated implementation. Agencies which are, or will be, requested to participate in the CWM process include the Department of Environmental Protection, Department of Agriculture and Consumer Services, the Florida Fish and Wildlife Conservation Commission, regional planning councils, Army Corps of Engineers, National Estuary Programs where appropriate, citizen groups and others.

Figure 2

Comprehensive Watershed Management

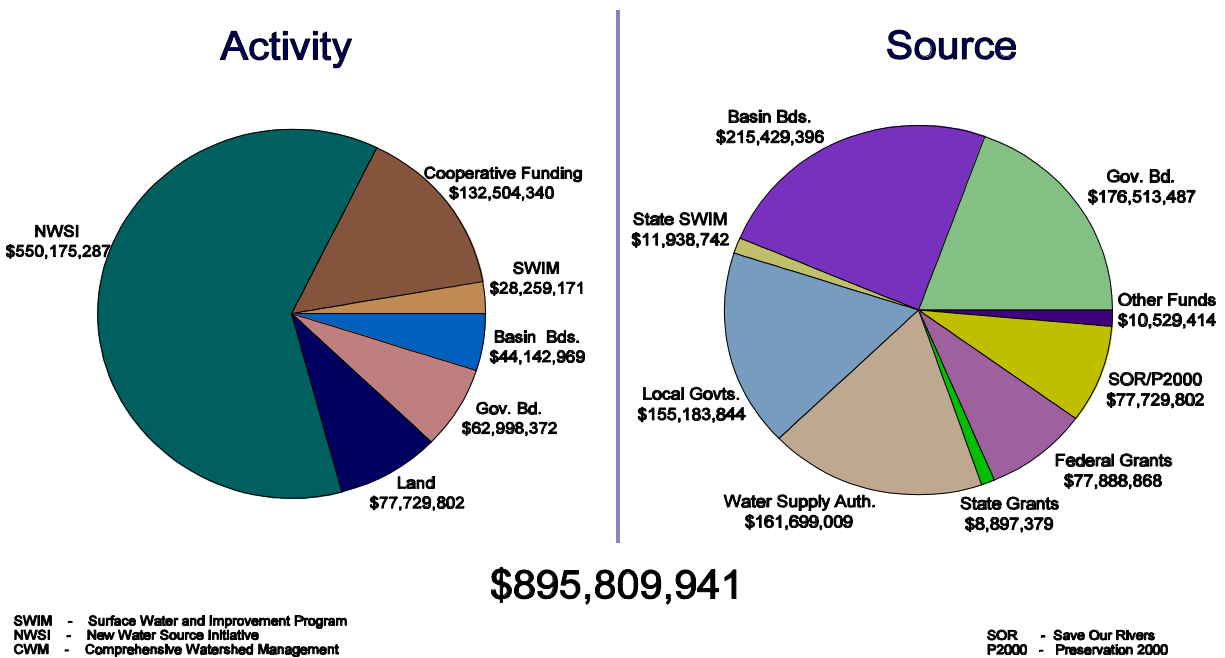


The CWM initiative helps to ensure that comprehensive, coordinated analysis and decision-making take place. It fosters closer cooperation and partnership between the District, local governments and other stakeholders to help preserve and improve the quality of watersheds as growth and development take place in the future. It allows rational and logical resolution of problems based on science. Integrated plans are developed with actual implementation of strategies involving multiple parties.

Funding Commitments

The District, in partnership with local, State and Federal governments, currently supports many significant water and related natural resource management projects and initiatives within each watershed. These efforts are currently contributing to effective management of water and related natural resources. Figure 3 summarizes the District's current efforts for the eleven primary watersheds as of Fiscal Year 2000. This figure shows the types of projects and initiatives being funded, and the estimated sources of revenues. A total of approximately \$896 million in water and related natural resource management projects, wholly or partially funded by the District, are currently underway within these watersheds. Of this amount, approximately \$169 million are designated for Springs Coast watershed projects (Figure 4). This does not include the many other resource management activities undertaken by local governments, DEP and others.

Figure 3
Estimated Funding by Activity and Source
CWM Active Projects



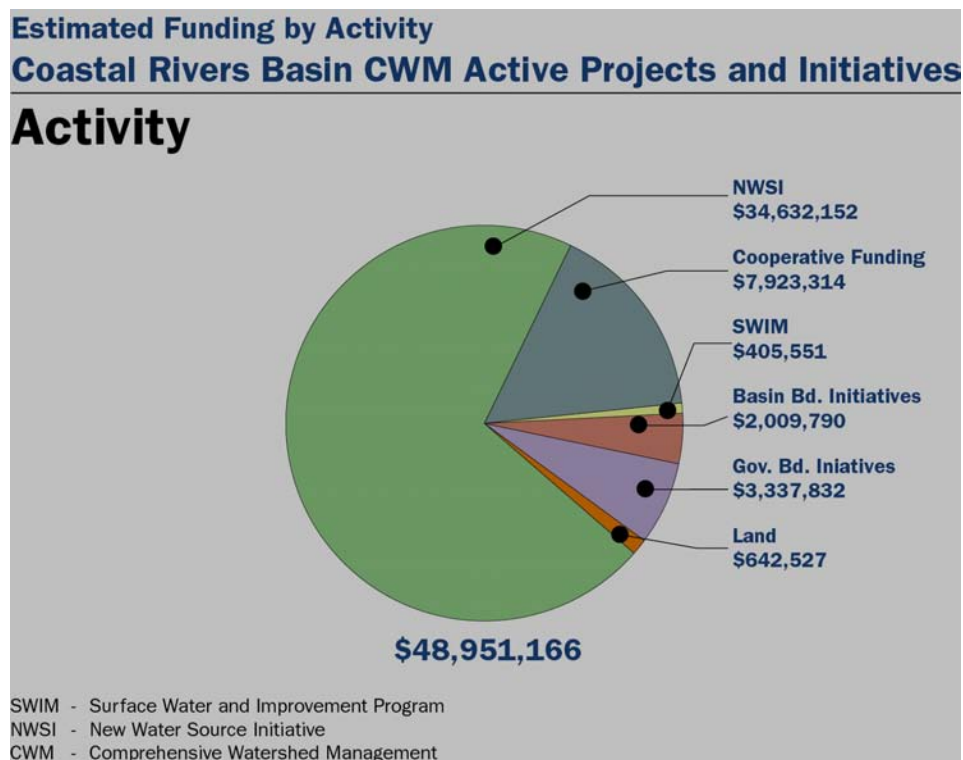
Implementation

Each watershed management team has suggested specific and realistic actions and tasks. Recommendations that the District is responsible for implementing are prioritized by a District senior management team (Steering Committee). This Committee is responsible for determining priorities, directing them to the appropriate staff and board(s), and allocating staff time and resources. A significant means of implementation for the District is through the Basin boards' cooperative funding programs. The recommendations from the CWM teams are incorporated into appropriate Basin board five-year plans which are updated on an annual basis.

The intent is that recommendations which fall within the implementation responsibility of local governments or others will be similarly prioritized and implemented. A formal partnership or Memorandum of Understanding between the District and participating parties may be proposed as a vehicle for coordinated implementation of these collaborative CWM planning efforts.

CWM teams will review the implementation of recommended actions on a regular basis. These teams will report on implementation status for the Annual Report on the District

Figure 4



Water Management Plan and provide a brief summary for each watershed. This information will be used within the Basin Board Five-Year Plans and in District accountability and performance reporting.

Future of CWM - A Watershed-based Partnership Approach

One of the most significant tools available to watershed teams is the District's Geographic Information System

(GIS). GIS is a database that is designed to efficiently store, retrieve, analyze and display mapped data. The ability to reference data by their location on the earth's surface provides an effective means of integrating data from many diverse sources. The GIS currently allows staff to integrate data from ground and surface water models, the District's Regulatory and Water Management Databases, and results from statistical analyses. This capability to integrate data from multiple sources allows staff to analyze previously undiscovered relationships between the data. For example, one might find a relationship between soil type, surface slope and vegetation cover that was not previously known. The GIS also provides a means of integrating disparate data such as census information and FEMA flood maps, allowing for example, the analysis of per capita income of individuals living within the 100 year floodplain. The power of GIS lies in its ability to integrate numerical, statistical, engineering and spatial models and then dynamically depict and visually present scenarios. The GIS allows the CWM teams to analyze the best available information in such a way as to not only understand current conditions, but to also anticipate future conditions through scenario modeling.

The development of a Decision Support System (DSS), utilizing the GIS as a tool in comprehensive watershed management, represents an evolution in direction for the District.

This effort will provide an opportunity to enhance coordinated action between the District, local governments and others. This GIS-based analysis and planning has, to-date, been applied only to a limited degree in selected watersheds. It is a major objective of the District that the use of the GIS, in conjunction with other modeling tools, be expanded and enhanced in a collaborative fashion with local governments and other participants for all eleven watersheds. The Coastal Rivers Basin Board has committed funding for a pilot project within the Springs Coast watershed, as part of the overall DSS development.

Future updates to this Springs Coast Comprehensive Watershed Management Plan will reflect progress made in further developing this GIS-based partnership approach. The maps referenced in this document are compiled in a separate document titled the “**Springs Coast Comprehensive Watershed Management Atlas**” (SWFWMD 2001a).

LOCATION

The Springs Coast watershed covers approximately 800 square miles of coastal Citrus, Hernando, and Pasco counties in west central Florida (Map 1). The watershed is bounded on the west by the Gulf of Mexico and on the east by the Brooksville Ridge physiographic region. Incorporated cities within the basin include Port Richey, New Port Richey, Weeki Wachee, Brooksville, and Crystal River. Residential and commercial development has expanded along the U.S. 19 corridor from Crystal River southward to New Port Richey. However, there is an area between Weeki Wachee and Chassahowitzka that remains relatively undeveloped.

CLIMATE

The following information on meteorology is adapted from the report An Ecological Characterization of the Florida Spring Coast: Pithlachascotee to Waccasassa Rivers (Wolfe, 1990):

West central Florida has a humid subtropical climate. The overriding climatological factor affecting the area is the Gulf of Mexico. Winter cold fronts and high summer temperatures are moderated by the Gulf waters. The average mean daily temperature is approximately 70E F (21E C). Mean summer temperatures are in the low 80's and mean winter temperatures are in the upper 50's. Summer temperatures are tempered by sea breezes. Winter temperatures are quite variable due to the passage of frontal systems.

Rainfall in the area is the result of three types of systems: frontal, convective and tropical cyclonic. Although most of the rainfall is associated with summer convective storms, the area has two distinct peak rainfall periods: June through September and February through April. The average rainfall totals vary from 54 to 58 inches per year.

ECONOMY

Agriculture was the historic economic base within Citrus, Hernando and Pasco counties. Several factors, including residential growth, the decreasing profitability of farming and freezes impacting the citrus industry, have dramatically changed economic base for each of these counties. Today, the economies of Citrus, Hernando and Pasco counties are predominantly comprised of retail trade, services, government and construction. A significant portion of Hernando County's economy is still based on industry (mining), cattle and agriculture.

LAND USE, GROWTH, AND DEVELOPMENT

Despite a great deal of growth in the last 30 years, Citrus, Hernando, and Pasco counties still retain a rural character. Covered by coastal swamps, dense woodlands, lakes and pastures (Map 2), the counties are rapidly changing as residential development expands.

The northern portion of the basin generally described as western Citrus County, contains a number of rapidly expanding retirement communities. Dense networks of streets and platted lots exist in the north-central portion of the County. Although relatively few houses now exist in these areas, the potential density of these developments at build out is extremely high. The U.S. Highway 19 corridor between Crystal River and Homosassa is also rapidly developing. The extreme western portion of this area is characterized by sparsely populated coastal swamps and wetlands (mostly state or federally owned). Residential and commercial development along U.S. Highway 19 has been concentrated in a narrow corridor between the coastal swamps and the upland forest of the Brooksville Ridge. The Withlacoochee State Forest represents much of this upland forest; it is regularly logged and virtually uninhabited. Northeast of the forest, the city of Inverness, while not in the watershed, supports a large residential community, commercial development and recreational land uses.

The central portion of the watershed, generally described as western Hernando County, also contains a number of rapidly growing communities. These communities are characterized by moderately-dense residential and commercial development. In the vicinity of Spring Hill and Weeki Wachee, residential development occupies a large portion of the area between U.S. Highway 19 and the Brooksville Ridge, particularly between State Road 50 and County Line Road. Conversely, pasture and forests are prevalent over the central and eastern portions of the area. The city of Brooksville, lying in the east-central portion of the watershed, is characterized by residential and commercial land uses. Limestone mining is a major land use northwest of Brooksville.

The southern portion of the watershed, generally described as western Pasco County, contains widespread mixture of residential and commercial development, pasture, forest and wetlands. The extreme western portion of the watershed in Pasco County is characterized by coastal hardwood forests and coastal swamps. The U.S. Highway 19 area

contains densely developed residential and commercial areas. The central and eastern portions of the watershed within Pasco County contain pasture, forest, open land, numerous lakes and wetlands, and some scattered row and tree crops.

It is important to note that the entire watershed has witnessed a pronounced increase in both on-site sewage treatment (septic tank/drain field facilities) and centrally-sewered communities in a relatively short period of time. Table 1 depicts the acreage and percent of total acreage for land uses within the Springs Coast watershed.

Table 1. 1995 Land use and land cover for the Springs Coast Watershed.

Land Use/Land Cover	Acres	% of Total Acres
Urban and Built-up	150,972	27.2
Agriculture	74,972	13.5
Rangeland	6,810	1.2
Upland Forests	171,607	30.9
Water	5,246	1
Wetlands	136,506	24.6
Barren Land	1,819	0.3
Transportation, Communication & Utilities	7,480	1.3
Total	555,412	100

Citrus, Hernando and Pasco counties have each experienced rapid growth since the early 1970's. The central ridge area of Citrus County contains land with excellent development potential and it is here that most of the current residential growth is occurring. Within Hernando County population growth is concentrated in the southwestern part of the County where a number of large-scale planned developments are located. Map 3 depicts Future Land Use through 2010. Spring Hill, a community of about 60,000 residents, is the largest of these subdivisions. Pasco County has seen much of its growth occur in the western and southern portions of the County. Table 2 depicts historic and projected population for the region.

Table 2. Citrus, Hernando, and Pasco County Population 1980-2010.

County/City	1980⁽¹⁾	1990⁽¹⁾	1999	2010⁽⁵⁾
Total Citrus County	54,703	93,513	114,898⁽²⁾	141,600
Crystal River	2,778	4,050	4,375 ⁽²⁾	n/a
Total Hernando County	44,469	101,115	127,392⁽³⁾	163,800
Brooksville	5,582	7,589	7,863 ⁽³⁾	8,921 ⁽⁶⁾
Weeki Wachee	8	11	15 ⁽³⁾	n/a
Total Pasco County	193,661	281,131	321,074⁽⁴⁾	381,000
New Port Richey	11,196	14,044	14,693 ⁽⁴⁾	n/a
Port Richey	1,742	2,521	2,667 ⁽⁴⁾	n/a

Sources:

- (1) Bureau of the Census, 1990.
 - (2) Bureau of Economic and Business Research (BEBR, 2000a).
 - (3) BEBR, 2000b.
 - (4) BEBR, 2000c.
 - (5) BEBR, 2000d.
 - (6) City of Brooksville, 1999.
- n/a - data not available

TRANSPORTATION

U.S. Highway 19 and U.S. Highway 41 are the major north-south corridors through Citrus, Hernando and Pasco counties within the Springs Coast watershed. Major east-west highways include: State Road 44 connecting the coastal areas around Crystal River with Inverness, State Road 50 which originates in West Hernando County near Weeki Wachee and passes through Brooksville and State Road 52 which originates in western Pasco County. Regional airports include the Crystal River Airport and the Hernando County Airport.

PHYSICAL DESCRIPTION

White (1970) delineated five major physiographic features in Citrus, Hernando and Pasco Counties. Three physiographic features within the Springs Coast watershed include the Coastal Swamps, Gulf Coastal Lowlands, and Brooksville Ridge. These physiographic regions are primarily a function of topographic relief and underlying sediments. The following is a brief discussion of each feature.

The **Coastal Swamp** area parallels the coast and extends inland from two to five miles. It is characterized by both tidal marshes and coastal swamps. Elevations are less than ten feet, and poorly drained, organic soils directly overlie limestones of the Floridan aquifer system in much of the coastal swamp area.

The **Gulf Coastal Lowlands** lie between the Coastal Swamp and the Brooksville Ridge and range from about two to eight miles in width. Elevations range from sea level to about 100 feet. The topography consists of relatively flat plains to rolling hills. The hills are made up of aeolian sand dunes.

The **Brooksville Ridge** trends northwest-southeast through the central part of Citrus County and eastern Hernando and Pasco Counties. The Brooksville Ridge measures approximately 17 miles in width in central Hernando County and reaches its southern terminus in northeastern Pasco County. Elevations along the ridge range from 70 to about 275 feet. The ridge has an irregular surface due to karst activity (Vernon, 1951) and elevations may vary more than 100 feet over short distances. The margins of the ridge are characterized by deep, sandy soils, while the ridge interior contains a mixture of poorly to well-drained sandy-clayey soils. The entire Brooksville Ridge area is underlain by a clayey unit that varies between 10 and 30 feet in thickness but allows good hydraulic connection to the underlying Floridan aquifer system through karst features and fractures.

The **Tsala Apopka Plain**, a fourth physiographic province not within the Springs Coast watershed, plays an important role in the water resources of the watershed. The plain lies between the Brooksville Ridge and the Withlacoochee River within the recharge area of the coastal springs. It has a large number of interconnected lakes that are divided by peninsulas and islands. Siliciclastic deposits cover the limestone surface and elevations range from 35 to 75 feet. The soils are generally sandy and weakly cemented with organic matter.

The main surface drainage features within the watershed are the Crystal, Homosassa, Chassahowitzka, Weeki Wachee, and Pithlachascotee Rivers. With the exception of the Pithlachascotee, these rivers are dominated by spring discharge and are relatively short (less than 10 miles in length). The drainage sub basins are depicted on Map 4. The lack of rivers and streams in the interior of the watershed results from a well-developed underground drainage system in the limestone that underlies the Springs Coast watershed. Precipitation falling on the Brooksville Ridge rapidly moves underground through numerous sinkholes and begins moving seaward through an extensive system of conduits.

SURFACE WATER HYDROLOGY

Physiography as described above plays a significant role in determining surface water features. In the northern part of the Springs Coast watershed principle water bodies include the coastal spring-fed Crystal, Homosassa, Chassahowitzka, and Weeki Wachee rivers.

These rivers start as spring discharge and are typically only a few miles long. Little overland drainage from surrounding areas contributes to the river's discharge. All four spring systems are first magnitude springs. This means that each spring discharges an average of 100 cubic feet per second (cfs) or more. Hammock Creek, at Aripeka, is a coastal system formed by several lesser magnitude springs and swamp discharge.

In the southern portion of the watershed, surface water drains either directly to the Gulf of Mexico or to the Pithlachascotee (Cotee) River. The Cotee River starts in Hernando County as channeled flow through the Masaryktown Canal, then southwest to its headwaters, Crews Lake, and on through Pasco County to the Gulf of Mexico at Port Richey (Cherry et al., 1970).

HYDROGEOLOGY

The following information on hydrogeology is adapted from the report *"Water-quality And Hydrology of The Homosassa, Chassahowitzka, Weeki Wachee, And Aripeka Spring Complexes, Citrus and Hernando Counties, Florida - Origin of Increasing Nitrate Concentrations"* (Jones and et al., 1997):

Geology

Geology of the watershed is relatively simple with thick sequences of limestone exposed at or very near (10 to 20 feet) the land surface in the eastern and western portions of the watershed. Where limestone is near land surface, the thin veneer of sediment that covers the limestone consists of unconsolidated deposits of primarily quartz sand. These sands are marine terrace deposits and coastal dune trains. Dunes are prevalent in the Coastal Lowlands and along the flanks of the Brooksville Ridge.

The limestone units include the Suwannee Limestone of Oligocene age and the Ocala Limestone of Eocene age. Underlying these exposed limestone units is the Avon Park Formation of Eocene age. The Avon Park Formation is the deepest formation containing potable water. The Suwannee and Ocala Limestones and the Avon Park Formation comprise the Floridan aquifer in the area. In the Brooksville Ridge area, the Floridan aquifer is overlain by undifferentiated, quartz sand and sediments of the Hawthorn Group. The Hawthorn Group sediments were deposited in a variety of environments and consist of sand, silty sand, and waxy green clay. Phosphorite pebbles and fossil oyster bars are common. Between the town of Brooksville and the Hernando/Citrus County line to the north, the Hawthorn sediments have largely been eroded off the Brooksville Ridge and limestone is exposed or near land surface in many of the high areas.

Karst

A prerequisite to comprehending the groundwater hydrology of the watershed is an understanding of the dominant role karst processes play in moving ground water through the Floridan aquifer. The four physiographic features within the spring recharge area

(Coastal Swamps, Gulf Coastal Lowlands, Brooksville Ridge, and Tsala Apopka Plain) are areas of intensive karst development. These areas are characterized by numerous sinkholes, lack of surface drainage, and undulating topography. In karst areas, the dissolution of limestone has created and enlarged cavities along fractures in the limestone which eventually collapse and form sinkholes. Sinkholes capture surface water drainage and funnel it underground, which promotes further dissolution of limestone. This leads to progressive integration of voids beneath the surface and allows larger and larger amounts of water to be funneled into the underground drainage system. Dissolution is most active at the water table or in the zone of water table fluctuation where carbonic acid contained in atmospheric precipitation and generated by reaction with soil carbon dioxide, reacts with limestone and dolostone (Carroll, 1970). Because the altitude of the water table shifted in response to changes in sea level, many vertical and lateral paths have developed in the underlying carbonate strata in the area. Many of these paths or conduits lie below the present water table and greatly facilitate groundwater flow.

Surficial Aquifer

The surficial aquifer system consists of quartz sand, silty sand, and clay. The surficial aquifer is most likely to occur as a distinct hydrostratigraphic unit along the Brooksville Ridge where low permeability clays of the Hawthorn Group retard the downward movement of water into the Floridan aquifer. However, collapse of the underlying limestone has produced numerous breaches in the clays that act as vertical conduits for the movement of water from the surficial to the Floridan aquifer. In addition, as discussed previously, the Hawthorn sediments are not widespread between the town of Brooksville and the Hernando/Citrus County line.

In areas where saturated sand lies directly above limestone, water in the sand is hydraulically connected to the Floridan aquifer. Since the majority of the watershed has no extensive confining layer, most of the region does not have a surficial aquifer, although surficial sands exist.

Floridan Aquifer

The Floridan aquifer system is divided into two major hydrostratigraphic horizons: the upper Floridan, which contains potable water, and the lower Floridan which is saline. The upper Floridan, henceforth termed the Floridan aquifer, is the focus of this discussion. The Floridan aquifer is the principal source of water for the springs in the watershed as well as domestic, agricultural, and industrial supplies.

Recharge

A number of previous investigations (Aucott, 1988; Ryder, 1985; Adams, 1985; Stewart, 1980) report Floridan aquifer recharge estimates for regions included in the watershed. The following summary references these investigations in describing the recharge characteristics of the Floridan aquifer and applies recharge estimates to the physiographic provinces.

Recharge potential for the Floridan aquifer in the watershed is primarily controlled by the thickness and composition of surficial sediments overlying the aquifer, and the presence of karst topography. Other factors affecting recharge rates include the development of surface drainage, variations in head gradients between surface water, the surficial aquifer, the Floridan aquifer, and aquifer permeability. Generally, high recharge rates occur where limestone is near land surface or where overlying sediments are lacking in low permeability confining materials. Occurrences of sinkholes with associated internal drainage of surface water also induces higher recharge to the Floridan aquifer. Lower recharge rates occur where confining materials overlying the aquifer retard downward vertical movement of water, or where an upward gradient between the Floridan and surficial aquifers exists.

Recharge is variably low to nonexistent along the Coastal Swamps province with estimated recharge values of -9 inches (discharge), to 11 inches per year (Map 5). This is primarily an area of regional Floridan aquifer discharge with only localized recharge over very short distances contributing to spring discharge. Recharge within the Tsala Apopka Plain is similarly low due to a diminished downward vertical gradient between surface waters or the surficial aquifer and the Floridan Aquifer (Rutledge, 1978). Groundwater discharge also is present along sections of the Withlacoochee River south and east of Tsala Apopka. Accordingly, recharge estimates range from -1 inches to 9 inches per year in the region.

Moderate to high estimated recharge exists in the Coastal Lowlands and Brooksville Ridge physiographic provinces. Potential recharge of 3 inches to 16 inches exists within the Coastal Lowlands, with 7 to 11 inches reported over land areas near the spring complexes. Recharge estimates in the Brooksville Ridge area are very high, ranging from 9 inches to 22 inches per year.

Recharge in the Brooksville Ridge area is highest because it is a karst terrain with internal drainage to the upper Floridan aquifer (Kimrey and Anderson, 1987). Sinkholes are abundant, the land surface is generally very well drained and the water table is relatively deep. Surface waters are not abundant and there are no permanent streams or extensive wetland areas. These factors maximize recharge because infiltration is rapid and surface runoff is non-existent.

DRASTIC

The United States Environmental Protection Agency's (USEPA's) DRASTIC methodology has been applied to all five water management districts to identify areas susceptible to groundwater contamination. The DRASTIC methodology was developed to evaluate the groundwater pollution potential of any hydrogeologic setting greater than 100 acres in size with existing information (SWFWMD, 1987). The seven parameters used to evaluate the DRASTIC pollution potential are: Depth to Water, Net Recharge, Aquifer Media, Soil Media, Topography, Impact of the Vadose Zone and Hydraulic Conductivity. The end product of the DRASTIC methodology is a map depicting color-coded areas of groundwater pollution potential (Map 6). Each area is assigned a pollution index which ranges from 23 (lowest

pollution potential) to 230 (highest pollution potential). For a detailed discussion of the DRASTIC methodology, the reader is referred to USEPA/600/2-85/018, May 1985.

The DRASTIC methodology was developed to be applied universally, and as such, may provide misleading results for certain hydrogeologic systems. Swancar and Hutchinson (1992) found that the DRASTIC indices do not agree with the results of groundwater chemistry analyses in the northern part of the SWFWMD. The index underestimates the potential for contamination along the Brooksville Ridge located in the northeast portion of the watershed.

In coastal areas and other areas where the confining unit is thin or absent, discharge from the surficial aquifer or Upper Floridan aquifer will lower the groundwater contamination potential. The DRASTIC index treats aquifer discharge areas as areas of zero recharge. All discharge areas are given the same net recharge score regardless of the magnitude of the discharge that is occurring (Map 5). Because the DRASTIC index does not account for varying aquifer discharge, the index generally overestimates the potential for groundwater contamination in discharge areas (Map 6).

Although discharge areas and areas with little recharge have a lower groundwater contamination potential, any change in the head gradient can alter this susceptibility. Areas of large groundwater withdrawals which were naturally discharge areas or had little recharge prior to pumpage, may become recharge areas due to lowered heads in the aquifers. This concept is referred to as induced recharge.

The Brooksville Ridge is an area of high elevation characterized by rolling sand hills which extends from central Hernando County southeast through east Pasco County. Although the regional confining unit between the surficial aquifer and Upper Floridan aquifer is thickest along the Brooksville Ridge, the integrity of the confining unit is variable in this area. Karst activity has created large breaches in the confining unit, many of which appear at the surface as relatively deep lakes. Due to the large head differences between the surficial and Upper Floridan aquifers, the presence of sinkholes that breach the confining unit, and the availability of thick surficial sands that act as reservoirs for potential recharge, recharge along the Brooksville Ridge can be quite high. Thus, despite the thick clays in this area, the potential for groundwater contamination in the Brooksville Ridge area is higher than estimated by the DRASTIC methodology.

In their study, Swancar and Hutchinson rated the potential for groundwater contamination as either very high, high, moderate, low, or very low. The authors determined that the majority of the Springs Coast watershed has a high groundwater contamination potential (Swancar and Hutchinson 1992, Figure 28). The very eastern edge of the watershed has a very high contamination potential.

DRASTIC indices and other hydrogeologic indicators are measures of susceptibility to groundwater contamination and are independent of the presence of actual pollutant sources. A high pollution potential does not indicate that groundwater contamination will occur, only that contamination could occur if pollutant sources were present. Potential pollutant sources in the Springs Coast watershed include landfills, borrow pits, stormwater ponds, septic systems, wastewater treatment facilities, and urban and agricultural runoff. Ground water may also be contaminated through the inadvertent release or spill of industrial or agricultural chemicals or waste products. Map 7 reveals domestic waste (sewage treatment facilities), landfills, and superfund sites in and adjacent to the Springs Coast watershed.

Freshwater/Saltwater Transition Zone

Most of the springs in the watershed lie in or near the freshwater/saltwater transition zone; a brackish zone in the Floridan aquifer where seaward-moving freshwater meets landward-moving saltwater. As a result of their proximity to the transition zone, many of the springs discharge brackish water. The high salt content of many brackish springs indicates that Gulf water has intruded through interconnected solution conduits gulfward of the springs (Yobbi, 1992). In general, springs located further inland are further from the transition zone and, therefore, have fresher water. A sharp boundary does not exist in coastal aquifers because of mechanical dispersion and tidal or water level fluctuations caused by changes in recharge or pumpage with time. Instead, a dynamic equilibrium has been established that causes freshwater and saltwater to mix and form a transition zone between freshwater and saltwater (Yobbi, 1992).

Thickness of the Potable Water Zone

Thickness of the potable water zone in the Floridan aquifer in the watershed ranges from more than 900 feet in south-central Pasco County, to less than 200 feet along the Withlacoochee River in southeastern Citrus County, and less than 100 feet along the coast. A general uniform thinning of the potable zone of the Floridan aquifer occurs from south to north across the watershed. The vertical extent of potable ground water across the inland area appears to be controlled by the occurrence of gypsum-bearing carbonates of the middle confining unit, and the presence of sulfate-rich waters derived from the dissolution of sulfate minerals at the top of the unit (Hickey, 1990). Average thickness of the potable zone in the Floridan aquifer is 400 to 600 feet in Hernando County and 200 to 300 feet in Citrus County.

Wastewater Treatment Facilities

Jones et al., (1997, 1998) determined that there are approximately 140 active wastewater treatment facilities in the groundwater basins of the Crystal, Homosassa, Chassahowitzka, Weeki Wachee, and Aripeka Spring Complexes (Map 7). These facilities have a total permitted capacity of 15.6 million gallons per day (mgd), and the average volume of waste water processed by these facilities is approximately 9.2 mgd. Effluent from treatment

facilities is disposed of in several different ways. Percolation ponds are used at a majority of the facilities. Additional disposal methods include a combination of percolation ponds and spray fields, spray fields only, a combination of percolation ponds and drain fields, and a combination of percolation ponds and reuse.

Jones and Upchurch (1993) and Jones and Upchurch (1994) documented that some effluent percolation ponds in the watershed drain extremely rapidly. This is because many of the ponds have highly porous bottoms composed of clean, fine-grained filter material. Since the geology of the area is such that low permeability confining units are either not present or are frequently breached by sinkholes, thus treated effluent can rapidly percolate directly into the Floridan aquifer. Jones and Upchurch (1994) demonstrated this in Citrus County by showing that levels of nitrate exceeding the drinking water standards were detected in numerous wells monitoring large effluent percolation ponds.

Jones et al. (1997) determined that the effect of effluent on springs in the Homosassa and Chassahowitzka complexes is probably insignificant because the amount of nitrogen contributed from effluent in their groundwater basins is low. The effluent nitrogen in the Weeki Wachee groundwater basin is high, but the treatment plants are dispersed over a very large area and most are located far from the spring. Additionally, nitrogen isotopic ratios in the springs indicate an inorganic source, most likely from fertilizer application. The effluent nitrogen in the Aripeka groundwater basin may contribute some nitrogen to springs in the Aripeka complex because the Hudson wastewater treatment plant, which contributes more than 76 percent of the 134 tons, is located approximately 3.5 miles from the spring. However, the plant is probably not the dominant source of nitrogen because, similar to Weeki Wachee Springs, the low nitrogen isotopic ratios indicate an inorganic fertilizer source.

CHAPTER II WATER SUPPLY

LITERATURE REVIEW

Overview

The Springs Coast watershed encompasses two water supply agencies: Tampa Bay Water and Withlacoochee River Water Supply authority (TBW and WRWSA respectively). These organizations are responsible for identifying and developing sources of potable water supplies in their respective areas and for balancing the development of the resource with protection of the environment. Tampa Bay Water, formerly known as West Coast Regional Water Supply Authority, is a regional wholesale water supplier formed through inter-local agreements and legislation in 1998. Member governments of Tampa Bay Water include Hillsborough, Pasco and Pinellas counties, and the cities of New Port Richey, Tampa and St. Petersburg. The WRWSA is responsible for Citrus, Hernando, and Sumter counties, and the city of Ocala.

Water supply in the Springs Coast watershed is derived principally from the Upper Floridan aquifer. As in other areas of the SWFWMD, the Upper Floridan aquifer in the Springs Coast basin has good water quality and is highly transmissive. In 1996, groundwater use in the basin was estimated to be 80 mgd or 94 percent of total water use as compared to 5.5 mgd of surface water. Hernando County accounted for about 45 percent (38.3 mgd) of total water use compared to 40 percent for Pasco County and 15 percent for Citrus County. The largest use of water was for potable supply (57.9 mgd or 68 percent). About 30.8 mgd is withdrawn from within Pasco County for potable supply.

The Springs Coast watershed is mostly contained within the Northern West-Central Florida Groundwater Basin (NWCGWB). However, the southwestern portion of the basin is situated in the Central West-Central Florida Groundwater Basin (CWCFGWB). Groundwater in the CWCFGWB and NWCFGWB is derived from rainfall that falls within the respective basins. As evidenced by the numerous sinkholes and springs that exist throughout the area, the geology of the watershed is characterized as karst. Approximately 1,700 million gallons of ground water per day discharges from 27 coastal springs. Groundwater flow occurs in the surficial and the Upper Floridan aquifers. Separating the two aquifers is a discontinuous clay confining unit. As you traverse the watershed from south to north, the confining unit becomes thin and is breached often by sinkhole activity. In some areas, limestone from the Upper Floridan aquifer is found to outcrop at land surface. The potential for sinkhole development is enhanced in the area due to the limited extent of the confining unit. A perennial surficial aquifer is considered non-existent on a regional basis in much of the watershed due to the variable nature of the confining unit. A result of the discontinuous confining layer is that rainfall is able to directly recharge the Upper Floridan aquifer in some areas of the basin. Recharge in the region is representative

of some of the highest rates of recharge in the SWFWMD. Rates of recharge, as calculated by Ryder (1985), can be as high as 22 inches per year.

The amount of water that can be supplied from the Upper Floridan aquifer in the basin will mostly likely be limited by the impacts of withdrawals on spring discharge, lake levels, wetlands, streamflow and movement of the freshwater-saltwater interface. Major natural attractions in the area include four first-order magnitude springs (springs that discharge in excess of 100 cubic feet per second) along the coast: Weeki Wachee, Homosassa, Chassahowitzka, and Kings Bay. The springs serve as headwaters for the coastal rivers and provide freshwater flows that are important to sustain the biological communities associated with the coastal estuaries. These rivers also provide for numerous recreational activities, including fishing and boating, and provide important habitat for native wildlife. Since the watershed is primarily internally drained, flow to these springs is principally derived from the Upper Floridan aquifer. Water supply development from the aquifer in the region will necessarily be evaluated based on the potential impact the proposed withdrawals will have on spring discharge.

In 1996 the Florida Legislature mandated that the SWFWMD develop a priority list for establishing Minimum Flows and Levels (MFLs) on surface water courses and groundwater aquifers. In addition, it mandated that MFLs be established on the lower Hillsborough River and in areas of impact in the Northern Tampa Bay area. The areas of impact were identified as those areas surrounding eleven major wellfields that are either owned or operated by Tampa Bay Water, Pinellas County, the city of St. Petersburg, Hillsborough County, or the city of Tampa. In an effort to facilitate a solution to the water supply problem in Northern Tampa Bay, a governance plan was adopted whereby the WCRWSA (now named Tampa Bay Water) became the owner/operator of all these wellfields and is now the sole party responsible for interacting with the District with regard to permitting issues related to these wellfields. In addition, a Partnership Agreement between Tampa Bay Water and the SWFWMD was entered into with the goal of developing new alternative water supplies to reduce groundwater withdrawals and the corresponding impacts to lakes and wetlands in the area. As part of the 1996 mandate, minimum levels have been adopted for selected lakes and wetlands in the vicinity of the Starkey, North Pasco, and Cross Bar Ranch wellfields. It is anticipated that in the future, minimum levels in the Upper Floridan aquifer will be set to protect against saltwater intrusion in the vicinity of the Starkey wellfield. According to the 1998 priority list, MFLs in the Weeki Wachee River and associated groundwater basin will be established by October, 2005.

Water Supply Planning Studies

Water supply planning studies have been conducted by various agencies throughout the years. In recent years, the SWFWMD has conducted three studies to quantify projected water supply demands and identify potential sources of water supply to fulfill these demands. The SWFWMD (1992) reported projected water demands and potential sources of water supply from 1990 to 2020. SWFWMD (1997a) updated these projected water

demands for the period 1996 to 2020. Most recently, SWFWMD (1998a) conducted a water supply assessment for four regions within the water management district boundaries. The purpose of the water supply assessment was to project the unconstrained demand on the water resources for the period 1995 to 2020 and to assess whether the water resources will be capable of fulfilling these demands without causing adverse impacts. The majority of the Springs Coast watershed was contained in the northern water supply planning region which includes Citrus, Hernando, and Sumter counties and portions of Marion, Levy and Lake counties. Water supply demands for the Northern region were projected to increase from 186.4 mgd in 1995 to 246.1 mgd in 2020, an increase of about 60 mgd (32 percent). It was concluded that the increase in water use could be accommodated through the expansion of existing facilities and implementation of conservation measures. It is anticipated that the establishment of MFLs in the region will provide the necessary guidance, in terms of water resource constraints, for the development of ground water in the region. The goal will be to ensure that the natural systems in the region are protected against excessive impacts from groundwater withdrawals.

In the late 1980s, the SWFWMD prepared "Groundwater Resource Availability Inventory" reports for Citrus, Hernando and Pasco counties. These studies summarize the hydrogeologic setting, and water supply sources and alternatives for the respective areas. Since 1984, the SWFWMD has also reported estimates of actual water use within the water management district.

The WRWSA has prepared several reports relating to water supply development in the region. In 1996 a "Master Plan for Water Supply"(Coastal Engineering, 1996) was completed for the WRWSA. This report was to provide a framework for the WRWSA to accomplish its goals of identifying and developing water supplies, and protecting the natural resources from impacts of withdrawals. A groundwater model was prepared and used to evaluate potential locations of future water supply. Recommendations of this study included the need for: additional hydrologic studies of the region (Northern District Water Resources Assessment Project); assessments of projected potable water demands; increased cooperation with local governments, regulatory agencies and water supply authorities; and clarification of legislation related to the intra-district transport of water, prior rights of use, long-range planning, and inter-governmental coordination.

In 1994, the former WCRWSA (now Tampa Bay Water) prepared a water resources development plan to identify existing and future water demands, facility capacities, demand management strategies and potential water supply sources for its respective service area (West Coast Regional Water Supply Authority, 1994). There are currently two water supply production facilities either owned or operated by Tampa Bay Water within the Springs Coast watershed: the Cross Bar Ranch and North Pasco wellfields. Rates of groundwater withdrawals from these facilities in 1996 were 20.2 mgd and 1.6 mgd, respectively. The establishment of MFLs in the Northern Tampa Bay region will affect the future water supply production capabilities of these facilities. As reported by the WRWSA, there is a small area

in central Pasco County that was identified in the development plan as a potential source for future groundwater withdrawals. Most of the area of TBW that falls within the Springs Coast watershed is considered unsuitable for future groundwater development due to existing impacts to the water table from groundwater withdrawals, the potential impacts to coastal spring discharge and landward movement of the freshwater/saltwater interface.

As part of the Partnership Agreement between the District, Tampa Bay Water and its member governments, a "New Water Plan" was prepared and submitted to the District by TBW in July of 1998 (Tampa Bay Water, 1998). This new plan provides information on water supply projects that will be used to meet present and future water needs for the Northern Tampa Bay area (which includes areas within the Springs Coast watershed) through 2010. By design, the water sources for these selected projects are diverse, with only a small portion to come from traditional groundwater sources. In addition to the limited ground water, other sources will include desalination, surface water, and pipeline interconnects. Total new capacity provided by this plan include 46 mgd by 2003 and a total of 94 mgd by 2008. The District has committed \$183 million to assist TBW with the task of providing these new water sources.

Surface Water Studies Related to Water Supply

Although there is significant flow in the coastal rivers, this flow is principally derived from spring discharge. With the exception of the Pithlachascotee River, the headwaters for these rivers are springs. The SWFWMD's Needs and Sources report (1992) discussed projected future water demands in the District and addressed potential sources to meet these demands. With respect to surface water sources, they concluded that the coastal rivers should not be used as long-term water supply sources. They suggested that it might be possible to develop up to 9.2 mgd from the Weeki Wachee River but that this should only be viewed as an auxiliary supply. It was also concluded that though it was not considered an optimal source, the Southeast Fork of the Homosassa River could potentially yield from 4 to 10 mgd. The determination of dependable yield from any of the coastal springs would need to consider the effects of reduced flows on the movement of the freshwater/saltwater interface and Minimum Flows to protect the biological functions of the rivers and their estuaries.

Groundwater Studies Related to Water Supply

In the late 1980s, the SWFWMD prepared "Groundwater Resource Availability Inventory" reports for Citrus, Hernando and Pasco counties (SWFWMD, 1987a, 1987b, and 1988, respectively). These studies summarized the hydrogeologic setting, and water supply sources and alternatives for the respective areas. Since 1984, the SWFWMD has also reported estimates of actual water use within the water management district.

The availability of ground water in the basin is dependent on the impacts that result from withdrawals from the aquifer. Water resource concerns in the basin include impacts to

lakes, wetlands, the freshwater-saltwater interface, and spring discharge. A recently completed report for the Hernando County Water Resource Assessment Project (HCWRAP) documents the development and calibration of a regional groundwater flow model used to determine the effect of current and future groundwater withdrawals on water resources in Hernando County and surrounding area (HydroGeoLogic, Inc, 1997).

The U. S. Geological Survey has conducted several investigations on the water resources of the region. Cherry et al. (1970) described the hydrology of the coastal area of the SWFWMD from Pinellas County to Citrus County. They concluded that there are ample supplies of good quality water available for use. However, they noted that the problem is one of water management and optimum development rather than the availability of water. That is, withdrawals should be located to avoid impacts to lakes, wetlands, spring discharge and the freshwater/saltwater interface. Sinclair (1978) evaluated the water supply potential of the Weeki Wachee area. He concluded that groundwater development in the area of the springs is possible. Yobbi (1989) developed a groundwater model of the coastal region to evaluate the interrelationships of groundwater levels and spring discharge. Model simulations were conducted to evaluate the impacts of various withdrawal scenarios on spring discharge. Simulated reductions in spring discharge depended on the location and amount of groundwater withdrawals. Yobbi (1992) evaluated the effects of tidal stage and groundwater levels on the discharge and water quality of coastal springs. He concluded that the coastal springs are an important segment of the regional groundwater flow system and that the chemical quality and flow rate of the springs is dependent on water levels in the Upper Floridan aquifer.

AVAILABLE DATA

Potable water resources within Citrus, Hernando and Pasco Counties are relatively plentiful, with the Upper Floridan aquifer as the major provider for public supply, agricultural, and industrial water demands. Public supply constitutes the greatest water use in Hernando County, with use for mining activities a distant second. In addition, wellfields within Pasco County serve as a major source of public water supply for the Tampa Bay area through the auspices of Tampa Bay Water. Only a very limited surficial aquifer system exists in the area, limiting it as a potential source of water. The estimated total and projected water use for each county is listed in Tables 3-5 below.

Table 3. Citrus County Water Use (millions of gallons per day).

CATEGORY	1990	2000	2010
Domestic Self Supply	5.9	6.2	7.9
Public Supply	8.5	16.9	20.2
Agricultural	2.6	3.0	3.4
Industrial/Commercial : non-mining	0.0	0.0	0.0
: mining	0.9	2.0	2.0
Power Generation	1.6	2.6	2.6
Recreation	3.0	4.3	5.3
Total	22.5	35.0	41.4

Table 4. Hernando County Water Use (millions of gallons per day).

CATEGORY	1990	2000	2010
Domestic Self Supply	1.3	1.7	2.2
Public Supply	15.1	23.4	28.5
Agricultural	4.1	5.3	7.7
Industrial/Commercial : non-mining	0.7	0.7	0.7
: mining	7.8	8.7	8.7
Power Generation	0.0	0.0	0.0
Recreation	3.0	4.1	5.1
Total	32.0	43.9	52.9

Table 5. Pasco County Water Use (millions of gallons per day).

CATEGORY	1990	2000	2010
Domestic Self Supply	9.7	10.7	9.8
Public Supply	27.7	37.7	48.4
Agricultural	20.6	39.1	46.1
Industrial/Commercial : non-mining	8.0	8.0	8.0
: mining	11.2	3.0	3.0
Power Generation	0.0	0.0	0.0
Recreation	4.8	6.3	7.3
Total	82.0	104.8	122.6

Source: SWFWMD, 1992. (Data adjusted to Integrated Plan convention format).

SUMMARY

Water supply in the Springs Coast watershed is derived mainly from the highly productive Upper Floridan aquifer. As part of the 1996 legislative mandate, future withdrawals in the watershed may be limited by the establishment of minimum flows and levels to protect against both saltwater intrusion and potential impacts to the coastal springs and other water bodies. In the Springs Coast watershed, three areas of concern related to water supply have been identified. They include water supply availability, water supply/aquifer protection and potential development and export of water to areas outside the watershed. A brief background and description for each of these issues and potential strategies for each are described in the following Issue Identification section.

WATER SUPPLY ISSUES

WS-1

Water Supply Availability.

As growth and development in the Springs Coast area continues, additional water supply sources will be necessary. In developing these new sources, careful planning and consideration will be required to protect the environment and natural resources of the area. Therefore, future water supplies should include the development of sustainable and drought resistant alternative water sources, in addition to the more traditional ground and surface water sources.

Background

The determination of water supply availability from traditional ground and surface water sources in the area is dependent on the restrictions that will be placed on the development of these sources. As a step in determining water supply availability, Minimum Flows and Levels will be established. The restrictions placed on the development of these sources will be based on maintaining sufficient freshwater to sustain the biological communities of the coastal estuaries. Of particular concern in this region is the impact of groundwater development on coastal spring discharge and freshwater flows to the coastal estuaries. The Springs Coast area is internally drained and the Upper Floridan aquifer is the primary source of water to the numerous coastal springs that in turn are the principal source of surface flow in the coastal rivers of the area. Approximately 1.3 billion gallons of water are discharged from the coastal springs daily.

Requirements for establishing MFLs in the region include expansion of the hydrologic and biological data collection networks and conducting investigations to describe the effects of changes in hydrology on the biological communities in the watershed. The District is currently conducting various investigations and hydrologic and ecologic monitoring projects in the watershed. These data and investigations will provide the scientific foundation for determining MFLs. Minimum Levels in the area will most likely be the minimum level in the aquifer that is required to sustain a "Minimum Flow" in the coastal streams. The establishment of MFLs will be used to guide the long-term allocation of water resources in the area. Minimum Levels will also be established in lakes and wetlands to protect against the lowering of these natural systems in response to groundwater withdrawals.

Although there appears to be sufficient quantities of traditional groundwater sources in the Springs Coast watershed to meet projected demand in the area through 2020 (SWFWMD, 1998a), sustainable and more drought resistant sources should continue to be encouraged and developed. These would include the use of alternative sources such as stormwater, reclaimed water and conservation. The District will continue to work with local governments and utilities to promote and develop effective conservation programs for residential,

commercial and industrial users. This is accomplished through a variety of programs that include plumbing retrofits and rebates, assistance in recommending and establishing local codes/ordinances, leak detection and water audits, and conservation education. The development of alternative water supplies including the use of reclaimed water and stormwater has been successfully implemented by golf courses and industrial permit holders to offset potable water use and reduce impacts to the aquifer. It is expected that the District will continue to fund the design and construction of regional reclaimed and stormwater transmission, pumping and storage facility projects.

Strategies

1. Data Collection - Basin Board/District cooperative funding for research and monitoring programs within the Springs Coast watershed should be encouraged and continued. The information obtained from these investigations will help to improve our understanding of both the hydrologic and ecologic systems and their inter-relationships. These data will be used to ensure protection of natural resources through the establishment of MFL's in the region.

Currently, the District is conducting/supporting several projects pertaining to base line data collection and hydrologic/ecologic investigations:

- Evaluation of Coastal Springs Along Coastal Pasco, Hernando and Citrus Counties, Florida - A cooperative funding project with the USGS involving the evaluation of ground water and spring discharge in the Springs Coast basin. The project will determine the response of spring flow to changes in groundwater levels. The data gathered will also be used to help design and implement a long-term monitoring network for the Springs Coast. A final report is expected in early 2001.
- Coastal Groundwater Quality and Level Monitoring Well Construction - The Coastal Rivers Basin Board approved the allocation of \$250,000 to the 1999 budget for the construction and prioritization of monitor wells in the Basin. These wells will be used to monitor long-term changes in water levels and water quality in the watershed. Data collection from these wells will also enable the District to monitor the movement of the freshwater/saltwater interface and determine the hydrogeologic setting of the area. Determining depth to the interface will also further our understanding of the potable thickness of the Upper Floridan aquifer. The information obtained from these wells will be used to support the Northern District Water Resource Assessment Project (NDWRAP), as well as aid in the development of Minimum Flows and Levels in the area.
- Regional Observation and Monitor-Well Program (ROMP) - The District's ROMP is the primary program for the collection of hydrogeologic data. Data

collection activities are associated with well construction, testing, and monitoring. Several groundwater level monitoring sites have been identified in the District's 1999 Five-Year Drilling Plan (SWFWMD, 1999) and have been or will be constructed according to this plan.

2. Alternative Water Supplies & Water Conservation Programs/Education - Water conservation programs and alternative water supplies should be developed and implemented to offset traditional groundwater sources and establish more drought-resistant supplies. As part of the District's mission, SWFWMD actively supports water conservation education, reuse, and retrofit projects through Cooperative Funding Programs. Within the Coastal Rivers Basin there are 25 cooperative funding projects listed in the Retrofit Programs and Reuse Projects Summary Report (SWFWMD, 1998b). These projects range from the construction of reclaimed water transmission lines, storage tanks and interconnects, to ultra-low volume toilet rebates, distribution of water conservation kits, reuse feasibility studies/master plans and public awareness/water education programs.
3. Improve water use and land use planning coordination and management - To minimize the problems and pressures of rapid growth and development, coordination between water and land use plans should be improved both within and between local governments and agencies. The District should increase involvement with the Regional Planning Council and local governments to improve and standardize comprehensive plans, Basin plans, and other planning documents related to water management.

Cooperators

SWFWMD, Citrus, Hernando, and Pasco Counties, USGS.

WS-2

Water Supply Protection.

Because water supply in the Springs Coast watershed is derived principally from the Upper Floridan aquifer, it is important that adequate protection be given to public water supplies and areas of high aquifer recharge, such as the Brooksville Ridge, to prevent aquifer contamination.

Background

While water quality in the Upper Floridan aquifer is generally good, thin surficial sediments coupled with a thin to non-existent clay confining unit can create a high potential for aquifer contamination in the area. The numerous karst features (sinkholes) in the area also allow for a direct connection between the surface and the underlying aquifer.

Within the Springs Coast watershed several types of contaminants exist. They include major ions (chlorides, sulfates, total dissolved solids), nutrients (nitrogen, phosphorus), microbiological contaminants (fecal coliform, giardia, human enteroviruses, cryptosporidium), trace organics (pesticides, polychlorinated biphenyls (PCB's), volatile organic compounds (VOC's), trihalomethanes) and metals (arsenic, cadmium, mercury, lead, cyanide, etc.). The contaminant types listed above may originate from multiple point and non-point sources. Landfills contain a variety of potential contaminants including nitrates, chlorides, sulfates, metals, PCB's and total coliform bacteria. Septic tanks also contain a variety of contaminants including high nutrient concentrations (nitrogen and phosphorus), microbiological contaminants (fecal coliform, fecal streptococci) and trace metals. Non-point sources of contamination found in the watershed include agricultural and urban runoff. These sources may contain high levels of nutrients, metals, suspended solids, and pesticides.

A major concern in the Springs Coast watershed has been the increased nitrate loadings observed in the major springs groups (see also Water Quality WQ-1). While data suggest that the dominant source of nitrate found in the springs is inorganic in nature (i.e., originating from residential and commercial use of fertilizers), organic sources may still contribute significant quantities in other areas, or on a local scale. Agricultural application of fertilizers is also a potential source of inorganic nitrogen in the watershed. Sources of organic nitrogen include: sewage effluent disposal, land disposal of sewage sludge or treated wastewater, effluent from septic tanks, agricultural activities (poultry, dairy, cattle) and the application of potentially nutrient-rich (nitrogen and phosphorus) reclaimed water as irrigation.

Strategies

1. Data Collection - Fund programs that monitor, research and improve ground and surface water quality within the Springs Coast basin. Research should be continued

into the causes, origins and effects of increasing nutrients (especially nitrates) found in springs and other water bodies within the basin and programs to reverse increasing contaminant trends should be developed and implemented. The information obtained from these projects should be used to improve existing, and develop new, management policies and regulations related to water supply protection.

2. Policy, Regulation & Enforcement - Establish and implement consistent policies and regulations at the local, state and federal level to protect water quality. Ensure regulatory compliance through proper and consistent enforcement.
3. Public Education - Develop education programs with local government and agencies to educate the public on water quality and water supply protection. Develop programs that encourage the use of proper and environmentally friendly methods and management practices for all land use types.
4. Land Acquisition and Remediation - Purchase sensitive lands to protect or restore areas that sustain water supply sources.

Cooperators

SWFWMD, Pasco, Hernando, and Citrus Counties, the Florida Department of Environmental Protection (FDEP).

WS-3

Potential Development and Export of Water to Southern Counties.

Many concerns have been raised over the potential development and export of water to other counties. While there are currently no plans to do this, it may become necessary in the future. The strategy for protecting the availability of water resources in the Springs Coast watershed should include support for the concept of “local sources first” and demand management measures and alternative sources to be developed to the greatest extent practicable (SWFWMD, 2000a).

Background

By law, all water in the state of Florida is owned by the public. While water-poor communities contend that the law gives them a legal right to go outside of their geographic boundaries to obtain water, “donor” communities claim that the water resources necessary to encourage local growth and development are being unfairly removed.

The export of water from water-rich to water-poor areas of the state has been a contentious issue. In an attempt to avoid potential conflict, and to encourage the development of alternatives, the District has developed a water supply policy which states that the District will, “encourage, assist in, and where appropriate, require, the development and efficient use of alternative sources of water” (SWFWMD, 2000a). Additionally, the District requires that “local sources, demand management measures, and alternative sources be developed to the greatest extent practicable” prior to developing sources outside a utility’s local service area (SWFWMD, 2000a). Related state legislation (Section II, 373.223, Florida Statutes (F.S.)) incorporates a “local sources first” principle into Florida water law.

It may be necessary to export water in the future, however, it should only be considered when the quantity exported is in excess of local needs and only as a last resort - when all feasible methods of local source development have been exhausted. Through aggressive development of feasible alternative sources and conservation programs, water export could effectively be delayed or potentially avoided.

Strategies

1. Maintain legislation that mandates the concept commonly referred to as “local sources first”.
2. Support export of water only if the amount of water exported is in excess to current and projected future needs within the watershed’s boundaries and only after all other reasonable alternatives of obtaining water have been exhausted.
3. Promote the development of alternative sources to ensure that the Springs Coast watershed has an adequate water supply for present and future generations.

Cooperators

SWFWMD, Pasco, Hernando, and Citrus Counties.

CHAPTER III FLOOD PROTECTION

LITERATURE REVIEW

Overview

First and foremost, it must be realized that flooding is a natural occurrence and man's encroachment into floodplains and flood prone areas only serves to exacerbate increased surface water elevations during high rainfall events. Surface water elevations naturally fluctuate in the landscape and water features within a watershed in response to rainfall and runoff. The watershed's response to these fluctuations has shaped the natural systems, their characteristics, functions, and interactions. Flooding occurs when surface water elevations are higher than 'bank-full' channel elevations and water overflows into the natural floodplain adjacent to the stream channels and water bodies. Flooding of adjacent land is a watershed's natural response to the surface runoff dynamics of the hydrologic cycle. When a watershed's capacity to store and convey runoff is exceeded, within the confines of its natural channels, lakes, ponds, and other depressions, then low-lying land adjacent to these natural water conveyance and storage features becomes inundated or flooded as a result of the excess runoff.

Historically, many of the people who have migrated to Florida in the last half-century have settled near rivers, lakes, and coastal areas simply because of the recreational benefits afforded by these locations. However, the attraction of living adjacent to a water body is not without its drawbacks for those living there, and for taxpayers in general. Riverine and coastal flooding have caused greater loss of life and property, and have disrupted more families and communities in the United States than all other natural disasters combined. Flooding has caused the deaths of more than 10,000 people since 1900, and property damage from flooding now totals over one billion dollars each year.

Floodplain management is a decision making process to achieve the wise use of a floodplain. Its aim is to accomplish reduction in the loss of life, disruption, and damage caused by floods, and preservation and enhancement of natural resources and functions of floodplains. Proactive measures must be taken to better balance the environmental benefits achieved through protection against the benefits attained from the economic development of these areas.

It is the District's policy to give preference wherever possible to non-structural surface water management methods. Non-structural methods include provisions such as avoiding incompatible land uses within floodplains and flood-prone areas and ensuring that land development does not alter natural patterns of water movement and storage. Structural methods involve alteration of natural surface water systems through construction of facilities such as ditches, canals, dams and control structures to ensure that formerly flood-prone

areas are reasonably protected against future inundation. The current management of the floodplain incorporates both structural and non-structural methods. Flood management within the watershed is the responsibility of federal, state, regional, and local agencies who are tasked to manage a menagerie of conveyance and storage systems.

A document is being prepared that will explain the role of local governments and the District's responsibility in terms of flood protection. This document, entitled Flood Protection Coordination (FPC), formerly known as the Memorandum of Understanding, will better define the purview of government entities in regard to flood protection issues. The purpose of the document is to provide a long term strategy for comprehensive flood protection within the political boundaries of local governments through an understanding, identification and coordination of responsibilities. The document is divided into two parts: Part A, Memorandum of Understanding, outlines the individual and mutual responsibilities of each party through the identification of programs, services and initiatives that address flood protection. Part B, Flood Protection Implementation, identifies projects and estimated costs that can be initiated through a cooperative effort. Part B further provides a reporting and tracking mechanism which will be annually updated to identify accomplishments and future priorities.

The challenge is to understand a water management element where the probability, magnitude, and duration depend on watershed characteristics which are dynamic in nature. A review of watershed characteristics, historical records, existing studies, available data, current governmental management practices, regulations, and activities provides a framework within which to re-evaluate the issues of floodplain management concerns in the Springs Coast watershed.

The issue of floodplain management or lack thereof is most obvious during periods of heavy rainfall. From December, 1997 through March, 1998, the El Niño phenomena created several cyclonic waves that produced rainfall events with intensities of three to five inches per hour. Some of these rainfall events caused flood damage to homes and inundated low-lying roads within the watershed. Extensive flooding could have occurred had a hurricane system made landfall following the 1997-98 El Niño. This scenario occurred in 1960 when Hurricane Donna made landfall. Precipitation from Hurricane Donna averaged only 5 to 7 inches, but the previous El Niño induced 3 week rainfall yielded approximately 10 inches which saturated the ground and exacerbated the flood situation.

Surface Water Drainage Basins

The surface water drainage basins, as delineated by the United States Geological Survey (USGS), are shown in Map 4. Most of the area has a well developed karst topography with hundreds of shallow depressions, sinkholes, circular lakes and ponds, and active springs. The drainage from the karst area is mostly through the subsurface with surface runoff entering the groundwater system through sinkholes and fissures.

In general, surface drainage systems in the area are categorized into three types of basins: internally (closed) drained, direct runoff to Gulf, and channelized. Surface runoff in the internally drained basins does not overflow into adjacent basins, and dissipates mostly through processes of evapotranspiration and underground drainage. A direct runoff to gulf basin is very close to the Gulf and does not have definite channels for surface runoff. On the other hand, the channelized basins provide channels (i.e. creeks and rivers) to direct surface runoff to down-gradient areas and finally empty into the Gulf.

The main surface drainage features in the watershed are Crystal, Homosassa, Chassahowitzka, Weeki Wachee, and Pithlachascotee Rivers. The Crystal, Homosassa, Chassahowitzka, and Weeki Wachee Rivers are located in the coastal portion of the watershed. The primary source of water for these rivers are major springs near the coast. These rivers are not necessarily meandering through large portions of the watershed and are generally very short. From this, they provide limited channelized conveyance of runoff from upper basins.

Streams

The Pithlachascotee River drainage basin originates with the Peck Sink subbasin, in which the southwestern portion of the city of Brooksville is located. The Peck Sink subbasin drains primarily into sinkhole features. During periods of high volume rainfall, when sinkholes are incapable of draining in a timely manner, the high water will overflow to the adjacent basins then cascade into the Crews Lake Outlet (Squirrel Prairie) basin, and finally into Crews Lake. Meanwhile, overflows from the Jumping Gully basin, in which the Cross Bar well field is located, also empties into Crews Lake. The lake is the headwaters of the Pithlachascotee River which flows southwest through Pasco County to the Gulf of Mexico at Port Richey. The channel of the river in specific localities is poorly defined.

Lakes, Springs, and Ponds

Most of the lakes, springs, and ponds occur in shallow depressions of the land surface. The surface area of lakes vary considerably due to the seasonal changes in rainfall accumulation. They cover large areas during the wet season and in some cases dry up completely during periods of infrequent rainfall. Many of these wetland areas are marshes rather than lakes. The marshes are hydraulically connected to the water table aquifer and the surface water elevation fluctuations are directly related to changes in the water table.

Several of the lakes located in the watershed are directly connected to the underlying Floridan aquifer by sinkholes occurring in the lake bottoms. Crews Lake is the largest of these water bodies with a sinkhole located in the north part of the lake. The stage fluctuation of lakes connected to the Floridan aquifer reacts much differently to seasonal climatic changes compared to the lakes directly connected only to the water table aquifer. These lakes periodically drain completely during extended periods without precipitation.

Where there is heavy pumping from the Floridan aquifer, lakes directly connected to the aquifer recede rapidly.

Flood Studies

Several flood studies have been performed in the Springs Coast watershed to develop relief alternatives for flooding situations within the basin. These and Lake Level studies are listed below:

A Preliminary Drainage Study of the Northeast Quadrant of the City of Brooksville, Florida and Surrounding Area. 1966. Coastal Engineering Associates, Inc..

Flood Profiles of the Pithlachascotee River, West-Central Florida. 1979. U.S. Geological Survey, Water-Resources Investigations 78-100, Prepared in cooperation with Southwest Florida Water Management District.

Floodplain Information on Bear Creek from Beacon Woods to SR 587. 1979. Southwest Florida Water Management District.

Pithlachascotee River Watershed Flood Plain Analysis. 1997. Ghioto & Associates. Prepared for the Southwest Florida Water Management District in cooperation with Pasco County.

Report of Investigation of the Weeki Wachee River. 1968. E. Black, Southwest Florida Water Management District.

Squirrel Prairie Watershed Management Plan: Floodplain Analysis. 1997. H. C. Downing, Southwest Florida Water Management District.

County Master Plan Studies

Bear Creek Stormwater Management Master Plan. 1993. Ghioto & Associates. Prepared for the Southwest Florida Water Management District.

Blue Sink Watershed Study, Hernando County. 1992. American Engineering Company.

Bystre Lake Stormwater Management Master Plan. 1989. Dames & Moore. Prepared for the Southwest Florida Water Management District.

Coastal Water Management Guidelines for Pithlachascotee River Basin. 1978. Missimer & Associates.

Comprehensive Water Management Plan - Phase I, II for Parts of Pithlachascotee River Basin. 1971. Sverdrup & Parcel. Prepared for the Southwest Florida Water Management District.

Drainage Wells in Hernando County. 1970. R. H. Stephens, Southwest Florida Water Management District.

Hydrology of Hunters Lake, Hernando County. 1986. S. E. Henderson, U.S. Geological Survey.

Peck Sink Watershed Study, Interim Status Report. 1992. Dames & Moore. Prepared for Hernando County Department of Public Works.

Peck Sink Watershed Study. 1995. Andreyev Engineering, Inc..

United States Army Corps of Engineers Studies

Comprehensive Report on Four River Basins, Florida. 1961. U.S. Department of Army, Corps of Engineers, Jacksonville, Florida.

Water Resources Management Study - Four River Basins Project, Florida. 1980. U.S. Department of Army, Corps of Engineers, Jacksonville, Florida.

Reconnaissance Survey for Location of the Masaryktown Canal, Masaryktown, Florida. 1963. Coastal Engineering Associates, Inc.. Prepared for the Southwest Florida Water Management District.

Lake Level Studies

Citrus, Hernando and Sumter Counties Lake Levels and Adopted Levels. 1994. G. M. Kelly and D. F. Richters, Southwest Florida Water Management District.

Directory of Lakes, within the Southwest Florida Water Management District. 1996. Southwest Florida Water Management District.

Lake Levels Program, Annual Report. 1996. Southwest Florida Water Management District.

AVAILABLE DATA

Masaryktown Canal

Flood problems in the Pithlachascotee River basin were centered in the upper reaches near Masaryktown where recurring flooding caused large agricultural damages and prevented

appreciable use of large fertile areas. In 1959-1960, a flood occurred that caused the area to be classified as a 'disaster area'. Therefore, the Southwest Florida Water Management District and its Basin Board initiated a project to seek a means of relieving this area of flooding.

One solution was to provide an improved canal from Masaryktown to Crews Lake. The project was completed in the mid 1960s by the Army Corps of Engineers. Additionally, the Army Corps of Engineers suggested that the Masaryktown Canal would be sufficient improvement for the Masaryktown area if combined with the Squirrel Prairie Sink's diversion to the Hillsborough River basin.

The alternative considered was the upstream diversion of flood flows that exceeded the capacity of the Squirrel Prairie Sink. Blocking the outlet to Masaryktown and directing the overflow across the low divide to the Hillsborough River Basin would enhance the downstream improvement of the Pithlachascotee River. The additional diversion work was never implemented.

Other District Structures

With exception of the Masaryktown Canal, the District does not operate or maintain other structures for flood management in the watershed.

Flow Measuring Stations Within the Watershed

The USGS and the District maintains stage and flow measuring gages within the watershed. Periods of record and frequency of measurement vary among the stations. Map 8 provides the general location and types of data stations maintained by the District.

Land Use Within the Federal Emergency Management Agency's (FEMA's) 100 Year Flood Plain

The District's Geographic Information System (GIS) system contains current and future land use designations, respectively based on 1995 data and the 2010 Comprehensive Plans of the counties within the watershed. Additionally, the GIS system has delineations of FEMA's 100 Year Flood Hazard Zones as shown in Map 10. An overlay of land use information with the Flood Hazard Zone boundaries provides an indication of current and future development patterns. Maps 11 and 12 provide the locations of current and future development within FEMA's 100 Year Flood Hazard Zones. These maps also depict the land use and type of development as classified by the Florida Department of Transportation Land Use, Cover, and Forms Classification (FLUCCS) System. It should be noted that FEMA's 100 Year Flood Hazard Zone boundaries may change based upon future watershed studies.

GOVERNMENT AND OTHER WATERSHED ACTIVITIES

Flood Complaints

All of the counties within the Springs Coast watershed have some system for tracking flooding complaints. Citrus County Development Services maintains flood complaint files by physical address and is converting hard copy files to a digital database. Hernando County Emergency Management tracks flood complaints by physical address in a digital database and is currently compiling a visual aid to display complaint locations. Flood complaints received by Pasco County are routed through the Public Information Department to the appropriate department to act on. The Pasco County Stormwater Department retains hard copy files by section, township, and range and displays them on a "flood-prone areas" map. The District tracks and records flood complaints by section, township, and range. These complaints are physically assessed to determine if there is a violation of District rules and, if so, actions are taken to correct the situation.

As part of each stormwater management program conducted within the boundaries of each watershed unit, the problem areas should receive a priority ranking, as well as a description of the cause and extent of flooding. The management program should provide a project scope for the identified flooding areas and the estimated cost to provide relief for the current and/or nuisance flooding conditions.

Land Acquisition Programs

Several agencies have land-buying programs that operate or may operate within the watershed. These programs include the Department of Environmental Protection's Conservation and Recreational Lands (CARL) program, and the District's Save Our Rivers (SOR) program.

Examples of these lands include riverine swamps and flood conveyance corridors, particularly those downstream of flood detention areas, those in areas of heavy development pressure, or those adjacent to other District or public land holdings. Usually, these land acquisition programs emphasize preservation of natural systems and enhancement/preservation of water quality. However, since the lands purchased are often flood-prone wetland areas, these acquisitions also serve to prevent development in historic flood storage areas.

Land Use Regulation

Each of the counties and municipalities in the watershed regulates land use within their boundaries in accordance with a state-approved comprehensive plan. These plans specify the type and amount of development allowed in any given area. As a result, the plans influence where and to what extent development will be allowed in floodplains.

Emergency Management

Many agencies and organizations are involved in emergency management, such as Federal agencies (including FEMA), state agencies, regional planning councils, county and city governments, and the Red Cross. Flooding requires actions such as evacuation planning and implementation (including operation of evacuation shelters and delivery of food and water), rescue operations, medical mobilization, flood control system operations, damage control and assessment, flood insurance compensation, delivery of federal aid, and repairs/replacement of damaged/destroyed infrastructure and buildings. Properly targeted building codes and regulations, including land use and other regulation mentioned above, can minimize the adverse impacts of flooding.

SUMMARY

Analysis of existing studies, available data and current governmental activities reveals several issues of concern in the watershed. In general, development impacts to floodplains fall into two categories, loss of storage and loss of conveyance. Loss of storage is usually the most common impact caused by development in the floodplains. Either of these types of impacts can result in increased flood levels upstream or downstream as a result of changes in the peak, timing, and volume of the runoff hydrograph of the affected area. The issues identified below relate to addressing or preventing impacts caused by loss of storage or conveyance in floodplains.

FLOOD PROTECTION ISSUES

FP - 1

Initiate Processes of Watershed Management Programs for Citrus, Hernando, and Pasco Counties.

Background

An understanding of a watershed's hydrologic and hydraulic responses to rainfall is necessary to provide flood protection. Understanding these responses and quantifying them aids in determining the flood protection Level of Service within a watershed. The Level of Service is the watershed's water level response to a storm event which is typically related to a specific return interval. To prevent future development within identified floodplains, watershed management programs (WMP) need to be developed by watershed units. A WMP would address flooding issues as well as related water quality problems and modifications to correct them. To complement a WMP, the county should investigate funding sources to correct deficiencies identified by the plan.

"The Trend" is to address the issues and strategies within the watershed unit, then to define the costs as a watershed management program evolves. The costs can be broken out by watershed, basin board or political boundaries. A watershed management program consists of the following elements:

Watershed Evaluation

- Aerial Topographic Mapping
- Digital Terrain Model
- Watershed Parameterization
 - Inventory of Water Resources of the Area (Wetlands and Water Bodies)
 - Inventory of Stormwater Management Infrastructure
 - GIS Coverages to SWFWMD Data Standards
 - Soils
 - Landuse
 - Sub-basins
 - Storage
 - Preliminary Link-Node Watershed Connectivity Map
- Immediate Maintenance (no permits required)
 - Immediate Maintenance Evaluation
 - Easement and Access Determination
 - Immediate Maintenance
 - Survey of Maintained Areas

Watershed Management Plan

- Survey of Identified Stormwater Infrastructure Elements and Control Points

- Floodplain Analysis

 - Development of a Simulation Model Using a Computer Program to Project the Response of the Watershed's Storage and Conveyance Elements to Storm Events

 - Floodplain Maps

 - Site Conditions Assessment Permit

- Water Quality Analysis

 - Identify Untreated Sources of Pollution

 - Non-point Source Loading Assessment

- Level of Service (LOS) Determination

 - Determine the LOS Provided Throughout the Watershed and Identify Areas Where the LOS is Deficient.

- Alternatives Analysis of Best Management Practices (BMP)

 - Preliminary Design

 - Probable Construction Cost

 - Alternative Cost/Benefit

 - Environmental Resource Permitability Analysis

 - Conceptual ERP permit

Implementation of Non Structural, Preventive Practices

- Regulations

- Land acquisition

Implementation of Structural, Mitigative Projects (Developed in the Watershed Management Plan)

- Design and Permitting

- Land Acquisition or Legal Access Agreements (for construction)

- Construction of the BMP

Implementation of Structural, Mitigative Projects (Not developed in the Watershed Management Plan)

- Evaluation

- Preliminary Design

- Design and Permitting

- Land Acquisition or Legal Access Agreements (for construction)

- Construction of the BMP

Data Management of Watershed Parameters and Updates to Watershed Computer Simulation Models

- Topographic features
 - Updated Digital Terrain Model
- Updates of GIS Managed Parameters
 - Soils
 - Land Use
 - Digital Ortho Quads (aerial features/mapping)
 - National Wetlands Inventory
- Land Alterations
 - Alterations from Permitted Sites
 - Private
 - Public
 - Infrastructure Changes
 - Transportation
 - Stormwater Management

The Watershed Evaluation element of the program is the first step in understanding a watershed. The evaluation provides an opportunity to explore the sub-basins, and conveyance and storage features within a watershed. Topographic maps are used to establish the study area and the boundary of the watershed and to determine the flow direction and the ridges on the watershed's land form. Topographic maps are not always available at the proper contour interval, or that properly reflects the land's current land use, to properly delineate a watershed and its sub-basins. Map 13 illustrates the current status and availability of traditional contour maps. During the Watershed Evaluation it is determined if the proper topographic mapping is available for the watershed. If new mapping is required to accomplish the watershed management program it should be funded and completed before work begins on the floodplain analysis portion of the watershed management plan. New mapping projects include a digital terrain model of the watershed which helps automate the floodplain analysis process.

An inventory of the resources of the area and stormwater management infrastructure identifies the watershed's natural and manmade conveyance and storage features. The inventory is accomplished through mapping and field verification. A photo and global positioning system (GPS) location inventory of the features is developed for documentation. At this time the resources of the area (wetlands, lakes, rivers, tributaries, creeks, and streams) and stormwater management infrastructure are identified and categorized by system scale (local, intermediate, regional). Documenting the inventory and the associated field work offers an opportunity to evaluate the watershed and determine which areas require immediate maintenance. These are areas where permits are not required to perform the necessary maintenance. After the immediate maintenance activities are completed a survey is performed to document the maintained facility. Limited survey is

accomplished during the watershed evaluation and the watershed features that require survey for the floodplain analysis are identified. An evaluation of the legal access for maintenance and control of conveyance and storage features in the watershed can be accomplished as the conveyance ways are mapped. This evaluation can also be accomplished later in the program. The information gathered along with recommendations from the Watershed Evaluation determine the level of detail required to analyze the identified watershed parameters for the floodplain analysis.

GIS coverages are developed during the watershed evaluation to document the watershed parameters. This information is entered into the GIS according to the District's Data Standard. If adequate topographic maps are available, the watershed sub-basins are delineated based on storage (flood prone areas) and conveyance features. A Geo-referenced Link-Node Watershed Connectivity coverage of the storage and conveyance features is developed in the GIS that includes the photos of the features from the inventory. District land use and soils coverages are included. Map 9 illustrates the various soil hydrologic groups as classified by the United States Department of Agriculture Natural Resource Conservation Service (formerly USDA Soil Conservation Service). The watershed parameters in the GIS will be available to the local government and District staff through their respective computer networks.

The watershed evaluation provides information used for management decisions and regulatory review. The information gathered is used to define the cost for future elements of the water management program.

The Watershed Management Plan provides an understanding of the capacity of the watershed, its level of service, and an alternative analysis to address deficiencies. The expectation for water managers is moving towards developing methods that project a watershed's response to the hydrologic cycle. Watershed parameterization provides the basic data to accomplish this expectation, but the watershed's water resource issues determine what analysis will be done. Understanding a watershed's capacity to provide flood protection, water supply, water for the natural systems, and good water quality is a positive step towards effective water management. The trend is to understand all the areas of responsibility and to be able to project the impact of conflicting management goals and the impacts of growth.

For flood protection a floodplain analysis is accomplished using a computer program to simulate the watershed's response to storm events based on the parameters or data developed for the watershed. During the watershed evaluation information is gathered to determine the level of detail, survey requirements and cost for the floodplain analysis. The capacity of the watershed to provide flood protection is determined, the floodplain boundaries are mapped and flood elevations are projected for the simulated storm events. Areas are identified where flooding causes property damage and where the floodplain can be protected. A Site Conditions Assessment Permit for the watershed can be applied for

at this time. This permit identifies and documents the boundaries of certain existing topographic and environmental conditions within a watershed that are measurably associated with waters. The level of service for flood protection can now be determined, which is based on the local government's level of service criteria in their comprehensive plan. It focuses on protecting property (homes should not flood during a 100-yr event) and the depth of flooding on roadways. The District is also concerned on protecting areas that flood, encouraging recharge, and not allowing excessive drainage.

If the current level of service is below the targeted level of service in the local government's comprehensive plan, growth in the watershed could be impacted unless the level of service is improved. Management technics should be implemented to address a deficient level of service, which could be nonstructural (preventive) or structural (mitigative). If infrastructure improvements can properly address a level of service deficiency, an Alternative Analysis and Environmental Resource Permitability Analysis would be initiated to establish preliminary costs, permitability and benefits for improvement alternatives that provide the targeted level of service. The improvement alternatives should also contain features that address other watershed issues: pollutant loading, estuary freshwater flooding, minimum flows and levels, etc. A Conceptual Environmental Resource Permit should be obtained to lock in the permitting criteria for multi-phased, multi-year funded implementation projects.

Watershed features are constantly changing with new growth and infrastructure improvements that service the growth, address LOS deficiencies, and benefit the water resource. Stormwater infrastructure improvements are also implemented when land alterations are made on private or public property to meet the regulations in the state's environmental resource permit (ERP) process. Surface water collection systems and stormwater management areas are constructed to collect, detain or retain, and treat stormwater according to a local government's design criteria and the state's ERP regulations.

Maintenance of the watershed parameter database, originally established during the watershed evaluation and floodplain analysis, requires updates as the watershed experiences change. With the updated the database water managers have the ability to assess the impacts of change on a watershed's dynamic response to the hydrologic cycle. The maintenance of the data, computer models and the measurement of gaged data provides an effective management tool to prevent adverse impacts to a watershed and to constantly monitor the effectiveness of the management strategies and regulations implemented in a watershed.

Costs for management practices are determined as the program progresses and is maintained. Information from previous elements quantify costs for future elements in the program. Decision makers have an opportunity to determine when funds are needed to address level of service deficiencies, provide benefits to the water resource, and maintain the information and analysis tools. Funding for the program should be included in a local

government's CIP and in the District's Basin Board 5-Year Plans. It is important to realize that the costs of management are constantly changing along with priorities. A hot issue today may cool down to become a non-issue in the future, but the strategy and costs to implement a solution can be presented for funding decisions. The process is dynamic, but the trend at the District is to document the change through the FPC and the Basin Board 5-Year Plans. The evolution of the issues, strategies, and goals will be documented in the CWM plan or guiding document.

Once the WMP is complete, various products are obtained for future land use planning and regulations. Examples of these products include a hydrodynamic model and an inventory of surface water structures that should be maintained and updated regularly as part of the County's infrastructure operations/improvements. Maps of land use, soils, infrastructure, and flood levels would be available for reference.

The District is currently utilizing Data Standards (SWFWMD, 2000b) to ensure that data collected by or for the District is published in a manner consistent with FEMA's format. This will aid in the FEMA approval/update process of base flood insurance maps created/redefined by studies when they are submitted. Once these maps are approved by FEMA, the county can use them to establish or enhance FEMA's Community Rating System credits.

Citrus County contains numerous closed drainage basins, extensive surface water features, and poorly drained soils in the coastal and lake regions. These features increase the potential for flooding during storm events.

Most of Hernando County has adequate drainage. However, flooding remains an issue in some closed basins and areas with poorly drained soil. These features increase the potential for flooding during storm events. Flooding may be intensified by improperly operated and/or maintained stormwater systems, ditches, or canals. One potential approach to flooding relief may be the development of regional stormwater systems, especially in areas with identified problems. The goal is to prevent future development on identified existing floodplains and to encourage the alteration and revision of existing structures to reduce flooding damage.

Drainage has been a problem for Pasco County's central and western regions. Both regions contain several localized drainage problem areas as result of the drainage patterns being altered by extensive development. The County's east-central region is also known to experience severe flooding from closed basins and other hydrogeologic features. In addition, the western region is prone to periodic coastal flooding.

Strategies

1. Develop or refine Watershed Management Programs by watershed units.
2. Initiate an aerial mapping program for areas that do not have suitable topographic aerials available or have been altered by development and require updated topographic aerials.
3. Use Department of Community Affairs's Web site, Resource Identification Strategy (RIS) Database (<http://www.state.fl.us/comaff/hcd/fccr/ris>), to research funding sources and similar project types.
4. Prioritize the basins within each County by existing flooding problems and future development pressure using the Future Land Use Map. Prioritize floodplains within watersheds using the Future Land Use map.
5. Initiate project(s) in areas of special concern.
6. Initiate studies in prioritized basins to determine base flood elevations.
7. Propose FEMA map amendments.
8. Develop and implement a 5-year capital improvement program for mitigative measures.
9. Implement flood protection regulations based on available studies.
10. Use updated FEMA maps for issuing building permits and develop local ordinance codes for regulatory enforcement.
11. Develop an ordinance to ensure that purchasers within flood hazard zones are notified prior to sale.
12. Develop a community education program to inform residents within flood zones of identified flood elevations and assist with applications for grants/loans to retrofit structures or move structures to minimize future flood claims.

Cooperators

Citrus, Hernando, and Pasco Counties, SWFWMD, and when applicable FEMA in conjunction with Counties Emergency Management Program Departments.

FP - 2

Implement Local Building Codes and Ordinances for Potential Coastal Flood Damage by Storm Surge.

Background

A storm surge can be generally defined as the rise in water level caused by wind and pressure forces associated with atmospheric and geologic anomalies such as hurricanes and earthquakes. A storm surge can be extremely devastating and is in fact a major cause of damage from hurricanes. The storm surge itself is caused by the wind and pressure "pushing" the water into the continental shelf and onto the coastline. The height of a storm surge is basically measured as a deviation from the mean sea level in the area. In some historical storms, this value has reached heights of over 20 feet.

Preparation and planning for evacuation when a storm is threatening will decrease loss of life and property damage resulting from a storm surge. Storm surge maps aid in emergency preparation by providing information relating to the height and inland distance the surge will impact based upon the storm's characteristics.

A numerical storm surge model has been developed and applied to the area of west Florida (National Oceanic and Atmospheric Administration, 1995). The model calculates sea, lake, and overland surges from hurricanes and has the acronym 'SLOSH'. The accuracy of the SLOSH model has been evaluated for observed surges at 523 sites during 10 hurricanes. On the average, modeled values were slightly less than those observed by 1.4 feet. The model was used to create maps of surge flooding in the Tampa Bay basin.

The Atlas of surge flooding provides maps of storm surge and extent of flood inundation for various combinations of hurricane strength, forward speed of storm and direction of storm motion. Furthermore, storm surge height partly depends on distance between the location of a particular site and the storm's center. The maps indicate that for severe storms, sea levels may surge as high as 28 feet above the mean sea level along the coastline of the Springs Coast watershed.

Strategy

1. Additional structural clearance and load design with considerations of best available information for storm surge should be incorporated into building codes.

Cooperators

Citrus, Pasco, and Hernando Counties, with technical assistance provided by Florida DCA and FEMA.

FP - 3

Establish Educational/Awareness Programs for Operation and Maintenance of Stormwater Management Systems.

Background

Stormwater ponds and their associated surface water management facilities are designed to capture specific volumes of stormwater runoff through processes of percolation and/or detention. These retention-detention facilities are regulated through Chapter 40D-4, Florida Administrative Code (F.A.C.) to prevent post-development downstream flooding and to improve water quality of stormwater runoff.

Stormwater management systems should be inspected on a routine basis to ensure that they are functioning properly. Inspections should be scheduled on a monthly or quarterly basis and with allowances to increase the inspection frequency during periods of heavy rainfall. Keeping detailed notes on maintenance activities will be a best management practice. Delegating responsibility of overseeing operation and maintenance activities, monitoring and reporting to one individual would prove beneficial in these activities.

Strategy

1. Prepare comprehensive operation, maintenance, and inspection guidelines to be distributed to facility owners and operators.

Cooperators

SWFWMD, local governments, residential developers and homeowner associations.

FP - 4

Establish Regulations for Discharge of Floodwater/Stormwater into Sinkholes in Karst Sensitive Areas.

Background

The majority of the Springs Coast watershed is underlain with highly porous limestone, which contains the Floridan aquifer, and is overlain by tens to hundreds of feet of sands, clays, and other materials. These materials act as a buffer isolating the Floridan aquifer from surface pollutants. Surface water percolating through these materials slowly allows filtration, adsorption, and biological removal of contaminants.

In karst sensitive areas, the limestone exists virtually at land surface. The formation of a unique type of sinkhole called a solution pipe is common in these areas. Solution pipes are formed due to the collapse of surficial material into long vertical cavities that have been dissolved in the upper portion of the limestone. In most cases, the solution pipes are capped by a natural plug of sands and clays. If the cap is washed out, the resulting solution pipe sinkhole can act as a direct conduit for the movement of stormwater into the Floridan aquifer before filtration through sands and soils can occur.

Solution pipe sinkholes often form in the bottom of stormwater retention basins where the capping plug is thinner due to partial removal of same. The thinning of this confining layer can create catastrophic failure due to the increased hydraulic pressure exceeding the overburden support properties of the capping plug and causing the collapse of same. Solution pipes act as natural drainage wells and can drain large stormwater basins. Another aspect is the degree of weathering irregularities of the limestone in the karst sensitive areas. This irregularity causes uncertainty and errors if well borings are used to determine the depth from land surface to limestone and subsequently results in the failure of stormwater basins.

Strategies

1. To perform mapping of karst sensitive areas in the watershed.
2. Establish design standards and guidelines specific to karst sensitive areas for stormwater facilities to assure adequate treatment of the water before it enters the Floridan aquifer. In addition, the facility's design should preclude the formation of solution pipe sinkholes in the basins. (St. Johns River Water Management District, 1988). Many different system designs will achieve these goals. The individual site characteristics may affect what design features will be required. However, for all projects, the following minimum design features are required:
 - a. A minimum of 3 feet of unconsolidated soil material between the surface of the limestone bedrock and the bottom and sides of a retention basin, or use

of an impermeable liner. Excavation and backfill of suitable material may be necessary to meet this criteria.

- b. Stormwater basin depth should be as shallow as possible with a flat bottom (no deep spots). Maximum basin depth is 10 feet. This reduces the potential for solution pipe sinkhole formation caused by a large hydraulic head.
- c. The side slopes and bottoms of all dry retention basins must be fully vegetated. Two species of grasses are best suited for use in retention basins in the karst sensitive areas: St. Augustine and Bermuda Grass.
- d. Pre-treatment of stormwater prior to entering the retention basin should be designed into the system whenever possible. Pre-treatment of stormwater by using sheet flow, swales, inverse-swales, initial treatment ponds, or other measures can remove a large percentage of the pollutants (up to 90%) that are present in stormwater.

The above conditions represent the minimum requirements. Depending on the potential for contamination, more stringent requirements may apply. Industrialized and some commercial sites will normally require more stringent design features.

- 3. Best management practices and recommended design. A list of general best management practices and recommended stormwater system design factors are listed below:
 - a. Stormwater runoff should never be discharged directly into surface or ground waters.
 - b. Stormwater management systems, especially those emphasizing vegetative practices, should be planned, constructed, and stabilized in advance of the facilities that will discharge into them.
 - c. The stormwater management system must be designed beginning with the outlet or point of outflow from the project.
 - d. Whenever possible, construct the components of the stormwater management system on the contour following the natural topography.
 - e. Whenever practical, multiple use of temporary storage basins should be an integral component of the stormwater management system.
 - f. Storage areas should be designed with sinuous shorelines.

- g. Vegetated buffer strips should be retained in their natural state or created along the banks of all water bodies.
- h. The stormwater management system must receive regular maintenance.

Cooperators

Citrus, Hernando, and Pasco Counties, SWFWMD.

FP - 5

Prepare Educational Materials for Potential Coastal Flood Damage by Sea-level Rise.

Background

Many climatologists believe that increasing atmospheric concentrations of carbon dioxide and other gases released by human activities are warming the earth by a mechanism commonly known as the "greenhouse effect". This warming effect appears to be partly offset by the cooling effect of sulfate aerosols which reflect sunlight back into space. The earth's average surface temperature has risen approximately 1°F (0.6°C) in the last century with the nine warmest years occurring since 1990.

Such warming is likely to raise sea level by expanding ocean water, and melting glaciers and portions of the Greenland Ice Sheet. Warmer polar ocean temperatures could also melt portions of the Ross and other Antarctic ice shelves. This has the potential to increase the conveyance rate that the Antarctic ice streams transport ice into the oceans. Warmer polar air temperatures would probably increase annual snowfall which would partly offset the rise in sea level caused by warmer temperatures. Much of the United States coast sea level is already rising 10 to 12 inches per century (2.5-3.0 mm/yr).

The U. S. Environmental Protection Agency performed a study to develop probability-based projections that can be added to local tide-gage trends to estimate future sea level at particular locations (Titus and Narayanan, 1995). The report is summarized as follows:

1. Global warming is expected to raise the sea level 6 inches (15 cm) by the year 2050 and 13.4 inches (34 cm) by the year 2100. The estimates do not include sea level rise caused by factors other than greenhouse warming.
2. By the year 2100, climate change is likely to increase the rate of sea level rise by 0.16 inch/yr (4.2 mm/yr). There is also a 1 in 10 chance that the contribution will be greater than 0.39 inch/yr (10 mm/yr), as well as a 1 in 10 chance that it will be less than 0.04 inch/yr (1 mm/yr).
3. Stabilizing global emissions by the year 2050 would be likely to reduce the rate of sea level rise by 28 percent by the year 2100. Stabilizing emissions by the year 2025 could cut the rate of sea level rise in half.
4. Along most coasts, factors other than anthropogenic climate change will cause the sea to rise more than the rise resulting from climate change alone. These factors include compaction and subsidence of land, groundwater depletion, and natural climate variations. If these factors do not change along the coast of New York, which typifies the United States, sea level is likely to

rise 10.2 inches (26 cm) by the year 2050 and 21.6 inches (55 cm) by the year 2100.

Strategy

1. The subject is still under debate and not yet conclusive. Maintain careful, close, consistent observation and attention to the scientific debate.

Cooperators

Citrus, Pasco, and Hernando Counties with technical assistance provided by the National Oceanic and Atmospheric Administration (NOAA).

CHAPTER IV WATER QUALITY

LITERATURE REVIEW

Surface Water Quality

Overview

As described in Chapter I, surface water features in the Springs Coast watershed are limited to lakes, relatively short rivers, and small coastal drainage streams. Overall, surface water quality of the basin is good. Over 150 individual reports have been identified (Dixon, 1997) which provide at least some physical, biological and/or chemical data on the near-shore estuaries and rivers of the basin. Overall water quality has best been characterized in the reports: ***An Ecological Characterization of the Florida Springs Coast: Pithlachascotee to Waccasassa Rivers*** (Wolfe, 1990), the ***1996 Florida Water Quality Assessment for the State of Florida, Section 305(b) Main Report*** (Florida Department of Environmental Protection, 1996), ***Data Inventory, Trend Analysis, and Recommended Monitoring: Florida Springs Coast*** (Dixon, 1997), the ***Project Coast Annual Project Summary*** (Frazer, 2000a), and the ***Coastal Nitrate Assessment: Nutrient Assimilation Capacity of Five Gulf Coast Rivers*** (Frazer, 2000b).

Another report of significance to the Springs Coast watershed is ***Florida's Springs, Strategies for Protection & Restoration*** (Florida Department of Environmental Protection, 2000). This report is the result of the work performed by 'The Florida Springs Task Force' under the direction of the FDEP Secretary David Struhs. This report outlines the strategies that the Task Force developed to protect and restore the State's springs. The Springs Coast watershed has many springs that need protection and restoration. The ***Florida's Springs, Strategies for Protection & Restoration*** report will provide direction toward addressing several of the issues described later in this section.

Impairments to water quality can generally be grouped into one of two categories, anthropogenic and natural. Anthropogenic factors are those directly resulting from human alteration of the systems. Examples include but are not limited to diversion of waters away from natural drainage areas, excessive withdrawal of ground water, physical destruction of natural filter areas and the introduction of pollutants through point and non-point discharges. Natural factors which dramatically affect water quality include seasonal changes and climatic variations (rain/drought).

Typically, only the anthropogenic impacts are of major concern. Pollutants such as nutrients, suspended solids, toxics (including metals and pesticides), oils and greases, and bacteria are common threats to water quality. While the causes of impairments to water

quality are generally known, the magnitudes of the impairments are often unknown. Baseline data are unfortunately absent in many instances. This lack of adequate data "prevents accurate detection of changes in surface water quality and hinders the interpretation of data gathered in short-term studies... (Wolfe, 1990)."

The **1996 Water-Quality Assessment for the State of Florida, Section 305(b) Main Report** (Florida Department of Environmental Protection, 1996) summarizes the quality of the water resources, regulatory developments, impacts to surface water and ground water, water quality trends, and current restoration and protection programs. The report's **Technical Appendix** contains detailed information on the status and quality of individual hydrologic units and watersheds. The report relies upon available data to rate the water quality of surface waters. Unfortunately, water quality information used in the report for many of the watersheds and reaches was found to be very sparse or historical (pre-1988). In the absence of measured water quality data, and to augment existing data, the 305(b) report rated water quality in some basins based on a qualitative assessment of water quality problems and probable sources identified by experienced field personnel who had information about individual water bodies.

The **Data Inventory, Trend Analysis, and Recommended Monitoring: Florida Springs Coast** (Dixon, 1997) report was completed by Mote Marine Laboratory under contract to the District. The purpose of this report was to collect and analyze existing water quality information in order to identify potential trends in water quality, particularly nitrate. Over 150 citations were found which referenced water quality and/or biological data pertaining to the coastal portion of the Springs Coast Basin. Most of these reports were short-term and site specific and therefore could not be used in the determination of water quality trends. One conclusion discussed by Dixon, similar to that of Jones et al. (1997), was that nitrates were increasing significantly in the discharge of the coastal springs. Dixon also concluded that further monitoring is needed to establish a base line for future comparisons and that a repetition of a base line effort will permit a minimal trend detection effort.

Two significant studies in progress are the *Coastal Nitrate Assessment - Assimilative Capacity of Five Gulf Coast Rivers* and *Project COAST*. Both projects are being conducted by the University of Florida, Institute of Food and Agricultural Sciences, under contract to the District. The primary goal of the *Nitrate Assessment* project is to document the fate of nitrate in the five Gulf Coast rivers and their associated estuaries. *Project COAST* is the establishment of a base line data collection effort in the estuaries. Both projects will provide documentation and essential quantitative information to detect future changes in these systems and the guidance for management activities related to the changes. Frazer (2000a) documents the data from *Project COAST* up through 1999.

Water Body Summaries

Crystal River System

Crystal River and Kings Bay, located in Citrus County approximately 60 miles (97 km) north of Tampa (Figure 5), form a truly unique hydrologic system. The tidally influenced Kings Bay is the headwater of Crystal River which forms at the northwest corner of the bay. Six miles west of Kings Bay the river ends at the Gulf of Mexico. The system is the fourth largest of the 27 first magnitude springs (those systems discharging 100 cubic feet per second or greater) in the state (Rosenau et al., 1977). While other spring systems within the state are tidally influenced, the 600 acre Kings Bay embayment makes this system unique. The Crystal River and Kings Bay are both designated as Outstanding Florida Waters (OFW). OFWs are considered to be waterbodies of exceptional recreational or ecological significance and are afforded the highest level of protection. This implies that no degradation of water quality is allowed other than that stated in Rule 62-4.242(2) F.A.C., notwithstanding any other FDEP rules that allow water quality lowering.

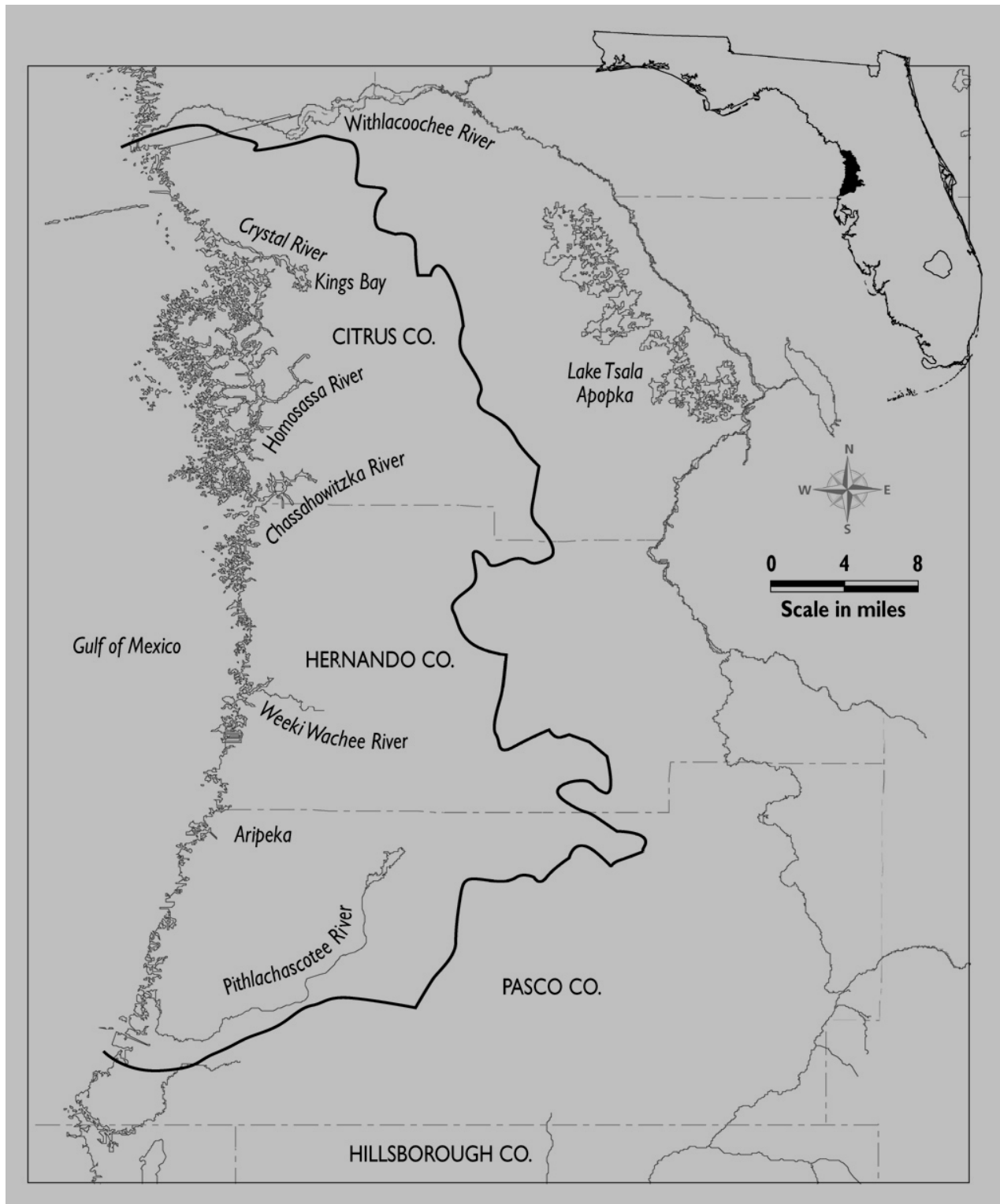
As a result of legislation passed in 1987 (Surface Water Improvement and Management Act - SWIM Act) and its regional significance, Crystal River/Kings Bay was designated the Southwest Florida Water Management District's (District's) fourth ranked SWIM priority water body.

A management (SWIM) plan was originally prepared and approved for Crystal River/Kings Bay in 1989 (SWFWMD, 1989). Many of the projects identified in the 1989 SWIM plan were studies and data collection efforts - diagnostic tools for resource managers - designed to provide an insight into the intricacies of the system. An emphasis was placed on the development of a comprehensive understanding of the water chemistry of Kings Bay and Crystal River. The results of this diagnostic work provided the necessary technical information to develop the management strategies for the 2000 SWIM Plan update (SWFWMD, 2000c). Ongoing work on five coastal rivers (including Crystal River) and their nutrient assimilative capacity may recommend expanding management actions further down the rivers and perhaps to the nearshore gulf systems.

Jones et al. (1998) reported that much of the nitrates entering the Crystal River/Kings Bay complex is coming from the ground water discharging from the springs. Nitrate concentrations discharging from the springs are 20 times higher than the natural groundwater concentrations in the Floridan aquifer statewide (Jones et al., 1998).

Changes in water clarity and the presence and spreading of nuisance aquatic vegetation are the major management issues for the Crystal River/Kings Bay system. Water clarity in Kings Bay is primarily affected by the concentration of suspended solids in the water column. The suspended solids appear to be primarily the result of bottom sediments being resuspended by either wind action or physical disturbance. While aquatic vegetation is

Figure 5. Major water bodies in and adjacent to the Springs Coast Watershed.



important to the water clarity of the system, undesirable aquatic vegetation has presented a problem for the residents of Crystal River since the introduction of hydrilla in 1960. Most recently, *Lyngbya sp.*, an undesirable filamentous algae, has dominated areas of Kings Bay causing habitat destruction, use impairment, and odor problems.

Another problem that has occurred in other waterbodies in the Springs Coast Watershed, is the closing of public swimming areas due to elevated levels of total and fecal coliforms. Hunters Spring Park, which is part of the Kings Bay system, was closed to swimming during most of the summer in 2000 due to elevated bacteria counts.

Homosassa River System

Like Crystal River, the Homosassa River is a coastal, spring-fed river/estuarine system located in west Citrus County (Figure 5). The river, which is also an OFW, extends approximately six miles from the Gulf of Mexico to the headwaters of Homosassa Springs. Increased development pressures within the Homosassa River Watershed have caused a degradation of the River's quality (Florida Land Design & Engineering, Inc., 1989). Residential and commercial growth in "Old Town" Homosassa and the Homosassa Springs area have contributed to the lowering of the water quality of the river. The Department of Health and Rehabilitative Services and the FDEP have found that the river has experienced degradation due to high concentrations of bacteria and nutrient enrichment. Dixon (1997) also reported increases in nutrients from 1992 through late 1996 in the upper reaches of the river above Halls River. The Homosassa Springs State Wildlife Park, with assistance from the District and the University of South Florida (USF) performed an investigation of the potential addition of bacteria and nutrients from the Park's wildlife, to the headwaters of the river. Griffin, et al. (1999) concluded that impacts from the Park to the Homosassa River were relatively minor. Jones, et al. (1997) reported that the most significant sources of nutrients in the Homosassa River Watershed were golf course, residential turf, and landscape fertilizing. Septic tanks were also considered a significant source but fertilizers were the dominant sources. These are the same significant sources reported by Jones, et al. (1997) for the Chassahowitzka, Weeki Wachee and Aripeka systems

Chassahowitzka River System

The Chassahowitzka River is located in southwestern Citrus County approximately 6.5 miles south of Homosassa and just north of the Citrus/Hernando County line (Figure 5). The river begins approximately 1.5 miles west of U.S. Highway 19 and just north of SR 480 and flows westerly to the Gulf of Mexico through about six miles of hardwood forests and low coastal marshland. Crab Creek, Cabbage Creek, Baird Creek, Salt Creek, Potter Creek, Crawford Creek, Blue Run, Ryle Creek and May Creek all flow directly to the Chassahowitzka River, while Chub Creek and Blind Creek flow to the Gulf of Mexico. Chassahowitzka River and many of the above listed creeks are designated as OFWs.

Water quality data for the Chassahowitzka River is rather limited. Data collected by Jones, et al. (1997) from 1992 through 1996 at selected springs is the most consistent data for this system. Jones, et al. reported that, as with the other coastal spring systems, nitrates are increasing in the Chassahowitzka system, but of the four spring complexes, mean nitrate concentrations were lowest in the Chassahowitzka spring complex.

Concerns about high bacteria levels in the Chassahowitzka River prompted the SWFWMD to perform remedial sampling of the headwaters and canals during the fall of 1997. Total and fecal coliforms were found to be in excess of State standards. A more detailed analysis, begun in October of 1999, revealed that septic tanks are adversely influencing the water quality of the Chassahowitzka River (Callahan, et al., 2001).

Weeki Wachee River System

The Weeki Wachee River is located in southwest Hernando County, approximately 12 miles southwest of Brooksville (Figure 5). Weeki Wachee Springs, the headwaters of the river, is located just southwest of the junction of U.S. Highway 19 and State Highway 50. The river extends westward through approximately 7.5 miles of predominantly lowlands (coastal swamps and marshes) to the Gulf of Mexico. The Mud River flows through primarily coastal marsh and joins the Weeki Wachee about 0.8 miles upstream of the mouth of the river. The headwaters of Jenkins Creek is located east of C.R. 595 and just less than a mile south of the Weeki Wachee River. The Creek flows west-northwest approximately 1.3 miles through predominantly coastal marsh before reaching the Gulf of Mexico less than a quarter mile south of the mouth of the Weeki Wachee River.

There are nine springs associated with or in proximity to the Weeki Wachee system. With the exception of Weeki Wachee Springs, most of the springs in the Weeki Wachee area have very limited flow and water quality data. Changes in land uses within the watershed of the springs, appear to have had impacts to the coastal springs, rivers/creeks and estuary. SWFWMD (1994) concluded that, though the overall water quality conditions in the river are still good, nitrate concentrations at the headspring have increased with time. Jones et al. (1997) reported the mean nitrate concentration of the Weeki Wachee Main Spring is 0.53 mg/l (for data collected from 1992 to 1996), which is 50 times higher than background levels (< 0.01 mg/l). The Weeki Wachee River is presently under consideration by the FDEP for Outstanding Florida Waters designation.

Aripeka/Hammock Creek System

The Aripeka/Hammock Creek system includes several small springs clustered in a one square mile area in southwestern Hernando County (Figure 5). Hammock Creek is approximately one mile in length and is joined by several lesser tidal creeks before reaching the Gulf of Mexico at the town of Aripeka. The springs either discharge directly into Hammock Creek or discharge into the lesser creeks flowing into Hammock Creek. Except for rising nitrate concentrations, as noted in the other spring systems, water quality in the

Aripeka/Hammock Creek system is relatively good. Dixon (1986) reported that though the Hammock Creek system experiences less inflow of freshwater than other river systems in the area, this system is an important part of the marine/estuarine ecosystem.

Following Jones, et al. (1997) study, the Water Quality Monitoring Program (WQMP) at the District has continued to sample springs in each of the five systems discussed above.

Pithlachascotee River, Including Crews Lake

The Pithlachascotee River (Cotee River) system is located in western Pasco County, Florida and includes both estuarine and freshwater reaches (Figure 1). The river extends approximately twenty-five miles in a southwest direction from its headwaters at Crews Lake, to the Gulf of Mexico. Although the upper portions of the river are surrounded by primarily rural land uses, the lower reaches are relatively urbanized, especially in the vicinity of the cities of Port Richey and New Port Richey. This reach of the river receives significant amounts of stormwater runoff. It is in this urbanized reach that nitrogen and phosphorus, as well as bacteria and protozoans, increase (SWFWMD and the University of South Florida, 1997). Stormwater remediation is necessary to enhance the quality of the Pithlachascotee River.

Lakes

Including Crews Lake, which is approximately 693 acres in size, there are approximately 137 lakes within the Springs Coast basin totaling approximately 1503 acres. Of this acreage, 555 acres are made up of lakes less than 10 acres in size, 763 acres consist of lakes bigger than 10 acres in size. Water quality data for these lakes are limited. In October of 1993, the SWFWMD and the Hernando County Planning Department began a cooperative effort to sample 10 lakes in Hernando County once a month for a one year period (Hernando County Planning Department & SWFWMD, 1997). This study provided good base line data for 10 representative lakes in the Hernando County area, seven of which fall within the Springs Coast basin. This means that approximately 130 lakes within the watershed have little or no water quality data. Consistent monitoring of a representative number of lakes within the watershed would be beneficial to evaluate trends and to detect declines in water quality.

Near-shore Estuary

As discussed earlier, water quality of the near-shore estuary is being documented. The *Nutrient Assimilative Capacity* project, Nutrient Limitation project, Seagrass Mapping project, and *Project COAST* are being conducted by the University of Florida and funded by the SWFWMD. Frazer et al. (1998) have determined from the first year's data that there were significant spatial and temporal variations for the most commonly measured eutrophication related parameters (namely nitrogen and phosphorus). This does not imply however that eutrophication is occurring. Frazer et al. (1998) strongly emphasized the need for long-term water quality monitoring of the Springs Coast estuaries to further understand

the estuarine systems and for the detection of water quality changes potentially resulting from manmade alterations in the Springs Coast and adjacent Withlacoochee watersheds.

Groundwater Quality

Overview

Covering some 800 mi.², the Springs Coast watershed is a karst landscape. Karst landscapes provide an ideal geologic environment for the recharge and transmission of large quantities of fresh, potable ground water. As a consequence of its karst geology, the watershed is the location of four major spring complexes, which combined, discharge approximately 900 mgd from the Floridan aquifer. A spring complex is defined as a group of springs, often spread over an area of several square miles, that are discharge points for ground water in a discrete groundwater basin. Rainfall is the primary recharge mechanism for the aquifer and averages 56 inches per year. Spring flow is a major discharge mechanism for the aquifer accounting for 64-84 percent of the total recharge input. The King's Bay Springs complex (also known as Crystal River), the largest spring complex in the watershed, discharges approximately 630 mgd. Weeki Wachee, Chassahowitzka, and Homosassa Springs discharge 113 mgd, 90 mgd and 68 mgd, respectively.

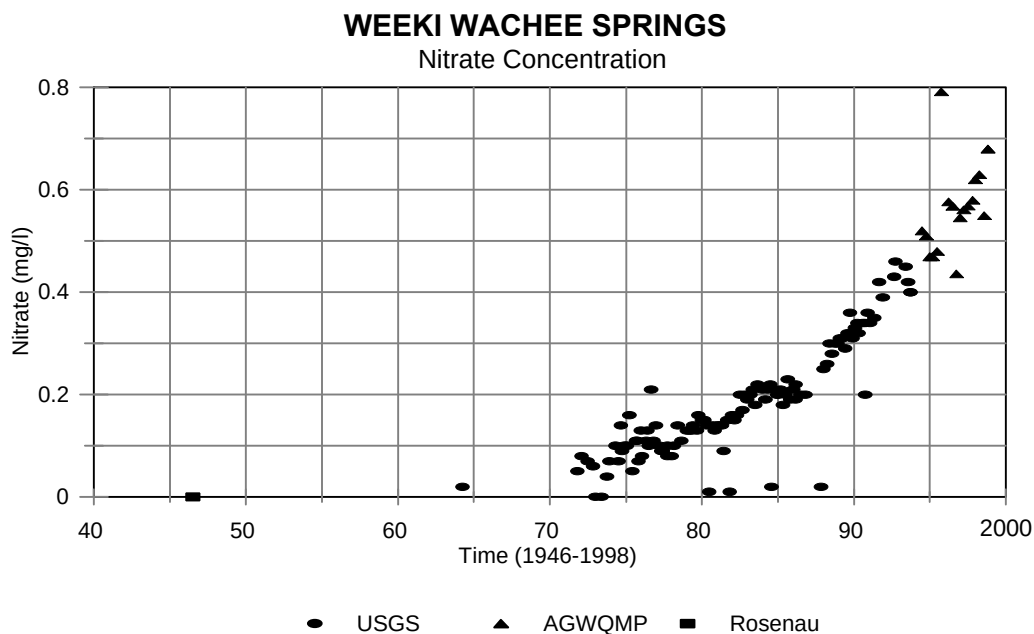
The overall groundwater quality in the Springs Coast basin is very good. Ground water in the basin is a Ca-HCO₃ water type typical of carbonate aquifers. pH values typically range 7-8 s.u., and specific conductance values range from <200 umhos/cm inland to >2000 umhos/cm along the coast. Temperature of the ground water is relatively constant, varying between 23 and 24°C.

Chemically, fresh ground water in the Floridan aquifer is dominated by calcium and bicarbonate. This is a result of the dissolution of limestone by acidic ground water. Sodium, chloride, magnesium, potassium and sulfate are typically present in much lower concentrations. However, saline ground water found along the coast is dominated by sodium and chloride with lesser amounts of sulfate and magnesium. Total dissolved solids values are typically below 200 mg/l inland and > 200 mg/l along the coastline. These data would suggest that ground water in the Floridan aquifer has moved, or is moving through a relatively short, shallow flow system, and has probably not been in the aquifer for more than a few decades at most. The data also suggest that fresh ground water is mixing with saline ground water in the saltwater/freshwater transition zone along the coast.

Tritium is a rare isotope of hydrogen that was enriched in rainfall during atmospheric testing of hydrogen bombs in the mid 50's to mid 60's. Tritium data, collected by the USGS, indicates that much of the ground water in the Coastal Rivers basin is relatively young (recharged since 1952).

Nutrient concentrations in the Floridan aquifer are typically very low. Nitrate is easily leached into the ground water where it disperses through the aquifer system. Natural inputs of nitrogen (e.g., organic decay) have always supplied very low levels of nitrate to the aquifer. However, anthropogenic sources (e.g., fertilizers and septic tanks) are increasing the input. As expected, nitrate concentrations are low in most areas of the basin; however, in southwestern Hernando County, leaching of nitrogen has caused increased nitrate concentrations in the aquifer. Recent water quality studies indicate that 95 tons of nitrate per year are discharged from the spring. Also, the dramatic increase in nitrate concentrations in Weeki Wachee Springs since the early 1970's (Figure 6), is most likely due to the increase in human population in and near Spring Hill.

Figure 6. Nitrate concentrations for the Weeki Wachee Springs from 1946-1998. The data was compiled from the USGS, the Ambient Ground Water Quality Monitoring Program of the SWFWMD (now called the Water Quality Monitoring Program), and from Rosenau et al., 1977.



Another source of nitrogen, and potentially various other pollutants in the watershed, are wastewater treatment facilities. Refer to the discussion on Wastewater Treatment Facilities in Chapter I.

Nitrogen isotopes, land-use distributions, and nitrate concentrations were recently investigated and used to show how nitrate in the Floridan aquifer is originating from inorganic fertilizers applied to turf acreage near the four major spring complexes in the

Coastal Rivers basin. However, increasing population will likely increase the significance of organic sources of nitrogen such as from septic systems and wastewater treatment plants.

AVAILABLE DATA

United States Geological Survey

The United States Geological Survey (USGS) collects, analyzes and reports water quality for two stations within the Springs Coast watershed. These two stations are located on the Pithlachascotee River. For discharge and/or stage data, the USGS monitors the two stations on the Pithlachascotee River, one on the Weeki Wachee River, and one on Moon Lake near New Port Richey. The USGS also has historic data for one or more stations on the Crystal, Homosassa, Chassahowitzka and Mud rivers. The USGS is presently under contract with the SWFWMD to perform an extensive evaluation of the relation between changes in spring flow and groundwater head. This study is being performed on the Aripeka, Weeki Wachee, Chassahowitzka and Homosassa Spring complexes and should be completed in 2001.

Florida Department of Environmental Protection

The Florida Department of Environmental Protection has merged what once was the Surface Water Ambient Monitoring Program with the Ambient Ground Water Quality Monitoring Program to form the Integrated Water Resource Monitoring program. This will include a state-wide monitoring network of river, lake, and groundwater stations for the regular collection of water quality samples. The Department contracts with the water management districts to assist with the collection of the water samples.

Southwest Florida Water Management District

The Water Quality Monitoring Program collects water quality information on 300+ lakes District-wide (as mentioned earlier, this same group collects water quality data from selected springs along the coast). Samples are collected from each lake on a three-year rotation (i.e., a group of approximately 100 lakes is sampled in the summer and winter each year; a second group is sampled the following year, and so on, until the fourth year when the first group is sampled again). Samples are tested for a broad range of typical water quality parameters including nutrients, chlorophyll, metals and cations. This is an ongoing program and includes most of the significant representative lakes within the District.

Florida Lakewatch Volunteer Monitoring Program

Florida Lakewatch is a volunteer program developed by the University of Florida to monitor water quality in Florida lakes and on some other surface waters. Water quality samples are collected monthly on most program lakes and are tested for concentrations of chlorophyll *a*, total phosphorus, and total nitrogen. In 1993, the list of parameters was expanded for a large number of the participant lakes, to include pH, total alkalinity, specific conductance,

color, chloride, iron, silica, sulfate, calcium, magnesium, sodium, and potassium. A total of 393 lakes were sampled in 1993, including one in the Springs Coast watershed. Lakewatch has also sampled 30 stations within the canal systems connected to Crystal River and two stations on the river itself. Lakewatch is partially funded by the FDEP, and the data are provided to FDEP for use in water quality assessments. This program may be expanded in the future to include more lakes within the Springs Coast watershed.

SUMMARY

Water quality in the coastal springs and other water bodies in the watershed, although relatively good, have been altered over time due to manmade impacts such as nutrient loading from point and non-point sources. Nutrient loading will likely increase as urban development expands in the watersheds. Other practices, including mining, have impacts to surface and groundwater quality within the watershed. Several priority water quality issues within the Springs Coast watershed have been the concern of the Coastal Rivers Basin Board of the SWFWMD. These issues, as well as several others, have been reviewed by the Springs Coast CWM Team. Action plans have been formulated to address these issues and are contained in the following pages.

WATER QUALITY ISSUES

WQ - 1

Reduce Nitrate Concentrations in Spring Discharge.

Background

Nitrate concentrations have been increasing in a number of major spring groups within the Southwest Florida Water Management District. Jones and Upchurch (1993) showed that increasing, elevated nitrate concentrations (2.0-3.0 mg/l) in Lithia and Buckhorn Springs in Hillsborough County is the result of the long-term operation of dairy farms and the cultivation of citrus. Jones et al. (1996) showed similar trends with somewhat lower concentrations (1.0 mg/l) in Rainbow Springs in Marion County resulting from the fertilization of thousands of acres of pasture. Similar increasing trends are evident in the Homosassa, Chassahowitzka, and Weeki Wachee Springs. The most dramatic increase in nitrate occurs in Weeki Wachee Main Spring where concentrations have increased from less than 0.02 mg/l in 1946 to 0.68 mg/l in 1998.

Nitrate concentrations in ground water in undeveloped areas of Citrus, Hernando, and Pasco Counties have been compared with nitrate concentrations in ground water discharging from the springs. These data indicate that the spring water concentrations exceed natural background groundwater concentrations. Since enrichment of nitrate to the level that occurs in the spring water is not a result of natural processes, human-induced contamination of the ground water must be occurring somewhere within the recharge area of the springs.

Although the nitrate concentrations (0.18-0.68 mg/l) in the coastal springs of Citrus, Hernando, and Pasco Counties are considerably lower than those of Lithia, Buckhorn, and Rainbow Springs, they are still of great concern. This is because even at these low concentrations, water discharging at the rate of approximately 900 cfs from the main springs and smaller surrounding springs contains an annual nitrate load of over 360 tons. This nitrate is rapidly delivered by the coastal rivers to the extensive estuaries along the Gulf Coast. The effect of this quantity of a limiting nutrient on aquatic vegetation in the estuaries is being investigated. It is likely that as nitrate concentrations continue to increase, algae blooms will increase in frequency and duration, and changes in the vegetative composition of these systems will occur. This could result in a decline in the diversity of other aquatic plant and animal species as the algae blooms deplete oxygen and block sunlight.

The chemistry of water discharging from the springs indicates that the ground water has moved through relatively short, shallow flow systems. That is, the water has probably not been in the aquifer for more than a few decades at most. Nitrogen isotopic data suggest that the dominant source of nitrate presently discharging in ground water from the springs is inorganic. Organic sources, although regionally less significant, may still elevate nitrate

concentrations to high levels on a local scale. Organic sources include: naturally occurring organic decay, sewage effluent disposal, land disposal of sewage sludge, effluent from septic tanks, land disposal of septage sludge, poultry, dairies and cattle.

Residential and golf course turf/landscape fertilization were identified as the principal source of nitrate in the springs. Supporting data include: 1) the inorganic nature of the source, 2) the close proximity of the source to the springs, and 3) the rapid increase in nitrate concentrations in the springs that began in the late 1960's, which correlates well with the development of the large, coastal, residential subdivisions that contain the largest densities of residential and golf course turf and landscape. Currently, the Nitrate Remediation Workgroup, with the assistance of the SWFWMD, is conducting a survey of residential fertilizer usage in the Springs Coast Watershed.

Recommendations

The District should work with county and local governments and other interested agencies to formulate land-use plans that would prevent additional nitrogen loadings to the basin. Educational projects explaining the need to reduce the loading of nitrogen to the aquifer and adjacent surface waters should be developed as soon as possible. Planning for the elimination of septic tanks in particular areas should begin immediately. First priority should be given to areas where high nitrogen is present in the Floridan aquifer. An investigation of the application of all inorganic nitrogen fertilizers within the Springs Coast watershed should be initiated in the near future. The study should focus on identifying the specific areas of application, the amount applied, and the amount of nitrogen reaching ground water following application. The study should also attempt to reduce the use of fertilizers by developing BMPs and/or promoting xeriscaping (depending on predominant land use, whether agricultural or residential). Municipal wastewater treatment facilities should either go to advanced wastewater treatment (AWT) or other nutrient-removal technologies. Stormwater runoff should not be routed directly to sinkholes and the geology of stormwater attenuation areas should be thoroughly evaluated for potential sinkhole formation. Runoff retention and plant fixation of nutrients is a necessary management alternative for sinkholes that receive stormwater runoff from suburban and urban areas.

The importance of sources, such as residential and golf course turf fertilization, septic tank effluent, sewage effluent disposal and stormwater runoff will greatly increase as rapid residential and commercial development proceeds in the area. It is, therefore, extremely important that best management and alternative landscape practices be developed that reduce the leaching of nitrate. Waste disposal practices that are compatible with the region's karst geology, and its accompanying extreme vulnerability to groundwater contamination, must be implemented. These practices include:

- a. Avoidance of high-densities of septic systems and the proper placement of each system.
- b. Planning for the development of centralized AWT systems.

- c. More stringent design, construction, and monitoring of large-scale percolation or spray field systems.
- d. Proper storage and treatment of stormwater.

Strategies

1. County/municipal governments expand sewer services so that the elimination of septic tanks begins in the near future (especially where nitrogen is present in the aquifer).
2. County/municipal governments construct or modify existing wastewater facilities to use AWT or other nutrient-removal technologies.
3. Emphasize the importance of runoff retention for stormwater runoff in suburban and urban areas. The design and permitting of the stormwater control and treatment structures must be emphasized.
4. Develop a program to investigate improperly constructed and improperly maintained stormwater management systems.
5. Develop educational projects with local entities to promote Xeriscape practices and explain the need to reduce the loading of nitrogen to the aquifer and adjacent surface waters and assist in implementing the load reduction measures. Proper fertilization of turf and other landscape areas and utilization of organic versus inorganic sources will be a major focus of the educational campaign, which should be patterned after the Florida Yards and Neighborhoods program to educate citizens.
6. Develop educational projects with local entities to educate property owners with septic systems on proper septic tank maintenance. Design requirements, ordinances, and permitting of septic tanks are currently the responsibility of the Florida Department of Health (FDOH) county public health units (CPHU) under Chapter 381 F.S. and Chapter 10D-6, "Standards for Onsite Sewage Disposal Systems", of the Florida Administrative Code (FAC).
7. Ensure proper application of sludge to spreading areas.
8. Work with commercial-scale users of fertilizers and pesticides (condominiums, developments, mobile home parks, golf courses, etc.) to implement BMPs.
9. Work with Florida Department of Agricultural and Consumer Services (FDACS) and Counties to develop regulations on fertilizer use in this area.
10. Integrate planning and regulatory efforts, such that permitting activities take into consideration comprehensive plans and policies; and planning efforts include consideration of all current environmental regulations and permitting activities.

11. Continue monitoring the coastal spring systems and associated estuaries in accordance with *Project Coast* and the *Coastal Nitrate Assessment - Assimilative Capacity of Five Gulf Coast Rivers* project.

Cooperators

SWFWMD, Citrus, Hernando, and Pasco Counties, FDEP, FDACS, and County HRS units.

WQ - 2

Reduce Septic Leachate within the Watershed.

Background

Numerous investigators have characterized septic tank effluent (leachate) for various chemical species including major ions, trace metals, nutrients, and biological scans. Major ions in septic tank effluent include sodium, chloride, sulfate and bicarbonate. These ions, with the exception of chloride, seldom reach ground water in large concentrations due to adsorption, precipitation, and biological uptake in the vadose zone. Chloride is a chemically conservative element meaning it does not react with rock, water, or organic components of the aquifer system. Elevated chloride concentrations are often the first indications of septic leachate.

Trace metals in septic tank effluent include lead, copper, cadmium, and zinc. These metals are typically associated with plumbing fixtures in the home, and due to prevalent redox-pH conditions of ground water in the watershed, seldom travel significant distances in ground water. Above the water table adsorption/precipitation reactions remove much of the trace metal concentration.

Biological scans of septic tank effluent include coliform and viral characterization. Fecal coliforms, total coliforms and fecal streptococci are associated with septic tank effluent. Viral contamination has received little study; however, viral detection in ground water has been reported. Filtration, sedimentation, adsorption, and natural die-off reduce biological/viral concentrations in the vadose zone if sufficient separation is given between the drainage lines and the water table. Insufficient separation, whether due to high water tables and/or improper construction/installation, can lead to biological (and chemical) contamination of ground water and surface water. Bacterial contamination of water wells by septic systems is the second most common reason for well replacement in the southeastern U.S. (Canter and Knox, 1985).

Nutrients in septic tank effluent include phosphorus and nitrogen. Nitrogen is present in high concentrations in septic tank effluent at a ratio of 75-80% ammonium-nitrogen to 20-25% organic nitrogen. Total nitrogen concentrations in effluent vary from 25 to 100 mg/l (avg. = 35-45 mg/l). Research indicates that 20 to 40% of the nitrogen in effluent may be removed by mineralization, nitrification, denitrification, adsorption, biological uptake, fixation or volatilization before the effluent reaches the ground water. The remainder is converted to nitrate. Phosphorus concentrations range from 6 to 30 mg/l (avg. = 25 mg/l) with 85% in the orthophosphate form. Due to strong adsorption/precipitation reactions in the soil and carbonate aquifers, phosphorus compounds seldom travel significant distances in ground water.

Recommendations

The District should work with county and local governments and other interested agencies to formulate land use plans that would prevent additional nitrogen loadings to the watershed. Planning for the elimination of septic tanks in particular areas should begin immediately. First priority should be given to areas where high nitrogen is present in the Floridan aquifer and areas of close proximity to discharging springs and coastal waters. Waste disposal practices that are compatible with the region's karst geology and high water tables, and its accompanying extreme vulnerability to groundwater contamination, must be implemented. These practices include:

- a. Avoidance of high densities of septic systems.
- b. Planning for the development of centralized AWT systems.
- c. More stringent design, construction, and monitoring of large-scale percolation or spray-field systems.
- d. Proper storage and treatment of stormwater.

Where dense populations of septic tanks occur, educational materials should be developed to inform property owners on proper septic tank maintenance with emphasis on tank rehabilitation every 3-5 years.

Strategies

1. County/municipal governments expand sewer services so that the elimination of septic tanks begins in the near future (especially where nitrogen is present in the aquifer). This is being done in the Homosassa area.
2. County/municipal governments construct or modify existing wastewater facilities to use AWT or other nutrient-removal technologies.
3. Develop educational projects with local entities to educate property owners with septic systems on proper septic tank maintenance. Design requirements, ordinances, and permitting of septic tanks are currently the responsibilities of the HRS county public health units (CPHU) under Chapter 381 F.S. and Chapter 10D-6, "Standards for Onsite Sewage Disposal Systems" of the Florida Administrative Code (FAC).
4. Develop program where septic tank maintenance is tracked in order to identify focus areas for educational, grant, or remediation efforts.

Cooperators

SWFWMD, Pasco, Hernando, and Citrus Counties, FDEP.

WQ - 3

Address Data Gaps and Monitoring Needs.

Background

There are no consistent surface or groundwater quality data monitoring efforts for many areas of the Springs Coast watershed. Furthermore, the interval, frequency, and quality of existing data is often inadequate and/or poor, limiting its usefulness to managers and planners for making informed decisions.

The Southwest Florida Water Management District has approximately 1,800 lakes (Gant, 1996), an estimated 8,900 miles of rivers, streams and canals, and vast aquifer systems. Of the District's total annual budget, approximately 22% is spent on water quality-related projects and programs associated with these water resources. Clearly, a level of monitoring effort must be maintained to ensure adequate water quality data for watershed planning, managing water quality, and ensuring the effectiveness of management activities. Generally, these data requirements fall into five general categories:

1. The collection of water quality data from consistent key sites and wells with the objective of water quality trend detection. Many such sites exist (e.g., USGS gaged sites, road crossings, structure outfalls, WQMP saltwater intrusion monitoring wells, etc.). It may be desirable to maintain most of these sites, particularly those with a long period-of-record, and to add new sites as necessary.
2. The collection of water quality data to identify surface and ground waters that deviate from local or regional ambient conditions. By increasing the spatial coverage of water quality data, it may be possible to identify streams, rivers, and lakes that have different water quality from other surface waters in the same geographical area. It will also be possible to identify areas of poor groundwater quality that threaten the use of aquifer systems.
3. The collection of water quality data for pollutant loading model development, and for the development of pollutant load reduction goals Pollutant Load Reduction Goals (PLRGs) and total maximum daily loads (TMDLs) for water bodies. Because concentrations of chemicals in flowing waters often vary greatly with the volume of flow, sites for the estimation of pollutant loads must be gaged, and samples should be collected across the range of flows common to the stream or river. Pollutant load monitoring sites should be selected to permit evaluations of loads from an entire watershed or tributary sub-basin.
4. To better protect aquifer resources, it is important to have water quality data prior to, during, and following the use of the aquifer. This allows staff to assess the impacts of

that use to processes such as saltwater intrusion, sulfate up-welling, or induced recharge.

5. The District funds numerous water quality projects within its 16-county area. Managers need pre- and post-project monitoring data to determine the effectiveness of water quality programs and projects.

The objective of this issue is to develop and implement a comprehensive water quality monitoring network for surface and ground waters within the Springs Coast watershed. This monitoring plan will be consistent with plans developed for other watersheds in the District.

Strategies

1. Formalize the Regional Ambient Monitoring Programs (RAMP) committee as the coordinating body for ambient monitoring in the SWFWMD. The RAMP committee will provide the framework for standardizing collection and analysis techniques and methods, and promote better flow of data between agencies. The monitoring committee will address a variety of sampling issues such as whether a standard suite of minimum sampling constituents should be used for all sample sites, when sampling of a particular site should end (for sites that are not long-term trend sites), and development of a review process to assess the continuing need for the level of data collection at sample sites. Other sampling issues to be addressed by the monitoring committee include the identification of entities to manage, utilize and analyze data, whether periodic summary data reports will be made available, and establishment of linkages with other agencies performing water quality monitoring to ensure ongoing maintenance of sample sites (e.g., if a sample site is dropped by one agency, others need to be informed so that sampling can be continued, if appropriate).
2. Inventory the existing data:
 - a. Identify which agencies are presently collecting water quality data, the location of sampling sites, sampling frequency, sampling purpose, which sample constituents are being analyzed, and the agency's laboratory QA/QC plan and record.
 - b. Identify the data quality, and period of record.
 - c. Identify data access, availability, and form (i.e., paper file, electronic file, etc.).
3. From the information gathered above, create a map of all sites currently monitored within the District (FY2000).

4. Identify data gaps and data needs (FY2000 to FY2001).
 - a. Coordinate with all sampling entities to attempt coordination of sample sites, sample frequency, sample quality, and sample constituents monitored, in order to avoid the duplication of monitoring effort and ensure the maximum benefit to all agencies for monitoring effort and expense.
 - b. For identified sampling sites, both existing and proposed, determine the priority for sampling, and a sampling plan for each site.
 - c. Identify where water quality data will reside, and establish the level of accessibility.
 - d. Identify means of funding and opportunities for cooperation between agencies for implementing an expanded water quality monitoring program.

2 a., 2c., 3, and the first part of 4 (for surface water sites), have been accomplished.

Cooperators

SWFWMD, RAMP, FDEP, Local Governments, USGS, and other data collection agencies.

WQ - 4

Develop and Implement Restoration Plans for Surface Water Bodies Having Poor Quality Water, and Preservation Plans for the Protection of Waters Having Good Quality Water.

Background

The FDEP adopted rules in 1979 to establish water quality standards to protect the public health or welfare and to enhance the quality of waters of the state. The standards were established taking into consideration the use and value of waters of the state for public water supply, propagation of fish and wildlife, recreational use, use or value for navigation, and agricultural, industrial and other purposes.

Restoration of areas of poor water quality and the preservation and/or enhancements of areas of good water quality are noted key issues within Citrus, Hernando and Pasco Counties. Areas of fair to poor surface water quality generally correspond to areas of increased development and/or improperly treated stormwater runoff. Some waterbodies have already been investigated and management plans and/or recommendations have been identified. Examples are the Crystal River SWIM Plan and recommendations outlined in the "Assessment of Water Quality Characteristics of the Pithlachascotee River, 1991".

In the Springs Coast watershed, another issue possibly impacting water quality may be recreational uses. The spring-fed rivers in the watershed are extremely popular for swimming, scuba diving, snorkeling with manatees, fishing and boating. These recreational uses have the potential to not only adversely affect water quality but aquatic wildlife and habitat as well. Boats in shallow waters often uproot desirable native vegetation and resuspend sediments as well as release oils and grease into the water.

Strategies

1. Work with local governments to implement management plans and recommendations already established for surface waters.
2. Assist local governments in identifying surface waters with poor water quality and in developing plans to improve water quality.
3. Coordinate with PLRG and TMDL activities.
4. Integrate planning and regulatory efforts so that permitting activities take into consideration comprehensive plans and policies. Planning efforts should include consideration of all current environmental regulations and permitting activities.

Cooperators

SWFWMD, FDEP, Florida Fish and Wildlife Conservation Commission (FWC); Citrus, Hernando and Pasco Counties.

WQ - 5

Identify Potential Mining Impacts to the Floridan Aquifer.

Background

Mining is an intense land use which has the potential to impact the Floridan aquifer system. Removal of vegetation, underlying soils, and rock stratigraphy result in vulnerable features. These vulnerable features could be exposed rock surfaces of the aquifer or rock pits that fill with ground water; both of which are susceptible to groundwater contamination. By removing the natural materials, contaminant transport rates are increased and the potential for contamination through exposed rock or ground water increases.

Major changes in the natural system could translate to effects on the Floridan aquifer. Changes in hydrology caused by mining should impact percolation rates, runoff response, and ultimately recharge rates. Loss of vegetation and the associated evapotranspiration may have an impact depending on the size of the disturbed area. Additionally, changes in hydrology or surficial aquifers impact surrounding vegetation, altering neighboring vegetative communities. An initial literature search resulted in little data or documentation of the effects of mining on the Floridan aquifer in the SWFWMD.

Groundwater pumping and/or de-watering effects associated with mining are documented in the Districts Water Use Plans (WUPs). Though localized effects are anticipated, regional models should continue to be applied to determine if regional effects are occurring.

Surface water runoff from surrounding land uses and runoff associated with mining or by-products from mining processes are potential sources for contamination. Database reviews, literature searches, various agency site inspections or corrective actions, and complaints are some of the information sources that could be used to determine if impacts are documented or occurring.

Blasting is commonly used to break loose limestone or other rock from the quarry face during mining resulting in vibrations. Blasting and other mechanical means of removing or breaking up rock could also result in vibrations. Residents living in close proximity to mines typically blame water quality changes or structural damage on blasting and the resulting vibrations. Although the effects of vibrations has been studied elsewhere, documentation regarding the correlation between water quality changes or structural damage as a result of blasting within the Floridan aquifer in SWFWMD is lacking.

Reclamation and the effects of various reclamation techniques on the Floridan aquifer within the SWFWMD also appear to have limited documentation. Although reclamation has begun in some areas, the lack of documentation may be due to a limited number of completed reclamation projects in this area. Research and techniques from other areas has been adapted and applied to this area.

It is anticipated that the effects of deposition from air pollution, particulate matter or fugitive dust on the Floridan aquifer should be negligible. These effects, if present, should first be observed at land surface or within surface water bodies. A recent study, *Sediment and Surface Water Quality of Selected Lakes in Hernando County, Florida* (Hernando County Planning Department & SWFWMD, 1997), did not detect an accumulation of heavy metals that were directly associated with air fall deposition.

It appears that effects (positive or negative) of mining and reclamation techniques on the Floridan aquifer system are not well documented within the SWFWMD.

Strategies

1. Review literature and databases (SWFWMD, USGS, FDEP, STORET, site cleanup databases, etc) to determine if water quality or other physical impacts are actually occurring in the Floridan aquifer when vulnerable features are created from mining activities.
2. Continue to use regional groundwater flow models such as the Northern Tampa Bay Water Resource Assessment Project (NTBWRAP) and the HCWRAP to determine if regional impacts are occurring.
3. Based on results of steps 1 and 2, propose specific projects or relief mechanisms, assess feasibility, determine responsible parties, and budget or negotiate for project implementation. Impacts deemed to be perception issues could be addressed through existing education programs to improve public knowledge.
4. When applicable, coordinate with and assist local governments to improve/develop land use policies and ordinances to decrease conflicts.

Cooperators

Citrus and Hernando Counties, SWFWMD, FDEP.

WQ - 6

Implement the Crystal River/Kings Bay Surface Water Improvement and Management (SWIM) Plan.

Background

Refer to Chapter II background information in the **Crystal River System** section under **LITERATURE REVIEW**. The Crystal River SWIM plan proposes several projects to further quantify the causes of the increased turbidity and to take remedial action. Proposed projects in this SWIM plan include: *Improvement of Stormwater Management Systems for Sediment and Debris Control, Removal of Accumulated Sediment from Targeted Areas of Kings Bay, Revegetation Following Sediment Removal, Water Quality Monitoring, and Removal of Accumulated Lyngbya sp. From Targeted Areas of Kings Bay*. The degree and speed of implementation of future projects will depend on available funding from the State (SWIM funding), the District, and local governments.

Strategies

- 1) The Crystal River/Kings Bay SWIM Plan has established the following goals:
 - a. Achieve and maintain water clarity that will provide an annual average horizontal Secchi reading of 45 feet.
 - b. Stabilize or remove the sediment from areas which have been demonstrated to contribute to reduced water clarity as a result of sediment resuspension.
 - c. Re-vegetate denuded areas with desirable submerged aquatic vegetation.
 - d. Restore vital aquatic habitat.

Cooperators

The City of Crystal River, Citrus County, SWFWMD, FDEP.

CHAPTER V NATURAL SYSTEMS

LITERATURE REVIEW

Overview

As stated in the District Water Management Plan, the District's overarching goal regarding natural systems is: *"To protect, preserve and restore natural Florida ecosystems and to establish minimum water levels and flows necessary to maintain these natural systems"*. The following discussion describes the current status of natural systems within the Springs Coast watershed and establishes the basis for the strategies and actions outlined in this chapter.

An Ecological Characterization of the Florida Springs Coast: Pithlachascotee to Waccasassa Rivers (Wolfe, 1990)

The above study, which is cited frequently throughout this report, provides a comprehensive description of the natural communities occurring in the watershed. General information on the overall extent, distribution and habitat value of each community are also provided. In combination with the descriptions of geology and physiography, this document serves as an outstanding source of information on the occurrence and distribution of natural systems in the Springs Coast.

Closing the Gaps in Florida's Wildlife Habitat Conservation System (Cox et al. 1994)

This document identifies important habitat for 30 focal species and certain rare communities or natural features. The Strategic Habitat Conservation Areas and Biodiversity Hot Spots delineated in the report were an important data set in the District's GIS-based identification and analysis of important core habitat and connecting corridors remaining in the watershed.

Save Our Rivers Resource Evaluations

Resource evaluations are prepared by the District in order to provide a comprehensive assessment of a candidate site's suitability for acquisition through the various land acquisition programs administered by the District. These include the Water Management Lands Trust Fund, a.k.a. the Save Our Rivers Program; Preservation 2000; and Florida Forever. Several sites in the Springs Coast watershed have been formally evaluated through this process and subsequently approved for acquisition (SWFWMD, 2001b). These include the Chassahowitzka Riverine Swamp Sanctuary, Weekiwachee Preserve, Annutteliga Hammock, Starkey Wilderness Preserve, Pasco 1 and the Hidden Lake Property. Acquisition of the Weekiwachee Preserve, Annutteliga Hammock and Pasco 1 projects is ongoing, while purchase of the other projects has been completed. The resource evaluations provide broad information regarding the hydrologic and geohydrologic characteristics of these tracts, in addition to discussions of the natural systems encompassed by the project areas.

Florida Atlas of Breeding Sites for Herons and Their Allies (Runde et al., 1991)

This publication provides a comprehensive, county-by-county listing of documented colonial nesting sites for wading birds. It includes site-specific information on the species composition of all known rookeries and estimates of productivity. Data on nesting concludes with the 1989 nesting season.

County Soil Surveys

The Natural Resources Conservation Service (formerly the Soil Conservation Service) has prepared soil surveys of each county in the Springs Coast watershed. These documents provide maps and soil descriptions, and also provide information regarding the suitability of the soils to support various land uses, e.g. agriculture. Collectively, these surveys served as the basis for the map of historic vegetation included in this plan.

AVAILABLE DATA

Geographic Information System Data Base

The District's GIS includes a wealth of geographic data and serves as one of the most important sources of information relative to the long-term protection of natural systems. Information on land use patterns, the distribution of natural land cover, the location and configuration of lands in public ownership, and a variety of site-specific information describing habitat value for wildlife were especially important in discerning natural areas that should be protected to maintain the integrity of natural systems in the Springs Coast watershed. These include digital data compiled by the FWC and the Florida Natural Areas Inventory (FNAI). The Strategic Habitat Conservation Areas and Biodiversity Hot Spots discussed previously were mapped by FWC. FNAI maintains an up-to-date digital inventory of conservation lands and has identified Areas of Conservation Interest.

Extent and Nature of Physical Alteration

Table 6 compiles land use and land cover data in a manner that helps to quantify the cumulative impacts of land development on natural systems. These data clearly reflect the disproportionate impact of development on upland communities. Wetlands in the watershed have fared much better than uplands, particularly when compared to the pattern of wetland destruction that has been characteristic of many other watersheds. This is because the majority of wetland acreage in the Springs Coast watershed occurs as large, continuous systems aligned along the coast (Maps 2 and 15). Such wetland systems have not been as susceptible to destruction through land development as the relatively small, isolated wetlands that characterize large portions of other watersheds. It has often been estimated that approximately 50 percent of Florida historically supported wetland vegetation, and that approximately 50 percent of this historic wetland acreage has now been lost to human alteration through land development.

Table 6. Comparisons of Current and Historic Land Cover in the Springs Coast Watershed.

Land Cover Category	Current Coverage (Acres)	Percent of Total	Historic Coverage (Acres)	Percent of Total	Area Lost (Acres)	Percent Historic Remaining
Disturbed	174,000	30 %	35,400	6 %	NA	NA
Agriculture	82,000	14 %	NA	NA	NA	NA
Herbaceous Wetland	17,100	3 %	14,900	2.5 %	+2,200	115 %
Forested Wetland	73,000	12 %	63,500	11 %	+9,500	115 %
Pine Flatwoods	16,700	3 %	82,600	14 %	65,900	20 %
Xeric Uplands	103,000	17.5 %	230,500	40 %	127,500	45 %
Upland Hardwoods	37,500	6.5 %	75,350	13 %	37,850	50 %
Saltmarsh	43,000	7 %	46,000	8 %	3,000	91 %
Open Water	35,750	6 %	33,150	5.5 %	+ 2,070	108 %

All land cover estimates were generated by the Mapping and GIS Section of the SWFWMD. Current land cover is based on photo interpretation of 1995 color infrared aerial photography (Map 2). Estimates of historic land cover are based on an analysis of soil surveys conducted by the United States Soil Conservation Service (Map 15). Historic land cover was extrapolated by assigning each soil type to the general land cover category most likely to occur on that soil type. Disturbance associated with mining activities and other development that pre-dated the soil surveys precluded inference of historic land cover over portions of the watershed, which accounts for the occurrence of a "disturbed" category under historic vegetation.

Although estimates of wetland area for the Springs Coast may vary somewhat, they account generally for around 25 percent of the watershed. The current and historic estimates presented in Table 6 approximate wetland proportions of 22 percent and 21.5 percent, respectively, and indicate that the percentage of historic wetland acreage remaining is approximately 115 percent for both forested and freshwater herbaceous wetlands. This suggests that the current extent of wetlands exceeds the historic and demonstrates that extrapolating historic vegetation on the basis of soils produces inexact approximations. However, when considered in terms of total acreage, the cumulative discrepancy amounts to only 2 percent of the total watershed area. Differences in aerial mapping and photo interpretation, and wetland creation resulting from mitigation and mine reclamation, may easily account for this small discrepancy. The slight increase estimated for open water areas is even less significant and can be similarly explained.

In contrast to wetland communities, the three categories of upland communities have been severely affected by development. Xeric uplands originally accounted for about 40 percent

of the total watershed land area. That figure has been reduced by more than half to only 17.5 percent. Though scrub communities accounted for a portion of these dry, well-drained “xeric” uplands, the vast majority were sandhill communities dominated by longleaf pine and turkey oak. Sandhill vegetation was the hallmark natural community of the Brooksville Ridge and is characteristic of the deep, well-drained sands which distinguish the Ridge and impart the very high groundwater recharge rates for which the region is noted. The permeability of these sands also makes the local ground water highly susceptible to contamination (Map 6).

Pine flatwoods is the natural community that has been most severely reduced by development. Only 16,700 acres remain, or approximately 20 percent of its historic coverage. The upland hardwood community which distinguishes the rich, biologically and culturally significant Annatteliga Hammock has been reduced to 50 percent of its historic coverage. Unfortunately, much of the remaining “hammock” consists of small fragments that retain little of their original habitat value.

Patterns of public land ownership can help to explain the effective protection of wetlands, relative to uplands, in the Springs Coast watershed. Table 7 lists publicly-owned tracts of land that have conservation value. As noted previously, most of the wetland in this watershed is concentrated along the coast and occurs in large, contiguous blocks. Of the 194,500 acres dedicated to conservation, approximately 141,350 acres are sandwiched between the Gulf of Mexico and US Highway 19. This amounts to fully 73 percent of conservation lands in the watershed. Three of the four large conservation tracts located inland of the coast (Citrus, Serenova and Starkey) lie on the watershed boundary, with large portions extending into adjoining watersheds. The importance of maintaining connectivity between the coastal tracts and disjunct inland tracts should be emphasized for future land acquisition.

Table 7. Conservation Lands in the Springs Coast Watershed.

Name of Conservation Tract	Total Acreage	Location	Managing Entity
Chassahowitzka National Wildlife Refuge	30,842	Citrus and Hernando Counties	USFWS ¹
Chassahowitzka Wildlife Management Area	28,656	Citrus and Hernando Counties	FWC ²
Chassahowitzka Riverine Swamp Sanctuary	5,680	Citrus County	FDEP ³
Crystal River National Wildlife Refuge	80	Citrus County	USFWS
Crystal River State Buffer Preserve	36,000	Citrus County	FDEP
St. Martins Marsh Aquatic Preserve	23,120	Citrus County	FDEP
Withlacoochee State Forest, Citrus and Homosassa Units	Approx. 32,500 (portion of Citrus outside watershed)	Citrus and Hernando Counties	FDOF ⁴
Weekiwachee Preserve	7,300	Hernando County	SWFWMD
Fickett Hammock	150	Hernando County	Hernando Co.
Annettella Hammock	8,600 (Acquisition still in progress by SWFWMD)	Citrus and Hernando Counties	FDOF and SWFWMD
Janet Butterfield Brooks Preserve	335	Polk County	TNC ⁵
Homosassa Springs State Wildlife Park	178	Citrus County	FDEP
Cross Bar Ranch Wellfield	Approx. 8,300	Pasco County	Tampa Bay Water
Hidden Lake	589	Pasco County	SWFWMD
Fillman Bayou Preserve	608	Pasco County	TNC
Werner Boyce Gulf Coast Reserve	1,685	Pasco County	Pasco Co.
Berkovitz-Pines Property	1,708	Pasco County	Pasco Co.
Serenova	6,533 (Approx. 4,500 acres in watershed)	Pasco County	FDOT ⁶
Starkey Wilderness Park	8,620 (Approx. 4,000 acres in watershed)	Pasco County	SWFWMD

TOTAL WATERSHED ACREAGE IN CONSERVATION = ca 194,500 (33.5% of total)

¹ United States Fish and Wildlife Service

² Florida Fish and Wildlife Conservation Commission

³ Florida Department of Environmental Protection

⁴ Florida Division of Forestry

⁵ The Nature Conservancy

⁶ The Florida Department of Transportation

SUMMARY

As the Springs Coast watershed continues to grow, so will the nature and variety of natural resource management issues. Several issues have been identified by the Springs Coast CWM team as priorities to be addressed. Acquisition and/or protection of remaining natural habitat areas to provide connection between coastal wetland and upland ridge preserve areas was a significant identified need. Ongoing drought conditions have resulted in declines in area surface and ground water resources, prompting concerns about the long-term availability of such resources. Increasing population has resulted in greater awareness of and demand for recreational and other uses of publicly-owned lands.

Other issues in the Springs Coast watershed include the potential for mining extraction activities on federal mineral rights within the Withlacoochee State Forest, management of invasive exotic plants and preservation of the estuarine ecosystems for their economic and habitat values.

NATURAL SYSTEMS ISSUES

NS - 1

The Destruction and Fragmentation of Natural Systems.

Background

Florida's population is estimated to experience a net increase of approximately 700-900 new residents each day. This phenomenal rate of growth has continued without apparent interruption for many years and is reflected in a myriad of impacts to natural systems. One of the most problematic of these impacts is the high rate of conversion or destruction of natural lands through development designed to accommodate the expanding population. Beyond the obvious destruction of those natural lands that fall directly beneath the footprint of new development is the more insidious destruction that results from fragmentation. As natural areas are broken into ever smaller units by new construction of buildings, roads, and utility corridors, the long-term viability of what remains is diminished significantly. The actual destruction of natural lands in Florida far exceeds any estimate based solely on acreage converted by development since many of the fragments remaining after development represent non-viable remnants that lack significant value to native wildlife.

One of the District's primary strategies for protecting natural systems is implemented through the acquisition and subsequent preservation of natural lands. The science of conservation biology has defined several guiding principles for designing preserve areas (Soule and Simberloff, 1986). The primary rule of preserve design postulates that "bigger is better". Small preserves can fulfill important conservation objectives, including the protection of highly-imperiled plant or animal populations or rare natural communities. They can also satisfy demands for certain forms of outdoor recreation. However, only large areas are likely, or able, to encompass a diverse range of natural communities that can be effectively managed with such necessary land management techniques as prescribed burning. Large preserves are also essential if we are to successfully provide sufficient habitat to ensure the long-term survival of genetically-viable populations of a complete assemblage or complement of native species.

The current extent of habitat fragmentation and alteration in Florida dictates that many of our existing preserves will not support populations of large mammals, and many other species, unless these areas remain connected to one another by natural corridors that will permit the movement of wildlife between a linked network of preserves. Maintaining such linkages can effectively increase the "size" of a preserve and allow for gene exchange between populations that would otherwise be isolated from one another, thereby reducing the likelihood or incidence of inbreeding and its negative biological consequences (Harris, 1991).

A recent analysis of endangered ecosystems in the United States determined that Florida faces the greatest overall risk of ecosystem loss (Noss and Peters, 1995). Given the tremendous extent to which Florida's natural landscape has been modified by development, the Springs Coast watershed is noteworthy for both the extent and diversity of its remaining natural lands. Of the 21 most-endangered ecosystems distinguished in the nationwide analysis by Noss and Peters six are well-represented in the watershed. These include: longleaf pine-turkey oak sandhill, which has been reduced to only 15 percent of its historic range on the Gulf coastal plain (Noss and Peters, 1995); Florida scrub, which has been eliminated from 65-75 percent of its original state-wide range; old-growth eastern deciduous forest, which is a forest type that reaches the southern limit of its range in this watershed's Annutteliga Hammock, though the remaining fragments are presumably second-growth stands as a result of extensive logging conducted during the early 1900s; southern forested wetlands, which are represented by a spectacular, unbroken expanse of hydric hammock along the watershed's Gulf Coast shoreline; cave and karst systems, consisting here of a unique network of first-magnitude springs and spring-fed rivers; and coastal communities which comprise one of the most pristine and productive estuarine systems in Florida. The degree of threat to these communities has also been recognized by the Florida Natural Areas Inventory (Florida Natural Areas Inventory and Florida Department of Natural Resources, 1990). Viewed from a broader perspective, the coniferous (longleaf pine) and broadleaf (hammock) forests of the southeastern United States were recently listed among the most "biologically-valuable" of the earth's "ecoregions" (Olson and Dinerstein, 1998). Consistent with the "most-endangered" status conferred by Noss and Peters on the basis of historic rates of destruction, these forests were designated as "critically-endangered" by Olson and Dinerstein.

In addition to being blessed with an impressive array of natural communities or ecosystems, the Springs Coast watershed has benefitted from a long history of land preservation efforts that have placed many of the most significant remaining natural areas under public ownership (Map 16). These sites are listed in Table 7. Additional sites proposed for protection through public purchase of either fee-simple title, or a less-than-fee interest, are also identified in Map 16. A District-wide analysis of remaining natural lands employed a Geographic Information System to assess the relative importance of these proposed acquisitions and identify other sites that may merit consideration for such protection. The analysis distinguished the most valuable areas of "core" habitat and the best remaining linkages, or corridors, between neighboring cores on the basis of total land area, contiguity, and configuration (Map 18). Additional coverages used in evaluating the relative importance of cores and corridors included: Strategic Habitat Conservation Areas as identified by the FGFWFC (Cox et al., 1994); Areas of Conservation Interest A and B as identified by the Florida Natural Areas Inventory; documented occurrences of rare species or ecologically-significant natural features; areas of high groundwater recharge; the 100-year floodplain as mapped by the FEMA; protection areas for surface water supplies; and priority watersheds. Areas of Conservation Interest, Strategic Habitat Conservation Areas and Areas of Conservation Interest are delineated in Map 17.

The analysis described above suggests that efforts to protect natural systems through land protection should be concentrated in specific areas. These areas include the northern segment of the coastline (extending from the Homosassa River northward to the boundary of the watershed), the Annutteliga Hammock, an existing gap in public ownership between the Weeki Wachee River and the southern boundary of the Chassahowitzka Wildlife Management Area, and a small coastal segment located immediately south and west of the District's Weekiwachee Preserve. Protection of these tracts would preserve the overall size of the core habitat area protected along the coastline by maintaining existing contiguity within that system; maintain existing connectivity between the coastal core and the core habitats provided by the Citrus Tract (Withlacoochee State Forest) and the Big Bend coastline located north of the watershed; and prevent loss of valuable coastal habitat at the southern end of the Weekiwachee Preserve. The latter lands serve as habitat for a population of the threatened Florida black bear and other imperiled species, and also help to buffer the Weekiwachee Preserve from the intensive development that has consumed the coastal area in the southern reaches of the watershed. Another portion of the watershed that may merit consideration for land protection efforts is west-central Pasco County, in lands east of Port Richey extending from the Starkey Wilderness Preserve toward the Weekiwachee Preserve.

The highest priority for habitat protection lies in the coastal lands at the northern end of the watershed. These lands connect the coastal systems of the watershed with the Big Bend coastline, creating a continuous swath of core habitat that accounts for a total land area of nearly 1.2 million acres. Although the vast majority of this core area lies outside the boundaries of the District, maintaining connectivity within this vast system may be essential to ensuring the long-term integrity of the watershed's network of preserve lands. The second level of priority rests with protecting the gap in public ownership north of the Weeki Wachee River and in maintaining connectivity with the Citrus Tract via protection of the Annutteliga Hammock. The latter project would, in addition to maintaining connectivity, protect the remaining remnants of the hammock vegetation that distinguished this region of Florida. Most of the original expanse of hardwood forest associated with the Annutteliga system has been lost to development and mining of limerock. Hernando County, which has implemented a local land acquisition program, has identified the remaining portions of the Annutteliga Hammock as an acquisition priority.

Strategies

1. Maintain connectivity of the District-held Weekiwachee Preserve with other natural lands to the north by placing a high priority on protection of those lands between the existing Preserve and the Chassahowitzka Wildlife Management Area.
2. Encourage the FDEP to pursue protection of lands situated between the Big Bend and publicly-owned lands located in the coastal area of the Springs Coast watershed in order to maintain connectivity between these neighboring systems. Many of the intervening lands are not currently identified as project lands of the state's Conservation

and Recreation Lands Program, or of any other public acquisition program. Possible partners in the project include Citrus County and the Florida Power Corporation, which owns lands associated with the Crystal River power plant facility.

3. Develop viable alternatives for wildlife movement on the coastal portions of the Cross Florida Greenway. The current canal portion of the Cross Florida Greenway effectively serves as a barrier to the movement of wildlife from habitat areas between the northern portions of the watershed and areas north. Specifically, modifications are needed to allow for the movement of bears and other wildlife across the canal portion of the Greenway. Such activities may include reduction or elimination of portions of the berm, reduction of littoral slopes or canal width, and/or creation of shallow water crossing areas.
4. Aggressively pursue the acquisition of lands in the Annutteliga Hammock project area. Coordinate such efforts with the FDEP and Hernando County acquisition programs.
5. Develop an outreach program to inform the public of the District's ongoing land acquisition projects and to cultivate understanding and support for continued land protection efforts in the watershed. The target audience for the outreach program should include local government officials and private citizens. The District will provide affected local governments with information regarding the District's analysis of natural systems and will also make speakers and related information available to local clubs, civic organizations, and interested citizens.

Cooperators

Local Governments, SWFWMD, FDEP, FDOF, FDOT, Florida Resource Conservation Service, FWC, Army Corp of Engineers, and USEPA.

NS - 2

Declining Ground Water and Lake Levels.

Background

As the region continues to grow, concerns have been raised about long-term declines in ground water and lake levels within the Springs Coast watershed. Some factors that have been cited as potential contributors to the declines include below-average long-term rainfall patterns and large-scale groundwater pumping.

In recognition of these concerns, the District's Governing Board established the Northern Tampa Bay Water Use Caution Area (NTBWUCA) in 1989 which includes the southernmost portion of the Springs Coast watershed. Establishment of the NTBWUCA resulted in target goals for water use reduction for a variety of users within the region. In support of the NTBWUCA, the District has undertaken extensive hydrologic studies to evaluate the region's ground and surface water resources, including ground and surface water interaction and limits on withdrawals for human needs. Two studies applicable to the Springs Coast watershed include the NTBWRAP and the Hernando County (the County) WRAP.

Reduced rainfall and regional wellfield pumping were cited as partial contributors to the decline of ground and surface water resources, including wetland and lake level impacts, within certain portions of the NTBWUCA (SWFWMD, 1990). To address these impacts, a series of management strategies were developed and/or implemented, including efforts to reduce per capita water use, promote aggressive conservation and wastewater reuse programs and proposed reductions in wellfield withdrawals (SWFWMD, 1990). To further offset groundwater withdrawals, the District developed the New Water Sources Initiative (NWSI) program to identify and fund the development of alternative water sources. This program, in conjunction with the recent Partnership Agreement and New Water Plan with Tampa Bay Water, has been successful in initiating several projects that will significantly offset demands on traditional groundwater resources.

In addition to the above activities, the District has recently established minimum flows and levels for site-specific ground and surface water resources within the NTBWUCA. The District has also developed a priority schedule for the establishment of minimum flows and levels for ground and surface water resources within other portions of the District, including the Springs Coast watershed. Lake levels have already been established for selected waterbodies within the watershed; however, additional flows and levels will be established based on the priority schedule included in the District's Water Management Plan (SWFWMD, 2000a). The establishment of such flows and levels will enhance the District's ability to manage and protect water resources and related natural resources.

As with the NTBWRAP, the Hernando County WRAP was implemented in response to concerns about declining groundwater levels between the late 1980s and 1994. These declines were attributed to reduced rainfall during this same period; however, concerns were raised about a possible correlation with groundwater pumping. Further, local interests also felt that the Tampa Bay region may be interested in developing additional wellfields within the County and an accurate accounting of the County's groundwater resources was necessary. As a result of these concerns, the District undertook a hydrologic analysis of the Hernando County region.

One of the primary goals of the ongoing Hernando WRAP is the development of computer models of the region's groundwater flow system. These models will subsequently be used by the District in assessing the availability of groundwater resources and establishing withdrawal strategies within Hernando County. Recently-completed phases of the Hernando County WRAP report provide an analysis of existing data, recommendations for new data collection and details on the development of the regional groundwater flow model. Several factors that may limit the development of groundwater resources within Hernando County have been identified including hydraulic characteristics of the aquifer, recharge, water quality, high susceptibility for pollutant introduction and potential impacts on lakes, streamflows and/or spring discharges from groundwater withdrawals (HydroGeoLogic, 1997).

Strategies

1. Continue to monitor the developments within the NTBWUCA as they relate to, and have the potential to affect, water supply development within the Springs Coast watershed.
2. Continue current data collection efforts to monitor hydrologic conditions within the watershed.
3. Implement additional data collection and monitoring programs identified in the Hernando County WRAP.
4. Initiate a Northern District WRAP to assess the resource and determine appropriate areas for water supply development.
5. Establish minimum flows and levels for selected water resource features within the Springs Coast watershed.

Cooperators

Local Governments, SWFWMD, FDEP, TBW, FWC.

NS - 3

Management of Publicly-Owned Lands.

Background

A total land area of approximately 194,500 acres is devoted to resource conservation in the Springs Coast watershed. These lands include: approximately 31,000 federally-owned acres managed as part of the national wildlife refuge system; 130,250 acres of state-owned lands; 18,500 acres of District-owned land; 3,500 of county-owned lands; and nearly 1,000 acres of privately-owned lands. The predominance of publicly-owned land among lands dedicated to conservation reflects the importance of public land management to the protection of natural systems in this region. Additional acquisitions are proposed in order to enhance the ability of these natural areas to perpetuate a full complement of native flora and fauna. Existing and proposed preserve lands are discussed in detail in NS-1.

Active management of publicly-owned preserve lands will be essential if the natural values of these areas are to be maintained. Many of Florida's natural communities (e.g. pine flatwoods, sandhill, scrub and wet prairie) are fire-dependent systems that require recurring fire if habitat values and biodiversity are to be preserved. In the prolonged absence of fire, fuel loads become greatly-elevated and the threat of destructive wildfire increases. A horrific series of wildfires during the summer of 1998 destroyed many private residences and other structures and reflects the destructive potential of wildfire on lands subjected to prolonged periods of fire exclusion. Prescribed fire has been, and of necessity will continue to be, the District's most important land management tool. Adjacency with privately-owned lands greatly complicates the District's ability to use prescribed fire. The danger of fire escaping to neighboring lands, or of fire-generated smoke blanketing adjoining lands and public roadways, sometimes precludes the use of fire in boundary areas. Yet these sites may pose the greatest danger to adjoining lands in the event of wildfire, and methods or strategies to manage fuel loads in these areas must be implemented.

The habitat values of District lands will play an important role in preserving Florida's native wildlife. Although use of prescribed fire will do much to maintain the habitat value of these lands, there are other management needs that must be met to adequately protect wildlife. Invasion by exotic species, which is addressed elsewhere in this chapter, must be controlled through aggressive action. Restoration of altered areas within District-owned lands must also be pursued and a comprehensive plan to accomplish habitat restoration objectives has been developed by the District. In some cases, species-specific actions are required to effectively manage wildlife, particularly those species with special habitat needs or those designated as threatened or endangered. The District recently implemented, in partnership with other public agencies and several private interests, a research project aimed at identifying habitat needs of a black bear population residing in the Weeki Wachee/Chassahowitzka Swamp region. The cooperative project may set the stage for

management of adjoining public lands on an ecosystem scale, rather than as independent ownerships.

Public use of the District's lands poses another major management challenge. Resource-based recreational use is permitted on virtually all District-owned tracts. Efforts to limit such use to activities that are compatible with resource protection objectives requires that certain uses be prohibited, resulting in pressure to compromise resource protection in order to accommodate intensive or incompatible uses. Incompatible recreational use or development is now widely perceived as one of the primary threats to protecting the environmental integrity of publicly-owned preserve lands. Uses other than recreation, such as cattle grazing or utility line rights-of-way, may also be permitted where appropriate or if compelled by overwhelming public interest. Increasingly, public lands are being targeted for uses other than conservation or preservation. Attempting to balance resource protection needs with the public's desire for access and use will remain a difficult management dilemma.

Strategies

1. Execute a Memorandum of Understanding, or other formal agreement, with the Florida Division of Forestry, FWC, FDEP, and other appropriate partners to ensure implementation of an ecosystem-based approach to management of the Chassahowitzka/Weeki Wachee population of the Florida black bear. Such agreement should recognize the necessity of coordinated management and the potential need for departures from established, ongoing management schemes. The agreement, and resulting cooperative management, should be viewed as a model for future application to other management-related issues that transcend ownership or jurisdictional boundaries.
2. Develop original materials to educate the public regarding the importance of prescribed fire as a land management tool. These materials should highlight: the natural and recurring incidence of fire as a fundamental force that shaped Florida's landscape and environment; fire's habitat-enhancement benefits; the habitat degradation that results when fire is excluded from fire-maintained natural systems; the increased threat of dangerous and destructive wildfire in areas where fire suppression or exclusion allows fuel loads to exceed safe, healthy levels; the basic protocols and scientific method that are followed when planning and conducting prescribed fires to protect the public and ensure an environmentally-beneficial result; and the long-term importance of continuing to manage public lands with prescribed fire. The materials should be freely-available to the public and should be actively-distributed to citizens residing or working near District lands that are managed with fire. Whenever possible, live presentations by District personnel should be used as the venue for distribution of such materials.
3. For each District-owned property, compile site-specific information and recommendations that can be used to guide future land use decisions for surrounding

lands and distribute the information to affected local governments. The information should pinpoint boundary areas where prescribe fire will be used so that future development of neighboring private lands can be designed to accommodate this, and other (e.g., public access, habitat restoration), land management needs. The District will coordinate with local governments to help ensure that neighboring private lands are used and developed in a manner that will be compatible with long-term land management needs.

4. Produce an updated recreational guide for District-owned lands that addresses recreational use of lands acquired since the initial publication of the District's current guide. Include a brief discussion of the adverse impacts that can result from inappropriate recreational use of sensitive areas and emphasize the importance of individual responsibility for compliance with guidelines on allowable uses.
5. Conduct, promote and fund research into the impacts of various recreational activities to determine their suitability and compatibility within various habitat areas. Determine BMP's and carrying capacities for recreational activities. Implement management and enforcement measures.

Cooperators

SWFWMD, FDEP, FDOF, FWC, USFWS, Local Governments.

NS - 4

Invasive Exotic Plant Management.

Background

The protection and preservation of natural ecosystems, including associated native plant communities, requires effective management of exotic plant species. The invasion of native plant communities and ecosystems is widely-recognized as one of the primary threats to the environmental integrity of Florida's remaining natural areas. Due to their rapid growth and freedom from the population controls typically imposed by their natural predators and pathogens, invasive exotics can often displace native species, destabilize community structure, and reduce the overall abundance and diversity of species on the wild. Aquatic species, such as water hyacinth, water lettuce and hydrilla can negatively affect fish and wildlife populations and interfere with recreational use of surface waters. If left unmanaged, these invasive species can also degrade water quality, impede flows and increase sedimentation rates. The District conducts aquatic plant management operations on natural waters in coordination with the Department of Environmental Protection, the FWC, the U.S. Army Corps of Engineers and local government agencies. Funding is provided through the above agencies and by District Basin Boards where appropriate (SWFWMD, 2000a).

In addition to aquatic species, many exotic terrestrial species have become increasingly prevalent in recent years and pose concerns for management of upland natural resources. Two plants of particular concern in the Springs Coast watershed include skunk vine and cogon grass. Vines are especially troublesome due to their ability to climb the bases of native trees and blanket the canopy, eventually killing the trees and understory vegetation. This characteristic growth pattern makes it difficult to control through the use of herbicides due to coincidental destruction of native, non-target species. Fire ecology is also disrupted as the vines provide a conduit for fire to reach tree canopies, thereby killing native trees. The District has budgeted funds for a cooperative two-year biological control feasibility study of skunk vine in an attempt to develop effective control methods.

Cogon grass is one of the most widespread invasive exotic plants in Florida and has invaded a variety of disturbed areas, such as roadsides, fence and fire lines, un-maintained pastures, powerline rights-of-way and timber-harvested lands. Cogon grass is now beginning to also invade undisturbed habitats, quickly replacing the diverse native plant species. Impacts from cogon grass include disruption and alteration of natural fire ecology and displacement of native plants. Although widespread, most populations of cogon grass are relatively small and respond well to an aggressive herbicide control program.

Concerns about the continued proliferation of exotic plants led to the formation of the Inter-District Exotic Plants Committee in 1996. The goal of the Committee is to broaden cooperative efforts on exotic plant management through additional partnerships with other

agencies, affected communities and the state university system. One product of the Committee was the 1997 publication of the cooperative inter-district report Exotic Plant Invasion On Florida's Water Management District Lands. The report provides an examination of the problems posed by invasive exotic plants, presents current efforts by the water management districts to manage problem species and provides specific recommendations for future cooperation on the issue (SWFWMD, 1997b).

Alternatives available for eradicating or controlling occurrences of exotic plant species normally rely upon mechanical, chemical, or biological methods. These methods, whether applied individually or in combination, may sometimes result in damage to non-target, native species. The possible impact of an eradication or control effort on native species must always be weighed against the perceived benefit and urgency of the project. Mechanical methods, consisting of physical destruction or removal, may potentially intensify or perpetuate problems associated with invasions of exotic plant species by disturbing soils or creating openings within existing layers of vegetation. Many exotic plant species prefer to colonize disturbed sites or gain an initial foothold in such areas. Chemical methods of controlling exotic species utilize herbicides to destroy plant tissues and have great potential for destroying non-target native species, as noted previously. Herbicides can also affect native wildlife or pollute nearby surface waters, and must therefore be applied very cautiously and judiciously. Generally, biological techniques dependent on the introduction of a predator or pathogen that is very host-specific to the offending exotic species is preferable to either mechanical or chemical methods. These techniques will be incorporated into the District's program as they are developed by researchers, provided that they are safe and effective.

Strategies

1. Inventory and map exotic plant infestations on public lands.
2. Develop property specific invasive exotic management plans which address species, acres infested and cost of control.
3. Develop management practices to minimize local introduction or reinfestation of invasive exotic plants.
4. Continue existing and formulate additional partnerships with local governments, universities and other government agencies for cooperative research to develop biological controls and "best management practices" for the control of exotic species.
5. Develop partnerships with private landowners to assist in the control of invasive exotic species.
6. Support legislation that addresses the control of invasive exotic species.

7. Develop public educational materials that describe the threat to Florida's ecosystems from invasive exotic plants. Include information on the threat of exotics in the District's plant guide and recommend against the installation of invasive exotics in home and commercial landscaping.

Cooperators

Citrus, Hernando and Pasco Counties, FDEP, SWFWMD.

NS - 5

Preserving the Economic Benefits of the Estuarine Ecosystem.

Background

The total size of the Springs Coast watershed has been estimated at 800 square miles, or 512,000 acres. This total does not include an estuarine ecosystem that extends in a nearly unbroken swath along the entire shoreline. The bays, rivers, saltmarshes, seagrass meadows, oyster bars and tidal flats of which the estuary is composed cover a total area of approximately 71,000 acres. When considered part of the watershed the estuary accounts for 12 percent of the total 582,000 acre watershed area; however, the importance of the estuary to the economic base of surrounding communities and its significance as a defining feature of the watershed far exceeds its areal extent. Protection and proper management of its resources will be of long-term importance to the region and will revolve largely around water-related issues.

The biological productivity and direct economic benefits associated with estuaries have long been recognized. Other benefits are more difficult to measure but still merit recognition. These "hidden" benefits include such intangible factors as quality of life considerations and aesthetic values, which are reflected in development patterns that have concentrated Florida's population along the coastline.

Less intangible, but also difficult to attach economic values to, are flood protection and water quality enhancement benefits. Estuaries generally consist of sheltered open water areas and associated shallow water features such as saltmarshes, seagrass meadows and tidal flats. In the Springs Coast watershed, the juxtaposition of such features between developed shorelines and the open waters of the Gulf of Mexico provides a buffer that can absorb some of the destructive impact of storm generated winds and tidal surges. Much of the shoreline of Hernando and Citrus Counties is offered additional protection by a long band of hydric hammock forest occurring just inland of the estuary. Most of this band of dense forest is protected through public ownership and its preservation greatly enhances the natural flood protection offered to coastal residents. The wetland vegetation of the estuary can also assist in maintaining or improving water quality conditions by filtering and assimilating many waterborne pollutants and stabilizing bottom sediments. These benefits may be especially important to estuaries that are ringed by development and therefore subject to inputs of contaminated waters. Additional discussion of the flood protection and water quality enhancement benefits of the estuary can be found in the flood protection and water quality chapters of this plan.

Direct human use of the estuary provides benefits that are much more easily measured in economic terms, although studies focusing on the Springs Coast region have apparently not been conducted. Statistics and anecdotal evidence alluding to those benefits are available from a number of sources. For example, it has been estimated that up to 97

percent of the total weight of seafood harvested commercially in the Gulf of Mexico consists of estuary-dependent species (Bell, 1989). Recreational harvests are estimated to be 80 percent estuary-dependent species, with such species defined as those that spend at least part of their life cycle in estuarine waters. Many of these species are wholly dependent on estuaries. It has also been estimated that the economic value of commercial seafood harvests on Florida's west coast are at least 95 percent estuary-dependent species.

A 1995 study of the Indian River Lagoon estuary on Florida's east coast produced an estimated economic value of \$700 million per year, with nearly half of that value provided by recreational fishing (Apogee Research, Inc. and Resource Economics Consultants, Inc., 1996). The remaining value was generated by commercial harvests and water-related recreational uses other than fishing. Values associated with flood protection and water quality enhancement were not considered. It is difficult to extrapolate similar values for the Springs Coast watershed; however, data for 1979 indicate that total recreational fishing trips and total number of fish landed by recreational fishing on Florida's west coast slightly exceeded the numbers for the east coast. In fact, recreational fishing activity on the west coast of Florida exceeded that of all other shorelines in the southeastern United States (Bell, 1997). Statistics specific to the counties of the Springs Coast watershed indicate that, collectively, the area generated a total of 18,370 fishing trips and landed over 4.5 million pounds of seafood in 1995 (BEBR, 1996). By 1999, the number of fishing trips had grown to 19,753 with approximately 5.1 million pounds of seafood landed (BEBR, 2000).

Other information that points to the economic significance of the estuary revolves around recreational usage. On a nationwide basis, the public's total expenditures for recreational saltwater fishing and wildlife watching during 1996 accounted for \$8.1 billion and \$29.2 billion, respectively (U.S. Dept. of Interior and U.S. Dept of Commerce, 1997). Approximately \$12.6 billion were spent on trip related expenses, e.g. food and lodging, associated with these activities. The portion of this total amount that can be traced to the Springs Coast is unknown; however, there are a number of nearby natural attractions that cater to these forms of recreational activity. The publicly-owned natural areas discussed previously include many that are situated within or beside the estuary, with the waterfront serving as the focal point of recreational use. The USFWS estimates there were 91,515 visitors to the Crystal River National Wildlife Refuge and 33,340 visitors to the Chassahowitzka National Wildlife Refuge during 1996. Estimates of visitation rates for 1997 at other nearby sites include: 250,000 for the Homosassa Springs State Wildlife Park; 17,800 to the Chassahowitzka River Campground and Park; and 70,000 to the park at Pine Island. These figures suggest that the economic impact of the estuary to local governments may generally exceed expectations and that protection of this valuable resource should be a continuing priority.

Oil spills may represent the most potentially-catastrophic threat facing the estuary of the Springs Coast. Large quantities of oil and related compounds regularly pass through the Port of Tampa a short distance to the south. Spills in that area clearly demonstrate the

plausibility of such an event occurring locally. The sensitivity of the local coastline to oil contamination has been analyzed and it was determined that of all the various forms of shoreline represented in the region, salt marshes are the natural community that would be affected most severely by oil contamination (Research Planning Institute, Inc., 1984). The extensive marshes of the estuary would be extremely difficult, if not impossible, to clean or rehabilitate following contamination. The contribution of salt marsh to the overall productivity and stability of the estuary and its related economic values suggests that such contamination would be devastating. The District should ensure that an appropriate emergency response strategy is prepared for the Springs Coast watershed's coastline.

Strategies

1. Promote protection of seagrass meadows by educating the public on the importance of these areas to estuarine fisheries production. Possible outreach measures include: erection of educational displays at major boat launching facilities; coordinating with the Department of Environmental Protection to produce a brochure or other educational literature that can be disseminated at local marinas and tackle shops.
2. Identify seagrass meadows that have been severely degraded by prop dredging and coordinate with FDEP and others, as appropriate, to implement exclusion zones designed to prevent additional damage and allow recovery.
3. Strongly encourage the Florida Department of Community Affairs to develop an emergency response strategy, with clearly established chain-of-command and assignment of responsibility, for addressing oil spills along the Springs Coast shoreline. The District should examine such an emergency response strategy and be prepared to assist or expedite its implementation, consistent with ownership and responsibility for management of the Chassahowitzka Riverine Swamp Sanctuary and the Weekiwachee Preserve.
4. Emphasize the economic significance of the estuarine system in support of strategies designed to improve water quality conditions where they have been degraded or to maintain water quality where it remains good. Refer to Chapter II for a discussion of initiatives related to water quality.
5. Emphasize the economic significance of the estuarine system in support of strategies designed to restore freshwater inflows to the system in areas where they have been reduced through human-related impacts and to maintain existing flows where they remain natural. Refer to Chapter V for a discussion of initiatives related to water supply.

Cooperators

Citrus, Hernando and Pasco Counties, USFWS, FDEP, Florida Department of Community Affairs, SWFWMD.

NS - 6

Mining in the Withlacoochee State Forest.

Background

The Withlacoochee State Forest (WSF) encompasses approximately 148,000 acres within Citrus, Hernando, Pasco and Sumter Counties. The largest tract, comprising approximately 43,000 acres of the WSF lands, is located in central Citrus County. The majority of this tract (approximately 30,000 acres) is within the boundary of the Springs Coast watershed. The smaller Homosassa Unit of the WSF is located wholly within the watershed. The WSF contains a variety of habitat types including sandhill, pine flatwoods and cypress swamps. In 1994, the United States Department of the Interior, Bureau of Land Management (BLM) submitted a draft Florida Resource Management Plan and Environmental Impact Statement (RMP/EIS) that included alternatives for future management of BLM-administered lands and mineral ownership within the state (United States Department of the Interior, 1994).

The RMP/EIS addresses split-estate Federal Mineral Ownership (FMO) on 395,000 acres within 59 of the state's 67 counties. On split-estate FMO, the federal government owns all or a portion of the mineral estate, but the surface estate is owned by either the State of Florida or private interests. The vast majority of split-estate FMO lands, approximately 300,000 acres, lie beneath state-owned lands including the Blackwater River State Forest, which has potential for oil and gas development, and the Withlacoochee State Forest, which has limestone development potential.

With respect to the WSF, the purpose of the RMP/EIS was to decide what restrictions to place on the mining of limestone. Four alternatives were analyzed as options. Alternative 1, or the no action alternative, would allow continued mineral development subject to Standard Management practices and additional case-by-case constraints. Alternative 2 would place explicit constraints on mineral development to protect natural resource values with mining in the WSF subject to the consent of the State of Florida. Alternative 3 would close the WSF to limestone mining. The Preferred Alternative, generally equivalent to Alternative 2, would place constraints on mineral development to protect natural resource values, with mining of the WSF subject to consent of the State (U.S. Department of the Interior, 1994).

A current proposal would require the State of Florida to buy lands within the Pinhook Swamp in Columbia and Baker Counties as an addition to the Osceola National Forest. In exchange, the BLM would relinquish all mineral rights within the WSF. The State Board of Trustees of the Internal Improvement Trust Fund has conducted appraisals of mineral rights within state-owned lands for use in exchange negotiations (Florida Department of Agriculture and Consumer Services, 1998).

Of related issue was a requested 10-year lease extension for a formerly active limerock mine within that portion of the WSF located in the Springs Coast watershed. The mine, operated by Florida Rock Industries at Radar Hill, is located adjacent to the Heatherwood subdivision in Citrus County. Provisions of the lease extension would have precluded disturbance or mining of additional surface areas within the lease holding, instead allowing the extraction of solution or "soft" limerock resources that underlie formerly mined "hard" limerock areas. The application for lease extension was subsequently denied.

Strategies

1. Continue to monitor negotiations related to the BLM mineral rights exchange issue. Provide comment or technical assistance as needed.
2. Continue to monitor current and future limerock mine lease extensions. Provide comment or technical assistance as needed.

Cooperators

US Forest Service, Bureau of Land Management, FDOF, SWFWMD, local governments.

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APPENDIX PROGRAMS, INITIATIVES AND REGULATIONS

FEDERAL

United States Army Corps of Engineers

Projects constructed by the U.S. Army Corps of Engineers for local flood protection are subject to regulations prescribed to cover operation and maintenance. These regulations are contained in Sections 208.10 and 208.11, Title 33 of the Code of Federal Regulations.

“The U. S. Army Corps of Engineers received jurisdiction over Inland Waters of the United States, for navigation purposes, in Section 9 and 10 of the Rivers and Harbors Act of 1899” (Barile et al. 1987). A revision of the Rivers and Harbors Act in 1968 extended Corps jurisdiction allowing them to consider the fish and wildlife, conservation, pollution, aesthetics, ecology and other relevant factors of a project. The Corps regulatory program was further expanded in 1972 with the passage of the Federal Water Pollution Control Act Amendments, also known as the Clean Water Act (CWA). The discharge of dredge and fill into United States waters is regulated by the Corps under Section 404 of this act. The Corps jurisdiction was extended to wetlands due to a Supreme Court order in 1975 and Amendments to the CWA in 1977 (Barile et al. 1987). The Corps also contributes 50% of the funds reimbursed to the SWFWMD by the Department of Environmental Protection for exotic aquatic plant control on Rainbow River.

United States Environmental Protection Agency

The Environmental Protection Agency (Southeast Regional Office, Area IV, Atlanta, Georgia) has jurisdiction over surface waters in the state. The agency was created in 1970 as an amalgamation of functions previously divided between the Interior Department, Department of Agriculture, Department of Health, Education and Welfare and other federal departments. Enforcement authority was given under the Clean Water Act of 1972 and broadened under its revision in 1977. Key activities include the issuance of National Pollution Discharge Elimination System (NPDES) permits and the review of permits issued by the FDEP for the treatment, disposal and storage of hazardous wastes. Authority regarding the discharge of oil or hazardous substances into surface water is divided between the USEPA and the United States Coast Guard (Barile et al. 1987).

United States Coast Guard

In inland waters the Coast Guard Auxiliary performs boating safety inspections and search and rescue missions. The Auxiliary is a volunteer group that is reimbursed for expenses when assigned a mission by the Coast Guard (Barile et al. 1987).

United States Fish and Wildlife Service

The US Fish and Wildlife Service is responsible for oversight of the federal program for fish and wildlife as authorized in the Coast Resources Barrier Act, National Environmental Protection Act, Migratory Bird Act, Endangered Species Act, and the Fish and Wildlife Coordination Act. "Under provisions of the Fish and Wildlife Coordination Act, the Fish and Wildlife Service must be consulted before the Corps of Engineers can submit a plan for Congressional approval. The Fish and Wildlife Service comments on the impacts of proposed projects on endangered species, migratory birds and other fish and wildlife and their habitats" (Barile et al. 1987). The Fish and Wildlife Service is directed to prepare environmental impacts assessments or statements for proposed Corps projects under provisions of the National Environmental Protection Act, and the Fish and Wildlife Service is authorized under the Endangered Species Act to issue "Jeopardy Opinion" against any proposed project which will negatively effect an endangered species (Barile et al. 1987).

STATE

Florida Department of Environmental Protection

The FDEP receives its authority partly from Florida state law, and partly from programs which have been delegated by the US Environmental Protection Agency. The FDEP generally has responsibilities in the following areas:

- Water quality protection
- Water management
- Drinking water quality protection
- Hazardous and solid waste management
- Wetland protection
- Power plant siting
- Aquatic vegetation management

Only a few of the areas of the FDEP's responsibility are applicable in this watershed. They are discussed more fully as follows:

Water Quality: There are a number of domestic wastewater (sewage) treatment plants within the watershed. Currently, none of the plants are approved to discharge effluent directly to surface waters. Each plant is required as a permit condition to dispose of their treated wastewater on-site, either via percolation/evaporation ponds or land-spreading (also referred to as spray irrigation). All are required to treat their effluent to at least secondary treatment levels (i.e., either 90% removal of biochemical oxygen demand and total suspended solids, or 20 mg per liter of each, whichever is least).

Since percolation ponds and land application could potentially contaminate ground water, all such sources of 100,000 gallons per day or more are required to monitor ground water around the perimeter of their treatment site. Depending upon the specific situation, the Department occasionally requires groundwater monitoring from sources exempted by the rule.

Sludge: Since sludge essentially consists of pollutants which were removed from wastewater in the treatment process, the FDEP is concerned about its use or disposal. Sludges are categorized according to their origin (domestic or industrial) and their content. Some industrial sludges may be categorized as hazardous wastes and would have to be disposed of in a place and manner approved for hazardous waste treatment or disposal. Other industrial sludges may be adequately handled by disposal in a landfill or by incineration.

Domestic sludge is typically spread on land and allowed to dry. Thereafter, it may be used as a soil supplement for certain agricultural uses. It is sometimes used directly in its wet state. Sludge disposal sites must be approved by the FDEP.

Industrial: Industrial waste facilities cover a wide range of types and sizes from large factories and power plants to small shops, and produce a broad variety of pollutants. Treatment requirements vary by facility based upon the type of pollutants involved.

Solid Waste: Solid waste must be disposed of either in an approved landfill or by an accepted means such as incineration. Solid waste is only being mentioned to point out that some waste materials are exempt from FDEP solid waste regulations (specifically brush and yard trash, and wastes of other types generated and disposed of entirely on one property). Wastes which are exempt from FDEP regulations might be disposed of in the watershed. Such wastes can contain putrescible matter (i.e., material which decays and might contribute nutrients to ground and surface waters).

Hazardous Waste/RCRA: The Department's Hazardous Waste Program is divided into two sections: compliance/enforcement and permitting. The compliance/enforcement section does inspections of facilities such as metal finishing shops, electronics manufacturing, automotive repair and maintenance, dry cleaners, boat builders, used oil recyclers and all types of manufacturing and other businesses that generate solid wastes. The purpose of the inspections is to evaluate all solid wastes generated by the facility and determine if they are being correctly identified, managed, and disposed in accordance with Federal and State waste regulations. Permits are issued to commercial facilities that store and/or treat hazardous wastes and facilities that recycle used oil and fluorescent lamps. Permit compliance is evaluated as a condition of issuance. This program functions as Department Project Management for contamination assessment and remediation of sites where soil and ground water have become contaminated as the result of discharges of hazardous waste.

Environmental Resource Permitting: Most construction, digging, filling, etc., in waters of the state, or in wetlands contiguous to waters of the state are regulated by the FDEP and/or the SWFWMD. The intent is to ensure that construction and the long term use of a property will not adversely impact water quality, or negatively impact threatened or endangered plant or animal species or their habitats.

Air Program: This program handles air quality regulation including permits and stationary source inspections; air monitoring of USEPA criteria pollutants such as ground level ozone,

sulfur dioxide and particulate; compiling emissions inventories for stationary, mobile and area sources of air pollution. As specified in the Clean Air Act of 1990, the FDEP monitors acid rain emissions from fossil fuel fired electric generating facilities.

Tanks: New aboveground or underground storage tank systems installed within the watershed require secondary containment features. Existing storage tank systems are required to upgrade with secondary containment no later than December 31, 2009. Monthly leak checks are required for all storage tank systems to prevent discharges to the environment. In addition, any storage tank system that transfers diesel fuel across water (such as a marina) is required to have a spill response plan in place, including the ability to contain a spill within one hour.

Point Source Pollution:

Point source discharges are regulated by the FDEP under authority of the U.S. Environmental Protection Agency (USEPA) for the NPDES permitting system. Permit holders are required to provide monthly operating reports for their facilities to the FDEP for each month they have a discharge. The monthly operating reports provide the results of laboratory analyses for the parameters of concern; i.e., for any effluent chemical concentrations that may potentially exceed state water quality standards.

Stormwater: Most new land use activities are subject to regulations which require retention or treatment of stormwater prior to its discharge. The FDEP has delegated most stormwater regulation to the Southwest Florida Water Management District, but has retained responsibility connected to an activity which requires another type of FDEP permit (e.g., dredge-and-fill, certain industrial facilities, etc.). Stormwater regulations generally presume that treatment or detention are adequate to meet standards, and monitoring is not ordinarily required, except in unusual cases (such as runoff from an industrial site).

Through responsibilities delegated to the former Department of Natural Resources, the FDEP has the following responsibilities/jurisdictions:

Under Chapter 62C-20, "Aquatic Plant Control Permits", the FDEP regulates the mechanical, biological (except grass carp) and chemical control of aquatic plants. As part of this task, the FDEP may take herbicide samples from spray tanks to determine if herbicides being used are permitted.

Under Chapter 62C-54, "Cooperative Aquatic Plant Control Program", the FDEP co-funds, with cooperators such as local governments, for the control of hydrilla, water lettuce and water hyacinth control. Fifty percent of such funds are received by FDEP from the U.S. Army Corps of Engineers.

Persons cultivating, re-vegetating, or collecting aquatic plants in the State are required under Chapter 16C-52, "Aquatic Plant Importation, Transportation, Cultivation and Possession", to obtain a permit from FDEP; therefore, persons transporting aquatic plants which are attached or adhering to boat trailers are in violation of this rule.

By authority of Chapters 18-20 and 18-21, "Sovereignty Submerged Land Management", before commercial docks or marinas can be placed in a water body, a submersed land lease is required from FDEP. These leases would also restrict the use of the facility to water dependent activities compatible with the resources. Also, residential docks (over 250 square feet) must meet certain FDEP requirements. Any other activity on submerged lands shall require consent or an easement from FDEP.

The FDEP also performs annual aquatic plant flora surveys, routine inspections of permit sites, investigates fish kills and algae blooms, and performs extension work such as the formulation of management plans.

Florida Department of Health

The (FDOH) responsibilities include the public health functions of water supplies (primarily small to medium supplies), onsite sewage disposal, septic tank cleaning and waste disposal (in conjunction with FDEP), and solid waste control (secondary role)" (Barile et al. 1987).

The primary statutes providing FDOH authority are to be found in Chapters 154, 381 and 386 of the Florida Statutes and the 10D Series of the Florida Administrative Code, known as the "Sanitary Code". Each county has a FDOH Office responsible for jurisdiction within the county (Barile et al. 1987).

Florida Fish and Wildlife Conservation Commission

As of July 1, 1999 the Florida Game and Freshwater Fish Commission and the Marine Fisheries Commission were brought under one Division of the FDEP called the Florida Fish and Wildlife Conservation Commission (FWC). The mission of the FWC is to conserve marine and freshwater aquatic and wild animal life and their habitats to perpetuate a diversity of species with densities and distributions that provide sustained ecological, recreational, scientific, educational, aesthetic, and economic benefits.

Florida Department of Agricultural and Consumer Services (FDACS)

The FDACS' Division of Agriculture Environmental Services regulates the registration and use of pesticides, including the purchase of restricted pesticides, maintains registration and quality of fertilizers, regulates pest control operations, mosquito control, and evaluates and manages environmental impacts associated with agrichemicals.

The FDACS' Division of Forestry is responsible for developing BMPs to control forestry-related nonpoint source pollution. The FDOF is also responsible for statewide implementation of BMPs, and for monitoring public and private forestry operations to determine BMP compliance and effectiveness. Florida's 34 State Forests and several other parcels of public land are managed by FDOF.

The Division of Plant Industry is responsible for, among other duties, regulating the movement of noxious weeds, and, with input from the Endangered Plant Advisory Council, protecting endangered, threatened, or commercially exploited plant species.

The FDACS' Office of Water Policy Coordination (OWPC) is responsible for participating in water policy issues to ensure the availability of an adequate supply and quality of water for the production of food and fiber. The OWPC cooperates with agencies and agricultural producers to make available streamlined agricultural regulatory processes and voluntary, incentive-based, acceptable alternatives and agricultural BMPs consistent with the sustainability of agriculture and resource conservation. OWPC provides assistance to Soil and Water Conservation Districts in carrying out conservation activities at the local and watershed level, and providing improved local delivery of resource management services to agricultural producers. OWPC facilitates the participation of Soil and Water Conservation Districts in water related issues at the district, county, or watershed level.

REGIONAL

Southwest Florida Water Management District

The Southwest Florida Water Management District was created by Chapter 61-691, Laws of Florida, as a public corporation for carrying out and effectuating the provisions of Chapter 378, Florida Statutes. Other than as provided in Chapter 61-691, Laws of Florida, the District operates under and is governed by provisions of Chapter 373, Florida Statutes.

The following permitted activities fall under the jurisdiction of the SWFWMD, and unless expressly exempted by law or District rule, the following permits must be obtained prior to commencement of activity:

- (1) A water use permit under Chapter 40D-2 must be obtained prior to use or withdrawal of water;
- (2) A well construction permit under Chapter 40D-3 must be obtained prior to the construction, repair or abandonment of a well;
- (3) A surface water management permit under Chapter 40D-4 must be obtained prior to construction, alteration, abandonment or removal of any dam, impoundment, reservoir, appurtenant work or works;
- (4) An artificial recharge permit under Chapter 40D-5 must be obtained prior to construction of any project involving artificial recharge or the intentional introduction of water into any underground formation;
- (5) A works of the District permit under Chapter 40D-6 must be obtained prior to connecting with, placing construction in or across, discharging into or otherwise making use of works of the district; and
- (6) A Stormwater Discharge permit under Chapter 17-25 must be obtained prior to construction or modification of a stormwater discharge facility." (Chapter 40D-1.602)

Chapters 40D-4 and 40D-40 were adopted to ensure continued protection of the water resources of the District including wetlands and other natural resources. The rules in these chapters are to implement the surface water management permit system mandated in part IV of Chapter 373, Florida Statutes; the statutes resulted from passage of Chapter 84-79, Laws of Florida, The Warren G. Henderson Wetland Protection Act of 1984.

Permitting under Chapter 40D-6 is required to protect existing works and works for which planning is under way (e.g., canals, water control structures, rights-of-way, lakes and streams) from actions which would impair their ability to function as intended. The District has declared the natural floodway, tributaries, connecting channels, canals and lakes of the following waterbodies to be "Works of the District": the Hillsborough River, Oklawaha River, Withlacoochee River, Peace River, authorized Green Swamp Basin, Anclote River, Lake Tarpon, Old Tampa Bay (north of Courtney Campbell Causeway), Alafia River, Little Manatee River, Palm River and Six Mile Creek, Pithlachascotee River, Waccasassa River, McKay Bay (north of 22nd Street Causeway), Weeki Wachee River, Lake Sloan, Crystal River, Homosassa River, Chassahowitzka River, Bullfrog Creek, and Delany Creek.

Chapter 40D-8 provides that for those lakes meeting specified criteria SWFWMD will establish regulatory levels for lakes in the District. Under this Lake Levels Program, SWFWMD will: provide guidelines (primarily in the floodplain) for development bordering lakes; conserve water storage and recharge capabilities of lakes; provide levels for operation of lake control structures; and provide information for District consumptive use permitting (CUP) activities.

Pursuant to Chapter 87-97 of the Laws of Florida, the District has been given the responsibility for prioritizing water bodies within the District in need of preservation or restoration. The Act also provides for the development of surface water improvement and management (SWIM) plans for priority water bodies and funding for the implementation of these plans.

The District provides for the control of noxious species of aquatic weeds (primarily hydrilla and water hyacinths) in waters designated by the FDEP (Chapter 16C-52).

Regional Planning Councils

Chapter 62-40 of the Florida Administrative Code, "State Water Policy", directs water management districts and local governments to coordinate water resource management efforts. One agency that assists in this coordination is the regional planning council. The Springs Coast watershed is covered by two regional planning councils: Withlacoochee, which includes Citrus and Hernando counties, and Tampa Bay Regional Planning Council, which includes Pasco County.

Tampa Bay Water

The Tampa Bay Water agency (previously West Coast Regional Water Supply) has formulated a Resource Development Plan which identifies the need for 123 mgd of new water supply sources to meet the public supply demands of the tri-county region through

2030 (West Coast Regional Water Supply Authority, 1994). The New Water Plan (West Coast Regional Water Supply Authority, 1998) identifies sources that include ground water, surface water, stormwater, brackish water and seawater desalination, and inter-regional sources. The Plan contains several water supply alternatives that are located within the Hillsborough River watershed, including the Cone Ranch Wellfield and Dispersed Wells and Pipeline Project, additional dispersed wells in the vicinity of the Cypress Bridge Wellfield (Cypress Bridge II), the Enhanced Surface Water System, a seawater desalination project, and a brackish water desalination project.

LOCAL

Growth management legislation passed in 1985 by the Florida Legislature has led to an increased city/county government role in water resource protection and conservation. The Local Government Comprehensive Planning and Land Development Regulation (LGCP) Act requires local governments to prepare and adopt comprehensive plans that address specific public services. Rule 9J-5 of the Florida Administrative Code provides the minimum criteria for local comprehensive plans. Several required plan elements (Infrastructure, Future Land Use, Conservation, and Coastal Management) correspond with many areas of water quality management responsibility.

Local governments have primary authority for land use control within their jurisdictions. Administration is accomplished through the local comprehensive plan and land development regulations. The water management districts review and comment on local plans for the State Department of Community Affairs, which must certify these plans for compliance with statutory and rule requirements. Further, the water management districts work with local governments on an ongoing basis to accomplish common water management objectives.

Citrus County

Citrus County has undertaken a number of water resource protection and enhancement initiatives in recent years. Initiatives have included the implementation of stormwater quality improvement projects and the development of a regional wastewater treatment concept.

The Citrus County Comprehensive Plan contains a number of natural resource protection and enhancement policies that assist in implementing the above initiatives and mitigate development-related impacts. Policies include those which address: limitations on floodplain development, wetland setback and preservation requirements, stormwater management criteria, wellfield protection, surface and groundwater protection and wildlife and associated habitat (including manatees) protection.

Hernando County

Hernando County has adopted ordinances based on land use with the intent to protect ground water and surface water resources within the County. The Riverine Protection Ordinance was adopted in 1990. The intent is to protect water quality and water-dependent habitat within one mile of either side of the Weeki Wachee, Mud, Withlacoochee, and Little Withlacoochee Rivers. It provides for natural buffer areas along these rivers, limits

development of water dependent structures, and establishes minimum stormwater treatment requirements.

The Ground-Water Protection and Siting Ordinance was adopted in 1994. The intent is to protect and maintain groundwater quality by providing land use siting criteria for public supply wells and vulnerable features. Wellhead protection areas are based on pumpage rates and delineated using a computer model developed by the USEPA. Vulnerable features, such as sinkholes and excavations, are designated as special protection areas (SPA) with a 500' setback and associated land use siting criteria.

Pasco County

The Pasco County Comprehensive Plan and Land Development Regulations contain a number of general measures to protect waters and related natural resources from land development impacts. These measures include, but are not limited to, restrictions on floodplain development, wetland setback and preservation requirements, adherence to District stormwater management criteria and wellfield protection provisions.

OTHER GOVERNMENTAL ACTIVITIES

FDEP Ecosystem Management

The FDEP initiated ecosystem management following the merging of the Department of Natural Resources and the Department of Environmental Regulation in 1993. The mission of Ecosystem management, which is similar to the CWM program of the District, is "to protect the functions of entire ecological systems through enhanced coordination of public land acquisition, regulatory, and planning programs". The FDEP divided the State into watersheds or "ecosystem management areas". Since the FDEP Springs Coast Ecosystem Management Area coincided with the District's Upper Coastal Comprehensive Surface Water Management Area, the two associated teams merged to form the Springs Coast Comprehensive Watershed Management team. The FDEP still has an Ecosystem Management program but it is now called Watershed Management.

ACRONYMS

AOR	Area of Responsibility
AWT	Advanced Wastewater Treatment
BEBR	Bureau of Economic and Business Research
BMPs	Best Management Practices
BLM	Bureau of Land Management
CARL	Conservation and Recreational Lands
cfs	cubic feet per second
CWM	Comprehensive Watershed Management
DSS	Decision Support System
F.A.C.	Florida Administrative Code
FDACS	Florida Department of Agricultural and Consumer Services
FDEP	Florida Department of Environmental Protection
FDOT	Florida Department of Transportation
FDOF	Florida Division of Forestry
FDOH	Florida Department of Health
FEMA	Federal Emergency Management Agency
FMO	Federal Mineral Ownership
FPC	Flood Protection Coordination
F.S.	Florida Statutes
FWC	Florida Fish and Wildlife Conservation Commission
GIS	Geographic Information System
HCWRAP	Hernando County Water Resource Assessment Project
LOS	Level of Service
MFL	Minimum Flows and Levels
mgd	million gallons per day
NPDES	National Pollutant Discharge Elimination System
NTBWRAP	Northern Tampa Bay Water Resource Assessment Project
NTBWUCA	Northern Tampa Bay Water Use Caution Area
OFW	Outstanding Florida Water
PCBs	polychlorinated biphenyls
PLRGs	Pollutant Load Reduction Goals
RAMP	Regional Ambient Monitoring Programs
RMP/EIS	Resource Management Plan and Environmental Impact Statement
SOR	Save Our Rivers
SWFWMD or District	Southwest Florida Water Management District
SWIM	Surface Water Improvement and Management
TMDLs	Total Maximum Daily Loads
USEPA	United States Environmental Protection Agency
USF	University of South Florida
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VOCs	volatile organic carbon
WMD	Water Management District
WSF	Withlacoochee State Forest
WUPs	Water Use Plans