Volusia Blue Spring Minimum Flow Regime Action Plan

Prepared by

St. Johns River Water Management District

In cooperation with the

Blue Spring Minimum Flow Interagency Working Group

September 27, 2006

Introduction

The St. Johns River Water Management District (District), pursuant to its statutory responsibilities, developed and has approved minimum flows for Blue Spring and Blue Spring Run, Volusia County, Florida, that increase incrementally over time and are referred to as a minimum flow regime. The first increment allows a minimum long-term average spring flow of 133 cubic feet per second (cfs), which is less than the current long-term average flow of 157 cfs, until March 31, 2009. This minimum long-term average flow would be raised during each of four subsequent 5-year intervals to the following:

- 137 cfs (from April 1, 2009, through March 31, 2014)
- 142 cfs (from April 1, 2014, through March 31, 2019)
- 148 cfs (from April 1, 2019, through March 31, 2024)
- 157 cfs (after March 31, 2024)

Under the approved rule, after March 31, 2024, the minimum long-term average flow of the spring run will be the current long-term average flow of 157 cfs.

The Blue Spring minimum flow regime (Blue Spring MFR) will support the protection of the use of Blue Spring as a winter warmwater refuge for the West Indian manatee population and will support the protection of all relevant water resource values (WRVs) in 62-40.473, *Florida Administrative Code* (*F.A.C.*). These WRVs include: recreation in and on the water; fish and wildlife habitats and passage of fish; estuarine resources; transfer of detrital material; maintenance of freshwater storage and supply; aesthetic and scenic attributes; filtration and absorption of nutrients and pollutants, sediment loads; water quality; and navigation.

To develop the flow regime, the District formed the Blue Spring Minimum Flow Interagency Working Group (Blue Spring MFIWG). Consisting of experts from various participating organizations, including the Florida Department of Environmental Protection (FDEP) and the Florida Fish and Wildlife Conservation Commission (FWC), the Blue Spring MFIWG assisted the District in the formulation of the minimum flow regime. The U.S. Fish and Wildlife Service (USFWS) and Save the Manatee Club, Inc., also participated in the Blue Spring MFIWG, primarily in reviewing and commenting on draft recommendations.

The District has received numerous comments from individuals and other agencies regarding implementation of the Blue Spring MFR. A recurring comment has been, given the phased structure of the rule, that the District may not be able to ensure the required flows will actually be achieved by the dates established in the flow regime. To address this concern, the Governing Board authorized District staff to develop a comprehensive Volusia Blue Spring Minimum Flow Regime Action Plan (Action Plan) that directs the implementation of a multifaceted approach by District staff to ensure, to the extent possible, that the increasing minimum flows required by the flow regime will be met in the future. The Action Plan has been designed so as to adaptively manage implementation of the Blue Spring MFR by incorporating both active and passive adaptive management components designed to reduce

uncertainties and to allow for modification of the plan as needed to ensure that the Blue Spring MFR will continue to be met in the future. The approach depends on a cooperative partnership between the FDEP, FWC, and the District.

The Action Plan was developed in consultation with the Blue Spring MFIWG and peer reviewers. The Action Plan describes the objectives, action strategies, funding responsibilities, and scheduling to implement the Blue Spring MFR and provides for the development of the data and monitoring tools to evaluate whether rule amendments are warranted in the future. The District intends to accomplish the Action Plan through strategic implementation of objectives and action strategies associated with the following four major plan components: (1) monitoring and periodic evaluation; (2) water supply planning and alternative water supply development; (3) permitting and enforcement; and (4) reporting. The Action Plan components and associated objectives and action strategies are summarized in the following sections.

1. Monitoring and Periodic Evaluation

The District used the best information available and computer simulation models of Blue Spring hydrodynamics to calculate minimum flows for Blue Spring. The research efforts that support the Blue Spring MFR are based on an analysis of the vast daily database of manatee occurrence at Blue Spring State Park documented by FDEP and FWC, spring flow records, and river stage and river temperature data collected and compiled by the U.S. Geological Survey (USGS) and the District. The District will rely in part on computer simulation models of regional Floridan aquifer groundwater flows to ensure that the flows from Blue Spring will not fall below established minimum flows resulting from groundwater withdrawals. It is imperative that all of these data collection and model development efforts be continued and enhanced, where necessary, to provide the required minimum flow regime evaluation tools.

This Action Plan component describes the monitoring objectives and the strategic actions to be accomplished in coordination and partnership with other agencies, groups, and efforts, such as the FDEP's statewide springs initiative, to continue and enhance existing data collection and monitor the assumptions inherent in the rule. This additional information and the District's work in other areas (e.g., refinement and improvement of groundwater and hydrodynamic models) will be used by the District to verify that flows from Blue Spring will not fall below the established minimum flows due to groundwater withdrawals and to determine whether rule amendments are warranted in the future.

The following monitoring and periodic evaluation will be performed as part of this Action Plan.

Physical, Chemical, and Ecological Monitoring

- Work plan development
- Physical and chemical conditions monitoring

- Manatee population and behavior monitoring
- General biological structure monitoring
- Ecosystem function monitoring
- Human uses monitoring

Development / Refinement of Predictive Computer Simulation Models

- Environmental Fluid Dynamic Code hydrodynamic model
- Development and application of groundwater flow models

1.1. Physical, Chemical, and Ecological Monitoring

The Blue Spring MFR is based on protection of the increasing numbers of manatee that use Blue Spring as a winter warmwater refuge. The MFR is also expected to protect all applicable ecological and human use Water Resource Values (WRVs) listed in Section 62-40.473, *F.A.C.* However, it was recommended to the District that additional data would be useful to verify these conclusions and to better understand the relationship between spring flows and related WRVs in Blue Spring and Blue Spring Run. This data collection effort is particularly important in the event that the actual growth rate of manatee usage of Blue Spring differs from the growth projections used to calculate the Blue Spring MFR. Monitoring recommendations included the need for additional physical, chemical, biological, and human use data collection from Blue Spring and Blue Spring Run for at least one full year during each 5-year cycle prescribed in the Blue Spring MFR.

1.1.1. Work Plan Development - Program Management and Reporting

Description: A detailed, consolidated work plan will be developed to organize and direct monitoring activities to allow continuing assessment of any Blue Spring flow regime impacts on manatee habitat requirements and applicable ecological and human use water resource values. Development and implementation of this work plan will require a significant amount of coordination between the District, FDEP, FWC, USGS, and USFWS and the Blue Spring MFIWG. The single most important deliverable from this task is identification of a commitment to consolidated reporting of monitoring results to resource agencies and the interested public.

Rationale: Multiple monitoring activities are already underway at Blue Spring. When combined with the new activities recommended in this Action Plan, a coordinated monitoring effort is required to increase efficiency, reduce costs, and ensure compatibility between differing data gathering efforts. All monitoring results need to be made available in a consolidated format to allow decision makers and the public an opportunity to independently assess the effects of any changes in spring discharge rates on the ecological and human use integrity of Blue Spring.

Objective: Develop a detailed work plan that encompasses all phases of the physical, chemical, and ecological data monitoring and analysis required for the

periodic evaluation of the Blue Spring MFR. Enter into partnership with the FDEP and FWC to cooperatively develop, fund, and implement the work plan elements.

Action Strategies:

Develop a program management team consisting of key District staff, Blue Spring MFIWG members, contractors, and academic partners by October 2006.

Develop a comprehensive work plan by April 2007. The work plan will be updated, if required, by September 30 in each of the following years: 2009, 2014, 2019, and 2024.

Implementation: The District intends to budget manpower and contractual funds and to request that FDEP and FWC also budget manpower and funds to cooperatively work with District staff to develop the Physical, Chemical, and Ecological Monitoring Work Plan. The estimated cost for work plan development is a one-time cost of $68,000. Plan revision will occur approximately every 5 years, if necessary, at an estimated cost of $32,000.

1.1.2. Physical and Chemical Conditions Monitoring

Description: The Blue Spring ecosystem is an expression of the physical and chemical environment it occupies. That physical environment includes air and water temperatures, precipitation rates, sunlight inputs, and groundwater inflow quantity and quality.

Rationale: The monitoring of selective environmental variables will allow the District to: (1) better understand the biological structure and functions that must be protected by the adopted minimum flow regime and (2) have data required for the development, calibration, and verification of predictive simulation and regression models, such as the Blue Spring Environmental Fluid Dynamic Code (EFDC) hydrodynamic model, steady state regional groundwater flow models, transient groundwater models, and predictive relationships between flows and various WRVs.

The following subsections summarize the recommended objectives and action strategies to accomplish the required physical and chemical monitoring.

1.1.2.1. Hydrological and Meteorological Data Collection

Objective 1: Maintain existing database of hydrological and meteorological data required for the development of the Blue Spring MFR, periodic evaluation, and development/refinement of computer simulation models. These data include: monthly and daily spring discharge; daily spring stage; hourly barometric pressure; and hourly spring run bottom temperatures recorded at 10 meter intervals to document maximum St. Johns River intrusion lengths.

Action Strategies:

Continue long-term collection of spring discharge and stage measurements (instantaneous monthly discharge and continuous hourly discharge) and hourly barometric pressure.

Continue collection of hourly spring run bottom temperature (measured every 10 meters (m), starting 50 m upstream of the St. Johns River and extending to a point 210 m above the confluence with the St. Johns River).

Implementation: The District intends to budget funds annually to continue long-term hydrological/meteorological data collection, currently being performed by the U.S. Geological Survey (USGS). Current estimated annual contractual costs are $53,500.

Objective 2: Expand and enhance existing hydrological and meteorological data collection relevant to the Blue Spring MFR and the periodic evaluation, and the development/refinement of computer simulation models.

Action Strategy: Install and maintain a weather station at Blue Spring State Park (BSSP) that continuously monitors air temperature, St. Johns River water temperature upstream of confluence with Blue Spring Run, precipitation, insolation, and photosynthetically active radiation.

Implementation: The District intends to request that FDEP budget funds during FY2008 to have USGS install a weather station at Blue Spring State Park (BSSP). Additionally, FDEP will be requested to budget funds annually starting in FY2008 to have USGS maintain the weather station and collect continuous (hourly) monitoring of air temperature, St. Johns River water temperature, precipitation, insolation, and photosynthetically active radiation. Estimated costs for weather station installation during FY2008 are $12,000. The estimated annual service costs for data collection and database maintenance are $18,000.

1.1.2.2. Water Quality Monitoring

Objective: Expand and enhance the ongoing water quality monitoring network at Blue Spring.

Action Strategies:

Continue and enhance hourly monitoring at one station in Blue Spring Run (swimming area) of in-stream field parameters including, pH, specific conductance, dissolved oxygen concentration, percent saturation, and water temperature by the USGS.

Expand existing USGS bimonthly water quality sampling to include three stations within the spring run. Parameters will include: calcium, magnesium,

silica, sodium, chlorides, sulfate, alkalinity, and nitrogen and phosphorous constituents.

Initiate six, two-week monitoring events of continuously recording, multi-parameter data-loggers to collect pH, specific conductance, dissolved oxygen concentration, percent saturation, and water temperature, at three spring run stations (i.e., boil, swimming area, and at the upper observation deck) in Blue Spring Run. Additionally, water quality sampling would be added at the three spring run stations to increase the sampling frequency to monthly. Parameters will include: calcium, magnesium, silica, sodium, chlorides, sulfate, alkalinity, and nitrogen and phosphorous constituents. This intensive water quality sampling would be conducted during 2008 and once every 5 years thereafter.

Implementation: The District intends to include funds in its annual budget to increase the existing water quality monitoring efforts at Blue Spring to increase the frequency and distribution of sampling. Estimated annual costs are $25,400 to be initiated during FY2008.

Funding would also be increased to allow the installation of continuously-recording, multi-parameter data-loggers, to collect temperature, pH, dissolved oxygen, conductivity, and specific conductance, at three spring run stations (i.e., boil, swimming area, and at the upper observation deck) for six, 2-week monitoring events during FY2008, and once every 5 years thereafter. Estimated costs in FY2008 are $40,000, and the same one-year cost will occur once every 5 years.

Additionally, the District intends to request that FDEP budget funds to add water quality sampling at the three spring run stations to increase the sampling frequency to monthly. This intensive sampling would be conducted in 2008 and once every 5 years thereafter. Estimated costs for this increased sampling frequency are $12,200 every 5 years.

1.1.2.3. Spring Run Bottom Elevation Contour Mapping

Objective: Expand and refine the bottom elevation contour mapping (bathymetric mapping) for Blue Spring Run to allow refinement of the Blue Spring EFDC hydrodynamic model to improve prediction of microhabitat conditions within the spring run. Because Spring Run bottom contours may change over time due to sedimentation, bathymetric mapping will be completed at least once every 5 years (i.e., in 2012, 2017, and 2022).

Action Strategy: Collect additional elevation cross sections of the Blue Spring Run in order to refine the bottom contour mapping.

Implementation: The District intends to prioritize Division of Surveying Services MFLs Program support to complete Blue Spring Run bottom

contouring during FY2007. Estimated project costs are $13,000 and the same one-year cost will occur once every 5 years.

1.1.3. Manatee Population and Behavior Monitoring

Description: Continuation of FDEP's proven monitoring program to monitor individual manatee attendance at the spring and provide the maximum one-day count at the end of each winter season for analysis of population size estimates for assessment and comparison with past monitoring data. Monitoring protocols for all phases of manatee monitoring (i.e., *Roll Call Surveys*, *Synoptic Surveys*, *Health Assessment Surveys*, and remote sensing techniques) will be developed/refined by the Blue Spring MFIWG and included in the Blue Spring work plan.

The Blue Spring MFIWG has recommended development of a long-term monitoring plan. Two tracks should be taken. First, endorse and support the training of several Blue Spring State Park (BSSP) staff to continue the existing manatee monitoring program. Second, consider the possibility of automating some manatee monitoring. A new field of research has recently emerged based on the detection and counting of marine mammals with sonar equipment. Evaluation of this approach is best done with a pilot study. Additionally, remote sensing may be practical for estimating manatee packing densities within spring run segments.

Rationale: The Blue Spring MFR was established to accommodate the increase in the number of manatees using Blue Spring and Blue Spring Run as a warm water refuge. The data analysis establishing the minimum flow regime centered on estimates of (1) projected growth in manatee usage of Blue Spring and (2) the maximum manatee carrying capacity of the spring that can provide manatees with winter refuge from death and debilitating effects due to cold stress. Upon implementation of the Blue Spring MFR, assessments of the status and trajectory of the manatee population and management of spring flows will rely on the same metrics used to establish the minimum flow regime (i.e., maximum daily manatee counts and manatee packing densities). Continued monitoring is required to provide the District with data to estimate these model parameters, to determine if actual manatee attendance and manatee carrying capacity have deviated from the original projections, and to identify any signs of negative ecological impacts to manatees.

Objective 1: Quantitatively document manatee use of Blue Spring Run as a winter warmwater refuge and maintain database attributes for evaluation of the Blue Spring MFR.

Action Strategy: Continue field data collection of manatee season (November – March) daily Blue Spring manatee *Roll Call Surveys* and *Synoptic Surveys* following sampling protocols established cooperatively by FDEP, FWC, USGS, and USFWS. These surveys include identifying and recording locations of individual manatees and manatee "clusters" within the spring run, locating St. Johns River intrusion into Blue Spring Run, data collation, data entry, and database maintenance.

Implementation: The District intends to request that FDEP and FWC continue to budget manpower to complete the ongoing Blue Spring manatee *Roll Call* and *Synoptic Surveys* and database maintenance and quality assurance that is currently being conducted by FDEP and FWC staff. Estimated annual costs for field data collection, database maintenance, and quality assurance are $21,000.

Objective 2: Qualitatively document manatee cold-weather-related health/body condition and maintain database attributes.

Action Strategy: Initiate individual manatee physiological/health assessments as a part of the annual manatee season *Roll Call Surveys*. The surveys will include an assessment of the level of cold stress skin lesions on manatees and the general body condition/health following protocols and scales developed cooperatively by FDEP, FWC, USGS, and USFWS.

Implementation: The District intends to request that FDEP increase the allocation of Blue Spring State Park Biologist staff time starting in the 2006 manatee season (November 2006 – March 2007), to expand the manatee season field data collection to include observations on manatee physiological/health assessments and database development/maintenance. Estimated annual costs are $4,000.

Objective 3: Design and implement a systematic annual protocol to monitor manatee packing density and to quantify manatee distribution patterns within the Blue Spring Run. Such data would be useful in verifying the manatee carrying capacity model developed by the District.

Action Strategy: Design and implement a remote sensing protocol, with digital cameras mounted above the spring run, to monitor manatee packing within spring run segments during set periods on the coldest days. Data collection will probably coincide with the annual statewide manatee *Synoptic Surveys*.

Implementation: The District intends to request that FDEP budget contractual dollars during FY2008 and annually thereafter to collect long-term manatee packing density assessments to coincide with the statewide manatee *Synoptic Surveys*. Estimated annual costs are $25,000.

Objective 4: Determine if automated/remote sensing devices can be used to provide constant monitoring of manatee populations within Blue Spring Run to supplement existing manual counting procedures, particularly during the night when no manual manatee observations are collected. Assess the effects of sonar sound production on manatee behavior and distribution in Blue Spring Run.

Action Strategy: Design and fund a pilot study to evaluate the effectiveness of sonar, or similar, technology and/or tracking technology to measure the daily movement of manatees in and out of the spring run, in order to estimate the total number of manatees using Blue Spring on a 24-hour cycle during the cold-weather season.

Implementation: The District intends to request that FWC budget contractual dollars during FY2008 to design and undertake the sonar pilot study. Estimated pilot project costs are $30,000.

Objective 5: Annual analysis, review, and evaluation of all data critical to the determination and evaluation of manatee winter warmwater habitat availability and the Blue Spring MFR.

Action Strategies:

The District, FDEP, FWC, Blue Spring MFIWG, and contractors will analyze and evaluate all data critical to the determination and evaluation of manatee winter warmwater habitat availability and the Blue Spring MFR and document their findings within a formal report to be presented to the District Governing Board at the September 2007 Governing Board meeting, and annually thereafter.

The District, FDEP, FWC, Blue Spring MFIWG, and contractors will develop criteria within 5 years of rule adoption based on manatee monitoring data and other physical data or observations made at Blue Spring that, if activated, will require the SJRWMD and/or other state or federal agencies to evaluate the Blue Spring MFR and/or take immediate remedial actions to safeguard manatees using Blue Spring as a winter warmwater refuge. Examples of some possible criteria are the divergence of modeled manatee use projections from collected data; the divergence of events outside model parameters or assumptions; or spring run bottom temperature drops below 70°F. The activation of criteria may result from the scheduled annual data review by the Blue Spring MFIWG or emergency review by the Blue Spring MFIWG necessitated by unforeseen circumstances.

Implementation: The District intends to request that FDEP and FWC budget manpower and contractual dollars to work cooperatively with District staff and the Blue Spring MFIWG to complete the annual data analysis and review. Estimated project costs are $70,000 annually.

1.1.4. General Biological Structure Monitoring

Description: This action item includes a quantitative inventory of the dominant flora and fauna inhabiting Blue Spring and Blue Spring Run.

Rationale: In addition to manatees, all of the normal aquatic trophic levels are well represented in Blue Spring and Blue Spring Run. These include primary producers (primarily attached algae), herbivores (macroinvertebrates, snails, fish, and manatees), and various levels of carnivores (fish, alligators, birds, and mammals). Basic quantitative inventories of the flora and fauna need to be collected periodically to allow assessment of normal population levels and year-to-year variability.

Objective: Inventory the dominant flora and fauna inhabiting Blue Spring and Blue Spring Run.

Action Strategies:

Continue on-going annual Stream Condition Index studies (macroinvertebrates and dominant algae surveys) conducted by FDEP.

Initiate quarterly flora and fauna inventories, conducted by FDEP and FWC once every 5 years, to quantify the biomass and spatial cover of dominant plant groups and species and estimate populations of dominant, fish, reptiles, amphibians, birds, mammals, and macroinvertebrates (dominant snails, insect larvae, worms, and crayfish).

Implementation: District intends to request that FDEP continue to budget for the annual Stream Condition Index studies at an annual cost of $2,000. Additionally, the District intends to request that FDEP and FWC budget funds to initiate a detailed quarterly flora and fauna inventory within Blue Spring Run during 2008, and once every 5 years thereafter, at an estimated cost of $60,000 for each year that the inventory is conducted.

1.1.5. Ecosystem Function Monitoring

Description: The response of the entire Blue Spring/Blue Spring Run ecosystem to changing groundwater inflow and other environmental conditions is integrated into ecosystem-level properties. These properties can be conveniently quantified using special techniques applicable to spring systems.

Rationale: There are too many individual abiotic and biotic components in the Blue Spring ecosystem to individually assess the function of each one. Fortunately, many of these spring components can be assessed by analyzing upstream-downstream changes in water quality. Also, ecosystem processes are finely tuned in spring systems to respond to changes in the dominant forcing functions, such as flow and water quality. While changes to the populations or biomass of individual organisms may be difficult to detect due to the normally high variability of plant and animal populations, ecosystem metrics such as gross primary production, community respiration, ecological efficiency, and community export are more constant and often have lower statistical variability between individual measurements.

Objective: Quantify ecosystem metrics, including gross primary production, community respiration, ecological efficiency, community export, and nutrient assimilation rates to provide a functional assessment of the possible effects of altered spring flow on the entire Blue Spring/Blue Spring Run ecosystem.

Action Strategy: Utilize data collected from the continuously recording, multi-parameter data-loggers (see Section 1.1.2.2 Water Quality Monitoring) to assess ecosystem metabolism and nutrient assimilation. Collect export samples using various traps and nets. It is recommended that this assessment be conducted for at least one year during each 5-year period of the Action Plan.

Implementation: The District intends to budget contractual funds to assess ecosystem metabolism, nutrient assimilation, and quantify spring run community export at an estimated annual cost of $40,000. Sampling would be initiated in FY2008 and repeated once every 5 years thereafter.

1.1.6. Human Use Monitoring

Description: Human use activities at Blue Spring State Park will be quantified, including total use, and levels of use for specific activities that may be related to flow (swimming, scuba diving, manatee watching, and general education). Because the relationship between flow and the level of visitor activities may not be able to be determined because of large variation in visitation due to other factors (e.g., weather, economy, gas prices, etc.), public opinion surveys may also be used to gauge the importance of flow to recreational and aesthetic water resource values.

Rationale: Changes in spring discharge have the potential to affect the levels of human activities at Blue Spring State Park. There are currently over 300,000 visitors annually to the park, resulting in an estimated economic impact of about $10 million per year.

Objective: Quantify human use activities at Blue Spring State Park. Expand data collection to include detailed daily use surveys and/or opinion surveys.

Action Strategy: Continue to monitor daily total human use at Blue Spring State Park annually. Expand data collection to include records of individual uses (such as manatee watching, swimming, fishing, and general education) and the public's perceptions of activity and aesthetic changes possibly related to flows.

Implementation: The District intends to request that FDEP budget manpower to continue to monitor total human usage of Blue Spring State Park, annually, at an estimated cost of $10,000. Additionally, the District intends to request that FDEP allocate staff time or contractual dollars to monitor daily individual uses, including manatee watching, swimming, fishing, and general education during 2009 and once every 5 years thereafter. An alternative action may be to conduct visitor opinion surveys to better detect the relationship between flow and the water resource values of recreational and aesthetics/scenic attributes. The estimated costs per survey year are $30,000.

1.2. Development / Refinement of Computer Simulation Models

The District utilizes hydrodynamic and regional groundwater flow computer models to simulate hydrologic and hydraulic conditions at District springs. Regarding hydrodynamic models, the District developed the three-dimensional Blue Spring Environmental Fluid Dynamic Code (EFDC) hydrodynamic model to predict microhabitat conditions (e.g., spring flow, water velocities, spring run temperature, and manatee habitat space) within Blue Spring Run, to develop, implement, and evaluate the Blue Spring MFR. Computational fluid-dynamics models are based on fundamental physical equations of motion that allow predictions beyond the

observed range of available data. Such features made computational fluid-dynamics models best suited for estimating environmental parameters (e.g., flow, velocities, temperature, and cold-water intrusion length) at Blue Spring under extreme climatic and hydrologic conditions.

Relative to groundwater systems, regional groundwater flow models have been constructed and calibrated to assess both the current hydrologic system and future hydrologic impacts associated with existing and proposed water uses throughout most of the District. Existing ground water flow models are implementations of the USGS MODFLOW code. These models are steady state applications and were calibrated to average 1995 hydrologic conditions. Reviews of historic climatic data indicate that climatic conditions in 1995 were reasonably average. The steady state models are used to assess potential changes in Floridan and surficial aquifer system water levels and spring flows when the impacts of groundwater withdrawals have been fully realized because the flow system has reached equilibrium (steady-state) conditions. The Volusia County area and portions of surrounding counties provide a geographic setting for one of these regional groundwater flow models – the Volusia Regional Groundwater Flow Model.

The Volusia Regional Groundwater Flow Model is a reasonable tool to use to evaluate the potential impacts of groundwater withdrawals on flow from Blue Spring within the model domain. This model can be used to simulate impacts to flow from Blue Spring that would occur under prescribed groundwater withdrawal scenarios, during average climatic conditions, and when the groundwater flow system has reached steady state conditions. These simulation results, which predict the mean annual flow under average climatic conditions, may be used to determine compliance with the Blue Spring MFR.

A transient groundwater flow model is being developed for the Volusia area, based on the Volusia Regional Groundwater Flow Model. This additional model, which will include significant spatial and temporal refinements of the steady state version of the model, is expected to improve the precision of model predictions. The transient model, when completed, may be used to supplement the existing steady state model in measuring compliance with the Blue Spring MFR.

The following sections identify tasks to be completed to refine and use both the Blue Spring EFDC hydrodynamic model and the Volusia Regional Groundwater Flow Model.

1.2.1. EFDC Hydrodynamic Model

Description: The District developed and calibrated a three-dimensional hydrodynamic computer model, based on EFDC, for estimating the simultaneous occurrence of extreme river stage, colder river temperature, and lower spring discharge. This model is capable of calculating the useable warmwater length (i.e., the manatee-carrying capacity of the spring) under extreme hydraulic and thermal conditions and the intrusion length of the St. Johns River into Blue Spring Run. The

model was calibrated using 18 observed intrusion events for which the input parameters were simultaneously observed.

Rationale: Evaluation of the reliability of the spring run as a warmwater refuge under catastrophic conditions requires estimation of cold river water-intrusion lengths under relatively infrequent combinations of relevant forcing parameters (i.e., river temperature, river stage, and spring discharge). Extreme combinations of river temperature, river stage, and spring discharge, however, are not included in the existing data, although more than 20 years of observed cold water intrusion lengths are available. A predictive model is required that can reliably estimate cold-water intrusion length under conditions that have not yet been observed (i.e., extreme combinations of river temperature, river stage, and spring discharge). Computational fluid-dynamics models are based on fundamental physical equations of motion that allow predictions beyond the observed range of available data. Such features made computational fluid dynamics models best suited for estimating cold-water intrusion lengths at the spring run under extreme hydrothermal combinations.

Objective: Refine/update the Blue Spring EFDC hydrodynamic model to improve prediction of micro-habitat conditions within the spring run and to monitor the effect of the Blue Spring MFR.

> **Action Strategy:** Refine/update the Blue Spring EFDC hydrodynamic model to improve the temporal resolution of the model based upon availability of USGS continuous daily spring flow data.
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> **Implementation:** The District intends to budget funds to refine/update the Middle St. Johns River EFDC hydrodynamic model that includes the Blue Spring Run. This work is scheduled for FY2008 at a total estimate cost of $10,000.

1.2.2. Development and Application of Groundwater Flow Models That Encompass the Spring Shed of Blue Spring

Description: A steady state ground water flow model – the Volusia Regional Groundwater Flow Model - was developed by the District to assess the groundwater resources located immediately beneath Volusia County and adjacent areas. This model incorporates the best available information to describe the flow dynamics and associated hydrogeologic structure of the groundwater system. The model was calibrated to average 1995 water levels and spring flows. It has been used as a predictive tool to assess the potential impacts of projected groundwater withdrawals for the years 2020 and 2025 in the District's water supply planning process and is proposed for use in future planning efforts. In addition, the model is routinely used to assess the potential impacts of proposed groundwater withdrawals in the District's consumptive use permitting process. This model is the basis for development of a transient model for the Volusia County area.

The transient groundwater flow model will incorporate several time varying processes, including rainfall, evaporation, and groundwater use. This simulation model should provide a useful tool for the simulation and assessment of the

dynamics of the groundwater flow system near Blue Spring and may improve the precision of model predictions. This model is currently under development and is scheduled for completion by the end of FY2007.

Rationale: The current steady state groundwater flow model for the Volusia area provides a reasonable and reliable predictor of average annual ground water flow conditions under normal climatic conditions and is quite appropriate for use in evaluating the potential impacts of groundwater withdrawals on flows from Blue Spring and, therefore, on the Blue Spring MFR. Development and use of a transient flow model based on this steady-state model may improve the precision of model predictions.

Objective: Determine if existing and proposed groundwater withdrawals will cause flows from Blue Spring to fall below the Blue Spring MFR.

Action Strategies:

Use the Volusia Regional Groundwater Flow Model, updated as necessary, to evaluate the potential impacts of existing and proposed groundwater withdrawals in the model domain on flows from Blue Spring. Use these results in the District's water supply planning and consumptive use permitting processes and in enforcement actions.

Develop a transient groundwater flow model based on the Volusia Regional Groundwater Flow Model to attempt to improve the precision of model predictions. If improved precision is realized, use this model to produce steady-state simulations to evaluate the potential impacts of existing and proposed groundwater withdrawals in the model domain on flows from Blue Spring. Use these results in the District's water supply planning and consumptive use permitting processes and in enforcement actions as appropriate to ensure compliance with the Blue Spring MFR.

Implementation: The District intends to budget funds to complete the Volusia County area transient groundwater model during FY2007. The total estimated cost for this effort is $100,000.

2. Water Supply Planning and Alternative Water Supply Development

The District will use the Blue Spring MFR as a water resource constraint in future versions of its districtwide water supply assessments and regional water supply plans. Accordingly, if projected water use through the District's planning horizon is projected to contribute to a decline in Blue Spring discharge such that the discharge would fall below the established Blue Spring MFR, then the District, in its water supply assessment process, will conclude that unacceptable impacts to water resources and related natural systems would occur as a result of the projected water

use. This conclusion will lead to identification of the Blue Spring area and the area within which groundwater withdrawals contribute to this condition as a priority water resource caution area.

In fact, the District has already identified the Blue Spring area and the area within which groundwater withdrawals contribute to Blue Spring flow as a priority water resource caution area. This designation was based on projected unacceptable impacts to lakes and wetlands (some with adopted minimum levels), and to groundwater quality. As a result, the 2005 District Water Supply Plan (2005 DWSP) already calls for the development of 6 to 20 million gallons per day (mgd) of alternative water supply sources (sources other than fresh groundwater) by 2025 in the Volusia area, in addition to groundwater withdrawals and the increased use of reclaimed water. These values are based on optimization modeling performed by the District and reported in the 2005 DWSP. The 20 mgd value is based on the increased spring discharge constraint that would be imposed as the minimum long-term average flow allowed under the Blue Spring MFR increases to 157 cfs. This value is also based on the assumption that public supply utilities are assured no equity in their existing facilities. Therefore, this value is likely lower than the quantities of alternative sources that will actually be developed because it is unlikely that public supply utilities will relinquish their equity to a significant extent in existing facilities.

Water suppliers in the area of Blue Spring have participated in the development of a master facility plan for the Water Authority of Volusia (WAV), created to be a wholesaler of new alternative water supplies to the member governments through interlocal agreements. This facility plan calls for the development of a new surface water plant on the St. Johns River, initially to provide at least 10 mgd to the member governments to meet new water supply needs rather than pumping additional groundwater. The District expects that either WAV, or several of the local governments working cooperatively by themselves, will be proceeding with the construction of the plant with the financial support of the District through the Water Protection and Sustainability Program.

The District will identify in future versions of its regional water supply plan, any additional water supply development project options which may need to be implemented in addition to the projects currently being planned, to avoid a condition in which groundwater withdrawals would cause flows from Blue Spring to fall below the Blue Spring MFR. Following is a list of water supply development project options, which could reasonably supply water to public supply utilities and other users in the Blue Spring area, and potential available quantities for each option as currently identified in the 2005 DWSP.

- Lower Ocklawaha River in Putnam County Project – 20 mgd (source could supply up to 107 mgd)
- St. Johns River near Lake Monroe Project – 50 mgd (source could cumulatively supply at least 155 mgd at all times from the headwaters downstream to near DeLand)

- St. Johns River near DeLand Project – 20 mgd (source could cumulatively supply at least 155 mgd at all times from the headwaters downstream to near DeLand)

The source of water that would supply the Lower Ocklawaha River in Putnam County Project is the lower Ocklawaha River. This water is fresh water of high quality and can be treated with conventional water treatment technologies. Several projects utilizing fresh water from surface water systems are in place and are being successfully operated in Florida today. These include the City of Melbourne's Lake Washington water supply facility, the City of Cocoa's Taylor Creek water supply facility, the City of Tampa's Hillsborough River water supply facility, and the Peace River/Manasota Regional Water Supply Authority Peace River water treatment facility.

Water from the St. Johns River in the vicinity of Lake Monroe and DeLand would require more advanced treatment including some demineralization. The District performed instream monitoring and treatability studies of the St. Johns River as part of its Water Resource Development Work Program. The results indicated that several effective and efficient water treatment combinations can be used to treat water withdrawn from the St. Johns River to a quality suitable for use in public supply systems and at an affordable cost. Similar treatment processes are currently used to treat brackish groundwater around the state for public supply use.

The District anticipates that alternative water supply development projects will need to be operational by 2018 in order to avoid shortfalls of water supply to support projected growth in areas that would be impacted by the Blue Spring MFR. These projects are likely to be multi-jurisdictional projects. Following, from the 2005 DWSP, is a typical project delivery schedule for a multi-jurisdictional surface water project (years reflect total time from decision to proceed with the project).

- Partnering agreement Years 0 -1.5
- Consultant selection Years 1.5 - 2
- Planning Years 2 – 4.5
- Design/permitting/bid Years 3 – 5
- Construction/start up Years 4.5 – 7

The District is currently working with suppliers to select one or more projects with the goal of reaching decisions in the next year. Given a 7-year estimated time to complete the project(s), it is reasonable to conclude that the needed project(s) will be online well in advance of 2018 if the decisions on specific projects are made by 2007. In addition, the District expects that some alternative water supply development projects will need to be operational well in advance of 2018 in the area that would be impacted by the Blue Spring MFR because of other water resource constraints such as wetland and lake impacts.

The District will consider the allocation of cost-share funds from the Water Protection and Sustainability Program to support the cost of construction of these identified water supply development project options. This program provides up to $30 million

per year for cost-sharing on the construction of alternative water supply projects, such as surface water withdrawal and treatment facilities on the St. Johns River, reclaimed water projects, and desalination of brackish groundwater and seawater. Such allocation of funds will be consistent with the District's guidelines for administering the Water Protection and Sustainability Program.

The District will identify, in its regional water supply plan, water resource development projects, which could be implemented to contribute to avoidance of the identified potential unacceptable impacts to Blue Spring. The District will consider the allocation of cost-share funds from the Florida Forever Trust Fund to support the cost of construction of these identified water resource development projects. Such allocation of funds will be consistent with the District's guidelines for administering its portion of the Florida Forever Funding Program.

3. Permitting and Enforcement

The District intends to use all available regulatory authority and requirements in the consumptive use permit (CUP) rules to ensure implementation and enforcement of the Blue Spring MFR. These tools include, but are not limited to, the following:

- Use environmental impact criteria in the CUP rules to limit water use so that there is no violation of the Blue Spring MFR
- Limit the duration of consumptive use permits (CUPs) based on specific consideration of the phased Blue Spring MFR requirements
- Structure groundwater allocations based on specific consideration of the phased Blue Spring MFR requirements
- Require monitoring to collect data to verify that no violation of the Blue Spring MFR is occurring
- Require the timely development of alternative water supplies (supplies other than groundwater withdrawals) as a condition of issuing a CUP to supplement or replace groundwater withdrawals as needed to achieve the Blue Spring MFR
- Use the 5-year compliance report review process to ensure that water use authorized in CUPs continues to meet all permitting criteria, including no violation of the Blue Spring MFR
- Use water shortage orders to reduce water use

Use of these tools in implementation of the Blue Spring MFR is discussed below.

District CUP rules provide, to obtain a CUP, an applicant must demonstrate that environmental harm must be reduced to an acceptable amount and that the proposed use of water will not cause or contribute to a violation of an adopted MFL. In processing CUP applications, staff will evaluate the impact of proposed water uses on the Blue Spring MFR using the most appropriate tools including groundwater and water-budget models, review of current hydrologic conditions, review of existing hydrologic information and other relevant information. Under the District's rule, the District may only issue permits when the applicant has provided

reasonable assurances that the proposed use of water, by itself, does not cause a violation of the MFR and does not contribute, with other existing legal uses, to a violation of the MFR.

The District issues CUPs with a limited duration, ranging from very short (such as a few years) up to 20 years. Prior to permit expiration, in order to continue the water use, a permittee must reapply for a new permit as would any other new user; in other words, there is no preference given because the use may have been permitted in the past. The District's CUP rules provide the permit duration shall be limited to the period of time the applicant has demonstrated that the proposed use of water will meet CUP criteria. Thus, the District will need to continue to limit permit durations to the period that the proposed use of water can occur without causing or contributing to a violation of the Blue Spring MFR, assuming the permit is not limited to a shorter duration due to other factors. In evaluating the effect of proposed water uses on the Blue Spring MFR, the District will take into account the phased increases in the Blue Spring MFR that place greater constraints on water use over time.

The District intends to utilize the phased increases in the Blue Spring MFR when determining what allocation is appropriate based on impact evaluations and shall structure the allocations to appropriately correspond to the time frame for the Blue Spring MFR phases.

The District intends to require all permittees to implement appropriate hydrologic monitoring, collect and evaluate data, and submit reports to the District to verify that permitted water uses are not causing a violation of the Blue Spring MFR. Under its rules, the District's practice has been to place conditions on CUPs that require water use to be reduced or curtailed, in the event that any unanticipated adverse impacts occur. The District intends to continue this practice with regard to the Blue Spring MFR.

Under the District's rule, CUPs issued by the District may contain permit conditions that require the permit holder develop new alternative water supply sources (AWS), either by itself or in conjunction with other water users. These permit conditions typically have contained specific enforceable performance milestones designed to ensure that AWS are being developed on a timely schedule such that they shall be available when needed. Specifically, in anticipation of the Blue Spring MFR and due to constraints from other minimum flows and levels in Volusia County, the District has already placed such conditions on permits issued to water suppliers in the area. The District has also required development of new AWS projects on a time frame to supplement demand where that demand is currently being met by groundwater withdrawal, which would be cut back due to the phased increase in the Blue Spring MFR. The District intends to continue this practice of placing such conditions on permits when needed. In addition, the District intends to enforce this permit requirement, as well as all other permit conditions, as has been its practice in the past.

Under the District's rule, permits of a 20-year duration may be subject to a requirement that the permit holder submit a 5-year compliance report. This compliance report must provide sufficient information to establish whether the

permitted use of water will continue to meet the District's rule that was in place at the time that the permit was initially issued. Based on review of the 5-year compliance report, the District may modify a previously issued permit, if necessary, to ensure that the water use will continue to be consistent with the established Blue Spring MFR. It has already been the practice of the District to place this 5-year compliance reporting requirement on permits authorizing water use that could have any measurable hydrologic impact on Blue Spring. Under its rule, the District expects that this practice will continue in the future. In addition, it has already been the District's practice to modify some permits throughout the District based on the 5-year compliance review. The District intends to continue this practice, and to modify permits when necessary to insure that authorized water uses continue to meet all District permitting criteria, including the requirement that the use not cause or contribute to a violation of the Blue Spring MFR.

Under Chapter 373, Florida Statutes, the District is authorized to issue water shortage orders, including water shortage emergency orders. A water shortage may be declared when insufficient ground or surface water is available to meet the needs of water users or when conditions require a temporary reduction in total water use to protect the water resources from serious harm. The District has by rule adopted a water shortage plan that lists the types of general water use restrictions that may be imposed. Such restrictions may include provisions designed to maintain minimum flows and levels. A water shortage emergency order may be issued if further water use restrictions are needed to protect the health of animals, fish or aquatic life, or to protect the public health, safety or welfare. The District has issued water shortage orders in the past including an order imposed to protect minimum flows and levels on the Wekiva River. The District intends to continue to issue water shortage orders when warranted.

4. Reporting and Periodic Review

The District intends to prepare a detailed, consolidated report summarizing actions and data collected under each section of this Action Plan by October 2009 and every 5 years thereafter (2014, 2019, and 2024). It is anticipated that at the 5-year interval, sufficient additional data will be available to warrant a review of the Blue Spring MFR established under the rule. This review will consider any changes in conditions within the spring ecosystem and the observed manatee population and its use of the spring run as a winter warmwater refuge.

Additionally, the Blue Spring MFIWG will annually review, analyze, and evaluate all data critical to the determination and evaluation of manatee winter warmwater habitat availability and the recommended Blue Spring MFR. The Blue Spring MFIWG will document its findings within a brief, formal report to be presented at the September 2007 Governing Board meeting and annually thereafter.

Finally, the District intends to periodically hold a benchmark conference or workshop to foster outreach to, and receive input from, stakeholders such as local residents,

utilities, academia, nursery growers, the Volusia Environmental Council and other environmental groups.

These periodic reports and evaluations are critical to the adaptive management approach of the action plan. In performing adaptive management, the District intends to utilize the information obtained from monitoring, periodic evaluation, benchmark conferences and other collected data to assess actual hydrological conditions and the effects of pumping and other water uses on the Blue Spring MFR. Staff will also track and consider new information regarding existing water use and proposed water resource development obtained through the District's regulatory and planning programs as discussed above. All information shall be evaluated for the purpose of reducing uncertainty in the plan and evaluating implementation of the Blue Spring MFR. When necessary, the District intends to modify the Action Plan based on the above.

Section 373.0421(3), F.S., provides that the District Governing Board may amend adopted minimum flows and levels based on additional information. In fact, this has been the practice of the District as several previously adopted minimum flows and levels have already been amended based on additional information. With regard to the Blue Spring MFR, the District intends to continue to follow this agency practice.