3.5 SOUTH FLORIDA HYDROLOGY MONITORING NETWORK MODULE

3.5.1 Introduction

This module addresses the hydrologic monitoring needs of the freshwater system including the natural and human systems dependent on fresh water for their sustenance that will either be affected by the Comprehensive Everglades Restoration Plan (CERP) or affect reaching CERP's restoration goals and objectives (USACE and SFWMD 1999). Hydrology drives the premises and hypotheses contained in the Greater Everglades Wetlands, Southern Estuaries, Northern Estuaries, and Lake Okeechobee Modules and provides the link between the physical changes to be implemented by construction of CERP projects and the water quality and biological attributes in the simplified conceptual ecological models. The simplified conceptual ecological models were derived from the conceptual ecological models (Appendix A) to focus specifically on CERP restoration expectations. Understanding the hydrology of South Florida will enable interpretation of the other modules' monitoring results and either confirm or lead to modification of their hypotheses. Details of how hydrology factors into the ecological premises and CERP hypotheses are included in the four regional modules.

This module also addresses the surface and ground water monitoring needs of the four regional modules, Greater Everglades Wetlands, Southern Estuaries, Northern Estuaries, and Lake Okeechobee, and provides information to evaluate progress towards other water-related needs of the region provided for in the CERP. This last purpose is to monitor CERP's ability to meet its second planning goal (enhance economic value and social well being) and two of its objectives: increase availability of fresh water (agricultural/municipal and industrial) and reduce flood damages (agricultural/urban) (USACE and SFWMD 1999). In addition, this module supports all of the modules by proposing to collect the meteorological data necessary to complete assessment of the system.

Hydrologic monitoring helps to meet the four broad objectives of the Monitoring and Assessment Plan (MAP) by aiding interpretation of chemical and biological performance measures when 1) establishing baseline variability; 2) determining status and trends; 3) detecting unexpected responses of the ecosystem to changes in stressors; and 4) supporting scientific investigations designed to increase ecosystem understanding, establish cause-and-effect, and be able to respond to unanticipated system responses. Without knowing the hydrology of the system as it changes, no greater understanding of the system is possible. Neither would it be possible to identify successes due to CERP implementation.

Hydrology measurements include the stage of surface water; ground water levels in the Biscayne and Floridan aquifers; stages at structures and pump stations that are converted to flow data; and meteorology information collected at weather stations such as rainfall, evapotranspiration, and pan evaporation. The aerial extent of the hydrologic monitoring network is limited to areas directly influenced by the CERP as presented in Figure 1-1 in Section 1. In addition to evaluating the effects of the CERP, the data collected support many other needs of the South Florida Water Management District (SFWMD) and other state and federal agencies. Some of the applications include developing and refining computer simulation models, operating the Central and Southern Florida (C&SF) Project, ascertaining the effects of extreme weather events, and providing data for SFWMD consumptive use permit reviews as well as other permits.

A summary of the projects expected to affect each module or areas within each module is provided in Appendix B. The South Florida Hydrology Monitoring Network Module is not included on this table because all CERP projects are expected to directly influence the hydrological stressors described in the simplified conceptual ecological models.

3.5.2 Ecological Premise and CERP Hypotheses as the Basis for Monitoring Components and Supporting Research

One overarching ecological premise forms the basis for most of the CERP restoration goals and strategies for the South Florida Hydrology Monitoring Network. The premise relates to the increased water storage capacity that will result from CERP implementation.

Figures 3-65 through 3-67 illustrate the linkages of the ecological premise to CERP hypotheses, monitoring components, and key uncertainties and supporting research relating to the natural system, water supply, and flood protection, respectively. Supporting research generally originates from monitoring components, in which case research supports the interpretation of monitoring results. In some cases, supporting research originates directly from a CERP hypothesis, and research will be required to develop an appropriate monitoring component. These linkages are indicated by a red arrow. A summary of the monitoring components and supporting research for South Florida hydrology monitoring is listed in Table 3-18. The list of research topics includes those identified during the development of the current version of the MAP. This list has yet to be prioritized, and it is anticipated that additional research topics of equal or higher priority will be identified in the future.

The process used to develop the monitoring plan for the South Florida Hydrology Network Module, and all of the other modules, is described in Section 2.0, Development of the CERP Monitoring Plan and Adaptive Management Program. The strategy for prioritizing and implementing monitoring components and research topics is discussed in Section 5.0, Implementation Strategy for the CERP Monitoring and Assessment Plan.

3.5.2.1 Water Storage Capacity (Figures 3-65, 3-66, and 3-67)

Ecological Premise: The implementation of the Comprehensive Plan will increase water storage capacity in the regional water management system of South Florida. That increased storage capacity will be sufficient to provide the volume, distribution, and timing of water needed to restore towards Natural System Model (NSM) hydrologic conditions in the Greater Everglades Wetlands and prevent releases of excess water to the natural system, while also providing water for expanding agricultural, industrial, and municipal demands.

CERP Hypotheses: Specific benefits from implementation of the Comprehensive Plan will include the following:

- Restore hydrology in the natural system to conditions similar to the NSM or other restoration targets by distributing the appropriate amount of water to the right place, at the right time, and of the right quality

- Reduce harmful releases of excess water to the natural system such as the Caloosahatchee Estuary, St. Lucie Estuary, Lake Worth Lagoon, and Everglades Protection Area

- Meet a 1-in-10 year level of service for urban and agricultural water supply demands through regional water deliveries and control seepage from the Water Conservation Areas and Everglades National Park (373.0361(2)(a)(1), Florida Statutes (FS))

- Achieve a minimum level for the Biscayne aquifer criterion by preventing saltwater intrusion into the Biscayne aquifer by maintaining the water levels in the primary coastal canals (Section 373.042, FS)

- As the CERP is implemented, maintain flood protection at the levels in existence on December 11, 2000 and in accordance with applicable laws: Section 601(h)(5)(B) Savings Clause, Water Resources Development Act of 2000 (WRDA 2000), and 373.1501(5)(d), FS

Adaptive Management Question: Will implementation of the CERP be able to provide adequate freshwater supplies to meet the natural system hydrologic targets while providing water to meet the water supply needs of agricultural, industrial, and municipal users and maintaining the existing level of flood protection to agricultural and urban land uses? If not, how and to what extent do we alter the physical structure or operations of the system to store an adequate volume of water and distribute it to the natural and human systems when needed, while also maintaining existing levels of flood protection?

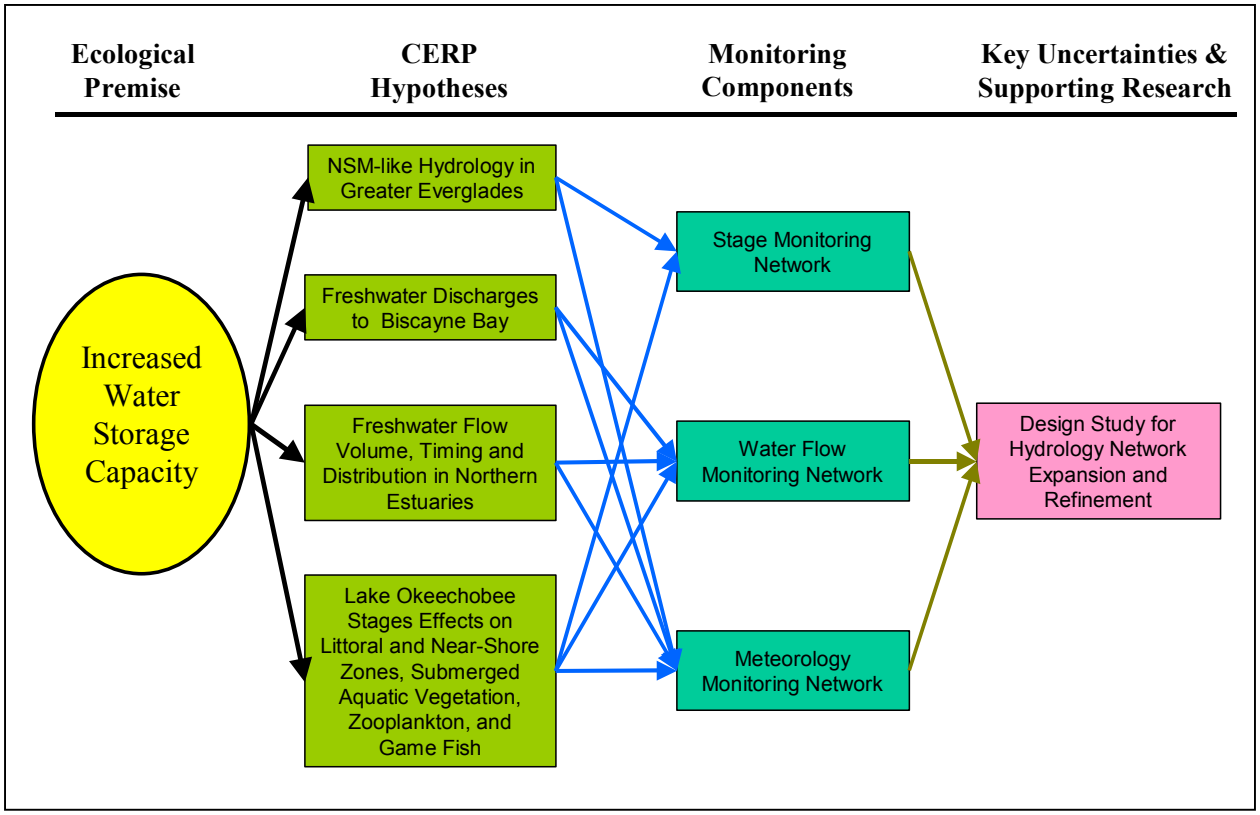

Figure 3-65: Diagram Depicting Relationships between the Ecological Premise, CERP Hypotheses, Monitoring Components, and Supporting Research for Increased Water Storage Capacity as it Relates to the Natural Systems

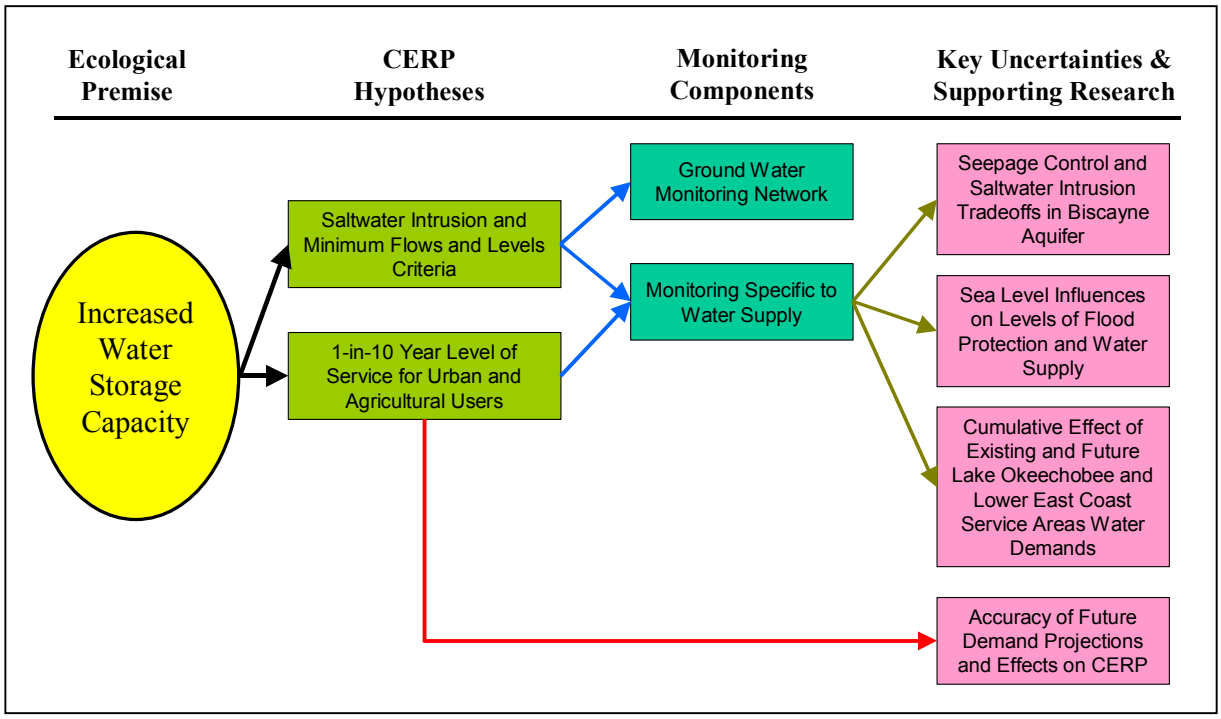

Figure 3-66: Diagram Depicting Relationships between the Ecological Premise, CERP Hypotheses, Monitoring Components, and Supporting Research for Increased Water Storage Capacity as it Relates to Water Supply

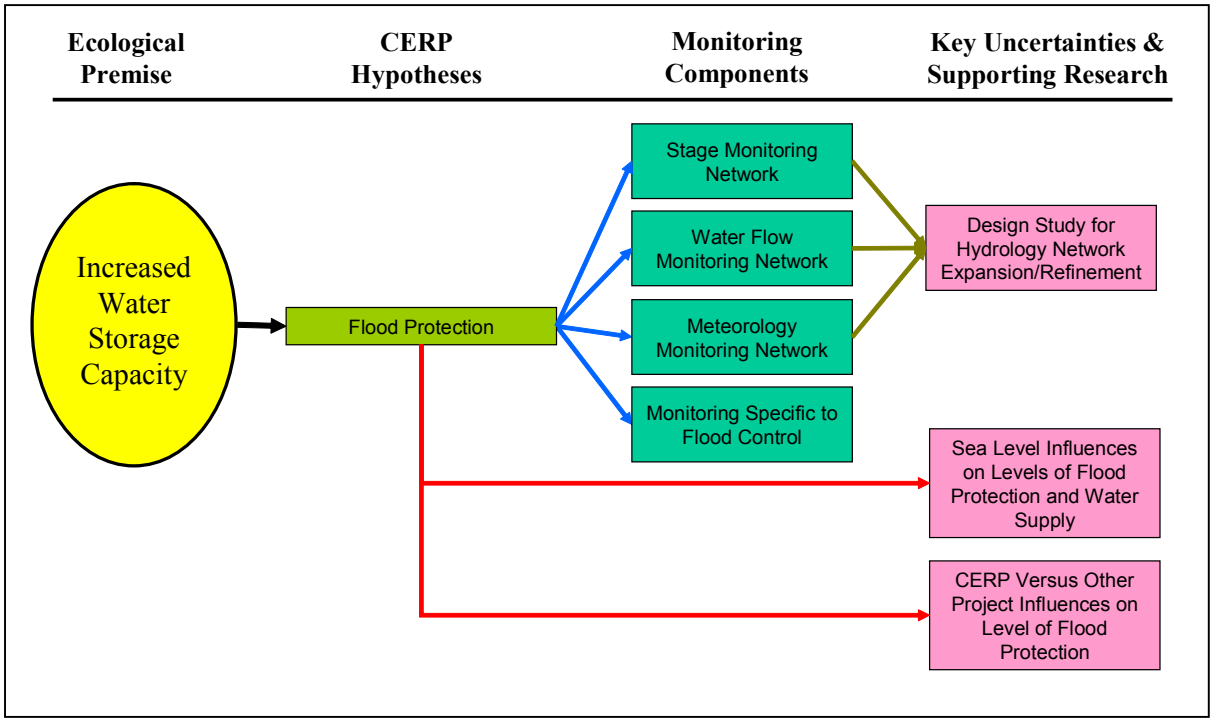

Figure 3-67: Diagram Depicting Relationships between the Ecological Premise, CERP Hypotheses, Monitoring Components, and Supporting Research for Increased Water Storage Capacity as it Relates to Flood Protection

3.5.2.2 Summary of Monitoring Components and Key Uncertainties and Supporting Research

Table 3-18 summarizes the monitoring components and key uncertainties and supporting research for the South Florida Hydrology Monitoring Network Module. The section of this document in which the item is discussed is provided in the second column of Table 3-18 for reference.

The system-wide assessment performance measures contained in the table below are published in a separate document, the Performance Measure Documentation Report (RECOVER In prep). Each MAP monitoring component has at least one corresponding performance measure. For reference, the performance measure identification number or numbers are provided in the last column of Table 3-18.

Table 3-18: Summary List of Monitoring Components and Key Uncertainties and Supporting Research for the South Florida Hydrology Monitoring Network

Monitoring Components	MAP Section	Performance Measure Number
Stage Monitoring Network	3.5.3.1	LO-A1 LO-A2 LO-A3 LO-A4 LO-A5 GE-A1
Ground Water Monitoring Network	3.5.3.2	GE-A1
Water Flow Monitoring Network	3.5.3.3	GE-A1 SE-A1 SE-A2 NE-A1 NE-A2 NE-A3 NE-A4
Meteorology Monitoring Network	3.5.3.4	N/A
Monitoring Specific to Water Supply	3.5.3.5	WS-A1 WS-A2 WS-A4 WS-A5
Monitoring Specific to Flood Protection	3.5.3.6	WS-A3
Key Uncertainties and Supporting Research		
Design Study for Hydrology Network Expansion/Refinement	3.5.4.1	
Sea Level Influences on Levels of Flood Protection and Water Supply	3.5.4.2	
Seepage Control and Saltwater Intrusion Tradeoffs in Biscayne Aquifer	3.5.4.3	
Methodology to Monitor and Evaluate the Success of Pre-CERP Baseline Meeting WRDA 2000 and FS Requirements	3.5.4.4	
Accuracy of Future Demand Projections and Effects on the CERP	3.5.4.5	
Cumulative Effect of Existing and Future Lake Okeechobee and Lower East Coast Water Demands	3.5.4.6	
CERP Versus Other-project Influences on Level of Flood Protection	3.5.4.7	

3.5.3 Monitoring Components

The stage, ground water, water flow, and meteorology monitoring networks are presented in this section. The SFWMD, the United States Geological Survey (USGS), the United States Army Corps of Engineers (USACE), the National Oceanic and Atmospheric Administration (NOAA), Everglades National Park, the Seminole Tribe of Florida and Miccosukee Tribe of Indians of Florida, and county and city governments all provide data that become part of these monitoring networks. The SFWMD manages a large majority of these data in their DBHYDRO database. Periodically the SFWMD updates "active site" maps of these monitoring networks. "Active sites" are defined as SFWMD sites from which data has been added to the database within the previous 12 months, other agency sites that have had data added within the previous 24 months, and new sites added since the previous update. The latest version of the "active site" maps is located at http://www.sfwmd.gov/curre/sitemaps/mapsindex.htm.

3.5.3.1 Stage Monitoring Network

The SFWMD, the USGS, the USACE, and Everglades National Park jointly fund and manage an extensive stage (water level) network within the SFWMD boundaries. As of May 14, 2003, 753 sites were being monitored (Figure 3-68).

The map depicting stage monitoring sites is too detailed to import into this document. It can be accessed on the web at ***http://www.sfwmd.gov/curre/sitemaps/stage.pdf****. If you are viewing this document on a compact disk, click on this link* **hydro maps/Stage.pdf***.*

Figure 3-68: Selected Stage Monitoring Sites

Within the Everglades Protection Area, the following sites are used to determine the daily average stage values:

- Arthur R. Marshall Loxahatchee National Wildlife Refuge: 1-7, 1-8C, and 1-9
- Water Conservation Area 2A: 2A-17B
- Water Conservation Area 3A: 3A-3, 3A-4, and 3A-28
- Everglades National Park: P33, P34, P35, P37, and TSB

Daily hydrographs for selected sites can be found on the SFWMD's Regional Real-Time Data web site at http://www.sfwmd.gov/org/omd/ops/rt/regions.html. In addition, daily stage data from a large number of sites within the SFWMD can be obtained from the USACE's web site at http://www.saj.usace.army.mil/h2o/index.html.

Implementation of the CERP will require periodic modifications to the existing stage monitoring network. REstoration COordination and VERification (RECOVER) anticipates a review of the network to define enhancements, fill in data gaps, and reduce redundancy.

3.5.3.2 Ground Water Monitoring Network

The SFWMD and the USGS jointly manage and fund an extensive ground water monitor well network in South Florida (Figure 3-69). During the 2002 water year (October 1, 2001 to September 30, 2002), the USGS monitored 512 wells in southern Florida to assess regional ground water conditions (Torres personal communication 2003). In southeastern Florida, the principal aquifers monitored are the Biscayne aquifer in Miami-Dade and Broward Counties (230 wells) and the Surficial aquifer system in Palm Beach, St. Lucie, and Martin Counties (52 wells). In southwestern Florida, water levels are measured in the following principal aquifers: water-table aquifer (77 wells), lower Tamiami aquifer (43 wells), sandstone aquifer (42 wells), mid-Hawthorn aquifer (36 wells), lower Hawthorn aquifer (or lower Hawthorn producing zone) (25 wells), and Floridan aquifer system (7 wells). Data from this group of wells is collected by USGS staff and funded cooperatively between the SFWMD and the USGS. These wells are jointly maintained between the two agencies. The second grouping consists of approximately 275 wells, with 245 in the Surficial aquifer and 30 in the Floridan aquifer. This group of wells is currently monitored and maintained by the SFWMD. Daily ground water data from a large number of sites within the SFWMD may be obtained from the SFWMD's Regional Real-time Data web site at http://www.sfwmd.gov/org/omd/ops/rt/regions.html.

*The map depicting stage monitoring sites is too detailed to import into this document. It can be accessed on the web at **http://www.sfwmd.gov/curre/sitemaps/groundwater.pdf**. If you are viewing this document on a compact disk, click on this link hydro maps/Groundwater.pdf.*

Figure 3-69: Selected Ground Water Monitoring Sites

Each of the four regional water supply plans recently published by the SFWMD included recommendations for additional and improved ground water monitoring within their respective regions. The Lower East Coast Regional Water Supply Plan (SFWMD 2000a) recommends augmenting the network to expand the existing saltwater intrusion monitoring in the area. The Upper East Coast Water Supply Plan (SFWMD 1998) recommends developing a comprehensive monitoring program to collect the necessary information to develop the water use, water quality, and water level relationships in the high water use citrus groves in St. Lucie County. Recommendations from the Kissimmee Basin and Lower West Coast Water Supply Plans (SFWMD 2000b and 2000c, respectively) are not included since they are located outside the aerial extent of the MAP.

An evaluation of the monitoring well network was completed in March 2002 by a SFWMD task force (Lukasiewicz et al. 2002), and the resulting report presents specific recommendations for improvements to this well network. The report concluded that, overall, the total number of wells in the network provides adequate spatial resolution; however, the frequency of water level readings is not sufficient to support future ground water computer modeling efforts including those being conducted for CERP regional evaluations. Many recent models developed by the SFWMD (to support regional water supply plan development) run on daily time periods because stages in surface water bodies (i.e., canals) vary on a daily basis. The frequency of ground water level monitoring will need to correspond to the daily time periods of the models to ensure adequate model calibration.

As of 2003, the USGS surface water data-collection network consisted of 40 continuous flow-discharge sites and 34 stage sites, many of which collect water quality data (Torres personal communication 2003). In addition to this surface-water network and as part of USGS special projects in support of Everglades restoration activities along Florida Bay, Barnes Sound, and the southwest coast of Florida, the USGS also

maintains and operates 27 flow, stage, salinity, and temperature stations; 6 continuous stage, salinity, and temperature stations; 2 continuous sheetflow velocity stations; and 1 continuous salinity and temperature station. The SFWMD (Lukasiewicz et al. 2002) has recommended an additional 40 percent of the network be automated. Approximately 30 of these new recorders will be installed on Floridan aquifer wells. The remaining recorders will be installed on existing Surficial and Intermediate aquifer monitor wells.

The SFWMD has provided the following recommendations to improve the USGS and SFWMD network (Lukasiewicz et al. 2002):

- A total of 15 wells can be eliminated from the network due to data redundancies: 7 from the Lower East Coast region, 6 from the Upper East Coast region, and 2 from the Lower West Coast region.

- At least 54 additional new wells need to be drilled and instrumented in the regional network: 37 in the Lower East Coast region, 2 in the Upper East Coast region, and 15 in the Lower West Coast region.

- New instruments recommended include the following: 4 new surface water stage recorders in the Lower East Coast region and 3 new rainfall gauges for the Upper East Coast region.

- A total of 40 wells were identified as requiring repair: 18 in the Lower East Coast, 16 in the Lower West Coast Region, and 6 in the Upper East Coast region. Thirteen of the total 40 wells were repaired by the SFWMD in 2001.

- A total of 82 wells were identified as a high priority to automate with recorders: 49 in the Lower East Coast, 23 in the Lower West Coast Region, and 10 in the Upper East Coast region.

An attempt will be made to coordinate with local governments and utilities that manage local monitoring programs and databases of their own. Much of these data are already received as part of the water use permit process. These data need to be integrated with the data available in DBHYDRO. Integration of data from these sources would be a cost-effective means to increase our coverage both temporally and spatially.

Temporal (semi-annual) water level maps were also recommended for the Lower East Coast and Lower West Coast regions. These maps would be helpful in determining the cone of influence of the major public water supply well fields in the area.

3.5.3.3 Water Flow Monitoring Network

As of May 14, 2003, the SFWMD operated and maintained 318 active flow monitoring sites (Figure 3-70). These sites include pump stations, spillways, culverts, weirs, and open channel measurements. Flow values are derived from instantaneous headwater and tailwater levels, i.e. stage data, measured at every structure and pertinent operating control information such as pump speed or spillway gate opening conditions. Instantaneous flow values are then computed using an in-house computer program called FLOW.

Within SFWMD boundaries, an additional 116 structures of significance are currently operated by other agencies. The SFWMD has agreements with these agencies to obtain their data and load it into DBHYDRO on a regular basis, thereby providing a single source of flow data.

The map depicting stage monitoring sites is too detailed to import into this document. It can be accessed on the web at http://www.sfwmd.gov/curre/sitemaps/flow.pdf. If you are viewing this document on a compact disk, click on this link hydro maps/Flow.pdf.

Figure 3-70: Selected Flow Monitoring Sites

Flow is also obtained at canal sites that are too far from structures to obtain valid data or where it is desired to collect flow-proportional water quality samples for calculating nutrient loads. In these cases, data are obtained from velocity meters installed in canals and stored in an on-site data logger such as a CR-10 for direct transmission or later downloading. A computer program is then used to convert the velocity data into site-specific flow data. The data logger is also programmed with a "trigger" volume that, when reached, sends a signal to an autosampler to collect a water quality sample which is stored in an on-site container. The resulting flow and nutrient concentration data are subjected to quality assurance and quality control (QA/QC) analysis and then used to calculate a load for the time period during which the data were collected. Flow-proportional water quality data are currently being collected by the SFWMD, the USGS, the USACE, and the Miccosukee Tribe of Indians of Florida.

Implementation of the CERP will require periodic modifications to the existing flow monitoring network as structures are removed and new ones are constructed to redirect water conveyance and store water. A review of the monitoring network design will be implemented in order to determine where flow monitoring needs to be modified or enhanced and where data gaps need to be addressed.

Daily flow data from a large number of sites within the SFWMD may be obtained from the SFWMD's Regional Real-time Data web site at http://www.sfwmd.gov/org/omd/rt.html or at the USACE web site at http://www.saj.usace.army.mil/h2o/index.html.

3.5.3.4 Meteorology Monitoring Network

Weather Stations

As of April 30, 2003, there were 40 active weather sites maintained by the SFWMD and two maintained by other agencies (Figure 3-71). The site map provides coded symbols of measured parameters as follows: 24 evaporation sites, 29 wind sites, 29 temperature sites, and 30 solar sites. Daily average data are stored in DBHYDRO after data have been processed and subjected to QA/QC review. Individual data values can be extracted from the District's Data Collection and Validation Process database if needed. Discussion of the rainfall monitoring network is presented below.

The map depicting stage monitoring sites is too detailed to import into this document. It can be accessed on the web at http://www.sfwmd.gov/curre/sitemaps/weather.pdf. If you are viewing this document on a compact disk, click on this link hydro maps\Weather.pdf.

Figure 3-71: Selected Weather Monitoring Sites

Evapotranspiration and Pan Evaporation

The SFWMD maintains a database for daily wetland evapotranspiration at Storm Water Treatment Area 1 West (STA 1W). The daily data are derived from weather station data at the site and application of an evapotranspiration equation.

As of April 30, 2003, the SFWMD's monitoring network contained an additional 23 active pan evaporation stations. District-wide potential evapotranspiration estimation using models and weather data inputs is being expanded by the Environmental Monitoring and Assessment Department and the Electronic Support and Data Acquisition Division to support a number of water supply and water balance needs. Eventually, the network will have 13 new weather stations to estimate potential evapotranspiration. These data will be stored in DBHYDRO (Reardon and Abtew 2002). Modelers running the South Florida Water Management Model (SFWMM) and CERP project teams needing water balance data for planned stormwater treatment areas and reservoirs are potential users of these data. Technical documents related to the subject of evapotranspiration include Abtew (1996), Abtew (2001), Abtew and Obeysekera (1995), and Reardon and Abtew (2002).

Rainfall Monitoring Network

As of April 30, 2003, the SFWMD maintained 293 active rainfall monitoring sites, and other agencies maintained 18 active sites (Figure 3-72). The SFWMD's Operations and Management Division has divided the SFWMD area into the following 15 rainfall regions to facilitate operations:

- Upper Kissimmee
- Lower Kissimmee
- Lake Okeechobee
- East Everglades Agricultural Area
- West Everglades Agricultural Area
- Water Conservation Areas 1 and 2
- Water Conservation Areas 3
- Martin/St. Lucie Counties
- Palm Beach County
- Broward County
- Miami-Dade County
- Lower East Coast
- East Caloosahatchee
- Big Cypress
- Southwest Coast

The map depicting stage monitoring sites is too detailed to import into this document. It can be accessed on the web at http://www.sfwmd.gov/curre/sitemaps/rain.pdf. If you are viewing this document on a compact disk, click on this link hydro maps\Rain.pdf.

Figure 3-72: Selected Rainfall Monitoring Sites

Data from rainfall gages in each region are used to calculate a daily basin-weighted average rainfall sum using the Thiessen Polygon method. Individual rainfall gage values are entered into DBHYDRO.

A plan has been prepared for upgrading and optimizing the current rainfall network over the next three years. The first step will be to upgrade sites that do not have tipping buckets and the ability to send data via telemetry. The second step will be to collect and compare NEXRAD data, i.e., rainfall data measured by radar, with data collected from the upgraded ground-based network. The third step will optimize the ground-based system by relocating selected ground sites from clusters, i.e., areas where there are too many monitoring sites, to areas needing additional sites. The optimization will provide the highest degree of correlation between the NEXRAD and ground-based rainfall data.

In addition to the above mentioned data sources, SFWMD meteorologists issue daily rainfall forecasts for each region and produce a monthly Surface Water Conditions Report that includes a graphical comparison of each region's current monthly rainfall with the region historical average for that month. The daily forecasts and monthly report are also on the Operations Division web site, as is other weather-related data.

Rainfall depth, resulting from a storm event occurring with a given frequency, is an essential variable for design and operation of water control structures, flood control, consumptive use estimation, water supply planning, and water resources management. Rainfall depth is usually evaluated for various durations and frequency of occurrence using point or regional frequency analysis. Recent rainfall frequency analysis reports written for various regions within the District include Ali, et al. (2000), Ali and Abtew (1999), and Pathak 2001.

3.5.3.5 Monitoring Specific to Water Supply

For water supply, a network exists to monitor and report on urban water withdrawals, Lake Okeechobee releases, surface water stages in canals, and ground water stages in the Biscayne and Floridan aquifers. This existing network should be adequate to assess the short-term ability to meet water demands and identify how the demands were met when coupled with information from SFWMD Governing Board declarations of water restrictions. What is lacking are the tools to assess the cumulative and long-term impacts of the current and future urban and agricultural demands on regional water availability, identify trends in water demands, and determine water withdrawal trends compared to demand projections used for planning. In addition, it is essential that the regional system is meeting urban and agricultural demands during drought events and minimizing the effects on the natural system. Therefore, drought event assessments are an important tool to understand the effects of droughts and how the system was operated in response.

3.5.3.6 Monitoring Specific to Flood Protection

The existing network that monitors surface water levels in canals, ground water stages, water releases from structures, and rainfall is adequate to assess real time conditions and provide operating data for the

regional system. The network lacks the ability to aggregate the information and determine a basin's flood protection level of service and provide a comparison to the existing level of flood protection provided by the C&SF Project or other appropriate baselines.

3.5.4 Key Uncertainties and Supporting Research

Many of the supporting research topics needed to answer the key uncertainties related to the South Florida Hydrology Monitoring Network have not been developed. Below is a brief summary of the topics that will be developed for inclusion in the next version of the MAP.

3.5.4.1 Design Study for Hydrology Network Expansion and Refinement

The existing network of surface water, ground water, flow, and meteorology monitoring maintained and operated by the SFWMD, the USGS, and Everglades National Park will be evaluated to determine if additional monitoring locations are necessary to support the other modules. The hydrologic network will provide the necessary information to link changes in the physical components to the changes in chemical and biological components of the system. The monitoring data provided will be sufficient to characterize the hydrologic condition and aid interpretation of the water quality and ecological data collected as part of the other modules. The primary areas of the study are Lake Okeechobee and its tributaries, the remaining Everglades, and the Lower East Coast and Upper East Coast Service Areas. The evaluation of the existing hydrologic and meteorological networks for this study will be divided into four phases:

- Phase 1: Surface water (stages) monitoring network
- Phase 2: Flow (structures and canals) monitoring network
- Phase 3: Meteorology (weather and rainfall) monitoring network
- Phase 4: Open marsh flow velocity estimation monitoring network

The first phase will be initiated as soon as possible to establish a portion of the baseline for hydrologic conditions in the natural system. The ground water monitoring network does not require additional study at the present time. The SFWMD completed an evaluation of the ground water monitoring network in March 2002 (Lukasiewicz et al 2002).

3.5.4.2 Sea Level Influences on Levels of Flood Protection and Water Supply

Flood protection and water supply may be compromised as sea level rises. Operations will need to be altered to mitigate its impacts. A supporting research topic will be developed to determine if the flood protection and water supply system will be adequate or will need to be modified in the future.

3.5.4.3 Seepage Control and Saltwater Intrusion Tradeoffs in Biscayne Aquifer

The C&SF Project drainage system is designed to decrease seepage from the natural system and release excess water to tide. A supporting research topic will be developed to determine the dynamics and cumulative effects of this drainage system on the ability to prevent saltwater intrusion into the Biscayne aquifer and meet other restoration performance measures.

3.5.4.4 Methodology to Monitor and Evaluate the Success of Pre-CERP Baseline in Meeting WRDA 2000 and Florida Statutes Requirements

A pre-CERP baseline is being established through model simulation to meet WRDA and FS requirements. A supporting research topic will be developed to determine how this baseline can be verified through monitoring. The research will determine whether the data will be averaged, weighted over time and space, or handled by some other method.

3.5.4.5 Accuracy of Future Demand Projections and Effects on the CERP

The accuracy of future demand projections and the effects on CERP project design and performance if the actual demands differ from those projected needs to be determined. Future water sources may diversify as lower quality water is sought as a source for urban water demands, perhaps diminishing the demands on fresh water in the system compared to current projections. This topic could be addressed as part of the adaptive management strategy.

3.5.4.6 Cumulative Effect of Existing and Future Lake Okeechobee and Lower East Coast Water Demands

A supporting research topic will be developed to determine the cumulative effect that the existing and future Lake Okeechobee and Lower East Coast Service Areas' demand on regional water deliveries, seepage, and the regional water availability will have on meeting other restoration performance targets. Also, the research will determine if the development of additional regional storage and alternative water supplies will be adequate to meet future demands while meeting natural system performance targets.

3.5.4.7 CERP Versus Other Project Influences on Level of Flood Protection

Other water development projects occurring in the same regional areas and/or timeframe as CERP projects may influence the level of flood protection. A supporting research topic will be developed to determine how other project influences can be differentiated from those of CERP.

3.5.5 References

Abtew, W. 1996. Evapotranspiration Measurements and Modeling for Three Wetland Systems. Journal of American Water Resources Association 32(3):465-473.

Abtew, W. 2001. Evaporation Estimation for Lake Okeechobee in South Florida. Journal of Irrigation and Drainage Engineering, 127(3): 140-147.

Abtew, W., and J. Obeysekera. 1995. Lysimeter Study of Evapotranspiration of Cattails and Comparison of three estimation methods. Transactions of the ASAE 38(1): 121-129.

Ali, A., and W. Abtew. 1999. Regional Rainfall Frequency Analysis for Central and South Florida. Technical Publication WRE 380. South Florida Water Management District, West Palm Beach, Florida.

Ali, A., W. Abtew, S. Van Horn, and N. Khanal. 2000. Temporal and Spatial Characterization of Rainfall over Central and South Florida. Journal of American Water Resources Association 36(4):833-848.

RECOVER. In prep. Performance Measure Documentation Report. RECOVER c/o South Florida Water Management District, West Palm Beach, Florida.

Lukasiewicz, J., C. James, H. Radin, E. Hopkins, D. Butler, T. Bengtsson, and J. Herr. 2002. Ground Water Monitor Well Network Assessment, a District Task Force Report. Technical Memorandum WS-12, South Florida Water Management District, West Palm Beach, Florida.

Pathak, C.S. 2001. Frequency Analysis of Daily Rainfall Maxima for Central and South Florida. Tech. Pub. EMA 390. South Florida Water Management District, West Palm Beach, Florida.

Reardon, A., and W. Abtew. 2002. Evapotranspiration Estimation for South Florida - Documentation for Program ET_SF. Resource Assessment Division, South Florida Water Management District, West Palm Beach, Florida.

SFWMD. 1998. Upper East Coast Water Supply Plan. South Florida Water Management District, West Palm Beach, Florida.

SFWMD. 2000a. Lower East Coast Regional Water Supply Plan. South Florida Water Management District, West Palm Beach, Florida.

SFWMD. 2000b. Kissimmee Basin Water Supply Plan. South Florida Water Management District, West Palm Beach, Florida.

SFWMD. 2000c. Lower West Coast Water Supply Plan. South Florida Water Management District, West Palm Beach, Florida.

Torres, A.E. Personal communication 2003. United States Geological Survey – Florida Integrated Science Center, Center for Water and Restoration Studies, Tampa, Florida.

USACE and SFWMD. 1999. Central and Southern Florida Project Comprehensive Review Study Final Integrated Feasibility Report and Programmatic Environmental Impact Statement. Jacksonville District, United States Army Corps of Engineers, Jacksonville, Florida, and South Florida Water Management District, West Palm Beach, Florida.