

I. – Introduction

A. The Withlacoochee Regional Water Supply Authority

The WRWSA is one of three water supply authorities within the SWFWMD. A portion of the WRWSA in Marion County is within the SJRWMD. Water supply authorities are multi-jurisdictional in membership and formed to jointly develop water resources for the mutual benefit of their members.¹ More specifically, water supply authorities are “... for the purpose of developing, recovering, storing, and supplying water for county or municipal purposes in such a manner as will give priority to reducing adverse environmental effects of excessive or improper withdrawals of water from concentrated areas” (Chapter 373, F.S.). The authorities have other important duties, responsibilities, and operational options including:

- a. Levying ad valorem taxes;
- b. Developing water supplies for county and municipal users;
- c. Collecting, treating and recovering wastewater;
- d. Wholesaling (not retailing) water supplies to customers;
- e. Exercising the right of Eminent Domain;
- f. Issuing revenue bonds;
- g. Developing alternative water supplies; and
- h. Ensuring consistency with the SWFWMD and SJRWMD with respect to water supply planning.

The WRWSA was founded in 1977 by Hernando, Citrus, Sumter, Marion and Levy Counties. An amendment to the WRWSA's inter-local agreement in 1984 provided for municipal membership, which allowed cities within each County to become members. In 1982, Levy County formally withdrew from the WRWSA. In 1991, Marion County became an inactive member, but the City of Ocala, an active municipal member, maintained its membership by separately paying its annual assessment.

Marion County petitioned and the WRWSA approved their request to be reinstated as an active member in 2008. The cities of Belleview, Dunnellon, McIntosh and Reddick located in Marion County also became active members of the WRWSA by provision of the WRWSA's inter-local agreement. Therefore, the current WRWSA membership includes Citrus, Hernando, Sumter, and Marion Counties and their associated municipalities. These include Belleview, Brooksville, Bushnell, Center Hill, Coleman, Crystal River, Dunnellon, Inverness, McIntosh, Ocala, Reddick, Webster, and Wildwood.

The apportionment of representatives on the WRWSA Board considers two city categories – “large city” and “small city”, and County population. Large cities are those of 25,000 populations or more, which includes the City of Ocala. Large cities receive representation equal to that of the counties. The small cities category, or cities with less than 25,000 people, make up the remaining cities in the WRWSA. All of these cities must caucus and select one member to

¹ Authorized by Florida Statutes under Chapter 373.1962, F.S.

represent all small cities in each county. Therefore, in Hernando County, there are four (4) representatives from the Board of County Commissioners (BCC) and one small city representative. Citrus County qualifies for three (3) representatives from the BCC and one small city representative. Sumter County qualifies for two (2) representatives from the BCC and one small city representative. Marion County qualifies for three (3) representatives from the BCC and one small city representative. Finally, the City of Ocala, as a large city, has two representatives. Figure I-1 shows the WRWSA service area and its member governments.

B. Planning History

Since the WRWSA is mandated to develop and supply water, the Authority has historically completed water supply planning studies, constructed a regional water supply facility in Citrus County, and developed a cooperative funding program to assist member local governments in developing adequate water supply facilities and water conservation (WRWSA Website).

A water supply planning effort by the WRWSA was completed in 1996 and was entitled "Withlacoochee Regional Water Supply Authority Master Plan for Water Supply". This report followed two previous efforts that included the "Water Sources and Demand Study" (1982) and the "WRWSA Master Plan for Water Supply" (1987).

Almost ten years elapsed from the completion of the 1996 WRWSA Master Plan, when the WRWSA determined it was necessary to update the regional water supply planning process. In 2007 the WRWSA, in cooperation with the SWFWMD, completed an update of the 1996 study. This report was entitled "Withlacoochee Regional Water Supply Authority Regional Water Supply Plan Update - 2005" (WRWSA RWSPU).

In 2005 the WRWSA established the WRWSA – MWSP&IP which is a comprehensive process to plan for the region's water supply future. The WRWSA – MWSP&IP is a multi-year, multi-phase program that was follow-on to the WRWSA RWSPU. It contains phases for water supply planning. Identification and prioritization of water supply projects, the design of selected projects and implementation the projects and initiatives.

This report, the WRWSA – Detailed Water Supply Feasibility, was initiated in 2007 to follow-on to the WRWSA RWSPU and is considered Phase II of the WRWSA – MWSP&IP process. Its purpose is to update regional population and water demands and determine potential water supply projects to supply these needs. As the study progressed Marion County decided to rejoin the WRWSA. The inclusion of Marion County into the WRWSA added challenges and opportunities with respect to regionally sustainable water supply development. Geographically, the WRWSA has increased by approximately 86% from 1,892 square miles to 3,516 square miles. The existing population of the WRWSA has increased by approximately 68% from 494,931 to 732,681 (2005 estimate). It was decided to suspend work on the WRWSA – Detailed Water Supply Feasibility until the Compendium was completed.

The inclusion of Marion County to the WRWSA required that the RWSPU be appended to consider existing and projected water demands in Marion County, and that the appended RWSPU outline the basis for future water supply development in the WRWSA region including Marion County. This Compendium was completed in December of 2009.

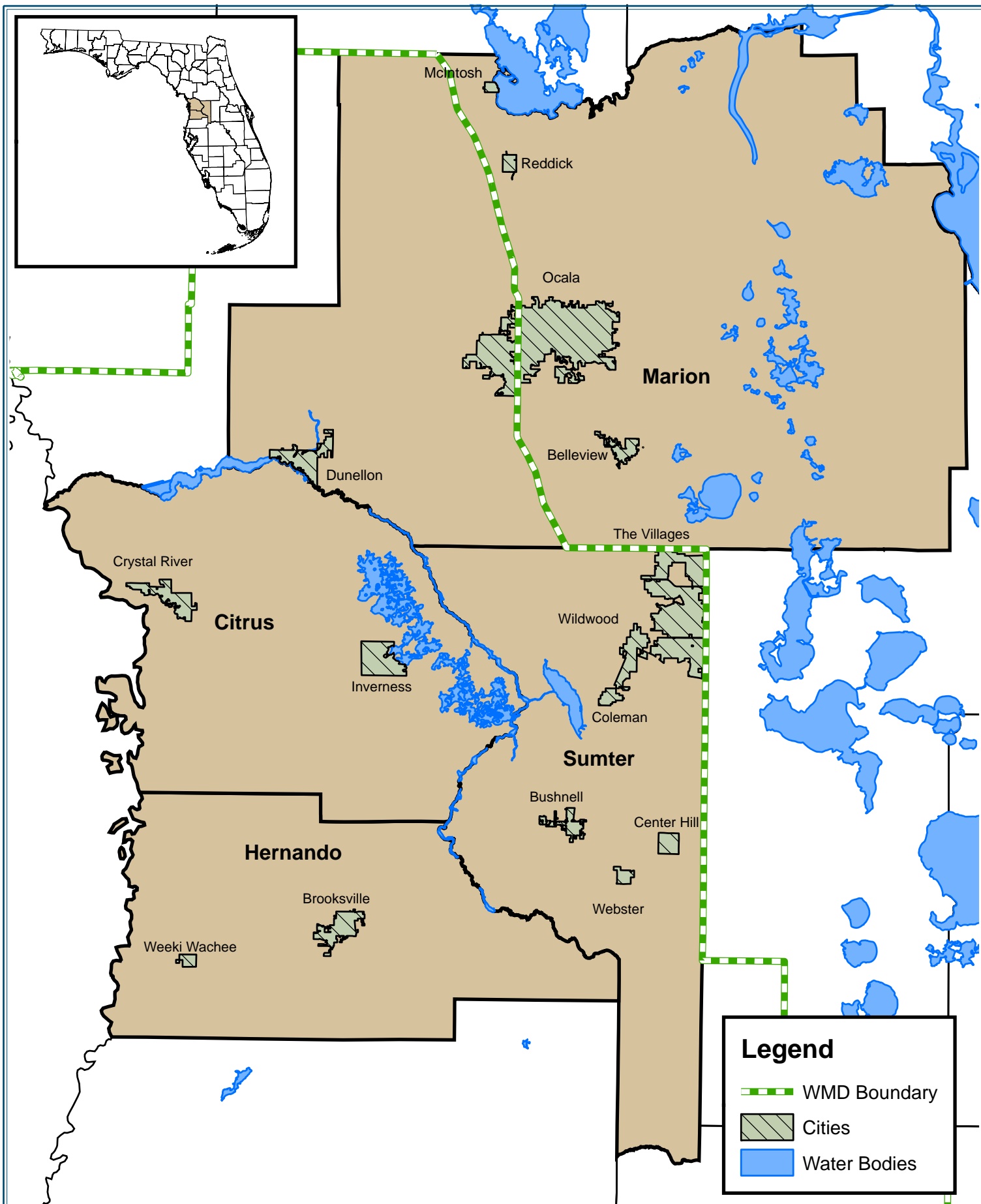
C. WRWSA Detailed Water Supply Feasibility Study

As stated the WRWSA Detailed Water Supply Feasibility purpose is to update regional population and water demands and determine potential water supply projects to supply these needs. The projects are conceptualized, evaluated, ranked and prioritized according to short-term, medium-term, and long-term planning horizons within this report.

D. Document Structure

The WRWSA – Detailed Water Supply Feasibility is organized into Chapters as follows:

- Chapter 1 – Population and Water Demand
- Chapter 2 – Water Resource Minimum Flows and Levels
- Chapter 3 – Groundwater Resource Assessment
- Chapter 4 – The Role of Water Conservation within the WRWSA
- Chapter 5 – Reclaimed Water Projects
- Chapter 6 – Groundwater Project Options
- Chapter 7 – Aquifer Recharge Project Option
- Chapter 8 – Surfacewater Project Options
- Chapter 9 – Seawater Desalination Project Option
- Chapter 10 – Evaluation and Ranking of Water Supply Projects
- Chapter 11 – Water Resources, Supplies and Demand
- Chapter 12 – WRWSA Regional Water Supply Framework
- Chapter 13 – Recommendations



Water Resource Associates, Inc.
 Engineering ~ Planning ~ Environmental Science
 4260 W. Linebaugh Ave.
 Phone: 813-265-3130
 Fax: 813-265-6610
 www.wraconsultants.com

PROJECT: 0468 - Withlacoochee - Phase II

Figure I-1
WRWSA Location Map

ORIGINAL DATE: 04-20-09

REVISION DATE: 04-09-10

JOB NUMBER: 0468

FILE NAME: Figure I-1.mxd

GIS OPERATOR: DR



1 inch equals 250 miles

Chapter 1 – Population and Water Demand

1.0 Key Points

Key Points

- This chapter analyzes and characterizes existing water demand and projections of future demand within the WRWSA. Existing water demand and projections use 2005 as a base year.
- Water demand projections are evaluated on a planning horizon of twenty (20) years from 2010-2030. The projections provide critical input to capital improvement plans and long-range water supply policy.
- The majority of the water withdrawn in the WRWSA is from groundwater sources.
- Public supply; domestic self-supply; industrial/commercial; mining/dewatering; power generation; agricultural; and recreational/aesthetic water use demands are considered. These provide a comprehensive picture of current and future water demands in the region.
- Public supply demands dominate, and will continue to dominate, water use within the WRWSA representing 70% of the increase.
- The total WRWSA public supply water demand was approximately 81.40 mgd in 2005 and is expected to increase to 147.77 mgd in 2030. This demand equates to an approximate increase of 66.37 mgd (82%) in 2030.
- The total WRWSA domestic self-supply water demand was approximately 30.22 mgd in 2005, and expected to be 47.85 mgd in 2030. This demand equates to an approximate increase of 17.63 mgd (58%) in 2030.
- The total WRWSA industrial/commercial, mining/dewatering and power generation water demand was approximately 26.03 mgd in 2005, and estimated to decrease to 21.10 mgd in 2030. This demand equates to an approximate decrease of 4.93 mgd (19%) in 2030.
- The total WRWSA recreational water demand was approximately 20.59 mgd in 2005, and anticipated to increase to 33.76 mgd in 2030. This demand equates to an approximate increase of 13.17 mgd (64%) in 2030.
- The total WRWSA agricultural water demand was approximately 16.12 mgd in 2005, and is expected to be about 18.59 mgd in 2030. This demand equates to an approximate decrease of 2.47 mgd (15%) in 2030.
- The total WRWSA current demand is approximately 174.36 mgd. This total water demand is expected to increase to approximately 269.07 mgd in 2030. This demand equates to an approximate increase of 94.71 mgd (54%) in 2030.

1.1 Introduction

This chapter analyzes, characterizes and projects population and water demand within the WRWSA. This includes existing population and water demand and projected population and water demand for the designated planning horizon. A critical component of the WRWSA – RWSPU was existing (2005) and projected water demands (2025) which were used for determining the availability of water resources in the region. Population and water demand have been updated for this report and a base year of 2005 is used. The planning horizon has been extended from 2025 to 2030 for use in this analysis.

WRWSA – Detailed Water Supply Feasibility Analyses

Existing and projected water demands were determined for all water use categories. These demands were determined on a county-by-county basis and were projected over the planning horizon. Although the WRWSA is mainly concerned with public water supply, the analysis also reviews water demands from other users in the area. This is important to gain a better understanding of overall water demand in the region and where this use will take place. Competition for traditional water and alternative water supply (AWS) development is not just between municipalities but will occur between all water users in the region. This includes the following water uses:

- Public Supply;
- Domestic Self-Supply;
- Industrial/Commercial;
- Recreation/Aesthetic; and
- Agricultural.

Based on the limitations of groundwater modeling in the WRWSA – RWSPU the water supply availability analysis has been refined and updated in this report. Part of this refinement involves updating demands as inputs to the Northern District Groundwater Model (NDGM). The District's demand projection methodology has not changed since WRWSA – RWSPU demands were published. However, changes in the base year, updated population projections and new data from water use permits (WUPs) have required revisions from the WRWSA – RWSPU data.

Also, since the WRWSA – RWSPU demands were published, Marion County has also been reinstated as an active member of the WRWSA. The inclusion of Marion County into the WRWSA has added challenges and opportunities with respect to regionally sustainable water supply development. Geographically, the WRWSA has increased in size by approximately 86% from 1,892 square miles to 3,516 square miles. The existing population of the WRWSA has increased by approximately 68% from 494,931 to 732,681 (2005 estimate).

This section relies primarily on data developed and published by the SWFWMD for the Citrus, Hernando, and Sumter Counties. The water demand and population projections for Marion County were provided by the SWFWMD and the SJRWMD and published in the RWSPU – Water Supply Planning Compendium for the Inclusion of Marion County (WRA, 2009).

1.2 General Assumptions

The following are the general assumptions for the analyses of population and water demand for this report.

- For the WRWSA – RWSPU, 2000 was used as the base year from which future population and water demand projections were projected. The base year used for future population and water demands projections for WRWSA – Detailed Water Supply Feasibility Analyses is 2005.
- Water demand projections are evaluated through a planning horizon of twenty 20 years from 2010-2030. These values were provided by the SWFWMD and the SJRWMD in technical memorandae were used for the district's individual water supply assessments.

2005 was used as the base year by the water management districts in projecting future water demands.

- Marion County is now an active member of the WRWSA. Since the publication of the WRWSA – RWSPU, Marion County has re-joined the WRWSA and the demands for Marion County were provided by the SWFWMD and the SJRWMD.
- Water demands are reported in this document for the average annual effective rainfall conditions. The analysis of a one-in-ten (1-in-10) drought-year scenario (an event that results in an increase in water demand of a magnitude that would have a 10 percent probability of occurring during a given year) for Phase II was not considered.
- The majority of the water withdrawn in the WRWSA is from groundwater sources, with minimal surface water withdrawals or other AWS sources. Therefore, no analysis of the difference between groundwater and surface water demands is provided in this section. Potential future surface water sources are assessed in later sections.

1.3 Public Supply Water Demand

1.3.1 Introduction

Existing public supply water use accounts for the greatest share of water demand in the WRWSA region. Public supply accounts for 47% of the total water demand in the WRWSA. The Public Supply category includes water distributed by public water systems and private water utilities. Some non-residential use (such as commercial and industrial operations) is also included in this category, as they are not self-supplied and do not report their individual water use to the districts. Table 1-1A depicts the methodologies and assumptions employed to determine public supply water demand values.

SWFWMD and SJRWMD calculated water demand projections for the years 2005, 2010, 2015, 2020, 2025, and 2030 based on population projections and average per capita rates for each utility. SWFWMD used a 5-year average per capita rate (2003-2007), and the SJRWMD used an 11-year average per capita rate (1995-2005) to calculate public supply water demand projections.

1.3.2 Base Year Populations

The base year utilized for the population projections is 2005. Population information was obtained from historical data provided as part of the SWFWMD RWSP, and SJRWMD WSA process to determine the Public Supply water use projections through the year 2030 or from previously reported data collected and analyzed by the districts.

1.3.3 Base Year Water Use

A base year of 2005 was used for the WRWSA – Detailed Water Supply Feasibility Analyses. In the SWFWMD, the base year water use was derived by multiplying the average 2003 – 2007 unadjusted gross per capita rates by the 2005 estimated population for each individual utility.¹

¹ Public supply base year water use methodology is taken from Bader (2009).

Within the SJRWMD, base year water use was derived by multiplying the utilities 11-year average per capita water use (1995-2005) by the 2005 estimated population.²

1.3.4 Population Projections

Within SWFWMD, small-area population projections were developed and apportioned using a parcel based methodology (GIS Associates, 2009).

The population projections developed by University of Florida Bureau of Economic & Business Research (BEBR) are generally accepted as the standard throughout the state of Florida. However, these BEBR projections are made at the county-level only. Accurately projecting future water demand requires more spatially precise data than the county-level BEBR projections. SWFWMD projections are based on census block-level data, which is developed using the smallest level of census geography. They are then disaggregated to land parcel data, which is the smallest area of geography possible for population studies.³

Within the SJRWMD, the 2006 projections of population growth published by BEBR were used as its control for population projections within each county. BEBR projections were then applied to a parcel based methodology (GIS Associates, 2009).⁴

1.3.5 Public Supply Water Demand Projections

The following sections describe the methodology used to develop public supply water projections for the planning horizon and the reference projection period, and the subsequent results.

1.3.5.1 Planning Horizon (2005 – 2030)

Water demand projections are calculated for the years 2010, 2015, 2020, 2025, and 2030. As mentioned, SWFWMD derived public supply water demands by multiplying 2003-2007 average per capita rates by the projected populations on a county-wide basis to develop these projections. SJRWMD used the 11-year per capita average (1995-2005) multiplied by the projected population to calculate the water demand projections in 5 year increments.

1.3.6 Results

The total WRWSA public supply water demand was approximately 81.40 mgd in 2005. Using the methods described, the demand is expected to increase to 147.77 mgd in 2030. These demands equate to approximate increases of 66.37 mgd (82%) for the planning horizon. Refer to Table 1-2 for the incremental public supply water demand increases.

² Public supply base year water use methodology is taken from SJRWMD (2008).

³ Population projections methodology taken from Bader (2009).

⁴ Population projections methodology taken from SJRWMD (2008).

Citrus County

The public supply water demand in Citrus County in 2005 is approximately 16.12 mgd, which is anticipated to increase by 14.58 mgd (90%) to 30.70 mgd over the planning horizon. (Table 1-3A and Figures 1-1A and 1-1B.)

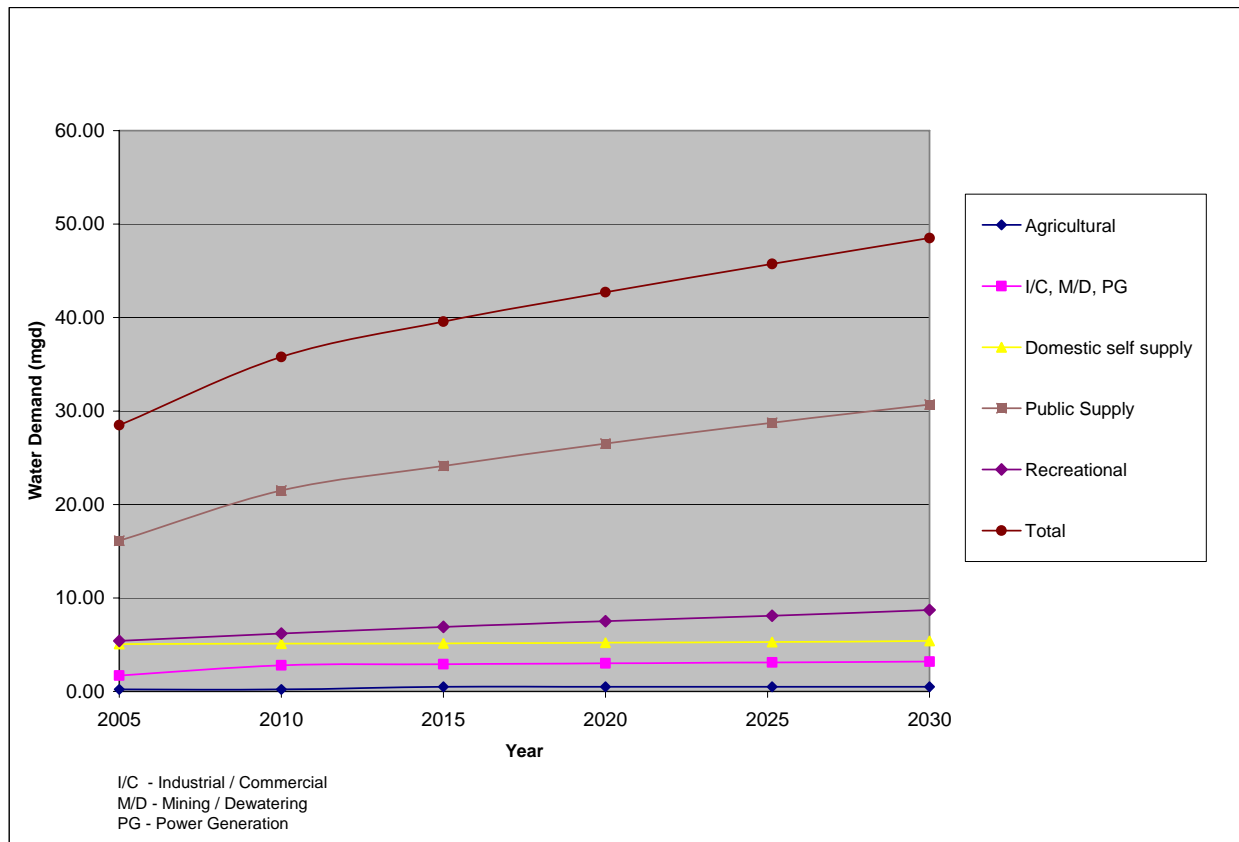


Figure 1-1A. Incorporated / Unincorporated Citrus County Projected Water Demand.

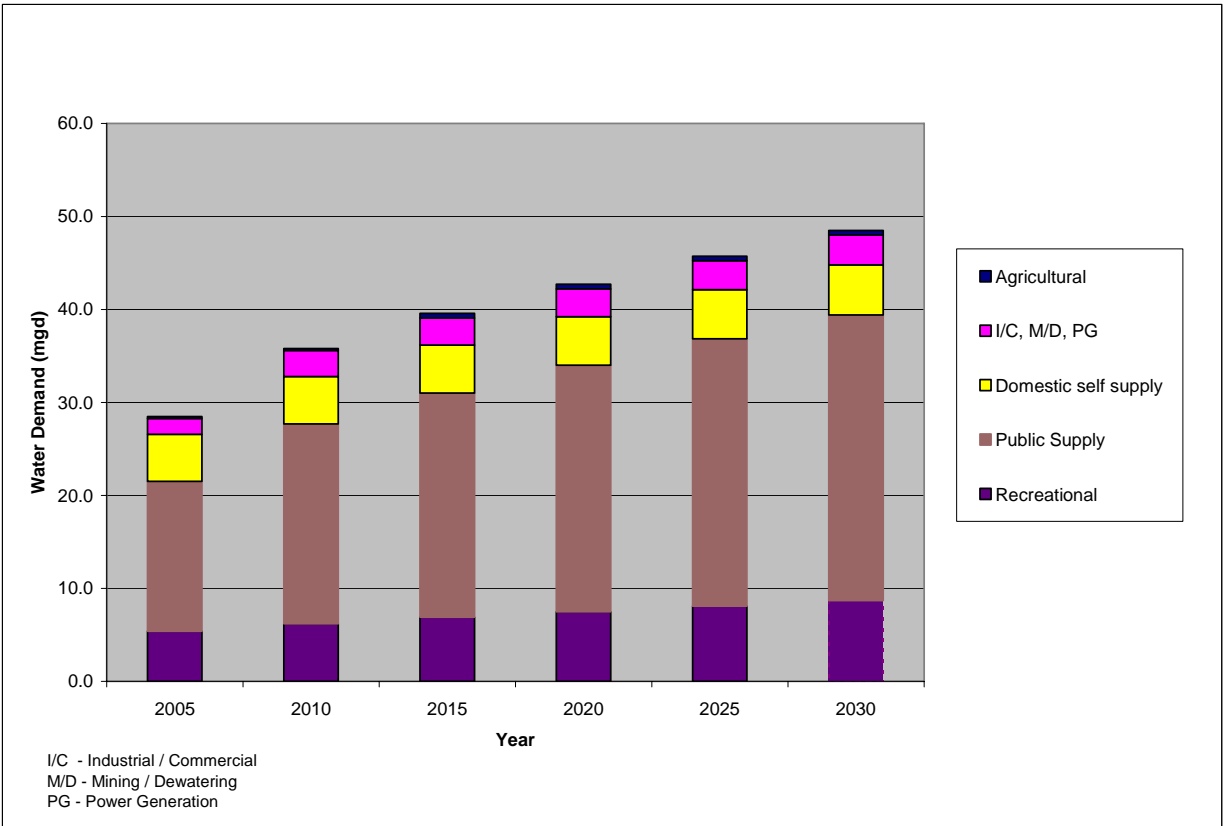


Figure 1-1B. Incorporated / Unincorporated Citrus County Projected Water Demand.

Hernando County

The public supply water demand in Hernando County in 2005 is approximately 24.09 mgd, which is anticipated to increase by 9.17 mgd (38%) to 33.26 mgd over the planning horizon. (Table 1-3B and Figures 1-2A and 1-2B).

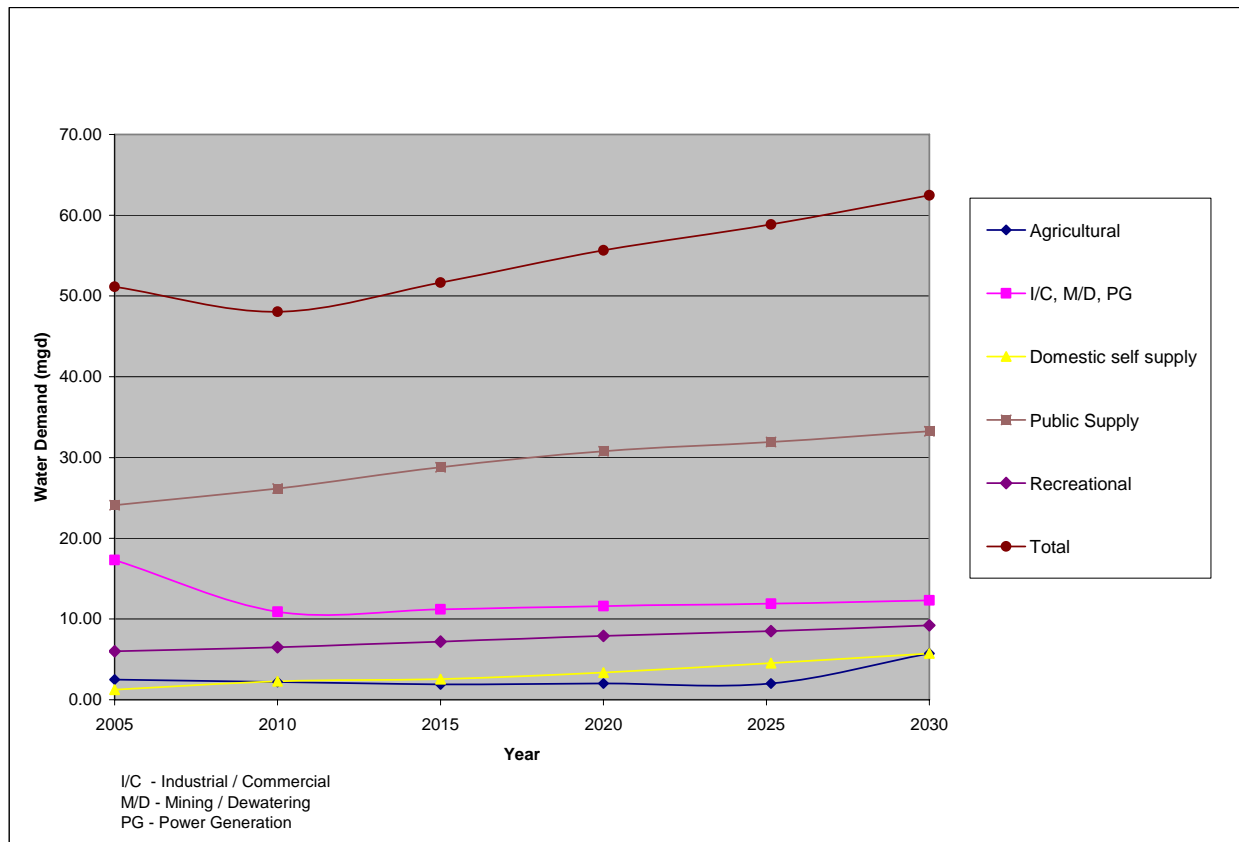


Figure 1-2A. Incorporated / Unincorporated Hernando County Projected Water Demand.

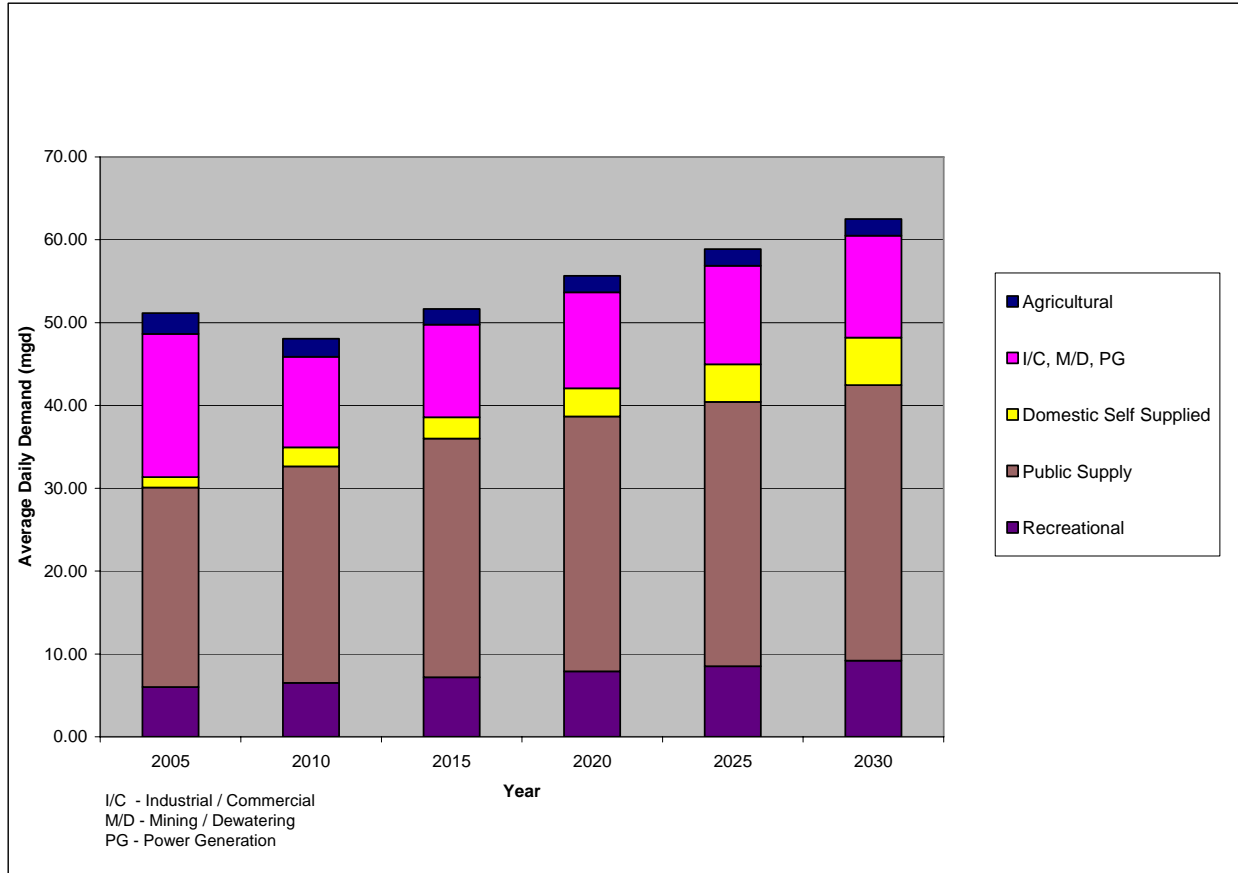


Figure 1-2B. Incorporated / Unincorporated Hernando County Projected Water Demand.

Sumter County

The public supply water demand in Sumter County in 2005 is approximately 11.06 mgd, which is anticipated to increase by 16.71 mgd (151%) to 27.77 mgd over the planning horizon. (Table 1-3C and Figures 1-3A and 1-3B).

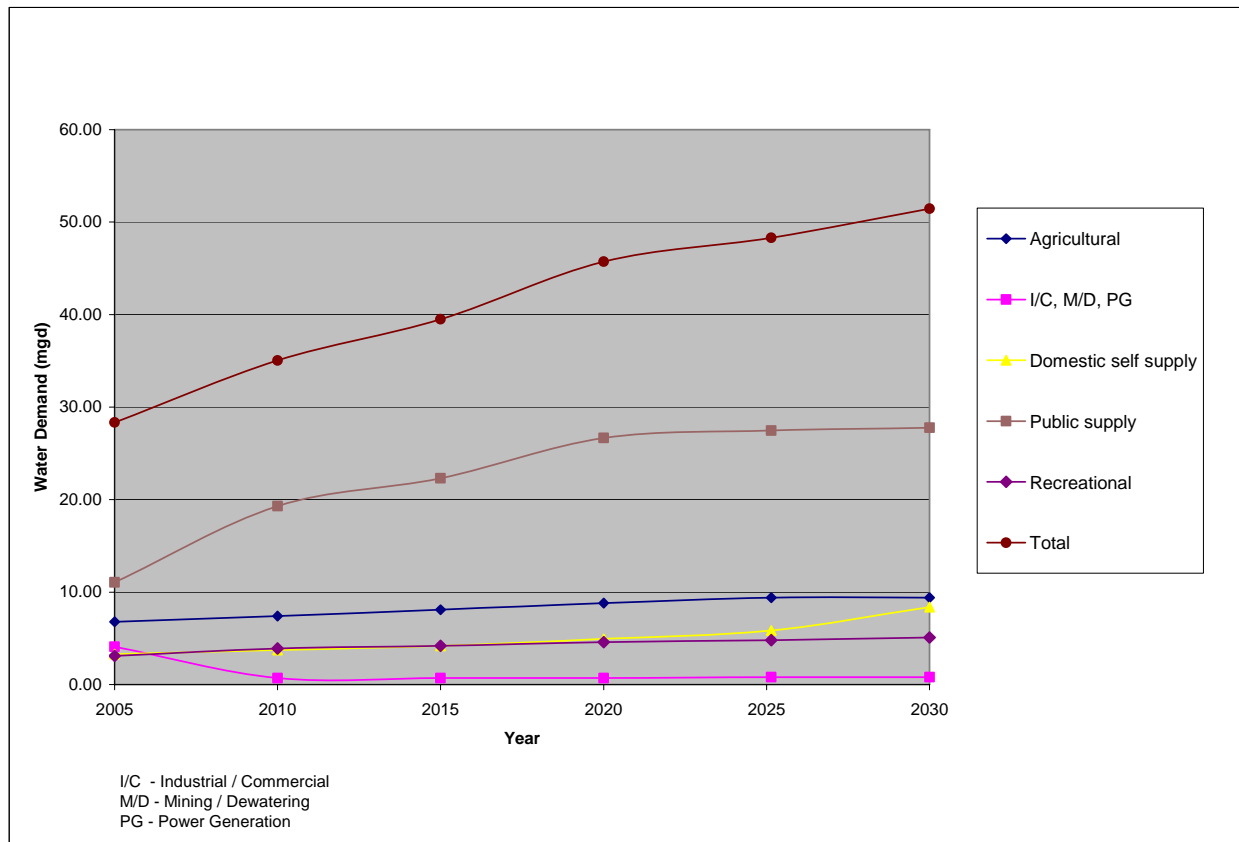


Figure 1-3A. Incorporated / Unincorporated Sumter County Projected Water Demand.

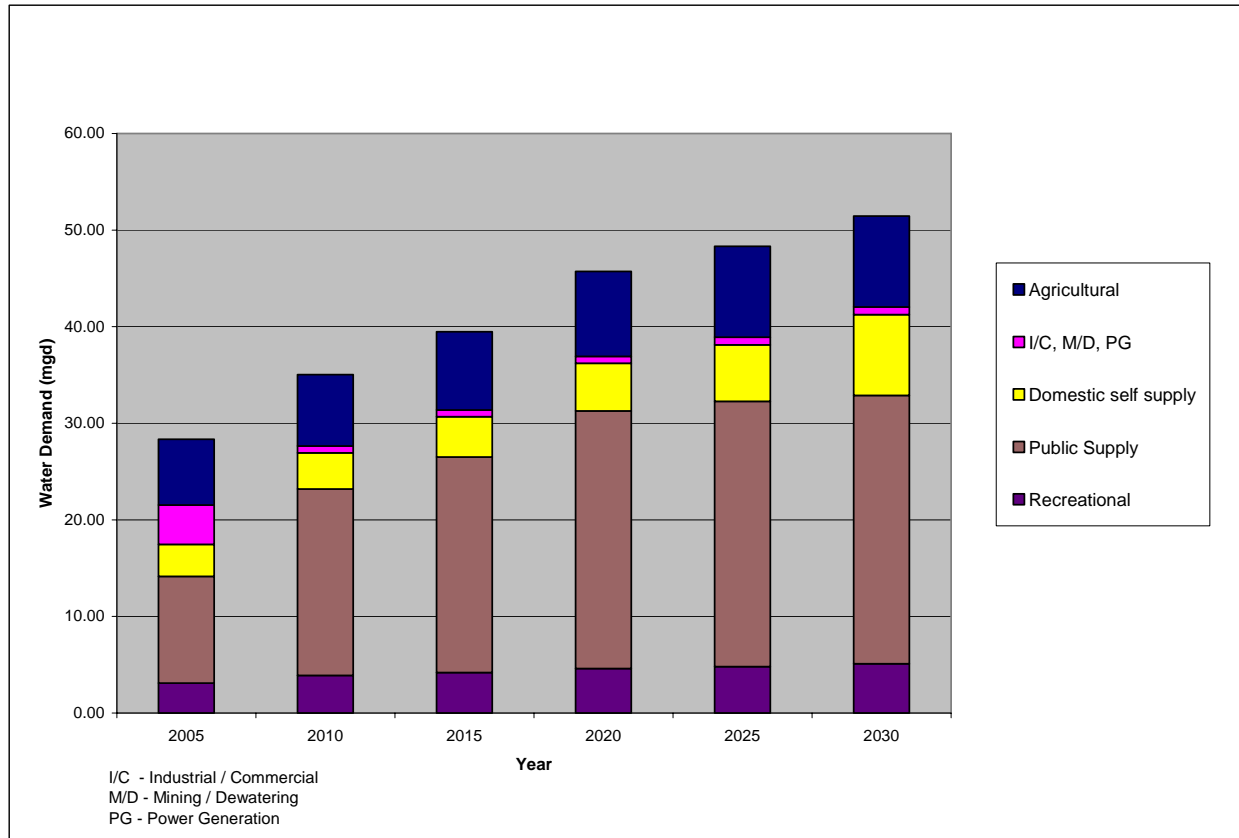


Figure 1-3B. Incorporated / Unincorporated Sumter County Projected Water Demand.

Marion County

The public supply water demand in Marion County in 2005 is approximately 30.13 mgd, which is anticipated to increase by 25.91 mgd (86%) to 56.04 mgd over the planning horizon. (Table 1-3D and Figures 1-4A and 1-4B).

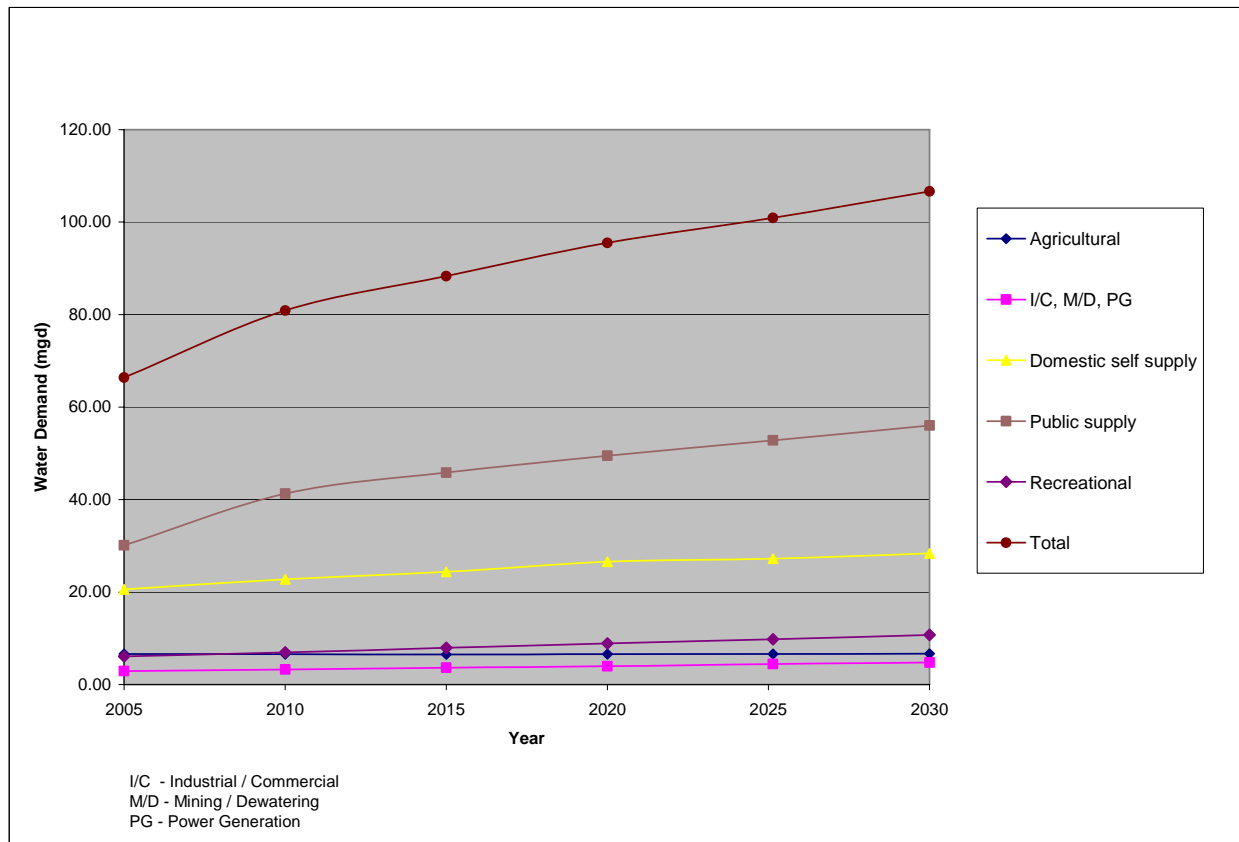


Figure 1-4A. Incorporated / Unincorporated Marion County Projected Water Demand.

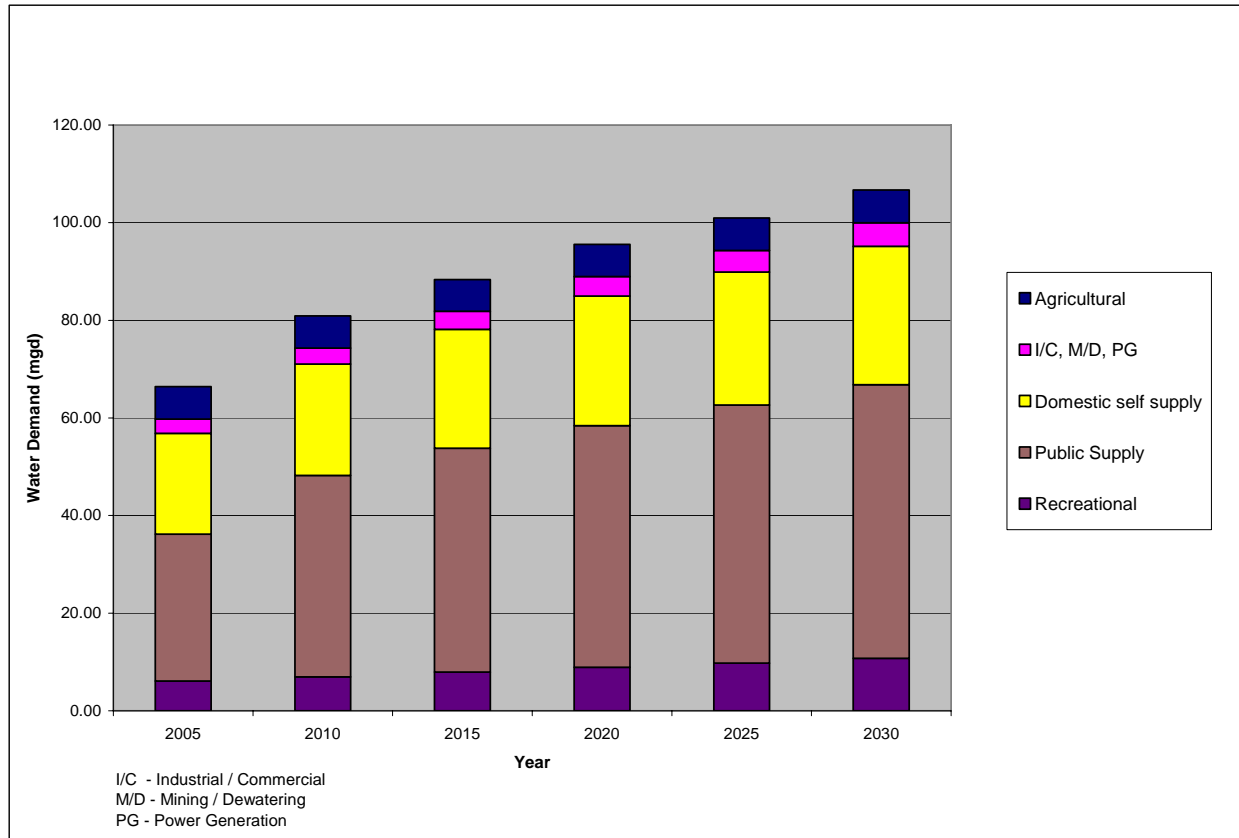


Figure 1-4B. Incorporated / Unincorporated Marion County Projected Water Demand.

1.3.7 Summary

In summary, public supply water demand projections were analyzed over the planning horizon and were determined to have the greatest expected water demand increase over the planning horizon of all the water use categories. These demand numbers were reached based on SWFWMD, and SJRWMD methodologies, including per capita determination and population projections. Public supply contributes 70% of the total WRWSA increase in water use over the planning horizon.

1.4 Domestic Self-Supply Water Demand

1.4.1 Introduction

Domestic self-supply is defined as that portion of the county population not serviced by municipal systems, but from residential wells. Domestic self-supply water use was broken out into a separate category for Phase II in order to depict those users that are not served by a municipal system.

As with public supply water use, domestic self-supply water use projections were based on 2005 base year population estimates, 2005 base year water use, and average per capita rate estimations (SWFWMD 5-year average per capita 2003-2007, and SJRWMD 6-year average

per capita 1995-2000). A description of the methodologies and assumptions employed to determine domestic self-supply water use follows and is outlined in Table 1-1B.

1.4.2 Base Year Populations

County domestic self-supply populations are calculated as the difference between the 2005 baseline total county population and the combined 2005 large and small utility service area populations.

1.4.3 Base Year Water Use

Base year water use for domestic self-supply is calculated by multiplying the domestic self-supply population for each county by the residential average per capita water use as described above. For the SWFWMD, the 5-year (2003-2007) average per capita rate was used to determine base year water use.⁵ In the SJRWMD, the 6-year (1995-2000) average per capita rate was used.⁶

1.4.4 Population Projections

As with the population projections mentioned above for public supply, the domestic self-supply population was projected using a parcel based model.

1.4.5 Domestic Self-Supply Water Demand Projections

1.4.5.1 Planning Horizon (2005 – 2030)

As mentioned, SWFWMD derived domestic self-supply water demands by multiplying 2003-2007 average per capita rates by the projected populations on a county-wide basis to develop these projections. SJRWMD used the 6-year per capita average (1995-2000) multiplied by the projected population to calculate the water demand projections in 5 year increments.

1.4.6 Results

The domestic self-supply water demand for the WRWSA was approximately 30.22 mgd in 2005. The estimated projected demand is expected to be 47.85 mgd in 2030. These demands equate to approximate increase of 17.63 mgd (58%) over the planning horizon. Refer to Table 1-2 for 5-year incremental increases of domestic self-supply water demand.

Citrus County

The 2005 domestic self-supply water demand in Citrus County is approximately 5.06 mgd, and is projected to increase by 0.34 mgd (6%) to 5.396 mgd over the planning horizon. (Shown in Figures 1-1A and 1-1B).

⁵ Domestic self-supply base year water use methodology is taken from Bader (2009).

⁶ Domestic self-supply base year water use methodology is taken from SJRWMD (2008).

Hernando County

The 2005 domestic self-supply water demand in the County is approximately 1.25 mgd, and is projected to increase by 4.47 mgd (357%) to 5.72 mgd over the planning horizon. (Shown in Figures 1-2A and 1-2B).

Sumter County

The 2005 domestic self-supply water demand in the County is approximately 3.29 mgd, and is projected to increase by 5.08 mgd (154%) to 8.37 mgd over the planning horizon. (Shown in Figures 1-3A and 1-3B).

Marion County

The 2005 domestic self-supply water demand in the County is approximately 20.62 mgd, and is projected to increase by 7.75 mgd (38%) to 28.37 mgd over the planning horizon. (Shown in Figures 1-3A and 1-3B).

1.4.7 Summary

Domestic self-supply projections over the planning horizon and reference projection period were determined by analyzing increases in populations not served by a municipal or private utility and applying each of the districts average per capita rates. These water use projections account for 8% of the total water use increase over the planning horizon in the WRWSA.

1.5 Commercial, Industrial, Mining/Dewatering and Power Water Demand

1.5.1 Introduction

This water demand category is associated with commercial, industrial, mining and other uses. Within SWFWMD, this water demand is calculated as follows:

I/C uses include chemical manufacturing, food processing, power generation, and miscellaneous I/C uses. While diversified, much of the water used in food processing can be attributed to agricultural crops. For the most part, chemical manufacturing is closely associated with mining and consists mainly of mine processing. A number of different products are mined within the SWFWMD's boundaries, including phosphate, limestone, shell, and sand. For the purposes of the water supply planning process, thermoelectric power generation (PG) is separated out as an individual use category. While the Water Demand Projection Subcommittee (FDEP, 2001) identified 0.1 mgd as the mandatory reporting threshold for the I/C and M/D categories, the SWFWMD examined and included all permitted or reported uses, regardless of the quantity in projecting demand. The decision to include all WUPs, regardless of size, resulted from a belief that projection accuracy would be improved by capturing all available water use data.⁷

⁷ Description taken from Wright (2009).

Within SJRWMD, this demand is calculated as follows: All permitted commercial /industrial/ institutional self-suppliers listed in the SJRWMD CUP database having an average daily use of at least 0.10 mgd in 2005 were included in the projection calculations.⁸

The sections below describe the methodology and projections of water use for commercial, industrial, and mining water demand. They also describe the methodologies the SWFWMD and SJRWMD developed for estimating water use under this category.

1.5.2 Base Year

Within SWFWMD jurisdiction, the base year for the purpose of developing and reporting water demand projections is 2005. This is consistent with the methodology agreed upon by the Water Planning Coordination Group (FDEP, 2001). The data for the baseline year consist of reported and estimated usage for 2005, whereas data for the years 2010 through 2030 are projected demands (estimated needs).⁹

Within SJRWMD jurisdiction, the base period used for the projections was 1995–2005, and the historic water use values were calculated by averaging data over this base period. The use of average values compensated for variations in rainfall and missing or anomalous annual flow values.¹⁰

1.5.3 Water Demand Projections

Demand projections within the SWFWMD were developed by multiplying permitted quantity data extracted from the District's Water Management Information System (WMIS) in October 2008 by the percentage of actual use for the I/C and M/D categories on a county-by-county basis. The percentage of permitted quantity used in each county was calculated by dividing total estimated county use by the county's permitted quantity in each category for the years 2001 through 2006, using data extracted from the District's yearly Estimated Water Use reports. During this six year period, 38.2 percent of M/D permitted quantities, and 42.1 percent of I/C permitted quantities were actually reported as used District-wide. However, the percentage of permitted quantity actually used in the I/C and M/D categories varies significantly from county-to-county. When data was available, the percentage of permitted quantity actually used by each PG WUP holder was calculated and used to project water demand on a permit-by-permit basis. When individual power plant data was not available, the District-wide average use for PG was used to project water demand.¹¹

Demand projections within the SJRWMD for commercial/industrial/institutional self-supply were divided into two groups—those that are likely to increase in the future (e.g., educational) and those that are not (e.g., military). Historical water use for those that are likely to increase in the future were summarized at the county level, and that total was multiplied by the population growth rate from 2005 to 2030. Historical water use for those that are not likely to increase in the future was also summarized at the county level. Because water use for those entities is not

⁸ Description taken from SJRWMD (2008).

⁹ Description taken from Wright (2009).

¹⁰ Description taken from SJRWMD (2008).

¹¹ Description taken from Wright (2009).

expected to increase in the future, the 2030 projections were held at the historic levels. The 2030 projection summaries for both types were then summarized by county.¹²

1.5.4 Results

The total WRWSA I/C, M/D and P/G water demand was approximately 26.03 mgd in 2005. Using the methods described, the demand is expected to be about 21.1 mgd in 2030. This demand equates to an approximate decrease of 4.93 mgd (19%) over the planning horizon. (Shown in Figures 1-1A through 1-3A and 1-1B through 1-3B). Refer to Table 1-2 for water demands given over five (5)-year increments.

1.5.5 Summary

It is recognized that the growth in these operations is difficult to predict, due to market “volatility” and the fact that existing operations are constantly in flux. Thus water use projections are also difficult to project. These water use projections account for -5% of the total water use increase over the planning horizon in the WRWSA.

1.6 Recreational/Aesthetics Water Demand

1.6.1 Introduction

SWFWMD includes in the recreational/aesthetic water demand the self-supplied freshwater used for the irrigation of golf courses, cemeteries, parks, and other large-scale landscapes. Golf courses are the major users within this category. The Water Demand Projection Subcommittee (FDEP, 2001) identified 0.5 mgd as the reporting threshold for all golf courses and others in the category. The threshold for the recreational/aesthetic category includes all permitted, reported, or otherwise identified uses because most golf courses and others in this category are below the identified 0.5 mgd threshold.¹³

The SJRWMD includes in the recreational/aesthetic water demand only of golf course irrigation, because SJRWMD does not have reliable estimates for other recreational uses and these other, recreational water uses (i.e., athletic field irrigation and swimming pools) are generally not significant in comparison to golf course irrigation. These other uses are often captured either in the public supply category or the commercial/industrial/institutional self-supply category.¹⁴

A description of the methodology and projections of water use for recreation and aesthetic is detailed as follows.

1.6.2 Base Year

The base year used for the recreational/aesthetic water use in SWFWMD jurisdiction is as follows: 2005 is the starting point, or baseline year, for the purpose of developing and reporting water demand projections. This is consistent with the methodology agreed upon by the Water Planning Coordination Group (FDEP, 2001). The data for the baseline year consist of reported

¹² Description taken from SJRWMD (2008).

¹³ Description taken from McGookey (2009).

¹⁴ Description taken from SJRWMD (2008).

and estimated usage for 2005, whereas data for the years 2010 through 2030 are projected demands (estimated needs).¹⁵

Within SJRWMD jurisdiction, water use values for each year between 1995 and 2005, where available for individual golf courses, were used as the basis of calculating an average water use per acre by individual golf course. For courses where water use data was incomplete, an estimation of the course's water use was calculated by multiplying the course acreage by the associated county-wide average.¹⁶

1.6.3 Water Demand Projections

Within the SWFWMD, the methodology for recreation/aesthetic demand is as follows:

Golf Courses

Golf course demands are based on the average water use per golf course hole by county and a projection of golf course growth. The demands include the average golf course pumpage from 2003 through 2007, for permitted golf courses in the SWFWMD, to calculate the average gallons per day per golf course hole. The pumpage was derived from the SWFWMD's Regulatory Database. The average annual pumpage per golf course hole is shown by golf course and by county. The county average was used to estimate future demand.

A minimum of three years of pumpage data was required to include the data from each golf course. Only surface water and ground water pumpage was used to determine the average use per golf course hole for those golf courses that utilized reclaimed water.

The historical number of golf course holes was derived from the National Golf Foundation (NGF) database (National Golf Foundation, 2007), the internet and data in the SWFWMD permit file of record (WMIS, 2006). Some golf courses were contacted to verify information such as the year the course opened and number of golf course holes. From this data, the historical growth of the number of existing golf course holes was used to forecast future growth. In order to forecast the average growth of golf course holes, a linear regression was performed using the historical golf course data in each county and that trend was used to project their growth to the year 2030. Although there are variations from year to year and from county to county, there is a general upward trend in the growth of golf course holes. The average annual use per hole by county was multiplied times the future growth in golf course holes to project future demands.

Aesthetic

Aesthetic water use includes landscape irrigation for parks, medians, attractions, cemeteries and other large self-supply green areas. For each county, per capita water use (expressed in gallons per day per person) is obtained from a five year average (2003 to 2007) of the published estimated landscape water use from the SWFWMD Estimated Water Use Report (EWUR). Estimates of population growth from 2005 to 2030 were obtained from the 2010 RWSP (Bader, 2009) and based on BEBR. These population projections were then multiplied times the per capita landscape water use to estimate aesthetic demand by county. The District's average per

¹⁵ Description taken from McGookey (2009).

¹⁶ Description taken from SJRWMD (2008).

capita water use for green space irrigation is 6.7 gpd per person. Projections were made in five-year increments to the year 2030.

1-in-10 Drought

The 1-in-10 drought event is an event that results in an increase in water demand of a magnitude that would have a 10 percent probability of occurring during any given year. The 1-in-10 year Drought Subcommittee of the Water Planning Coordination Group (SWPCG), as stated in their final report to the Florida Department of Environment Protection (FDEP, 2001), determined that, methodologies for estimating the 1-in-10 year demand high for recreational self supply are similar to methodologies used to estimate agricultural demand. The optimum irrigation requirements for the 1-in-10 year event, as opposed to the average year event, were 30 percent for golf courses and 26 percent for landscape irrigation. The projected water use for an average year was multiplied by this percentage value to produce a projected water use for a 1-in-10 year rainfall.¹⁷

Within SJRWMD jurisdiction, the methodology for recreation/aesthetic demand is as follows:

Golf Courses

SJRWMD digitized a district wide golf course polygon GIS layer by using aerial imagery to delineate the irrigated portions of golf courses. During the digitization process, only those areas that appeared irrigated were included in defining each course's boundary. For instance, surface water bodies, forested and shrub areas, and large paved areas were excluded from irrigated acreage.

Water use projections (i.e., projected golf course development) for each county were calculated by multiplying the irrigated acreage in each county in 1995 by the respective county population growth rates between 1995 and 2030. The 2005 golf course acreage and water use data were interpolated from the acreage and water use values from the projected increase between 1995 and 2030.

It is expected that a significant portion of the projected water use will be supplied by reclaimed water and storm water. SJRWMD, through its CUP program, routinely requires the use of reclaimed water and storm water when such use is technically, environmentally, and economically feasible.

Aesthetic

SJRWMD does not calculate aesthetic water use, as it does not have reliable estimates for its recreational/aesthetic water use demands as mentioned above.

1-in-10 Drought

Water use for a 1-in-10-year drought was calculated by multiplying the projected 2030 water use by the county change ratio reported in WSA 2003 for 2025 water use (see WSA 2003).¹⁸

¹⁷ Description taken from McGookey (2009).

¹⁸ Description taken from SJRWMD (2008).

1.6.4 Results

The total WRWSA recreational water demand was approximately 20.59 mgd in 2005. Using the methods described, the demand is expected to be about 33.76 mgd in 2030. This demand equates to an approximate increase of 13.17 mgd (64%) during the planning horizon timeframe. (Shown in Figures 1-1A through 1-3A and 1-1B through 1-3B). Table 1-2 shows demand projections incrementally for this water use category.

1.6.5 Summary

Recreational water use for the SWFWMD was projected based on the 2003-2007 average gallons per day per hole calculation and a linear regression analysis of increasing golf course holes. For the SJRWMD, only golf course irrigation was taken into account, because the district does not have reliable estimates for aesthetic water use. These water use projections account for 14% of the total water use increase over the planning horizon in the WRWSA.

1.7 Agricultural Water Demand

1.7.1 Introduction

In SWFWMD, agricultural water use demand projections were generated “for thirteen crop categories.” These crops include: “citrus, cucumbers, field crops, nursery, melons, other vegetables and row crops, and pasture, potatoes, sod, strawberries, tomatoes and blueberries” (SWFWMD, 2009). Water use projections for permitted irrigated crop categories were determined by multiplying projected irrigated crop acreage by crop irrigation requirements (AGMOD).¹⁹

Within SJRWMD, agricultural water demand is assessed by different crops due to specific consumption requirements. Corresponding estimates are based on a modified Blaney-Criddle model and Benchmark Farms Program data that is supplemented by U.S. Department of Agriculture-NRCS Conservation Service (USDA-NRCS CS) and National Oceanic and Atmospheric Administration (NOAA) information. Crop type and acreage data are provided through FAAS and a SJRWMD survey of county agricultural extension agents.²⁰

The sections below describe the methodology and projections of water use for this category.

1.7.2 Base Year

Within SWFWMD, “The data for the baseline year consist of reported and estimated usage for 2005” (SWFWMD, 2009).

Within SJRWMD the base year was 2005, and this data was taken from the 2005 Annual Water Use Data Fact Sheet. Monthly agricultural water use data was calculated using a modified Blaney-Criddle model and data from SJRWMD’s Benchmark Farms Program (BMF).²¹

¹⁹ AGMOD is a computer program developed and used by the SWFWMD in their water use permitting process to calculate supplemental irrigation, crop establishment, cold protection and other irrigation water uses.

²⁰ Description taken from SJRWMD (2008).

²¹ Description taken from SJRWMD (2008).

1.7.3 Water Demand Projections

Within SWFWMD, the methodology for computing agricultural demand is as follows:

Several assumptions were made, including: 1) agricultural land use conversion to residential/industrial/commercial use is irreversible; 2) water use/land use change analysis determines future agricultural land and water quantities; and 3) for purposes of the RWSP (2010), major agricultural types include citrus, cucumbers, field crops, nursery, melons, other vegetables and row crops, and pasture, potatoes, sod, strawberries, tomatoes and blueberries (added in 2008 for 2010 Plan).

The GIS model retrieved and compared the agricultural water use permitting information and land use/land cover county property appraiser's parcel data and recorded the future land use for each parcel and permitted area. The acreage increases were limited by the total available and remaining land and total water use permitted quantities. The GIS model accounted for land use transition from agriculture to residential/commercial/industrial use and a land use conversion trend was determined. Blueberry acreage was added to forecast the potential growth of this emerging crop type in the District. Aerial photography provided another layer of information for land use/land cover analysis and crop category determination.

Projected water uses associated with 'Miscellaneous' (*i.e.*, non- irrigated) agricultural operations include aquaculture, dairy, cattle, poultry, and others. The projected water use demands are presented under these two identified water use scenarios:

- Average annual effective rainfall conditions (5-in-10 year scenario); and
- A 1-in-10 drought year scenario (an event that results in an increase in water demand of a magnitude that would have a 10 percent probability of occurring during any given year)

Water use projections for permitted irrigated crop categories were determined by AGMOD. Acreage projections through the year 2030 were formulated based on a cumulative review of the information through GIS/permitting analysis and by other identified sources using a base year of 2005. For those counties that are not located wholly within the District (*i.e.*, Levy, Lake, Marion, Charlotte, Highlands, and Polk), only the portion of the crop acreage located within the District was considered.

Crop irrigation requirements were derived using AGMOD. Irrigation allocations were developed for each reporting category by using AGMOD and incorporating typical site-specific conditions for each crop, including location, climatology, soil type, irrigation system, and growing season(s). Planning level water use projections were developed through the year 2030 for average annual effective rainfall conditions and for a 1-in-10-drought year scenario.

For purposes of this analysis, the following assumptions were made with regard to crops included in the 'Vegetables, Melons, and Berries' category:

- All crops in the 'Vegetables, Melons, and Berries' category except for potatoes were assumed to be grown on plastic mulch. Although it is recognized that this is not entirely true for all operations in the planning regions (*e.g.*, some melon

acreage), the impact of this assumption on the overall water use projections is not believed to be significant;

- Irrigation allocations for all crops grown on plastic mulch were calculated assuming zero effective rainfall. The result of this assumption is that projected water use needs for mulched crops are the same under both the 5-in-10 (average annual) and 1-in-10 drought year scenarios; and
- Irrigation allocations for all crops grown on plastic mulch include quantities for crop establishment.

All of the foregoing assumptions are believed to be reasonable in the context of mulched crop operations.²²

For the demand projections of agricultural water use within SJRWMD, the district created a spatial database of 1995 and 2005 irrigated agricultural acreage for its entire jurisdictional area. Based on the information in this database, between 1995 and 2005 agricultural acreage declined by 13% and this trend is expected to continue.

This 2005 agricultural spatial database was intersected with all parcels projected to grow in population between 2005 and 2030. The population model also determines the maximum carrying capacity, in population, for a parcel that is at build-out (fully developed). A build-out percentage (ratio) can be calculated by dividing a parcel's projected population by its build-out population, which is shown:

$$[\text{Parcel growth build-out ratio}] = ([\text{2030 population}] - [\text{2005 population}]) / [\text{build-out population}]$$

As stated above, parcels projected to grow in population were intersected with the database for agricultural lands. Agricultural acreage loss was calculated by multiplying the intersecting (area common to both growth parcels and agricultural acreage) area acreage by the growth- to build-out ratio for each growth parcel, that is:

$$[\text{AG acres lost}] = \text{acres } ([\text{AG intersect growth parcel}]) \times [\text{growth build-out ratio}]$$

For each county (or portion thereof) in SJRWMD, the percentage change in irrigated agricultural acreage between 2005 and 2030 was calculated, as follows:

$$[\text{County AG 2030 acres}] = [\text{2005 county AG acres}] - [\text{county AG acres lost}]$$

Projected 2030 agricultural irrigation self-supply water use was calculated by multiplying the percentage change in acreage by the 2005 agricultural irrigation self-supply water use (see SJRWMD Technical Fact Sheet SJ2006-FS2 for 2005 water use).

Data from the consumptive use permitting process regarding future agricultural irrigation was taken into account in situations where agricultural irrigation was increasing significantly, but the typical assumption was that agricultural acreage will decline in the future. Therefore, it is assumed that agricultural irrigation self-supply water use will decline in the future. Water use for a 1-in-10-year drought was calculated by multiplying the projected 2030 water use by the county

²² Description taken from Nourani (2009).

change ratio reported in WSA 2003 for 2025 water use (see WSA 2003).²³

1.7.4 Results

The total WRWSA agricultural water demand was approximately 16.12 mgd in 2005. Using the methods described, the demand is expected to increase to 18.59 mgd in 2030. These demands equate to approximate increases of 2.47 mgd (15%) over the planning horizon. (Shown in Figures 1-1A through 1-3A and 1-1B through 1-3B). Table 1-2 depicts the incremental water demand estimates for this use category.

1.7.5 Summary

Agricultural water use for irrigated and non-irrigated uses was projected from multiple sources by the SWFWMD. Water use increases in this category account for 3% of the total increase in WRWSA.

1.8 Total WRWSA Water Demand

1.8.1 Summary

In summary, existing and future water demands in the WRWSA region were analyzed for each of the following categories:

1. Public supply;
2. Domestic self-supply;
3. Commercial/Industrial, Mining/Dewatering and Power Generation;
4. Recreational/Aesthetic; and
5. Agricultural.

The total WRWSA water demand for all water use categories was approximately 174.36 mgd in 2005. Using the methods described, the demand is expected to increase to 269.07 mgd in 2030. These demands equate to an approximate increase of 94.71 mgd (54%) during the planning horizon timeframe. (Figures 1-5A and 1-5B).

²³ Agricultural water demand methodology taken from SJRWMD (2008).

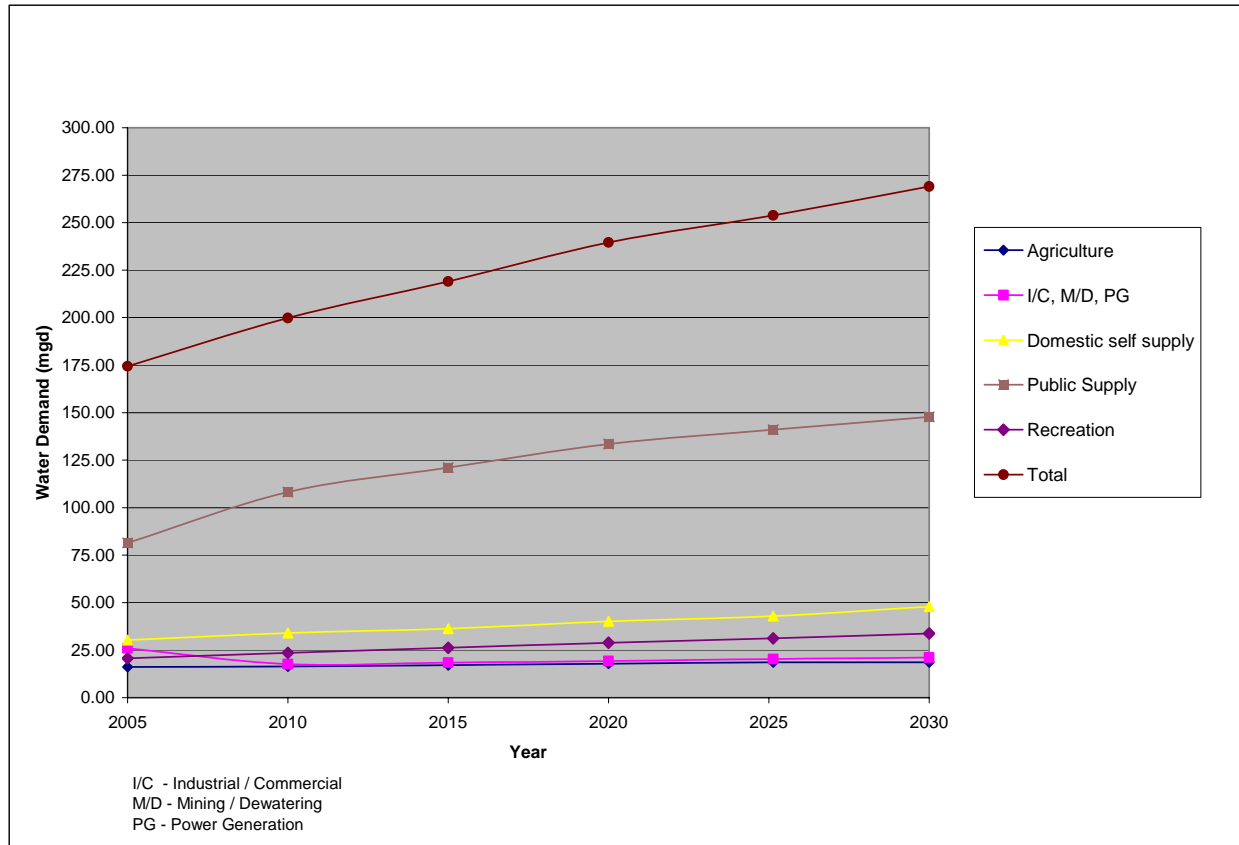


Figure 1-5A. Total Existing and Projected Water Demand for the WRWSA.

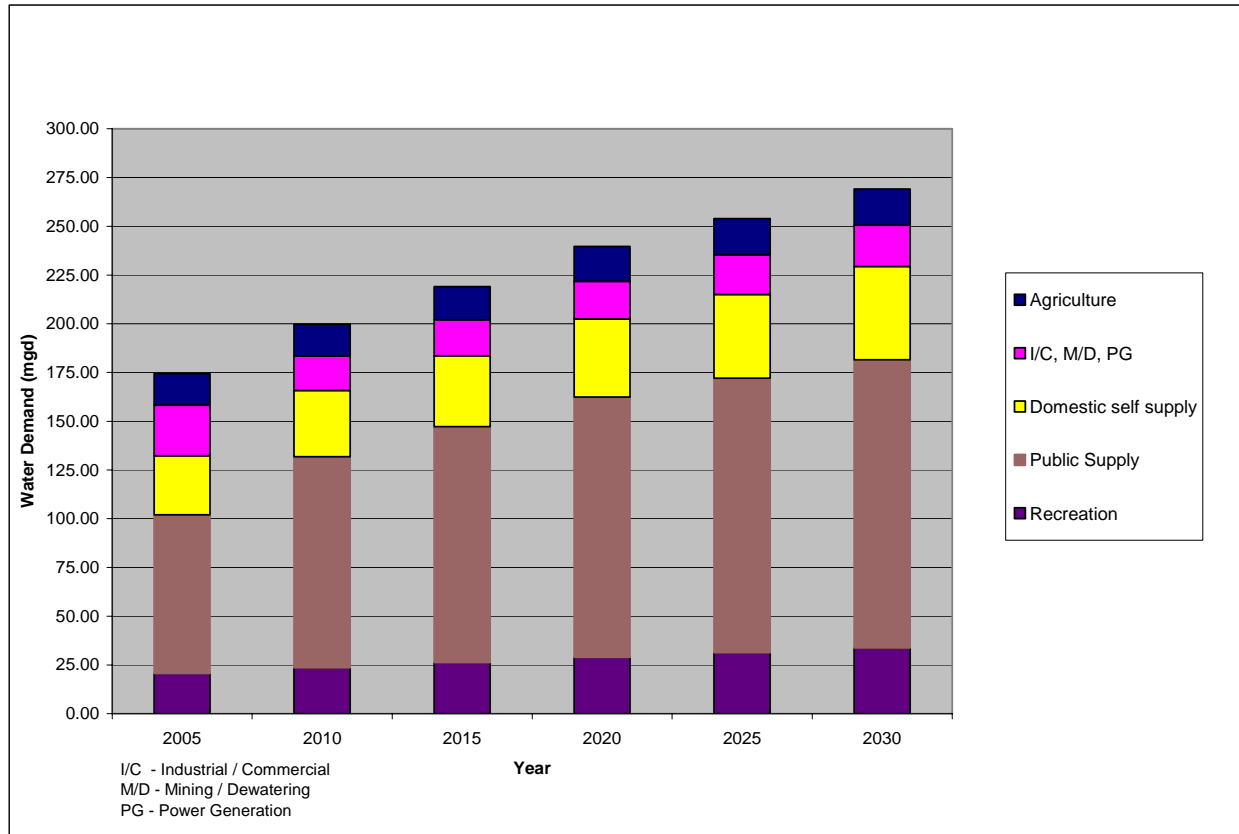


Figure 1-5B. Total Existing and Projected Water Demand for the WRWSA.

Marion County

Marion County had the highest water use increase during the planning horizon, of all the members of the WRWSA. This demand increases 40.27 mgd (61%) over the planning horizon to about 106.66 mgd. Public supply is the water use projected to increase the most for Marion County and is 64% of the total water demand increase. Domestic self supply is the second highest water use for Marion County. Domestic self supply in Marion County is much greater than any other county within the WRWSA. Domestic self supply in Marion County is 68% of the total domestic self supply for the entire WRWSA in 2005 and will increase to 28.37 mgd in 2030.

Sumter County

Sumter County was the second county with the highest water use increase during the planning horizon, of all the members of the WRWSA. Sumter County water demand in 2005 was 28.35 mgd. This demand increases 23.09 mgd (81%) over the planning horizon to about 51.44 mgd. Public supply is the water use with the greatest increase, making up 73% of the total increase in water for Sumter County. Industrial/Commercial water use in Sumter County, unlike most categories in the WRWSA, actually decreased in water demand. In 2005 the industrial/commercial water use for Sumter County was 4.10 mgd, and is projected to decrease to 0.80 mgd in 2030.

Citrus County

Citrus County's water demand in 2005 was 28.48 mgd. This demand increases approximately 20.02 mgd (72%) over the planning horizon to 48.50 mgd. Public supply water use was the highest increase for Citrus County nearly doubling during the planning horizon. Unlike other counties in the WRWSA, domestic self supply for Citrus County had a minimal increase. During the planning horizon domestic self supply increased 0.34 mgd, or a 6% increase.

Hernando County

Hernando County has the lowest total projected demand increase of any county in the WRWSA. Hernando County water demand in 2005 was 51.14 mgd, and is expected to increase by 11.34 mgd (22%) over the planning horizon to about 62.48 mgd. Domestic Self supply in Hernando County has the second highest rate of increase, when compared to all other counties in the WRWSA. Domestic self supply is expected to increase from 1.25 mgd to 5.72 mgd in 2030. This is a 4.47 mgd (358%) increase over the planning horizon.

1.9 Uncertainties and Issues with Projecting Public Supply Water Demand in the WRWSA

Overview

As discussed in the WRWSA – RWSPU, uncertainty is inherent in projections of population and water demand, because the rate and distribution of future population growth is not known. The recent economic downturn has clearly illustrated the limitations of population forecasting, as an unprecedented population decline occurred which was not foreseen by any of BEBR's low, medium or high-range projections.

The WMDs processes to project water demand have evolved over the course of the RWSPU - Phase I and Detailed Water Supply Feasibility - Phase II efforts. Small-area GIS forecasting is now being used by both the SWFWMD and SJRWMD to apportion BEBR population growth rates within counties, reducing inaccuracies in these rapidly developing areas. The WMDs are updating their projections at more frequent intervals. Nevertheless, the fundamental volatility associated with growth in Florida is an uncertainty that is impossible to eliminate in the planning process.

This fundamental volatility has been evident in the WRWSA. There have been dramatic swings in projected 20-year member water demands over the course of the Phase I and Phase II efforts. The most notable of these include regulatory acceptance of The Villages demand projections at the end of Phase I, which dramatically increased the projections for northeastern Sumter County; the 2010 SWFWMD RWSP update during Phase II which greatly reduced the demand projections for Hernando County; and the draft 2010 SJRWMD DWSP update at the end of Phase II which significantly reduced the demand projected for Ocala. Each of these events were significant enough to influence portions of the resource assessment and water supply development components of the WRWSA planning process, as presented in subsequent chapters. For any individual service area in the WRWSA, the 2030 demand projections should be viewed with a potentially large margin of uncertainty.

Proposed Levy County Power Complex

Industrial activity in and around the WRWSA region also has the potential to affect public supply demand, by generating economic development that supports population growth. The region is home to one of the largest power generating complexes in Florida, Progress Energy's Crystal River Power Plant. Enhancements to this Crystal River complex are under construction and Progress Energy has proposed a second large power generating complex to the north of the existing plant in Levy County. While the BEBR forecasts consider the effect of industrial activities on population growth on a county-wide basis, the new generating complex in Levy County could affect the distribution of projected growth within Counties in the WRWSA.²⁴ It is notable that the current population projections indicate very high rates of population growth for the northern Citrus County service areas, with much lower rates for the southern Citrus County service areas.

Progress Energy's Combined License Application was reviewed to obtain data relevant to the projected distribution of population growth associated with the proposed Levy County complex (Progress Energy, 2008). The application indicates that growth effects of the complex will be felt in Citrus, Sumter, Levy, Marion, Alachua, Gilchrist, Dixie, and Hernando Counties during both construction and operations. An estimated 35% of the incoming workforce for the complex is projected to reside in Marion County and 17% is projected to reside in Citrus County. Less than 5% of the incoming workforce is projected to reside in Sumter and Hernando Counties. Each incoming worker is considered to be a head of household. A multiplier is used to estimate the indirect workforce resulting from development of supporting industries.

Using the state-average value for persons per household, the permanent incoming population projected for the complex and its indirect activity totals 558 persons for the four-county WRWSA. The permanent increase in population equates to a public supply demand of 83,700 gpd assuming a per capita of 150 gpcd. With these values projected to be dispersed across the four counties of the WRWSA, the permanent effects on public supply demand should be minimal.

Using the state-average value for persons per household, the peak temporary incoming population projected for the complex and its indirect activity totals 1,882 persons for the four-county WRWSA (e.g., during the construction peak). The peak temporary increase in population equates to a public supply demand of 282,300 gpd assuming a per capita of 150 gpcd. With these projected values projected to be dispersed across the four-counties of the WRWSA, the temporary effects on public supply demand should be modest. Appendix LEVY provides a detailed tabular summary of the permanent analysis.

As discussed above, uncertainty is inherent in projections of population and water demand. The temporary growth associated with the Levy County complex could have a more significant affect on member service areas if population increases vary or are not dispersed as projected. Perhaps the most significant issue is for member utilities that currently exceed the proposed SWFWMD 150 compliance per capita requirement. For these systems, temporary population influxes could distort estimates of per capita consumption and affect compliance with their water use permits.

²⁴ The upgrades to the Crystal River Power Plant are not expected to result in significant increases in public supply water demand.

Conclusions

While uncertainty is inherent in projections of population and water demand, the fundamental volatility associated with growth in Florida is a significant issue in the WRWSA that is impossible to eliminate. In this largely rural area, updates and variations in demand projections have influenced, and will continue to influence, resource assessment and water supply development activities. Since water demand is the basis for the water supply planning process, this uncertainty indicates that flexible planning strategies are needed in the WRWSA.

Category	Year(s)	Reporting Category	Methodology	Sources
Population SWFWMD	2005 (base year)	-	Utility populations were taken from the Estimated Water Use report (2005).	"Estimated Water Use, 2005", Southwest Florida Water Management District, and Utility-submitted information
	2010-2030	-	2008 BEBR Medium population projections applied to a GIS Population Projection Model. The model projects future permanent population growth at the census block level, distributes that growth to parcels within each block, and normalizes those projections to BEBR county projections.	"Projections of Florida Population by County, 2007 – 2035", Bureau of Economic and Business Research, March 2008, and "The Small-Area Population Projection Methodology of The Southwest Florida Water Management District", September 29, 2008.
Population SJRWMD	2005 (base year)	-	Populations were taken from the 2006 BEBR population projections.	"Projections of Florida Population by County, 2006", Bureau of Economic and Business Research.
	2010-2030	-	2006 BEBR Medium population projections applied to a GIS Population Projection Model. The model projects future permanent population growth at the census block level, distributes that growth to parcels within each block, and normalizes those projections to BEBR county projections.	"Projections of Florida Population by County, 2006", Bureau of Economic and Business Research, March 2008, and "The small area population projection and distribution methodology of the St. Johns River Water Management District for the 2008 District Water Supply Assessment and the 2010 District Water Supply Plan", GIS Associates, 2009.
Water Demand SWFWMD	2005	Large Utilities	Water use is defined as the utilities' (with greater than 0.1 mgd withdrawal) permitted withdrawals, plus imports, minus exports. Individually reported base year water use for large utilities. "Estimated Water Use 2005," Table A-1.	"Estimated Water Use, 2005", Southwest Florida Water Management District, 2006.
Water Demand SJRWMD	2005	Large Utilities	Water demand from publicly and privately owned public water supply utilities that had a 2005 annual average daily flow of at least 0.1 mgd. Public supply water use includes any uses of water from a public supply system.	"2008 Draft Water Supply Assessment", St. Johns River Water Management District, 2008.
Water Demand SWFWMD	2005	Small Utilities	Water use for small utilities is the sum of all small utilities' water use in the county identified in "Estimated Water Use 2005," plus the additional estimated water use associated with those non-reporting utilities.	"Estimated Water Use, 2005", Southwest Florida Water Management District, 2006.
	2010-2030	N/A	The District used the 2003-2007 average per capita water use rate and multiplied it by projected populations for each entity.	"2003-2007 Estimated Water Use Reports", Southwest Florida Water Management District.
Water Demand SJRWMD	2010-2030	N/A	The District used the 1995-2005 per capita water use rate and multiplied it by projected populations for each entity.	"2008 Draft Water Supply Assessment", St. Johns River Water Management District, 2008.

TABLE 1-1A - Public Supply Methodology and Assumptions

Category	Year(s)	Methodology	Sources
Population SWFWMD	2005 (base year)	County domestic self-supply populations are calculated as the difference in 2005 baseline total county population and the combined 2005 large and small utility service area populations	"Estimated Water Use, 2005", Southwest Florida Water Management District, and Utility-submitted information.
	2010-2030	2008 BEBR Medium population projections applied to a GIS Population Projection Model. The model projects future permanent population growth at the census block level, distributes that growth to parcels within each block, and normalizes those projections to BEBR county projections.	"Projections of Florida Population by County, 2007 – 2035", Bureau of Economic and Business Research, March 2008, and "The Small-Area Population Projection Methodology of The Southwest Florida Water Management District", September 29, 2008.
Population SJRWMD	2005 (base year)	Population for the domestic self-supply and small public supply systems category was calculated by subtracting the publicly supplied population (not including small public supply systems) from the SJRWMD portion of the total county population.	"Projections of Florida Population by County, 2006", Bureau of Economic and Business Research.
	2010-2030	2006 BEBR population projections applied to a GIS Population Projection Model. The model projects future permanent population growth at the census block level, distributes that growth to parcels within each block, and normalizes those projections to BEBR county projections.	"Projections of Florida Population by County, 2006", Bureau of Economic and Business Research, March 2008, and "The small area population projection and distribution methodology of the St. Johns River Water Management District for the 2008 District Water Supply Assessment and the 2010 District Water Supply Plan", GIS Associates, 2009.
Average Per Capita Rate SWFWMD	2003-2007	Average of 2003-2007 residential public supply water use divided by population.	2003-2007 Estimated Water Use Reports, Southwest Florida Water Management District.
Average Per Capita Rate SJRWMD	1995-2000	Average of 1995-2000 residential public supply water use divided by population.	"Draft 2008 Water Supply Assessment", SJRWMD, 2008.
Water Use SWFWMD	2005	Base year water use for domestic self-supply is calculated by multiplying the domestic self-supply population for each county by the residential per capita water use.	"Estimated Water Use, 2005", Southwest Florida Water Management District, 2006.
	2010-2030	Multiplied 2003-2007 average per capita rate by the projected self-supplied population.	N/A
Water Use SJRWMD	2005	Base year water use for domestic self-supply is calculated by multiplying the domestic self-supply population for each county by the residential per capita water use.	"Draft 2008 Water Supply Assessment", SJRWMD, 2008.
	2010-2030	Multiplied 1995-2000 average per capita rate by the projected self-supplied population.	"Draft 2008 Water Supply Assessment", SJRWMD, 2008.

TABLE 1-1B - Domestic Self-Supply Methodology and Assumptions

Table 1-2 - Existing and Projected Water Demand for Phase II

			2005			
	Public Supply	Domestic Self Supply	Agricultural MGD	I/C, M/D MGD	Recreational MGD	Yearly Total MGD
Citrus	16.12	5.06	0.20	1.70	5.40	28.48
Hernando	24.09	1.25	2.50	17.30	6.00	51.14
Sumter	11.06	3.29	6.80	4.10	3.10	28.35
Marion	30.13	20.62	6.62	2.93	6.09	66.39
TOTAL	81.40	30.22	16.12	26.03	20.59	174.36

			2015			
	Public Supply	Domestic Self Supply	Agricultural MGD	I/C, M/D MGD	Recreational MGD	Yearly Total MGD
Citrus	24.12	5.15	0.50	2.90	6.90	39.57
Hernando	28.80	2.56	1.90	11.20	7.20	51.66
Sumter	22.30	4.19	8.10	0.70	4.20	39.49
Marion	45.83	24.40	6.53	3.64	7.94	88.33
TOTAL	121.05	36.29	17.03	18.44	26.24	219.05

			2025			
	Public Supply	Domestic Self Supply	Agricultural MGD	I/C, M/D MGD	Recreational MGD	Yearly Total MGD
Citrus	28.75	5.28	0.50	3.10	8.10	45.73
Hernando	31.93	4.54	2.00	11.90	8.50	58.87
Sumter	27.46	5.85	9.40	0.80	4.80	48.31
Marion	52.82	27.23	6.63	4.45	9.79	100.92
TOTAL	140.96	42.90	18.53	20.25	31.19	253.83

All Values shown are mgd
I/C - Industrial/Mining
M/D - Mining/Dewatering

			2010			
	Public Supply	Domestic Self Supply	Agricultural MGD	I/C, M/D MGD	Recreational MGD	Yearly Total MGD
Citrus	21.49	5.10	0.20	2.80	6.20	35.79
Hernando	26.16	2.29	2.20	10.90	6.50	48.05
Sumter	19.29	3.75	7.40	0.70	3.90	35.04
Marion	41.28	22.79	6.57	3.28	6.96	80.88
TOTAL	108.22	33.93	16.37	17.68	23.56	199.77

			2020			
	Public Supply	Domestic Self Supply	Agricultural MGD	I/C, M/D MGD	Recreational MGD	Yearly Total MGD
Citrus	26.52	5.20	0.50	3.00	7.50	42.72
Hernando	30.78	3.37	2.00	11.60	7.90	55.65
Sumter	26.67	4.95	8.80	0.70	4.60	45.72
Marion	49.50	26.56	6.58	3.99	8.91	95.54
TOTAL	133.47	40.08	17.88	19.29	28.91	239.62

			2030			
	Public Supply	Domestic Self Supply	Agricultural MGD	I/C, M/D MGD	Recreational MGD	Yearly Total MGD
Citrus	30.70	5.40	0.50	3.20	8.70	48.50
Hernando	33.26	5.72	2.00	12.30	9.20	62.48
Sumter	27.77	8.37	9.40	0.80	5.10	51.44
Marion	56.04	28.37	6.69	4.80	10.76	106.66
TOTAL	147.77	47.85	18.59	21.10	33.76	269.07

Table 1-3A Citrus County Public Supply Water Demand and Population

Utility	Population Projections						Gross GPCD	Demand Projections ^{1,2}					
	2005	2010	2015	2020	2025	2030		2005	2010	2015	2020	2025	2030
CITRUS COUNTY													
City of Crystal River (207)	3,685	12,132	12,582	12,915	13,332	13,773	177	0.65	2.15	2.23	2.29	2.36	2.44
City of Inverness (419)	9,300	24,457	26,126	27,628	29,324	31,368	165	1.54	4.04	4.31	4.56	4.84	5.18
Floral City Water Assoc. Inc. (1118)	5,668	6,876	7,169	7,371	7,574	7,850	56	0.32	0.39	0.40	0.41	0.42	0.44
Citrus County Utilities													
Citrus County & WRWSA (7121)	23,917	27,851	33,977	38,126	41,608	44,462	197	4.71	5.49	6.69	7.51	8.20	8.76
Citrus Springs / Pine Ridge (2842)	13,080	14,894	17,567	21,036	25,031	29,119	181	2.37	2.70	3.18	3.81	4.53	5.27
Oak Forest (7879)	415	424	426	426	430	440	119	0.05	0.05	0.05	0.05	0.05	0.05
Sugarmill Woods (9791)	9,659	9,743	11,552	13,769	15,373	15,903	226	2.18	2.20	2.61	3.11	3.47	3.59
Lakeside Estate (13219)	574	619	623	623	624	624	130	0.08	0.08	0.08	0.08	0.08	0.08
Rolling Oaks Utilities Inc. (4153)	12,242	12,653	12,700	12,704	12,726	12,777	178	2.18	2.25	2.26	2.26	2.27	2.27
Homasassa Special Water District (4406)	6,075	6,488	7,013	7,588	7,972	8,353	130	0.79	0.84	0.91	0.99	1.04	1.09
Gulf Highway Land Corporation (6691)	578	590	646	760	816	819	143	0.08	0.08	0.09	0.11	0.12	0.12
Walden Woods LTD (11839)	752	832	945	1,058	11,711	1,284	189	0.14	0.16	0.18	0.20	0.22	0.24
Small Utilities	5,842	6,035	6,317	6,441	6,547	6,665	177	1.03	1.07	1.12	1.14	1.16	1.18
County Total	91,787	123,594	137,643	150,445	173,068	173,437		16.12	21.49	24.12	26.52	28.75	30.71

1. Demands developed by the SWFWMD.

2. Demand projections based on methodology described in the text, not compliance per capita of 150 gpcpd.

Table 1-3B Hernando County Public Supply Water Demand and Population

Utility	Population Projections						Gross GPCD	Demand Projections ^{1,2}					
	2005	2010	2015	2020	2025	2030		2005	2010	2015	2020	2025	2030
HERNANDO COUNTY													
Hernando County Water and Sewer ³													
West Hernando Service Area (2983)													
East Hernando Service Area (5789)													
Hernando County Water and Sewer (2179)	129,476	138,820	153,193	163,548	169,451	176,076	171	22.14	23.74	26.20	27.97	28.98	30.11
Cedar Lane Water Plant (5817)													
Seville Water System (12011)													
Royal Oaks Subdivision (13286)													
City of Brooksville (7627)	12,590	16,240	17,200	18,074	19,234	20,528	111	1.40	1.80	1.91	2.06	2.14	2.28
Small Utilities	3,405	3,819	4,241	4,632	5,011	5,365	163	0.56	0.62	0.69	0.76	0.82	0.87
County Total	145,471	158,879	174,634	186,254	193,696	201,969		24.09	26.16	28.80	30.78	31.93	33.26

1. Demands developed by the SWFWMD.

2. Demand projections based on methodology described in the text, not compliance per capita of 150 gpcpd.

3. Water Demands aggregated by the SWFWMD.

Table 1-3C Sumter County Public Supply Water Demand and Population

Utility	Population Projections						Gross GPCD	Demand Projections ^{1,2}					
	2005	2010	2015	2020	2025	2030		2005	2010	2015	2020	2025	2030
SUMTER COUNTY													
Lake Panasoffkee Water Assoc. Inc. (1368)	4,380	5,008	5,202	5,770	6,570	6,816	77	0.34	0.39	0.40	0.44	0.51	0.53
Continental Country Club RO Inc. (2622)	2,906	2,906	2,921	2,961	3,122	3,204	147	0.43	0.43	0.43	0.44	0.46	0.47
City of Bushnell (6519)	2,119	4,639	4,790	5,182	6,218	6,828	186	0.39	0.86	0.89	0.96	1.16	1.27
City of Webster (7185)	819	1,364	1,431	1,627	1,702	1,800	114	0.09	0.16	0.16	0.19	0.19	0.21
Cedar Acres, Inc. (7799)	637	649	707	915	1,203	1,293	70	0.05	0.05	0.05	0.06	0.08	0.09
City of Wildwood (8135)	12,450	16,764	21,027	29,781	32,545	33,274	167	2.08	2.80	3.51	4.97	5.44	5.56
City of Center Hill (8193)	983	1,621	1,666	1,816	2,081	2,526	70	0.07	0.11	0.12	0.13	0.15	0.18
The Villages (13005, 12236, 11404)	33,420	65,145	75,443	88,069	88,069	88,069	217	7.25	14.14	16.37	19.11	19.11	19.11
Small Utilities	1,962	1,997	1,997	1,997	1,997	1,997	184	0.36	0.37	0.37	0.37	0.37	0.37
County Total	59,676	100,093	115,184	138,118	143,507	145,807		11.06	19.29	22.30	26.67	27.46	27.77

1. Demands developed by the SWFWMD.

2. Demand projections based on methodology described in the text, not compliance per capita of 150 gpcpd.

Table 1-3D Marion County Public Supply Water Demand and Population

Utility	Population Projections						Gross GPCD	Demand Projections ^{1,2}					
	2005	2010	2015	2020	2025	2030		2005	2010	2015	2020	2025	2030
MARION COUNTY SWFWMD													
Marion County Utilities Department													
Summerglen (377)	9,248	16,883	24,124	29,103	34,399	39,787	128	1.18	2.16	3.09	3.73	4.40	5.09
Marion County Utilities (6151)	9,093	12,603	13,718	14,506	15,264	15,870	179	1.63	2.26	2.46	2.60	2.73	2.84
Quail Meadow (8165)	500	1,009	1,051	1,107	1,189	1,295	217	0.11	0.22	0.23	0.24	0.26	0.28
Marion County Utilities (11752)	80	1,833	1,886	1,950	2,038	2,149	536	0.04	0.98	1.01	1.05	1.09	1.15
Spruce Creek (12218)	1,200	1,430	1,530	1,662	1,802	1,914	487	0.58	0.70	0.75	0.81	0.88	0.93
Marion Utilities Inc (Private Utility)													
Marion Utilities Inc (2999)	681	681	681	681	681	681	187	0.13	0.13	0.13	0.13	0.13	0.13
Marion Utilities Inc (7849)	807	954	1,055	1,109	1,138	1,166	185	0.15	0.18	0.20	0.21	0.21	0.22
Spruce Creek (8481)	3,000	5,533	6,469	6,903	7,100	7,246	241	0.72	1.33	1.56	1.66	1.71	1.75
On Top of The World Communities Inc (1156)	5,824	8,443	9,100	9,603	10,023	10,645	277	1.61	2.34	2.52	2.66	2.78	2.95
Rainbow Springs Utilities LC (4257)	2,774	3,013	3,448	3,807	4,107	4,424	221	0.61	0.67	0.76	0.84	0.91	0.98
Utilities Inc of Florida - Golden Hills (5643)	1,785	1,841	1,945	2,063	2,217	2,449	97	0.17	0.18	0.19	0.20	0.22	0.24
Sateke Village Utilities Hoa (6290)	76	87	87	87	88	88	124	0.01	0.01	0.01	0.01	0.01	0.01
Sun Communities Operating LP (6792)	845	845	845	845	845	845	146	0.12	0.12	0.12	0.12	0.12	0.12
Century Fairfield Village LTD (8005)	513	513	513	513	513	513	208	0.11	0.11	0.11	0.11	0.11	0.11
Marion Landing HOA (8020)	1,144	1,196	1,196	1,196	1,196	1,196	157	0.19	0.19	0.19	0.19	0.19	0.19
City of Dunnellon (8339)	2,770	6,135	7,064	8,166	9,255	10,151	125	0.35	0.77	0.88	1.02	1.16	1.27
Windstream Utilities Co (9360)	1,440	2,333	2,518	2,700	2,903	3,152	409	0.59	0.95	1.03	1.10	1.19	1.29
Upcharch Marinas - Sweetwater (9425)	249	452	452	452	452	452	277	0.07	0.13	0.13	0.13	0.13	0.13
Small Utilities	4,925	6,657	7,776	8,724	9,541	9,973	177	0.87	1.18	1.38	1.54	1.69	1.77
MARION COUNTY SJRWMD													
City of Ocala (50324)	52,760	66,121	75,293	84,447	93,525	102,604	185	9.74	12.52	13.97	15.54	16.96	18.60
Aqua Utilities of Florida Inc	3,414	3,570	3,638	3,663	3,673	3,673	104	0.35	0.46	0.46	0.47	0.47	0.47
City of Belleview (3137)	10,227	12,802	14,895	16,723	17,691	17,691	77	0.79	1.00	1.16	1.30	1.38	1.38
Marion County Utilities Department SJRWMD													
Deerpath (50381)	1,936	2,452	2,706	2,960	3,215	3,489	64	0.12	0.20	0.22	0.24	0.26	0.28
Raven Hill Subdivision (51172)	686	689	689	689	689	689	159	0.11	0.14	0.14	0.14	0.14	0.14
Silver Springs Regional Water & Sewer (4578)	1,025	1,230	1,233	1,253	1,335	1,335	272	0.28	0.34	0.34	0.34	0.36	0.36
Silver Springs Shores (3054)	16,908	24,849	30,348	34,081	36,010	36,010	76	1.29	1.60	1.74	1.83	1.91	1.91
Southoak Subdivision (51173)	953	971	974	974	974	974	140	0.13	0.18	0.18	0.18	0.18	0.18
Spruce Creek Golf and Country Club (399)	4,899	6,730	6,758	6,759	6,759	6,759	394	1.93	2.97	3.12	3.24	3.32	3.35
Spruce Creek South (82827)	2,733	2,751	2,751	2,752	2,752	2,752	260	0.71	0.91	0.91	0.91	0.91	0.91
Stonecrest Utilities	10,200	13,983	16,566	17,837	20,339	20,339	99	1.01	1.65	2.01	2.01	2.01	2.01
Marion Utilities Inc	4,979	5,043	5,058	5,074	5,089	5,089	153	0.76	0.77	0.77	0.77	0.78	0.78
Ocala East Villas	0	458	459	461	461	461	328	0.00	0.15	0.15	0.15	0.15	0.15
Sunshine Utilities	4,342	4,977	5,277	5,579	5,770	5,770	343	1.49	1.71	1.81	1.91	1.98	1.98
The Villages of Marion ³	8,863	8,890	8,890	8,890	8,890	8,890	245	2.17	2.13	2.13	2.13	2.13	2.13
County Total	170,879	227,957	260,993	287,319	311,923	330,521		30.13	41.28	45.83	49.50	52.82	56.04

1. Demands developed by the SWFWMD and the SJRWMD for their water supply assessments.

2. Demand projections based on methodology described in the text, not compliance per capita of 150 gpcpd.

3. This utility is owned and served by The Vilalges in Sumter County.

Chapter 2 – Water Resource Minimum Flows and Levels

2.0 Key Points

Key Points

- MFLs for priority water bodies are required by Florida Statutes to be established by Florida's Water Management Districts to protect water resources and ecology from significant harm due to water withdrawals. Established MFLs can be constraints to water supply development.
- MFL priority water bodies are identified and scheduled based on the importance of the water resource and the existence of or potential for significant harm to the water resources or ecology of region. MFL priority lists are updated by the Districts annually.
- The SWFWMD and SJRWMD have adopted 23 MFLs located in the WRWSA region. MFLs have been established for 21 lakes, one (1) wetland and one (1) spring. MFLs have been established in every county within the WRWSA.
- The SWFWMD and SJRWMD have scheduled 14 MFLs located in the WRWSA for establishment. MFLs are scheduled for five (5) lakes, two (2) rivers, and seven (7) springs. These MFLs are also located throughout the WRWSA.
- MFLs are scheduled but have not been adopted for the Withlacoochee or Ocklawaha River systems and most of the springs within the WRWSA. These MFLs may have a significant impact on future groundwater and/or surface water development within the region.
- As part of this report, the WRWSA has developed proxy thresholds on water systems that are yet to be completed. These proxy thresholds will ensure that proposed water supply projects recognize potential MFL withdrawal constraints. Proxy MFLs are developed for the Withlacoochee River and springs in Citrus, Sumter, and Hernando Counties.

2.1 Introduction

The WRWSA region is home to a diverse array of water and natural resources, including springs, rivers, lakes and wetlands (WRA, 2007). In order to protect water resources and ecology from significant adverse impacts due to water withdrawals, SWFWMD and SJRWMD are required to establish MFLs by Section 373.042, Florida Statutes. MFLs can be a constraint on water supply development, requiring that water withdrawals must not cause water levels or flows to decrease below MFL criteria. The minimum flow or level is defined as the amount of "...groundwater in the aquifer and...surface watercourses at which further withdrawals would be significantly harmful to the water resources or ecology of the area."

MFLs are to be developed using the best available information and may consider seasonal variations and protection of non-consumptive uses in their establishment. Generally, MFLs consider protection of a broad array of environmental and water resource values, including:

- Recreation in and on the water;
- Fish and wildlife habitats and the passage of fish;
- Estuarine resources;
- Transfer of detrital materials;

- Maintenance of freshwater storage and supply;
- Aesthetic and scenic attributes;
- Filtration and absorption of nutrients and other pollutants;
- Sediment loads;
- Water quality; and
- Navigation.

Under 373.042, a priority list and schedule for the establishment of MFLs is required to be submitted to FDEP for review and approval each year by the SWFWMD and SJRWMD. The priority list and schedule is to be based on “the importance of the waters to the state and region and the....existence of or potential for significant harm to the water resources or ecology of the state or region”. The WRWSA region contains a number of SWFWMD or SJRWMD priority water bodies with either adopted or scheduled MFLs.

MFLs for priority water bodies are not the only resource constraint to water supply development. SWFWMD and SJRWMD water use permitting criteria generally prevents unacceptable adverse impacts from withdrawals to water resources which do not have a MFL. The water use permitting criteria prevents unacceptable impacts to wetlands, lakes, and springs as well as water quality (i.e., saline water intrusion). Resource constraints for water features which do not have a MFL are discussed in Chapter 3.

2.2 Minimum Flow and Level Priority Lists and Schedules

SWFWMD and SJRWMD have established, or slated for establishment, MFLs throughout the WRWSA (Table 2-1 and Table 2-2, respectively). As shown, MFLs have been adopted for numerous lakes throughout the region and Weekiwachee Springs. The Withlacoochee River and Ocklawaha River systems are scheduled for 2010 to 2011, while additional springs are to be completed through 2013.

The location of the Withlacoochee and Ocklawaha Rivers and the long-term United States Geological Survey (USGS) flow gages used for MFL development can be seen in Figure 2-1.¹ Adopted springs and those slated for MFL development can be seen in Figure 2-2. Adopted lakes and those slated for MFL development can be seen in Figure 2-3.

¹ The analyses in this report assume that USGS funding will be maintained over time for these and other flow gages related to MFL development.

Table 2-1. Adopted MFL Waterbodies within the Withlacoochee Regional Water Supply Authority.

Watercourse	Type	Schedule	County	Water Management District
Big Gant Lake	Lake	Adopted	Sumter	SWFWMD
Bowers Lake	Lake	Adopted	Marion	SJRWMD
Charles Lake	Lake	Adopted	Marion	SJRWMD
Deaton Lake	Lake	Adopted	Sumter	SWFWMD
Halfmoon Lake	Lake	Adopted	Marion	SJRWMD
Hopkins Prairie	Lake	Adopted	Marion	SJRWMD
Hunters Lake	Lake	Adopted	Hernando	SWFWMD
Lake Fort Cooper	Lake	Adopted	Citrus	SWFWMD
Lake Kerr	Lake	Adopted*	Marion	SJRWMD
Lake Panasoffkee	Lake	Adopted	Sumter	SWFWMD
Lindsay Lake	Lake	Adopted	Hernando	SWFWMD
Miona and Black Lake	Lake	Adopted	Sumter	SWFWMD
Mountain Lake	Lake	Adopted	Hernando	SWFWMD
Neff Lake	Lake	Adopted	Hernando	SWFWMD
Nicotoon Lake	Lake	Adopted	Marion	SJRWMD
Okahumpka Lake	Lake	Adopted	Sumter	SWFWMD
Smith Lake	Lake	Adopted	Marion	SJRWMD
Spring Lake	Lake	Adopted	Hernando	SWFWMD
Tsala Apopka Chain	Lake	Adopted	Citrus	SWFWMD
Weekiwachee Prairie Lake	Lake	Adopted	Hernando	SWFWMD
Weekiwachee Spring System	Spring	Adopted	Hernando	SWFWMD
Weir Lake	Lake	Adopted	Marion	SJRWMD

*Re-evaluate 2012

Table 2-2. MFL Schedule for Priority Waterbodies within the Withlacoochee Regional Water Supply Authority.

Watercourse	Type	Schedule	County	Water Management District
Chassahowitzka Spring System	Spring	2010	Citrus	SWFWMD
Gum Springs	Spring	2010	Sumter	SWFWMD
Homosassa Spring System	Spring	2010	Hernando	SWFWMD
Rainbow Springs	Spring	2010	Marion	SWFWMD
Upper Withlacoochee River	River	2010	Hernando	SWFWMD
Middle Withlacoochee River	River	2010	Sumter	SWFWMD
Silver Springs	Spring	2011	Marion	SJRWMD
Bonable Lake	Lake	2011	Marion	SWFWMD
Little Bonable Lake	Lake	2011	Marion	SWFWMD
Tiger Lake	Lake	2011	Marion	SWFWMD
Crystal Springs System	Spring	2011	Citrus	SWFWMD
Ocklawaha River	River	2011	Marion	SJRWMD
Lower Withlacoochee River	River	2011	Citrus	SWFWMD
Lake Tooke	Lake	2013	Hernando	SWFWMD
Silver Glen Springs	Spring	2013	Marion	SJRWMD
Whitehurst Lake	Lake	2013	Hernando	SWFWMD

2.3 Approaches to Proxy Minimum Flows and Levels – Springs and Rivers

MFLs have been adopted for a number of water bodies within the WRWSA, but have not yet been adopted for the Withlacoochee River system and most of the coastal springs systems. These MFLs may have a significant effect on groundwater and surfacewater development within the WRWSA.

Since Phase II of the WRWSA's MRWSP&IP includes conceptual design of both groundwater and surfacewater projects, the design of the projects must carefully consider the resource constraints of developing these two water supply sources. As a significant constraint on water resources these pending MFLs in the WRWSA were considered in the evaluation of the potential yield of water supply projects. Scheduled MFLs on the freshwater portion of the Withlacoochee River (Upper and Middle reaches) and major springs systems that are located within the watershed are considered and proxy MFLs have been developed.

The goal of the development of proxy MFLs was to estimate a threshold for each of these watercourses and waterbodies at which significant harm was reached. The proxy MFL functions as a predictive tool intended to estimate a potential and plausible minimum flow on a watercourse or waterbody slated for future MFL development. Figure 2-4 shows the location of proxy MFLs.

Fundamentally, a proxy threshold is non-binding and is unable to incorporate the usual field data and model-based methods of MFL determination (due to factors such as cost and time constraints). It also does not address potential future changes to historic flow patterns, which may occur due to anthropogenic changes in the watershed or global climate change. Rather,

the proxy MFL is a compendium of previously completed scientific work that has close similarity to the water body being studied. A proxy threshold assumes that climatological and biological similarities amongst the watercourses and waterbodies are such that the water resource values observed elsewhere are also applicable to the target waterbody, and thus be used to approximate the potential yield of water supply projects where MFLs have not yet been adopted.

Due to the fact that a proxy threshold does not incorporate data gathered in the field, but rather relies on analyses performed on other systems to be applied within the WRWSA, it is inherently subject to error. In order to correct for a portion of that error, a range for a potential proxy threshold is estimated, based on the MFLs determined for other systems of similar geographical location and precipitation regime. It is assumed that, by determining the frequency of occurrence of other minimum flows within their long-term periods of record, a reasonable range for potential thresholds within the WRWSA may be developed. However, these ranges are subject to complete re-evaluation once the actual MFLs are adopted for the gages on the Withlacoochee River and other watercourses and springs within the WRWSA.

It should also be noted that the proxy thresholds were reviewed by the SWFWMD for the development of this report. Knowing that these proxy MFLs were to be used in a water supply planning process and ultimately established through the formal MFL determination process, the SWFWMD was comfortable with utilizing the proxies established for this report.

2.4 Proxy Minimum Flows for Selected Springs

2.4.1 Withlacoochee Regional Water Supply Authority – Site-Specific Considerations for Development of Proxy Threshold Methodology

The Withlacoochee River and its drainage basin are located in the northern portion of the SWFWMD, bordering the Suwannee River Water Management District (SRWMD), to the north, and SJRWMD, to the east. This location suggests that elements from each of the districts' prior minimum flow studies should be considered in the development of proxy thresholds. Therefore, in developing methodologies to estimate proxy thresholds throughout the WRWSA region, techniques employed in each of these districts were evaluated. Springs MFLs have been developed in each of the districts and provide the necessary background to help predict proxy thresholds for springs in the WRWSA.

2.4.2 Guidance Springs for Development of Proxy Threshold

2.4.2.1 Criteria – Spring Magnitude and Water Resource Values

In the establishment of proxy thresholds for springs in the WRWSA, springs for which MFLs have already been developed were chosen for guidance in this process. The choice of each spring was based on two factors:

- Spring magnitude
- Water resource values

Spring magnitude refers to a classification system developed based on the discharge of springs in Florida. There are three classification types which are relevant to the present study and were adapted from Meinzer (1927):

- First magnitude: long-term average flow greater than 100 cfs;
- Second magnitude: long-term average flow between 10 cfs and 100 cfs; and
- Third magnitude: long-term average flow between 1 cfs and 10 cfs.

Additionally, certain key water resource values were considered in the choice of guidance springs for proxy thresholds. Springs across north and central Florida provide a number of ecological functions to local ecosystems and human populations. Among those observed in springs within the WRWSA include (Scott et al., 2004):

- Manatee thermal refuge during cold months;
- Contribution of flow to receiving streams during low-flow periods;
- Maintenance of salinity regimes in tidally-influenced portions of spring runs and receiving streams; and
- Aesthetic value and recreational opportunities for human use.

A review of existing MFLs for springs within the three districts was conducted (Table 2-3). Details of this survey are included in this section.

2.4.2.2 Suwannee River Water Management District Springs MFLs

Manatee (1st magnitude) and Fanning (2nd magnitude) springs are significant contributors of flow to the Lower Suwannee River. Located in Manatee and Fanning state parks, respectively, these springs provide water for a number of water resource values that have been deemed of importance in the setting of MFLs. Recreation and aesthetic values were considered in the development of MFLs for these springs, with canoeing and swimming cited as key uses. During low-flow periods on the Lower Suwannee River, these springs also provide significant amounts of baseflow to the river. Finally, these springs are recognized as secondary thermal refuges for manatees during the colder months, and therefore must have enough water to allow passage of the endangered animals into the spring area. However, due to the lack of extensive stage data for springs in the WRWSA, Fanning Spring will not be used for guidance. It is included here for the purpose of supporting the water resource values that are used in the development of springs MFLs throughout Florida (WRA, 2005).

Madison Blue Spring is a 2nd magnitude spring located within Madison Blue Spring State Park in Madison County. It is a major contributor of discharge to Withlacoochee River flows in north Florida, and is the largest spring on the Withlacoochee River in terms of discharge. The key water resource value for Madison Blue was identified as its role in the contribution of baseflow to the Withlacoochee River during periods of low flows and the MFL was chosen accordingly (WRA, 2004).

Table 2-3. Summary of Existing Springs MFLs in Three Water Management Districts.

Spring	District	Magnitude	Average Annual Flow	Minimum Flow Requirement	Water Resource Values
Manatee	SRWMD	1st	150 cfs	130 cfs during the winter months	Maintain thermal refuge for manatees; maintain flow contribution to Suwannee River during low river stages
Fanning	SRWMD	2nd	94 cfs	2.71 ft National Geodetic Vertical Datum (NGVD) stage during the winter months	Maintain thermal refuge for manatees; maintain flow contribution to Suwannee River during low river stages
Madison Blue	SRWMD	1st	117 cfs	70 cfs	Maintain flow contribution to Withlacoochee River during low river stages
Buckhorn	SWFWMD	2nd	13 cfs	15% flow reduction	Maintain habitat in Buckhorn Creek
Sulphur	SWFWMD	2nd	34 cfs	18 cfs; 13 cfs when Hillsborough River levels are low; 10 cfs during low tide stages in the Lower Hillsborough River	Maintain low salinity habitats in the Hillsborough River; minimize high salinity incursions into spring run; maintain thermal refuge for manatees
Volusia Blue	SJRWMD	1st	162 cfs	Minimum Long Term Mean Flow: December 3, 2006 through March 31, 2009, 133 cfs; April 1, 2009 through March 31, 2014, 137 cfs; April 1, 2014 through March 31, 2019, 142 cfs; April 1, 2019 through March 31, 2024, 148 cfs; After March 31, 2024 157	Maintain thermal refuge for manatees; maintain flow contribution to St. John's River
Weekiwachee	SWFWMD	1st	176 cfs	10% flow reduction	Maintain meso-haline habitat (15 ppt) isohaline
Wekiva	SJRWMD	2nd	74 cfs	Head: 24 ft (NGVD); Flow: 62 cfs	Maintain flow contribution to Wekiva River
Rock	SJRWMD	2nd	65 cfs	Head: 31 ft (NGVD); Flow: 53 cfs	Maintain flow contribution to Wekiva River

2.4.2.3 St. John's River Water Management District Springs MFLs

Volusia Blue Spring is a 1st magnitude spring located in Blue Springs State Park in Volusia County. Volusia Blue Spring has been designated a critical warmwater habitat for the endangered West Indian manatee during the colder months of the year by the U.S. Fish and Wildlife Service. In the establishment of a minimum flow for Volusia Blue Spring, the role of the spring as a thermal refuge for manatees was deemed to be the most significant water resource value (SJRWMD, 2007a). The MFL for Volusia Blue Spring is intended to ensure that enough water is available to permit passage of manatees from the spring run into the pool and its warmer waters during the colder months.

Wekiva and Rock springs are 2nd magnitude springs located in Wekiva Springs State Park and Rock Springs Run State Reserve, respectively, in northeast Florida. Each spring system is recognized as a key contributor of flow to the Wekiva River, which is a large tributary of the St. John's River. These two springs are actually the two largest springs, by discharge, in a series of 2nd and 3rd magnitude springs for which MFLs were recently developed in support of minimum flow requirements to the Wekiva River (SJRWMD, 2007b).

2.4.2.4 Southwest Florida Water Management District

Sulphur Springs is a 2nd magnitude spring located in Hillsborough County, proximal to the Lower Hillsborough River in Tampa. The primary water resource values identified for Sulphur Springs are associated with its flows into the Lower Hillsborough River (SWFWMD, 2004a). The Hillsborough River is tidally-influenced at its confluence with the spring run. The spring discharge helps to maintain low salinity habitats in the river, while also preventing incursions of relatively high salinity water into the spring run. Additionally, a secondary water resource value was identified for the spring as a thermal refuge for manatees during colder periods of the year (SWFWMD, 2004a).

SWFWMD has also developed an MFL for Buckhorn Springs in Hillsborough County off of the Alafia River. It is a small 2nd magnitude spring that contributes some baseflow to the Alafia River during low-flow periods, as well as maintenance of the salinity regime in the receiving waters of the river. However, the minimum flow for this spring was developed primarily to protect habitat in the spring run, particularly for the largemouth bass and spotted sunfish (SWFWMD, 2004b).

Weekiwachee Spring is a 1st magnitude coastal spring located in Hernando County (within the WRWSA). It is the largest of two springs (the other being Twin Dees Spring) that form the headwaters of the Weekiwachee River, which then flows approximately 6.6 miles down to its confluence with the Mud River, approximately one (1) mile from the Gulf of Mexico. Discharge from Weekiwachee Spring has ranged from a maximum near 250 cfs down to a minimum of 85 cfs (ATM, 2007). The average flow is 176 cfs (Scott et al., 2004).

Weekiwachee Spring has been extensively developed for human use, primarily as an amusement park that features mermaid shows and submerged observation areas. FDEP has purchased the spring from prior ownership, but the amusement park remains. It is also a significant thermal refuge for the West Indian manatee during the late fall and winter months (Scott et al., 2007). Modeling was completed to assess the effects of flow reduction on the winter thermal regime as part of the MFL development process (ATM, 2007).

The SWFWMD adopted the Weekiwachee spring MFL based on maintenance of the salinity regime and estuarine habitat in the river run. The MFL is based on the 15 ppt isohaline and limits flow reduction to 10% from pre-development conditions (SWFWMD. 2008). Since Weekiwachee is the first MFL adopted for a coastal spring in the WRWSA, it will be used for guidance for the proxy thresholds for other coastal springs in the WRWSA.

2.4.3 Proxy Thresholds for Selected Springs

Following the survey of established MFLs for springs within SWFWMD, as well as for those in the adjacent districts, SRWMD and SJRWMD, a comparison of the magnitudes of these springs, as well as the key water resource values used to develop their minimum flows, was performed with the priority springs slated for MFL development in the WRWSA. Using shared attributes such as magnitude and ecological function, proxy thresholds can then be estimated for the WRWSA springs based on similarity with existing springs MFLs.

2.4.3.1 Chassahowitzka Spring

Chassahowitzka Spring is a coastal spring of 1st magnitude located in the Chassahowitzka National Wildlife Refuge in Citrus County. It is the largest spring in a group of springs that form the headwaters of the Chassahowitzka River, which then flows approximately six (6) miles into the Gulf of Mexico. The entire river is tidally-influenced, and the spring functions in maintaining the salinity regime of the river and spring run. The maximum discharge is 197 cfs while the minimum discharge is 31.8 cfs. Its long-term average flow is 138.5 cfs (Scott et al., 2004).

Chassahowitzka Spring is used for a variety of recreation purposes, including fishing, swimming, snorkeling, and pleasure boating. It is also a year-round refuge for manatees, but is especially frequented during the winter (Scott et al., 2004). This water resource value may be significant for MFL development, especially during the winter months.

Considering its proximity to Weekiwachee Spring and the Gulf of Mexico, as well as its discharge magnitude, the proxy threshold for Chassahowitzka Spring is taken from the MFL described in the Weekiwachee springs section. Therefore, in order to be conservative and consistent, a range of 5% to 10% flow reduction from historic flow regimes is recommended year-round and serves as the only proxy threshold for this spring. As a minimum flow is developed for this spring, this range may need to be amended higher or lower.

2.4.3.2 Homosassa Spring

Homosassa is also a coastal spring located in Citrus County. It is a 1st magnitude spring and the largest of a group of springs that form the headwaters of the Homosassa River. The Homosassa River then flows approximately six (6) miles towards the Gulf of Mexico. The entire system is tidally-influenced, and therefore, Homosassa Spring functions in maintaining salinity regimes in the river and spring run with its freshwater inflows. The maximum observed discharge of the spring is 165 cfs while the minimum flow is 80 cfs. The long-term average discharge of Homosassa Spring is 106 cfs (Scott et al., 2004).

Homosassa Spring is located within Homosassa Springs Wildlife State Park. The park functions as a wildlife education center with a submerged observation area open to the public and as a rehabilitation center for injured manatees (Scott et al., 2004). Swimming and snorkeling are not

allowed. Therefore, the primary ecological value of the park is as a permanent refuge for manatees. This water resource value may be significant for MFL development.

Acknowledging the close proximity of Homosassa Spring to Weekiwachee Spring (and Chassahowitzka Spring), as well as the similar characteristics of the receiving waters (e.g., length of the receiving stream and distance of the spring from the Gulf of Mexico), an appropriate proxy threshold is taken from the MFL described in the Weekiwachee springs section. Again, in order to be conservative and consistent, a 5% to 10% flow reduction range from historic conditions, observed year-round, is recommended as the proxy threshold at Homosassa Spring. As a minimum flow is developed for this spring, this range will be amendable as minimum flow analyses are conducted.

2.4.3.3 Crystal River

Crystal River Spring/Kings Bay is a 1st magnitude spring located in Citrus County and flows through its run approximately seven (7) miles until it discharges into Crystal Bay and the Gulf of Mexico. The spring system is comprised of approximately 30 spring boils with Kings Bay representing the largest. The first magnitude spring system that forms the 600-acre Kings Bay embayment has an average total discharge rate of 975 cubic feet per second (SWFWMD, 2004). This embayment forms the headwaters of the Crystal River and is tidally influenced throughout the run. The system is designated as an Outstanding Florida Water (OFW).

Crystal River/Kings Bay is used for a variety of recreation purposes, including fishing, swimming, snorkeling, scuba diving, and pleasure boating. It is an important year-round refuge for manatees, with water temperatures of 72 degrees year-round. The spring run flows through the Crystal River National Wildlife Refuge. This refuge, which is comprised of 46 acres of islands and the Kings Bay basin, is the only federal preserve in Florida that is devoted to the manatee.

Acknowledging the similar characteristics of Crystal River Springs to Weekiwachee Spring (and other coastal springs), as well as the similar characteristics of the receiving waters (e.g., length of the receiving stream and distance of the spring from the Gulf of Mexico), an appropriate proxy threshold is taken from the MFL described in the Weekiwachee springs section. Again, in order to be conservative and consistent, a 5% to 10% flow reduction range from historic conditions, observed year-round, is recommended as the proxy threshold at Crystal River Spring. As a minimum flow is developed for this spring, this range will be amendable as minimum flow analyses are conducted.

2.4.3.4 Gum and Citrus Blue Springs

Citrus Blue Spring is a 2nd magnitude spring located in Citrus County and flows through its run roughly 0.4 miles until it discharges into the Withlacoochee River. Citrus Blue Spring has a maximum discharge of 19.6 cfs and a minimum discharge of 11.1 cfs. Its long-term average is 16 cfs (Scott et al., 2004). Gum Spring is a 2nd magnitude spring, located in northwest Sumter County, and is the largest of a group at least seven individual springs that discharge into Gum Slough, and eventually the Withlacoochee River. The average discharge at Gum Spring is about 68 cfs (Basso, pers. comm., 2010).

The ecological role of these smaller springs lies primarily in their contribution of flows to the Withlacoochee River during its low-flow periods and to the maintenance of habitats in their respective spring runs. Due to their size and their ecological functions, the minimum flows at Buckhorn Spring in SWFWMD and Rock and Wekiva springs in SJRWMD were chosen for estimation of proxy thresholds at Citrus Blue and Gum springs. Additionally, similar to the Rock and Wekiva springs groups, Citrus Blue and Gum springs represent the largest in a system of 2nd magnitude springs.

The flow reduction recommended in the Buckhorn Spring MFL is 15%, while for Rock and Wekiva springs, the recommended MFLs are 18.5% below the long-term mean of flows and 16.3% below the long-term mean of flows, respectively. The average of these three minimum flows is 16.6%. Therefore, in order to protect flow contributions to the Withlacoochee River and to protect spring run habitats for Citrus Blue and Gum springs, the recommended proxy threshold for these springs is 16.6%, year-round. Considering that these springs are not recognized as manatee refuges, this recommended proxy threshold is consistent with springs of similar geographical location, magnitude and water resource values.

2.5 Proxy Minimum Flows for the Withlacoochee River – Site-Specific Considerations for Development of Proxy Threshold Methodology

The Withlacoochee River and its drainage basin are located in the northern portion of the SWFWMD, bordering the SRWMD, which is to the north, and the SJRWMD, which is to the east. This location suggests that elements from each of the districts' prior minimum flow studies should be considered in the development of proxy thresholds. Thus, in developing methodologies to estimate proxy thresholds throughout the Withlacoochee River, techniques employed in each of the districts may be relevant. However, for freshwater portions of the river, only results from SWFWMD's previous minimum flow efforts were incorporated into the methods. SWFWMD has specific district-wide criteria, discussed in the next section of this document, that render use of other freshwater MFLs developed outside of the district to be inappropriate.

For estuarine portions of the river, including the discharge from Lake Rousseau, SRWMD and SJRWMD techniques may be applicable in conjunction with SWFWMD methods. The estuarine portion of the Withlacoochee River is also discussed below.

2.5.1 SWFWMD Approach to River MFLs

SWFWMD applies the percent-of-flow method to determine minimum flows for the rivers in their jurisdiction. The percent-of-flow method is a unique approach that allows water users to take a percentage of streamflow at the time of the withdrawal. The percent-of-flow method has been used for the regulation of water use permits within SWFWMD since 1989, when it was first applied to withdrawals from the Lower Peace River. The method is oriented for use on rivers that still retain a largely natural flow regime. The percent-of-flow method has been applied to determine and adopt minimum flows for a series of freshwater streams within SWFWMD, including the freshwater reaches of the Alafia, Myakka, and Hillsborough Rivers, and the upper and middle reaches of the Peace River.

A goal of the percent-of-flow method is that the natural flow regime of the river be maintained, albeit with some flow reduction for water supply. Natural flow regimes have short-term and

seasonal variations in the timing and volume of streamflow that reflect the drainage basin characteristics of the river in question and the climate of the region. Maintenance of the natural flow regime and its seasonal variation is linked to the integrity of biological processes within the river and its floodplain. As summarized in SWFWMD's MFL reports for rivers throughout the district, these processes are related to fish passage, the inundation of instream and floodplain habitats, and maintenance of adequate water levels and velocities to provide habitat suitable for the growth and reproduction of fishes and invertebrates.

2.5.2 Definition of Seasonal Flow Blocks

In the development of minimum flows on rivers within its jurisdiction, SWFWMD uses a “building block” approach in an attempt to simulate the short-term and seasonal hydrologic variations that are observed in the period of record flows. Previous MFL documents have identified three different building blocks within a year, each corresponding to a period of low, medium, or high flows. These blocks differ according to river. For the Withlacoochee River, Block 1, from May 10 to July 26 (Julian Day 130 to 207), is the low flow period, whereas the highest flows occur during Block 3, from July 27 to November 2 (Julian Day 208 to 306). Block 2 is comprised of the remaining days and corresponds to the medium flow. As the percent-of-flow method is applied individually to each block, the availability of water thus differs according to seasonal block.

2.5.3 The Low-Flow and High-Flow Thresholds

Previous applications of the SWFWMD minimum flows methodology have identified two flow thresholds which maintain the biological integrity of communities within a river and its floodplain. First, the low-flow threshold traditionally protects the instream habitats of fishes and invertebrates, and analyzes the relationship between habitat availability and changes in streamflow. Habitat availability is estimated through proxies such as a stream bed's wetted perimeter. Fish passage, which is the ability of fish to traverse longitudinally upstream and downstream within a river, ensuring connectivity between distinct populations and preserving spawning habitat, is another metric employed in the determination of low-flow minimum flows. As multiple indices are used in the estimation of low-flow MFLs, the most conservative flow requirement is often taken as the final number. It is assumed that protection of the most stringent water resource value will also protect those values that have lower flow requirements. The low-flow threshold applies to flows that are to be protected in their entirety year-round.

The high-flow threshold is intended to ensure inundation in floodplain vegetation communities regardless of seasonality. Wetland vegetation communities which are located in a river's floodplain depend on periodic out-of-bank flows to maintain historical distribution. The goal of the high-flow threshold is to maintain the frequency of floodplain inundation upon which these communities survive. Block 3 flows, and to some degree, Block 2 flows, provide the seasonal flows which inundate floodplains.

2.5.4 Estimation of Proxy Thresholds

For the estimation of minimum flows on the Withlacoochee River, a range of flows intended to bracket a likely MFL was developed for each threshold. A range allows for some error in the estimation of a proxy threshold, recognition of the inherent uncertainty that a transfer of water resource values from one or more systems to another entails. The purpose of this exercise is to

characterize the “typical” thresholds developed previously throughout SWFWMD. Examination of past MFL efforts has identified a series of key flow statistics that are consistent indicators of the low-flow and high-flow thresholds:

- Low-flow:
 - 98% exceedance flow
 - 5-year mean flow of Block 1 flows. The 5-year mean is a 5-year rolling average of annual mean flows, above which all 5-year means for the period of record are located.
- High-flow:
 - 25% exceedance flow
 - 15% exceedance flow

The range of flows used to bracket proxy thresholds on the Withlacoochee River is based on these key flow statistics, and were based on the thresholds adopted in previous documents on four systems within the SWFWMD:

- the Alafia River (freshwater segment),
- the Hillsborough River (upper segment),
- the Myakka River (upper segment), and
- the Peace River (upper and middle segments).

The following sub-sections provide summaries of each of these minimum flows.

2.5.4.1 Alafia River MFL Methodology Summary

SWFWMD’s recommended low-flow threshold for the Alafia River (USGS gage at Lithia) is 59 cfs. This flow represents the 95% exceedance flow. This low-flow threshold was developed based on the protection of instream habitats, using the wetted perimeter criterion, as this index had the most conservative associated flow requirement. As a point of reference, the 5-year mean of Block 1 flows is 53 cfs and is similar to the recommended low-flow MFL.

The high-flow threshold on the Alafia River is 374 cfs, which represents the 25% exceedance flow. This threshold was designed to maintain connectivity in floodplain habitats, such as palm, cypress, and hardwood swamps and various hammock communities. The 25% exceedance flow from this example forms the lower bound of the high-flow proxy threshold range applied in the present study.

2.5.4.2 Hillsborough River MFL Methodology Summary

A low-flow MFL of 52 cfs was developed for the upper portion of the Hillsborough River, which is exceeded 99% of the time at the USGS gage at Morris Bridge. This flow protects fish passage and is the most restrictive of the metrics used on this reach of the Hillsborough River, thereby protecting habitat availability as well. The 5-year mean of Block 1 flows is 57 cfs and is similar to the recommended low-flow threshold.

SWFWMD recommends a high-flow threshold of 470 cfs on the Upper Hillsborough River. This flow, the 15% exceedance flow, represents the upper bound of the high-flow proxy threshold range applied to the Withlacoochee River.

The Hillsborough and Withlacoochee rivers share headwaters, which is a desirable trait when choosing rivers upon which to base a proxy threshold. The Green Swamp, which is an area of approximately 870 square miles that include portions of Hernando, Lake, Pasco, Polk, and Sumter counties, is a wetland and upland mixed region that supplies baseflow to multiple rivers in the SWFWMD. Note that the two drainage basins for these systems are proximal to one another as well. For these reasons, the Hillsborough River is likely to share many hydrologic characteristics with the Withlacoochee River, resulting in a potentially more reliable proxy threshold.

2.5.4.3 Myakka River MFL Methodology Summary

SWFWMD has recommended a low-flow threshold of 0 cfs on the Myakka River (USGS gage near Sarasota). A flow of 0 cfs is consistent with the 99% exceedance flow for the period of record at this gage. In comparison to the 5-year mean flow of Block 1 flows, which is 4 cfs, the low-flow threshold developed by SWFWMD on the Upper Myakka River is similar to this guidance value. The Myakka River, however, represents an unusual case amongst SWFWMD rivers. It has a high historical incidence of zero flows. And, although wetted perimeter and fish passage analyses yielded flow requirements where $Q > 0$ mgd, the District deemed it inappropriate to impose such standards on a river that had zero flows so frequently.

The proposed high-flow threshold on the Myakka River is 577 cfs; this flow is the 15% exceedance flow. This threshold was based primarily on the inundation of the communities in the highest elevations within the floodplain, including the oak/palm wet hammock and assorted mixed wetland types. The 15% exceedance flow from the upper Myakka River represents the upper bound of the high-flow proxy threshold range used for estimation of proxy thresholds on the Withlacoochee River.

2.5.4.4 Peace River MFL Methodology Summary

The Peace River, like the Withlacoochee and Hillsborough rivers, has its origins in central Florida, in the Green Swamp. In contrast to the Hillsborough River, however, the Peace River and its drainage basin have a southerly track that takes it further away from the Withlacoochee's watershed, which increases the likelihood that greater ecological distinctions will emerge between the two systems as distance increases. Please also note that the Peace River represents a unique case amongst the systems being incorporated into this proxy threshold study; it has two reaches for which MFLs have been developed, an upper and a middle, both of which will be discussed in this subsection.

The recommended low-flow threshold on the southern (middle) reach of the freshwater portion of the Peace River (USGS gage at Arcadia) is 67 cfs. This flow is exceeded 99% of the time. The 5-year mean at this site is 160 cfs, and is the only instance amongst these four systems where this flow statistic was a poor indicator of the low-flow threshold.

The high-flow MFL on the Middle Peace River at Arcadia is 1362 cfs, and is the 25% exceedance flow, again representing the low range of flows applied to the high-flow proxy

threshold estimation. This flow protects the frequency of flows which inundate floodplain vegetation communities such as cypress swamp, hardwood hammock, and hardwood swamp.

An MFL has been developed for the USGS gage at Zolfo Springs, north of Arcadia, as well. The low-flow MFL is the 95% annual exceedance value of 45 cfs, and results from a combination of fish passage and wetted perimeter conservation criteria. The 5-year mean of Block 1 flows at Zolfo Springs is 90 cfs, and, like Arcadia, does not provide a reliable estimate of the low-flow threshold. The high-flow MFL at Zolfo Springs is 783 cfs. This flow is exceeded approximately 25% of the time on an annual basis. Please note that two other gages on the Upper Peace River (USGS gages at Ft. Meade and Bartow) have had MFLs developed. However, appropriate mid to high flow MFLs were unable to be estimated, and thus these sites have been removed from consideration for this study.

2.5.5 Application of Proxy Thresholds to the Withlacoochee River

2.5.5.1 Hydrological Characterization of Gages of Interest

The present study is focusing on three USGS gages of interest on the Upper Withlacoochee River:

- 02313000 at Holder, FL,
- 02312000 at Trilby, FL, and
- 02312500 at Croom, FL.

Before an appropriate proxy threshold range for these gages could be accomplished, however, it was necessary to examine the long-term flow periods of record for these gages. A prerequisite to applying SWFWMD's methodology is to make sure that these gages exhibit the same type of hydrologic periodicity as is observed elsewhere in West-Central Florida. To assess the usability of these gages under the aforementioned "building block" approach, median daily flows calculated from each gage's period of record were plotted by block, in Figures 2-5 through 2-7 below, and then visually inspected for periodicity. This approach is consistent with SWFWMD's methodology.

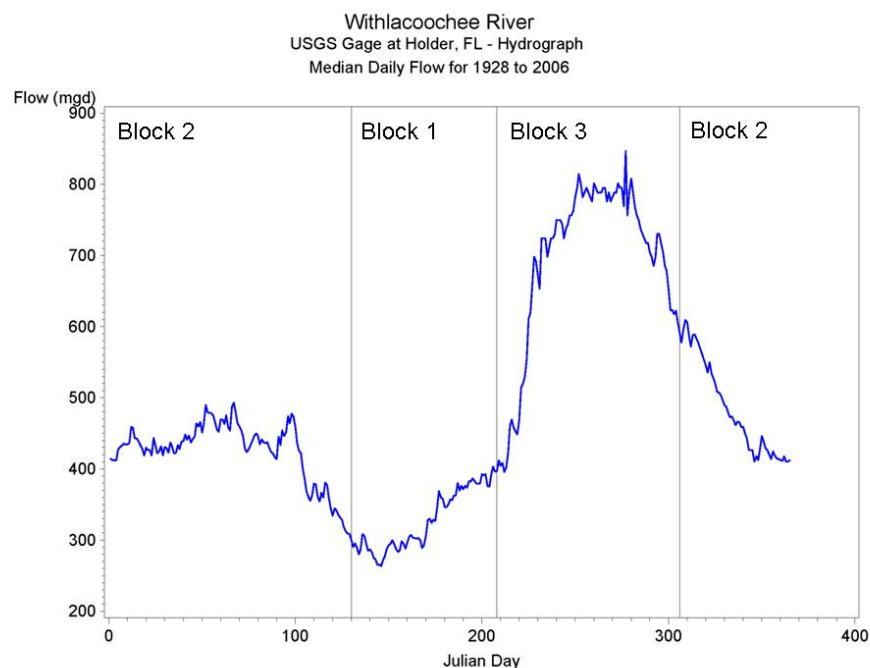


Figure 2-5. Median daily flows from 1928 through 2006 on the Withlacoochee River at the USGS gage at Holder, FL, by seasonal flow block.

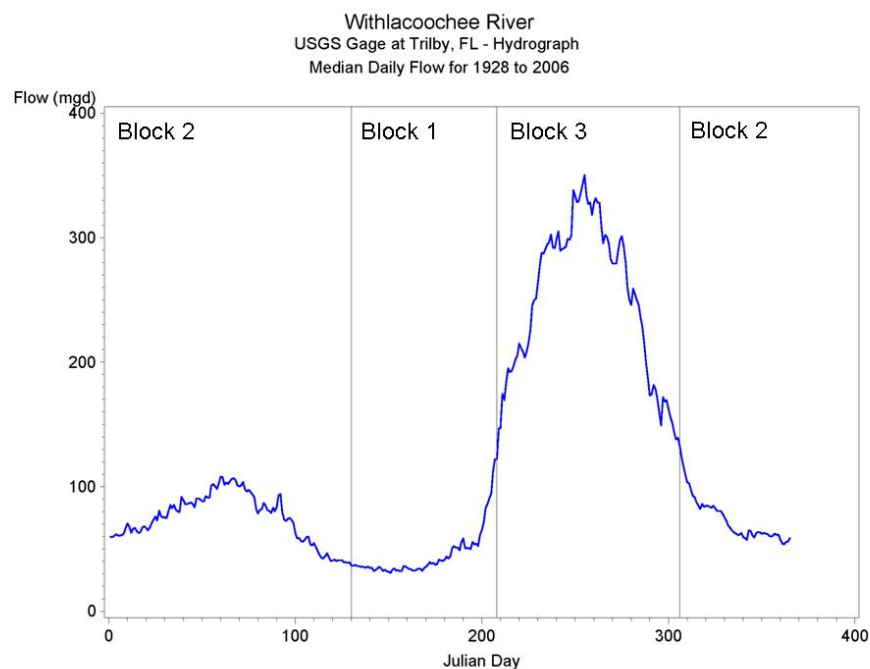


Figure 2-6. Median daily flows from 1928 through 2006 on the Withlacoochee River at the USGS gage at Trilby, FL, by seasonal flow block.

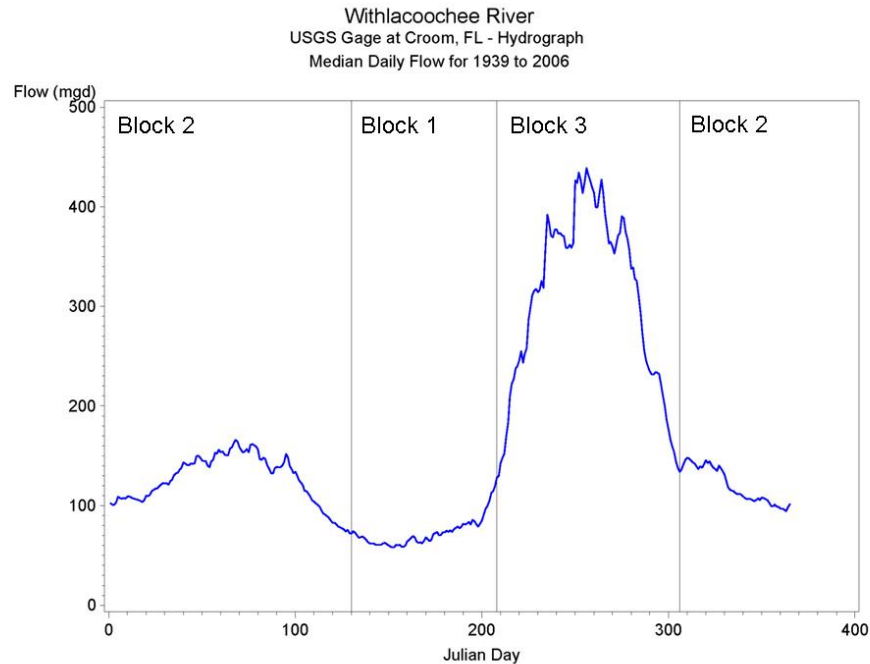


Figure 2-7. Median daily flows from 1939 through 2006 on the Withlacoochee River at the USGS gage at Croom, FL, by seasonal flow block.

The gages on the Upper Withlacoochee exhibit similar long-term flow patterns as have been suggested from SWFWMD’s “building block” approach. Examination of these plots shows that the periods of lowest flow have historically been observed in Block 1 and periods of highest flow have been observed in Block 3. The mid-flow range has historically occurred during Block 2 at all three gages as well. As a result, current SWFWMD methodology is anticipated to be applicable.

2.5.5.2 Low-flow Proxy Threshold Estimation

In establishing the range to be applied for a low-flow proxy threshold recommendation, the first step was to calculate a mean of the four low-flow minimum flow frequencies. On average, the low-flow MFLs on the systems used in this study represented flows that were exceeded 98% of the time. On the Withlacoochee River, at each of the three gages used in this study, the 98% exceedance flows for the period of record are as follows:

- USGS gage at Holder: 77 mgd
- USGS gage at Trilby: 4.1 mgd
- USGS gage at Croom: 2.3 mgd

Additionally, with the exception of the MFL for the Middle Peace River, inspection of other key flow statistics determined that the 5-year mean flow of Block 1 flows was a useful indicator of low-flow thresholds. On the Withlacoochee River, at the three gages of interest, the 5-year means are as follows:

- USGS gage at Holder: 186 mgd
- USGS gage at Trilby: 23 mgd
- USGS gage at Croom: 37 mgd

Another potentially important flow statistic is the 5-year median of Block 1 flows. Due to the significance of the Holder location for surfacewater treatment facility design, the 5-year rolling median was identified as 90 mgd.

2.5.5.3 High-flow Proxy Threshold Estimation

For the estimation of the high-flow proxy threshold range for the three gages on the Withlacoochee River, the same process that was employed for low flows was used. A mean of the frequency of occurrence of the four high-flow MFLs was calculated, yielding an average exceedance frequency of 20%. However, no other key flow statistics consistently provided useful estimates of a high-flow threshold, and thus, the upper bound and lower bound of the range provided in the four previously developed SWFWMD MFL documents was used. MFLs developed for the Alafia and Peace rivers were flows that were exceeded 25% of the time, while the other systems (Hillsborough and Myakka) had MFLs with flows that were exceeded 15% of the time. Using this range to estimate the high-flow proxy threshold, the three gages on the Withlacoochee River have the following relevant flow statistics:

25% exceedance flow:

- USGS gage at Holder: 789 mgd
- USGS gage at Trilby: 247 mgd
- USGS gage at Croom: 316 mgd

15% exceedance flow:

- USGS gage at Holder: 1073 mgd
- USGS gage at Trilby: 408 mgd
- USGS gage at Croom: 511 mgd

A summary of the proxy thresholds developed for the three gages on the Withlacoochee River is provided in the following table (Table 2-4):

Table 2-4. Summary of Proxy Threshold Ranges for Three Gages on the Upper Withlacoochee River.

Low-Flow		
USGS Gage	Lower Bound (98% exceedance flow)	Upper Bound (5-year mean, Block 1 flows)
Holder	77 mgd	186 mgd
Trilby	4.1 mgd	23 mgd
Croom	2.3 mgd	37 mgd
High-Flow		
USGS Gage	Lower Bound (25% exceedance flow)	Upper Bound (15% exceedance flow)
Holder	789 mgd	1073 mgd
Trilby	247 mgd	408 mgd
Croom	316 mgd	511 mgd

2.5.5.4 Percent-of-flow Reduction Recommendation

After establishing the high-flow and low-flow proxy threshold ranges, a determination of the percent-of-flow reductions for each seasonal block was necessary. The following guidelines, based on previous MFL documents, were observed:

- Zero flow is available when flow drops below the low-flow threshold, and
- Percent-of-flow available varies when flow is between the low-flow and high-flow thresholds and when flow is above the high-flow threshold.

As establishment of minimum flows on the Withlacoochee River is currently in-progress, consultation with SWFWMD staff was also useful for this exercise. Thus, in accordance with these rules and SWFWMD staff guidance, the following percent-of-flow reductions are recommended, and are applicable at all three gages in the present study (Table 2-5):

Table 2-5. Percent-of-flow Reductions Recommended for the Upper Withlacoochee River, by Seasonal Block.

	Block 1	Block 2	Block 3
Q > High-Flow MFL	12%	12%	8%
Low-Flow MFL < Q < High-Flow MFL	13%	13%	15%
Q < Low-Flow MFL	0%	0%	0%

2.5.5.5 MFL-Adjusted Hydrographs for the Upper Withlacoochee River

Upon final estimation of the proxy threshold ranges and the percent-of-flow reductions, the thresholds and reductions were applied to the long-term flow records and inspected for periodicity. A stated goal of the SWFWMD methodology is to maintain the long-term natural seasonal variability of a system's flow regime. In order to accomplish this task, the means of each proxy threshold range for each gage was calculated (Table 2-6). The percent-of-flow reduction recommendations from Table 2-5 and the thresholds from Table 2-6 were then applied to the median daily flows from each gage's period of record to create a hypothetical,

MFL-adjusted hydrograph (Figures 2-8 through 2-10). The hydrology and seasonality of each block has been preserved in these scenarios.

Table 2-6. Estimated Proxy Threshold for Three Gages on the Upper Withlacoochee River.

	Low-Flow MFL	High-Flow MFL
Holder	90 mgd	931 mgd
Trilby	13.6 mgd	328 mgd
Croom	19.7 mgd	414 mgd

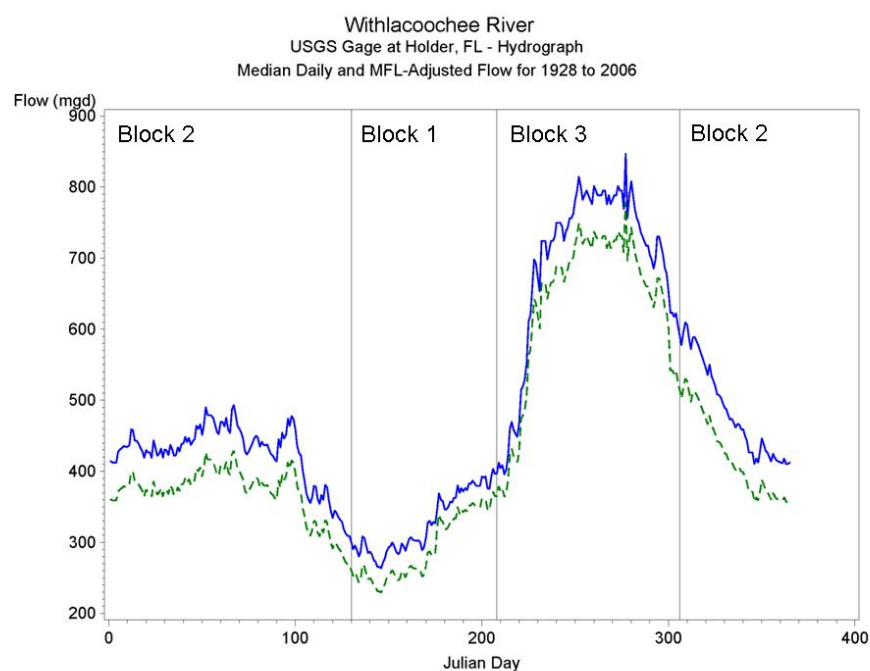


Figure 2-8. Median daily (blue line) and hypothetical MFL-adjusted (green line) flows from 1939 through 2006 on the Withlacoochee River at the USGS gage at Holder, FL, by seasonal flow block.

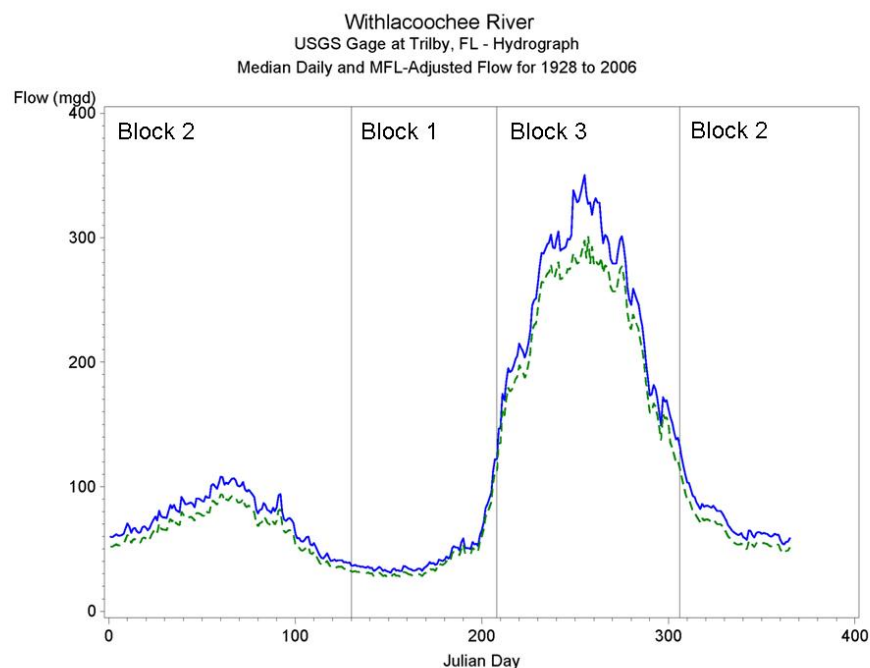


Figure 2-9. Median daily (blue line) and hypothetical MFL-adjusted (green line) flows from 1939 through 2006 on the Withlacoochee River at the USGS gage at Trilby, FL, by seasonal flow block.

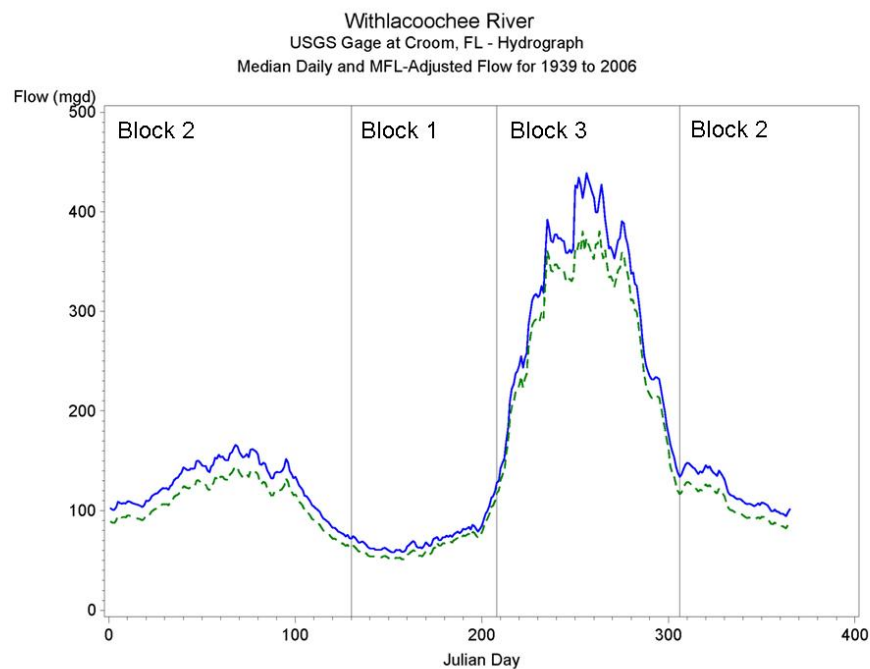


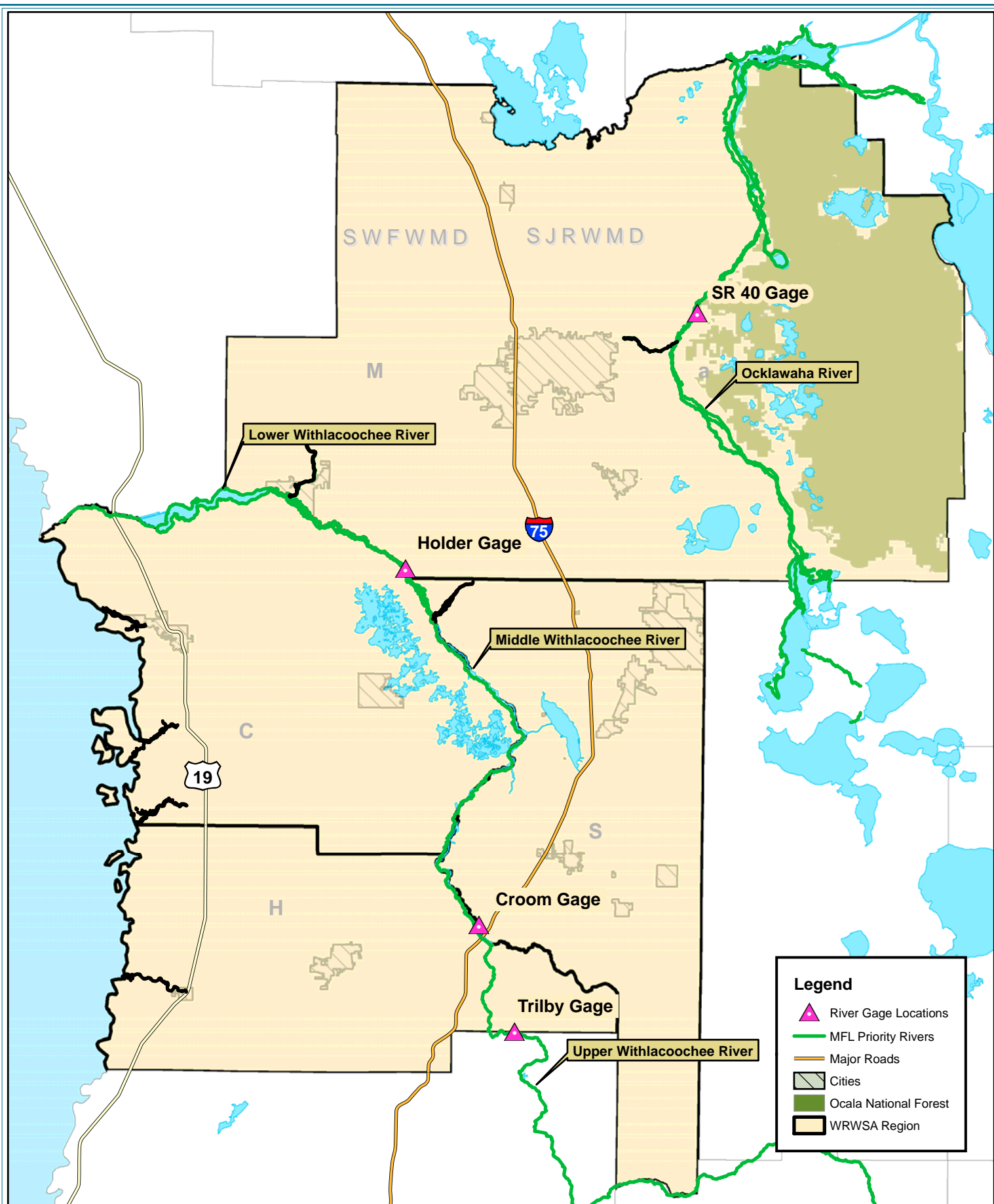
Figure 2-10. Median daily (blue line) and hypothetical MFL-adjusted (green line) flows from 1939 through 2006 on the Withlacoochee River at the USGS gage at Croom, FL, by seasonal flow block.

2.6 Lower Withlacoochee River and Lake Rousseau

The MFL development process for the Lower Withlacoochee River (the river's estuarine portion) and Lake Rousseau is underway. Progress is preliminary at this point, and the estimation of a proxy threshold for this portion of the river is not recommended at this time. This reach of the river has been significantly altered by human activities throughout the years due to the construction of the Inglis Dam and the Cross Florida Barge Canal, and is thus a system that is not readily comparable to other estuarine systems with MFLs in Florida. This system is far more complicated and requires a much more data-intensive approach than the springs and the freshwater portions of the Withlacoochee River in the WRWSA. As a result, the proxy MFLs for Holder and other freshwater reaches of the Withlacoochee River do not consider the flow requirements of the Lower Withlacoochee.

Potential hydrologic restoration alternatives for the Lower Withlacoochee are under review by the District and others and will need to be considered in conjunction with the MFL. However, a brief discussion of the water resource values that a future MFL would address and the techniques likely to be employed is appropriate.

Changes to the Lower Withlacoochee River due to construction of portions of the Cross Florida Barge Canal have reduced flows to the tidal portion of the river from those that were observed historically. Concerns have been raised that resultant changes in the salinity regime in various sections of the river may be tied to alterations in the riparian vegetation, benthic, and fish communities. This is not unlike other estuarine reaches of rivers elsewhere in Florida. Therefore, the approach to setting a minimum flow on the Lower Withlacoochee River is likely to follow procedures that have been employed in other estuarine rivers in Florida, including the Peace, Myakka, and Hillsborough rivers, and the Tampa Bypass Canal in SWFWMD and the Waccasassa River in SRWMD, and currently being applied in the Little Manatee and Anclote rivers in SWFWMD. The goal of these techniques involve relating the availability of riparian, benthic, and fish habitat, as a function of salinity, to the amount of freshwater inflows to the estuarine reaches of these systems.



Water Resource Associates, Inc.
 Engineering - Planning - Environmental Science
 4260 West Linebaugh Avenue
 Phone: 813-265-3130
 Fax: 813-265-6610
 www.wraconsultants.com

PROJECT: 0468 - Withlacoochee Phase II

Figure 2-1
MFL Priority Rivers

ORIGINAL DATE: 12-14-09

REVISION DATE: NA

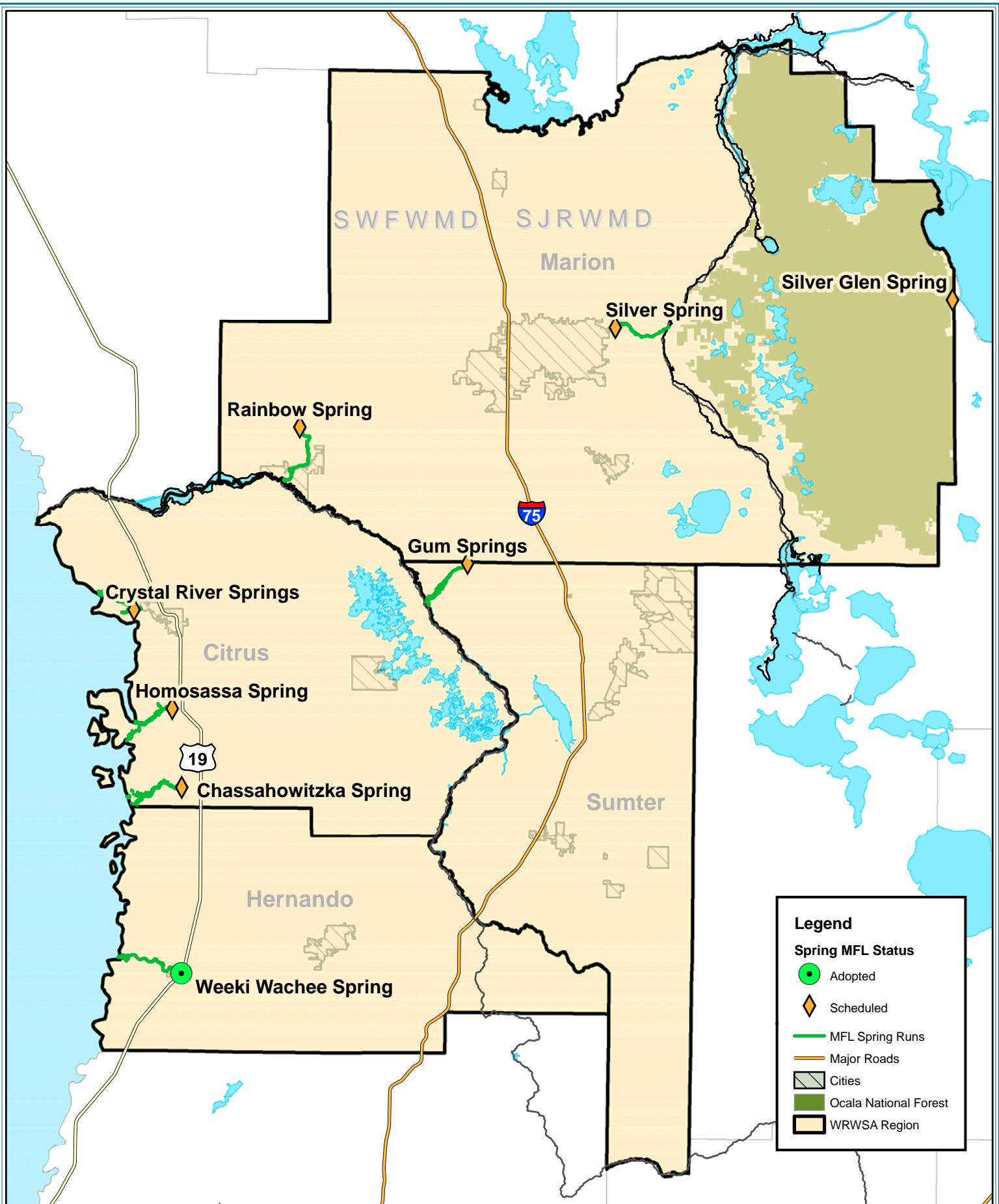
JOB NUMBER: 0468

FILE NAME: Figure 3-xb.mxd

GIS OPERATOR: LEF



1 inch equals 9 miles



Water Resource Associates, Inc.
 Engineering ~ Planning ~ Environmental Science
 4260 West Linebaugh Avenue
 Phone: 813-265-3130
 Fax: 813-265-6610
 www.wraconsultants.com

PROJECT: 0468 - Withlacoochee Phase II

Figure 2-2
MFL Priority Springs

ORIGINAL DATE: 12-14-09

REVISION DATE: NA

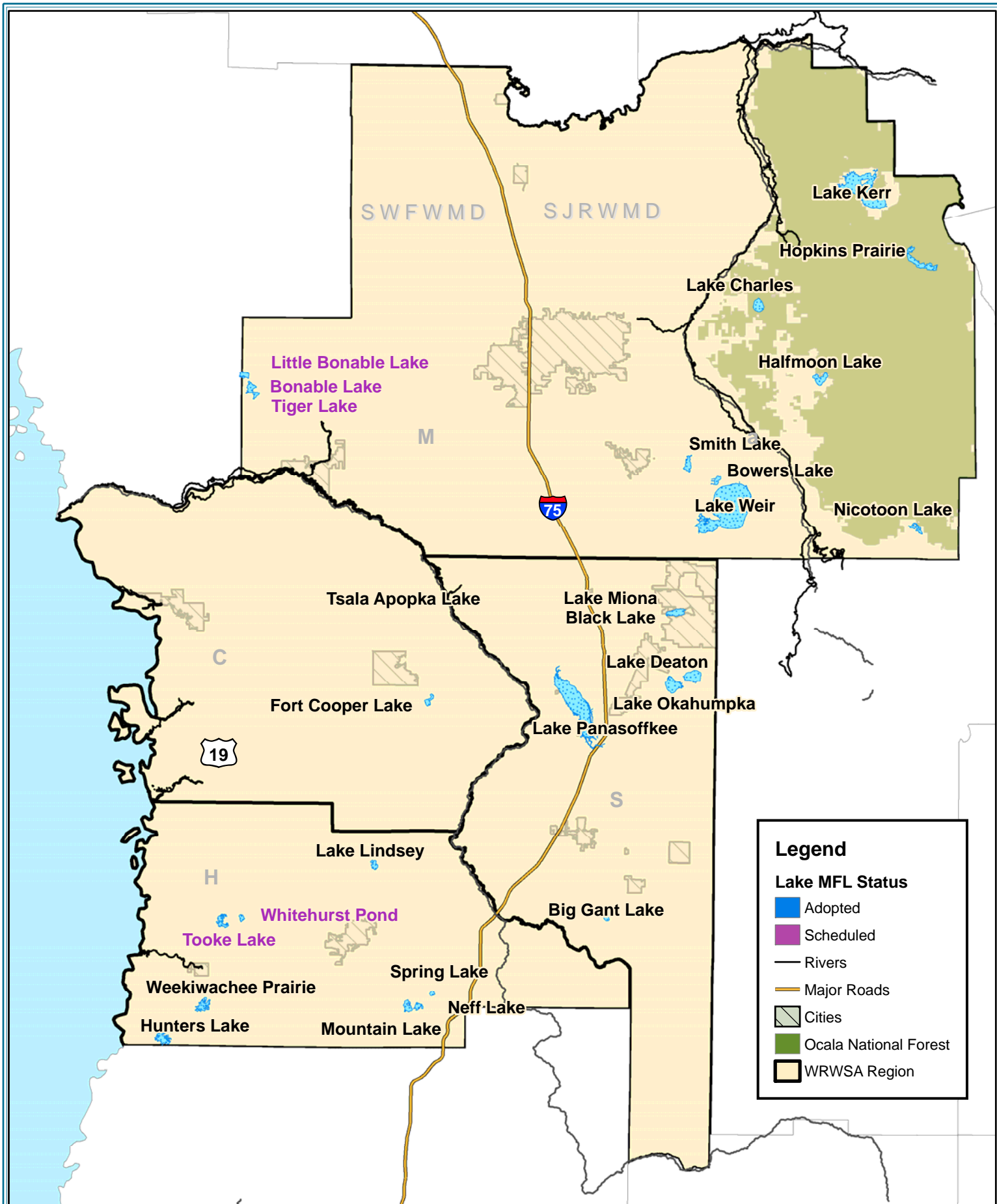
JOB NUMBER: 0468

FILE NAME: Figure 2.2.mxd

GIS OPERATOR: LEF



1 inch equals 9 miles



Water Resource Associates, Inc.
Engineering ~ Planning ~ Environmental Science
4260 West Linebaugh Avenue
Phone: 813-265-3130
Fax: 813-265-6610
www.wraconsultants.com

PROJECT: 0468 - Withlacoochee Phase II

Figure 2-3
MFL Priority Lakes

ORIGINAL DATE: 12-14-09

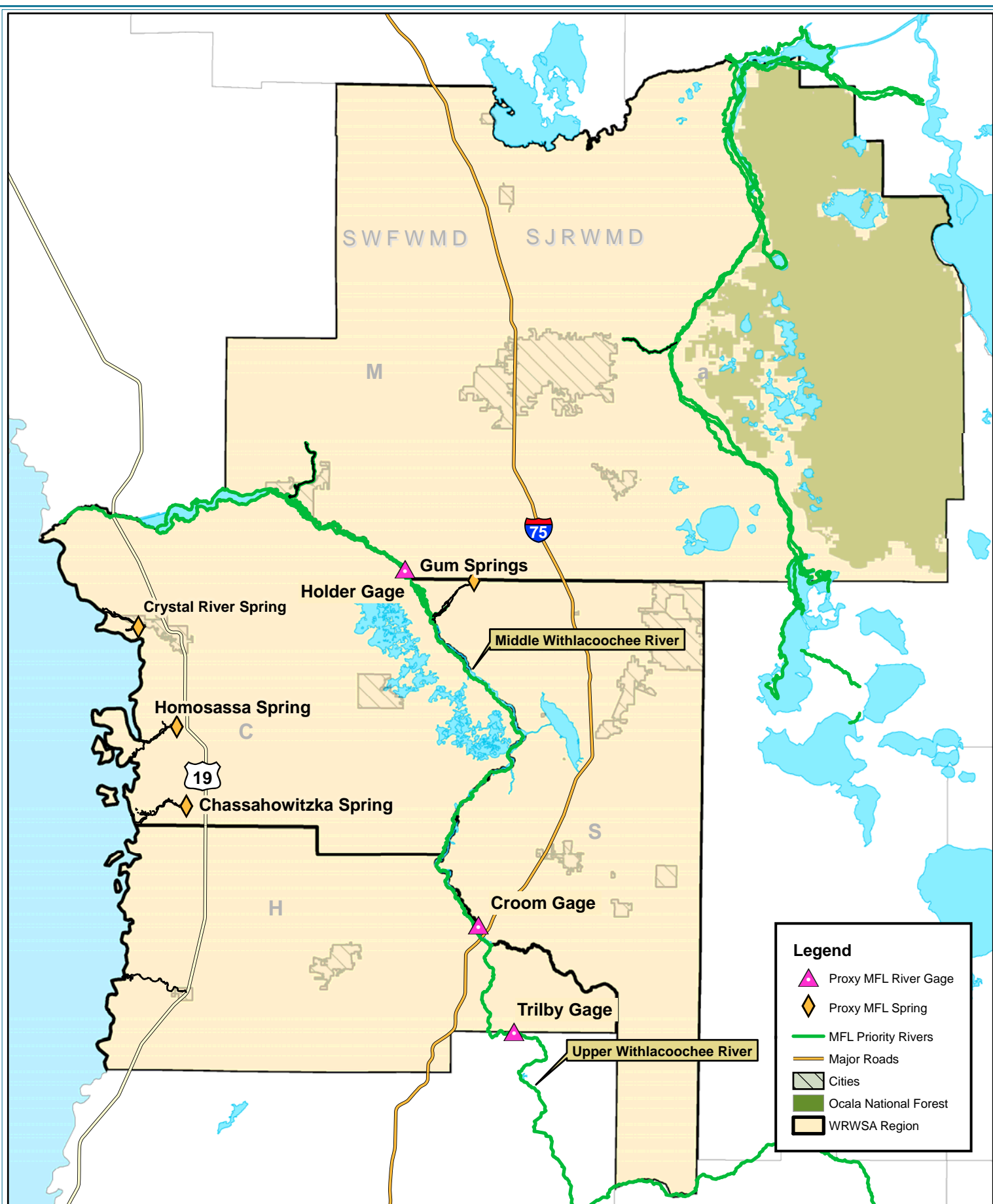
REVISION DATE: NA

JOB NUMBER: 0468

FILE NAME: Figure 3-xb.mxd

GIS OPERATOR: LEF





Water Resource Associates, Inc.
Engineering - Planning - Environmental Science
4260 West Linebaugh Avenue
Phone: 813-265-3130
Fax: 813-265-6610
www.wraconsultants.com

PROJECT: 0468 - Withlacoochee Phase II

Figure 2-4
Proxy MFL Locations

ORIGINAL DATE: 12-14-09

REVISION DATE: NA

JOB NUMBER: 0468

FILE NAME: Figure 2-4.mxd

GIS OPERATOR: LEF



1 inch equals 9 miles