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Work Plan for the St. Johns River (SJR) Alternative Water Supply Cumulative Impact Assessment

Introduction

Groundwater supplies have reached their sustainable limit in large areas within Florida, or will reach these limits in the very near future. Water supply utilities in these areas are moving rapidly to decide which alternative sources they intend to use for water supply in lieu of additional groundwater supplies. In the SJRWMD there is considerable interest in surface waters, such as the St. Johns (SJR) and Lower Ocklawaha Rivers (LOR) as alternative water supply (AWS) options. Some AWS projects are already in the design or preliminary design stages. Minimum flows and levels (MFLs) have been established for the SJR at several locations within the middle basin (SJRMB) and additional MFLs are under development. Based on the established and pending MFLs, it appears that significant quantities of water could be developed from these river systems (155 million gallons per day (mgd) from the SJR at DeLand and 107 mgd from the LOR). The District is undertaking an evaluation of potential cumulative effects of the AWS withdrawals on the biological and water resources of the SJR basin (SJRB). The evaluation will be accomplished using the best available science and information recognizing that project-specific efforts would follow as part of regulatory programs (discharge permits, consumptive use permits, etc). Potential effects will be screened to determine those that have the potential to cause significant adverse effects to critical biological communities, species and water resource values in the SJR. If the evaluation identifies significant adverse effects to the river's resource values from the cumulative withdrawal of 262 mgd from the SJR and LOR under certain stated assumptions(e.g. withdrawal schedule), then the District will determine what level of withdrawal reduction from 262 mgd will avoid the significant adverse effects to the river system and identify measures that could avoid or minimize such effects. The evaluation will be used by the District, as appropriate, for making decisions in the consumptive use permitting, MFL development and water supply planning processes.

Work Plan

The proposed work plan provides for an evaluation of potential cumulative effects on the SJR's resources in the lower and middle basins from potential AWS withdrawals in the SJR's middle basin and LOR.

The proposed work plan includes the following 6 Tasks.

1. Modeling the LSJRB
2. Modeling the MSJRB

3. Development of Evaluation Criteria and Recommendation of Environmental Boundaries associated with Significant Adverse Environmental Effects
4. Evaluations of Cumulative Effects
5. Coordination
6. Report and Recommendations

The evaluation will be done in close coordination with the District's ongoing MFL activities in the SJR and LOR, led by Dr. Sonny Hall. In addition, issues identified from peer review comments on the Lake Monroe/SR 50 MFL work that warrant additional analysis or data collection will also be addressed in this evaluation.

This work plan also includes a schedule and a list of key project staff defining their roles and responsibilities for completing the work. It is anticipated that this work will be done in phases in order to deal with the possibility of the need for additional data collection or investigation. Phase 1, the work described herein, is anticipated to take 10 months. Phase 2 efforts, as needed, are expected to take 14 months.

An excursion to the proposed maximum withdrawal of 262 MGD from the SJR and LOR will be performed at approximately 80-100 MGD from the SJR only. This excursion and assessment of environmental effects will be completed during Phase 1.

Task 1—Modeling for LSJRB

The water quality effects of upstream withdrawals need to be investigated further. Some salinity modeling has been done but more scenarios should be investigated. Other parameters of interest include temperature, nutrients, and transparency. Scenarios should address withdrawals from SJR and LOR, the discharge of concentrate back into the SJR, and the removal of over 100 million gallons per day of treated wastewater currently being discharged to the LSJR. The effects of deepening the navigation channel in the LSJR and effects from sea level rise (25-year time horizon) will also be investigated.

The District's current EFDC hydrodynamic model will be used as the primary tool for generating the flow and water quality scenarios to be used in the effects analysis. The HSPF hydrology model for the LSJRB will be used to better define the boundary conditions for the EFDC model.

The steps in the LSJRB modeling effort will include:

- 1.1--EFDC screening runs
- 1.2--EFDC modifications and HSPF hydrologic model integration
- 1.3--Detailed modeling runs

Task 2—Modeling for MSJRB

An inflow time series for the MSJRB is required as an input to the LSJR EFDC model for the detailed modeling analysis. The current SSARR hydraulic model for the MSJRB will be used to generate a time series input to the LSJRB EFDC model. The EFDC model for the MSJRB is under development. It is expected that this model may be available for use in 12 months during the latter stages of the evaluation. While the EFDC model may be a good tool to generate the time series input for the LSJR model, and to evaluate some effects of proposed AWS withdrawals in the MSJRB, it is not required for the LSJR cumulative effects evaluation. When the MB EFDC model is available project staff will determine the value of using the model for the LSJR cumulative effects evaluations.

The steps in MSJRB modeling effort include:

- 2.1--Develop a 1995 to 2006 SSARR model time series input for LSJRB EFDC model

- 2.2--Develop EFDC model for the MSJRB

- 2.3—Conduct EFDC modeling runs for MSJRB, as needed

Task 3—Develop Evaluation Criteria for Assessing the Likelihood of Population and Community Level Effects

The effect of hydrological and water quality changes on sensitive species and biological communities must be evaluated. Target species groups identified to date are algal blooms, grass beds, fishes, and planktonic and benthic invertebrates. Once the critical resource values are defined, then the hydrologic and water quality conditions that will effect population or community level changes in the biological resources of the SJR will be defined. This approach will define the likelihood of population change based on changes in environmental conditions (hydrology and/or water quality). This activity will require coordination between ES and MFL staff with support from external experts as needed.

Potential cumulative effects that would be evaluated might include:

- spatial and temporal changes in the salinity regime
- changes in residence time
- change to severity, frequency and duration of algal blooms
- changes to biogeochemical cycling in floodplain soils
- fate of oxbow and braided channel habitats
- habitat effects on aquatic communities
- changes in nutrient and pollutant loading
- effects on temperature, DO, TSS, TDS, metals and other chemical and physical parameters
- effects on submerged aquatic vegetation (SAV)
- food web impacts of impingement and entrainment
- effects on listed species
- effects on commercial species: white shrimp, sport fish, american shad

Dr. Ed Lowe and Environmental Sciences Division staff have developed an initial list of likely technical issues that will need to be addressed in the evaluation of cumulative effects. Their outline of the key issues is contained in Attachment A. This summary will provide the starting list of issues and will be modified as needed as the evaluation moves forward.

For Tasks 3 and 4 the project's team will consist of working groups for the seven salient environmental components. Each working group would be composed of a SJRWMD staff leader with one or more support staff, and one or more outside experts with the requisite expertise. The use of outside experts with national scientific stature will help to ensure that SJRWMD brings to bear the highest level of analysis on each issue. It is anticipated that it will take 3-4 months to select and procure the outside experts. During this period, SJRWMD staff would also begin organizing data and literature pertinent to their respective issues and initiating screening analyses.

Seven working groups are proposed:

- Benthos
- Littoral Zone
- Fish
- Wetlands
- Modeling
- Plankton
- Biogeochemistry

The steps in the Task 3 effort include:

- 3.1—Develop initial list of criteria and initial estimate of environmental boundaries (preliminary list of potential effects is in Attachment A)

- 3.2—Procure outside technical experts, as needed

- 3.3—Finalize criteria and recommend environmental boundaries that are associated with significant adverse environmental effects

Task 4— Evaluation of Cumulative Effects

Once the criteria and their respective predicted biological responses have been defined, then the modeling outputs (flow regime and water quality summaries for an array of scenarios) will be used to evaluate the environmental effects of different water withdrawal scenarios. Mitigation and avoidance measures will be developed and evaluated for scenarios in which population effects are considered to be significantly changed from baseline conditions. Also, if needed, a cumulative impact avoidance withdrawal scenario will be developed. If the evaluation identifies one or more significant effects (based on environmental boundaries that are associated with significant environmental effects) to the river's resource values from the cumulative withdrawal of 262 mgd from the SJR and LOR, then the District will determine what level of withdrawal reduction from 262 mgd or what withdrawal scenario will reduce the effects.

The steps in this task of the evaluation effort include:

- 4.1—Conduct a preliminary screening analysis of the environmental effects using LSJRB EFDC model for both the 262 MGD and 80-100 MGD scenarios.

- 4.2—Conduct detailed evaluation of effects including characterization of the environmental effects based on recommended environmental boundaries associated with significant adverse effects for each flow/water quality scenario. The evaluation will describe the level of uncertainty associated with the evaluation's conclusions regarding significant adverse effects.

- 4.3—Develop impact mitigation or avoidance measures, and identify scenarios that would minimize or avoid significant adverse effects based on the recommended environmental boundaries.

Task 5—Coordination

Coordination with other ongoing projects and investigations will be important (e.g., CH2M HILL's evaluation of concentrate discharge). If additional investigations or research needs are identified in Phase 1, then further work efforts may be required. The additional work efforts are expected to be the responsibility of either the District or one or more regional water utilities. In addition, District staff is monitoring several AWS projects and coordination will be required as environmental, permitting, and design work proceed.

Task 6—Reports and recommendations

Findings, conclusions and recommendations for future action will be summarized in a final report. The final report will be prepared first as a preliminary draft which will be submitted to technical reviewers and interested stakeholders. A final draft of the report will be prepared in response to reviewers' comments. It is anticipated that interim documents, such as technical memoranda (TMs), will be prepared to summarize individual investigations, literature reviews, and other project activities.

In addition, one or more workshops will be convened as analyses are nearing completion. At each workshop the findings from specific work efforts will be presented to reviewers and interested stakeholders.

Roles and Responsibilities and Project Structure

Two expert subgroups of SJRWMD staff have already been established one for modeling and the other for determining sensitive biological resources and then defining and evaluating the likelihood and nature of effects on populations and communities. Bill Dunn/Watershed Connections, Inc. has been facilitating the planning and scoping efforts with these two subgroups.

The modeling subgroup currently includes the following staff: Pete Sucsy, Price Robison, Dale Smith, Joseph Stewart, Tom Jobes, and John Hendrickson. The effects evaluation currently consists of the following staff: Erich Marzolf, Ed Lowe, Sonny Hall, John Hendrickson, Dean Dobberfuhl, and Dean Campbell.

Bill Dunn will continue as technical coordinator for the project working with both subgroups. Tom Bartol is the District project manager

Task leads are assigned as follows:

Task 1—Pete Sucsy
Task 2—Price Robison (SSARR) and Pete Sucsy (EFDC)
Task 3—Ed Lowe
Task 4—Ed Lowe
Task 5—Bill Dunn
Task 6—Ed Lowe, Pete Sucsy, Bill Dunn and Tom Bartol

As noted above, for Tasks 3 and 4, the project's evaluation team will consist of working groups for the seven salient environmental components. Each working group will be composed of a SJRWMD staff leader, one or more support staff, and one or more outside experts with the requisite expertise. The use of out-of-house experts with national scientific stature will help to ensure that we bring to bear the highest level of analysis on each issue.

At this point, seven working groups are proposed:

- Benthos
- Littoral Zone
- Fish
- Wetlands
- Modeling
- Plankton
- Biogeochemistry

Schedule

A 24 month project schedule, January 2008 through the end of December 2009, is planned for the overall project, including both Phases I&II (see project timeline, Figure 1). Phase I will be completed in the first 10 months of the project. Phase II is scheduled for a 14 month duration starting as Phase I tasks are completed. In Phase I, Tasks 1 through 5 will run in parallel, all starting in January 2008.

Task 6 reporting and development of conclusions and recommendations will occur in the last 4-6 months of the Phase I schedule. In addition to writing the reports, a workshop will be convened as analyses are nearing completion. At the workshop all SJRWMD staff and external experts would be brought together to summarize their work. The workshop will provide greater assurance that unexpected interactions among effects were not overlooked. It will also be the basis for an overall evaluation of effects. Meetings with stakeholders will be held to communicate findings.

It is premature to anticipate specific Phase II studies or data collection efforts. The need for Phase II studies, further investigations, data collection, or other efforts will be identified throughout the course of the Phase I. If necessary, additional data will be collected and/or more refined models developed. If necessary, a second analysis will be performed with improved data and/or models to reduce uncertainty. With the exception of data collection and/or development of more precise models, the steps for the analysis of environmental effects in Phase II will be the same as in Phase I. Recommendations for Phase II work will be passed on to SJRWMD management for their review and consideration. The work effort for those Phase II efforts approved is expected to extend into year 2.

Summary Assumptions for Work Planning

This work plan was developed with the following assumptions

- The time frame for the evaluation of cumulative effects is a 25 year horizon, 2008 through 2033.
- Phase I will be done using the best available science and information. If additional investigations or research needs are identified, then further work efforts will be required in Phase II.
- The evaluation will be done in close coordination with the District's ongoing MFL activities in the SJR and LOR, led by Dr. Sonny Hall.
- An initial preliminary set of screening analyses will be done to prioritize the low flow regime (flow, volume, velocity and water level) and water quality (salinity, specific conductance, turbidity, and nutrients) conditions of most concern and the resources at risk (i.e., biological and water resource values).
- The Phase I evaluation of effects will be completed in 10 months
- The current EFDC model will be used for modeling evaluations for the LSJRB
- The HSPF hydrology model for the LSJRB will be used to better define the boundary conditions for the EFDC model
- The current SSARR hydraulic model for the MSJRB will be used to generate a time series input to the LSJRB EFDC model.
- The EFDC model for the MSJRB is under development. It is expected that this model will be available in 12 months in time for its use in the latter stages of the evaluation.
- It is anticipated some new environmental data will be required to evaluate effects of AWS withdrawals in the Middle Basin (e.g. continuous monitoring of specific conductance at the bridges in the MB, diurnal inorganic nitrogen monitoring in Lake George and additional ichthyoplankton monitoring in the middle basin.)
- Once the critical resource values are defined, then the modeling outputs (flow regime and water quality summaries for an array of scenarios) will be used to evaluate the environmental effects of different water withdrawal scenarios.
- Coordination with other ongoing projects and investigations will be important (e.g., CH2M HILL's evaluation of concentrate discharge).
- The District's ES Division has identified some other environmental issues that would need to be considered and evaluated if a time horizon of 50 years or more

is used for the evaluation. Since the time horizon for this project is limited to 25 years, however, these issues will not be addressed. Specifically the evaluation will not address carbon fluxes, climate change, or large scale climatic oscillations, such as the El Nino South Oscillation (ENSO) and the Atlantic Multi-decadal Oscillation (AMO).

Attachment A

Potential Environmental Effects on the SJR of Potential AWS Withdrawals

Outlined below are the salient environmental issues potentially associated with surface water withdrawals from the St. Johns River system. The Phase I analysis will be done with the best available information. This analysis will provide initial conclusions regarding the significance of each issue. A comprehensive literature review will be part of the analysis. At this phase, some concerns could be judged insignificant and removed from further consideration. Other issues could be judged sufficiently significant that additional analyses to reduce uncertainty are warranted. Finally, for some issues it might be concluded that best available information leaves such a high degree of uncertainty that additional data should be collected.

1. Comprehensive literature review
2. Selection of critical species or species groups
3. Delineation of response surfaces or biological effects of environmental factors
4. Comparison of response surfaces to predicted changes in relevant environmental factors
5. Evaluation of biological effects and uncertainty

Potential Effects on Water Quality

1. Increased concentrations of pollutants due to increased retention time

a. If withdrawals increase the retention time of a water body for a pollutant, the predicted concentrations of that pollutant would increase for any given loading rate.

b. Assessment of this effect will require hydrologic modeling of the effect of the withdrawal. The model must use time steps smaller than the predicted water retention times and must account for the effects of compensating changes in regulation schedules if applicable.

c. If withdrawals return pollutants to the water body in brine, then the brine pollutant load will need to be determined from brine discharge rates and pollutant concentrations.

2. Increased concentrations of pollutants due to augmentation of water-sediment interactions

a. If withdrawals lower the stage-frequency curve, then interactions between the water and sediments could increase the concentrations of pollutants recycled between sediments and water. The major pollutants of concern are total suspended solids and nutrients (nitrogen and phosphorus).

b. To assess these effects, we will need hydrodynamic models that include the interactions among water level, wind speed, sediment resuspension, and water column concentrations of total suspended solids and nutrients, especially phosphorus.

c. This issue is not likely to be significant in the SJR or the lower Ocklawaha. Studies underway by District staff should provide a sufficient basis for assessing the environmental effects.

3. Increased concentrations of pollutants due to exposure of organic floodplain soils

a. Lowering of water levels can affect biogeochemical cycles in floodplain soils leading to increased nutrient loading and decreased capacity for nutrient sequestration in organic soils.

b. Assessment of these effects will require hydrologic modeling of water levels in floodplain wetlands.

c. The scientific literature and SJRWMD research appear adequate to assess the environmental effects; we will assess this, however, in the first phase of work.

4. Increased salinity due to decreased freshwater discharge

a. By reducing freshwater discharge rates, withdrawals could increase saltwater intrusion from the ocean into the LSJR. This could alter the balance between freshwater and saltwater species and, most significantly, reduce the abundance of submersed aquatic vegetation.

b. Hydrodynamic modeling will need to predict changes in discharge rates and consequent changes in salinity isopleths. It is important that the model be capable of predicting salinity changes in the nearshore areas where there is the potential for submersed aquatic vegetation. The model should also be capable of predicting changes in other variables that affect SAV growth, most significantly water transparency.

5. Increased salinity due to lowering of water levels

a. Many areas of the St. Johns River have elevated levels of salts due to upwelling of connate seawater. This upwelling is negatively correlated with water depth via hydrostatic pressure. If withdrawals lower the stage-frequency relationship, salt concentrations may increase both in the water column and in the pore water of sediments and floodplain soils.

b. To assess this effect, models will need to be capable of predicting the effects of withdrawals on the stage-frequency relationship and empirical or mechanistic models will need to predict the effect on upwelling of high salinity groundwater.

6. Increased salinity/nutrients due to discharge of brine –

a. By removing water but returning other substances in the brine, withdrawals using reverse osmosis could increase salinity and/or nutrient concentrations, especially near the discharge point, and harm sensitive aquatic species or increase the potential for algal blooms. To assess this effect, the hydrodynamic model employed will need to be capable of predicting the proximate and distal distribution of the brine plume. The District is currently using plume models to evaluate brine discharge scenarios in the middle basin. This work is expected to provide the information needed to assess the environmental effects.

Potential Effects on Flora and Fauna

1. Nutrient effects

a. If nutrient concentrations increase due to one or more of the mechanisms listed above, then we would expect an increase in one or more measures of the severity of algal blooms (frequency, extent, duration, and intensity). This, in turn, could alter zooplankton populations.

b. To assess this effect we will need models that predict the effects of nutrient concentrations on the spatial and temporal abundance of phytoplankton. In most areas, the scientific literature, SJRWMD research, and SJRWMD models should be sufficient for this assessment. It appears that we need additional work in the Middle St. Johns to develop the tools for this assessment.

2. Water Level Effects

a. Lowering the stage-frequency curve of a water body alters the vegetation and hydroperiod of floodplain wetlands. These effects can significantly degrade habitat for wetland-dependent species. Moreover, a minimum depth can be one of the habitat criteria needed for successful spawning of fish. If depths over critical habitats are insufficient, spawning of some species could be impacted.

b. We will use the predictions of hydrologic models to predict changes in vegetation and the effects of altered hydroperiods on species that feed and/or breed in wetlands and on the availability of suitable habitat for fish spawning.

3. Flow and velocity effects

a. If withdrawals reduce flow rates, populations of sensitive species could be deleteriously affected. A prominent example is the American shad.

b. To assess these effects, hydrologic/hydrodynamic models would need to be capable of predicting changes in the flow velocities.

4. Turbidity effects

a. If withdrawals lead to increased turbidity, either by increasing sediment resuspension or increasing phytoplankton abundance (due to increased nutrient concentrations), then the abundance of submersed aquatic vegetation would be predicted to decline.

b. This effect will likely be most pronounced in the lakes within the main stem of the SJR. Studies underway will provide the information needed to assess the potential effects.

5. Salinity effects

a. Large wetlands in the St. Johns River are influenced by high salinity in the water table. If withdrawals lower a wetland's stage-frequency curve, water table salinity may increase. The vegetation likely would respond to this increase leading to habitat alteration.

b. If withdrawals increase salinity in the river from any of the mechanisms described above, we would predict effects on both flora and fauna. The strength of these effects will reflect the tolerances of aquatic species and the degree of salinity change in terms of intensity, area, frequency, and duration.

c. The scientific literature and SJRMD research will be adequate to provide an initial assessment of salinity impacts to submersed aquatic vegetation based on the predictions of the hydrodynamic models. Assessment of impacts to other species groups may be more problematic. We will need an extensive literature review of salinity tolerances of freshwater species.

6**. Direct effects on plankton from entrainment and impingement**

a. Withdrawals can remove large numbers of planktonic organisms from water bodies and potentially affect the reproductive success and growth of significant species groups.

b.It is unlikely that our site-specific data on the plankton will be adequate for this assessment, especially with regard to the ichthyoplankton. Information in the scientific literature may be sufficient for initial estimates of potential effects.

c.Site-specific data and ecological modeling will be required to predict the population and ecosystem effects of the estimated annual losses of planktonic organisms. Hydrodynamic models may also be needed to predict circulation patterns in order to determine what areas of the water body are potentially affected. We will need a literature review of research on the effects of other freshwater surface withdrawals to determine whether pre-existing data and analyses are sufficient to assess the potential environmental effects.