Exhibit B -Statement of Work
May 21, 2007
Lake Apopka Sediment Resuspension Model Development

I. Introduction:

St. Johns River Water Management District (District) seeks to investigate the potential impacts of changing Lake Apopka's water elevation regime on water quality. Changes in water levels might affect wind-generated sediment resuspension within the lake. Increased sediment resuspension may likely increase internal nutrient recycling and reduce light penetration, thereby impeding the restoration of submersed plants within the lake. This information will be important for development of Minimum Flows and Levels (MFL) for the lake, as well as consideration of any management options that might change typical lake stages.

II. Background:

Lake Apopka is a 31,000-acre lake in central Florida about 15 miles northwest of the Orlando metropolitan area. The fourth largest lake, and historically one of the most polluted large lakes in Florida, Lake Apopka is a headwater for the Ocklawaha Chain of Lakes. Lake Apopka was once bordered on the north by an extensive floodplain marsh. Until 1946, the lake was clear and had extensive submersed plant beds in which game fish flourished (Clugston 1963). The subsequent polluted condition of Lake Apopka resulted from excessive phosphorus loading, primarily from a large (about 20,000 acres) farming area created on the floodplain marsh (Battoe et al. 1999; Lowe et al. 1999; Schelske et al. 2000). Degradation of the 50,000-acre Lake Apopka ecosystem persisted for more than 50 years.

Restoration efforts for Lake Apopka began in 1985 with passage of the Lake Apopka Restoration Act (Chapter 85, Laws of Florida) and were continued by listing Lake Apopka as a priority water body in the 1987 Surface Water Improvement and Management Act (SWIM Act) (Chapter 373.461, Laws of Florida). Both acts directed the District to develop and implement a plan to restore and preserve the lake and its environment. Cessation of farming and restoration of wetland and aquatic habitat was recognized by the Florida legislature as the most effective and equitable means of achieving the first, and most essential, step in the lake's restoration: reduction of phosphorus loading. Acquisition of the farms began in 1989, continued in 1996, and was largely complete by 1998.

Lake Apopka has a mean depth of 1.65 m and its stage is regulated by a lock-and-dam structure located on the Apopka-Beauclair Canal, the lake's only downstream outlet. The regulation schedule has an annual range of 0.15 m, although actual stage regularly departs from the schedule due to heavy rain and drought.

As a result of the District's restoration efforts, the water quality in Lake Apopka has been improving for over a decade, including decreases in total phosphorus, chlorophyll, and total suspended solids concentrations, increases in water transparency, and re-appearance of native submersed plants. However, a thick layer of easily resuspended organic sediments underlies Lake Apopka. Due to the lake's large surface area and shallow depth, changes in water levels may significantly affect sediment resuspension.

III. Objectives:

The objective of this study is development of a sediment resuspension model for Lake Apopka. This model shall predict spatial sediment resuspension for varying wind velocities. The model shall also predict the degree of mixing of resuspended sediments vertically within the entire water column or the degree to which the sediments remain near the bottom in a separate fluid-like layer. Predictions shall be done as a function of wind velocity, spanning both typical and storm velocities and durations, discharge induced scour, and site-specific water depth and sediment conditions. Water depths under consideration shall include the potential effects of both lowered and increased average lake levels. This model shall be well-documented and based upon rich calibration and verification data sets. The District will use water column sediment concentrations predicted by the model to infer changes in light penetration within the water column and the nutrient recycling from the sediments to the water column. The model may be subjected to peer review and/or legal challenge.

IV. Scope of Work:

To meet the project objectives, the District will provide to the University available hydrologic, meteorological and other data for Lake Apopka, including:

1. All available water quality data (3 primary sites; 2 monthly, 1 bi-weekly) dating from the mid-1980s
2. All available stage and downstream discharge data for the lake
3. Reports from contracted sediment surveys (1987, 1995-96)
4. All meteorological data collected at a weather station located at the center of the lake
5. Both old (1989) and new (2007) bathymetric maps of the lake, if available
6. Reports from a contracted hydrodynamic model for primarily the NW quadrant of the lake

The UNIVERSITY shall:

1. Collect any additional data needed to develop, calibrate and verify a sediment resuspension model. The University's equipment may be deployed on an existing meteorological tower located at the center of the lake. The University shall make all provisions for data logging and/or telemetry from their equipment. Any additional deployments of equipment at other sites shall be handled by the University. The University shall also be

responsible for obtaining any permits necessary for establishment of other monitoring sites.

2. Provide the District the well-documented model code and input data files and train District staff in use of the model.
3. Use the model to analyze the spatial distribution of sediment resuspension as a function of wind velocity and duration at various lake stages from very high to very low. This analysis shall include area-weighted water column total suspended solids concentrations.
4. Summarize all phases of the work in a well-written report. The report shall be of equivalent quality and detail to a peer-reviewed publication. All field data collected shall be included in appendices and in associated data files.

V. Task Identification:

University shall provide all necessary equipment, personnel and supplies to perform the tasks listed below.

Task 1. Work Plan Development

The University shall develop a detailed work plan fully describing the tasks to be undertaken to achieve the project objectives.

Task 2. Field Data Collection

Deployment of instrument arrays and measurement

For acquisition of the time-series of relevant physical (dynamical) quantities, the University shall deploy two instrumental arrays: a primary, fixed-point, array to be located at the District's meteorological tower in the center of the lake, and a secondary, roaming array. The arrays shall measure physical parameters in air and water necessary for model calibration. The duration of the deployment of the primary array will be approximately one year. Equipment placed on the District's meteorological tower by the University shall be located so no antennae or other structures are directly above existing equipment, or otherwise interfere with measurements by District meteorological equipment. The secondary array will be deployed for shorter periods at locations other than the meteorological tower.

Also, the University will attempt to traverse selected cross-sections in the lake using a vessel mounted Acoustic Doppler Current Profiler (ADCP) to detect spatial variability in the current field at high wind speeds.

Bottom sediment collection

The University shall conduct bottom sampling at multiple stations. Sampling sites shall be visited twice over the one year field study period to evaluate temporal patterns in sediment mixed depths and properties on seasonal scales and shorter time scales associated with any changes resulting from mixing events related to storms. Replicate sediment cores shall be collected at each site using a hand-driven sediment-water interface piston corer. Spatial variability of coring sites between the two sampling periods will be minimized by using differential Global Positioning System (GPS).

X-radiography, gamma-ray attenuation (GRA) bulk density, and magnetic susceptibility shall be measured on a subset of the cores. Also, a subset of the cores shall be sectioned for physical and chemical properties necessary for model calibration. One core shall be used for shear strength measurements using a vane shearometer.

To quantify the magnitude and timing of sediment resuspension in the lake, time-varying inventories and profiles of sedimentary tracers over the upper several decimeters of core shall be measured. Because sediment resuspension events occur on time-scales of days to weeks, the appropriate tracers to measure mixing shall have comparable half-lives. Tracer measurements shall be made for each of the sampling locations for the two sampling periods.

Task 3. Data Analysis and Laboratory Measurements

Analysis of data from arrays

The University shall develop time-series and spectral density plots from field data collected by the primary and secondary arrays. These time-series and spectral plots shall be used to provide a physical description of the lake's short-term (hours to year) resuspension, and be used as inputs for model calibration and validation under Task 4, which in turn will enable the simulation of short-term resuspension dynamics.

The University will attempt to use gravimetric measurements of suspended sediment concentration (SSC) from water samples collected by autosamplers on the primary array to calibrate the acoustic backscatter and other array sensors to provide vertical profiles of SSC in the water column.

Analysis of sediment core data

Analyses of the field and sediment core data shall be conducted to 1) determine the depth of mixing in sediment, 2) quantify the magnitude and timing of sediment resuspension; and 3) examine the influence of sediment composition and mineralogy on sediment shear strength. Because episodic events can perturb sediment density profiles and shear strength, it is imperative to establish the magnitude and frequency of sediment resuspension events using a time-series tracer and monitoring approach. Doing so allows for the testing of the assumption of steady-state sediment consolidation. Additionally, analyses shall be conducted to determine whether the mineralogy and organic content of the sediment affect sediment bulk density and shear strength. Shear strength measurements will also provide information for the identification of the interface between the consolidating bed and the benthic nepheloid layer.

Hydraulic testing of bottom sediment samples

Sediment from the grab samples shall be hydraulically tested to determine the rate of entrainment of bed sediment. Suspended sediment collected by one of the auto-samplers shall be tested in a settling column for determination of the relationship between particle settling velocity and SSC. Entrainment and settling velocity relationships derived from these tests shall be used to set the resuspension coefficients in the sediment transport model.

Field measurement of flocs and settling
Several field and laboratory methods will be used to estimate *in situ* settling velocity and erosion rate constants for sediment flocs. The usefulness of mud pore pressure and acceleration data to be collected lies in the interpretation of these quantities along with waves in estimating the threshold for liquefaction of bottom mud as a function of wind and waves.

Task 4. Model Development

Adaptation of existing models to Lake Apopka
Resuspension in Lake Apopka shall be simulated using two numerical models: EFDC (Environmental Fluid Dynamics Code) and SWAN (Simulating Waves Nearshore). EFDC is a three-dimensional, hydrostatic flow model with a compatible model for sediment transport (Hamrick, 1992; 2000). The model has been modified (Jain et al., 2005) to include functions for the calculation of the combined bottom shear stress due to current and short period waves using the methodology by Soulsby et al. (1993). SWAN (Ver 40.41) is a numerical wave model for obtaining realistic estimates of wave parameters in coastal areas, lakes and estuaries from given wind-, bottom- and current-conditions (Booij et al., 1999; Ris et al., 1999). The model is based on the wave energy balance equation with requisite energy sources and sinks. SWAN is a third-generation wave model, in which wave generation and dissipation processes include: generation by wind, dissipation by white-capping, dissipation by depth-induced wave breaking, dissipation by bottom friction, and wave-wave interaction. The grid to be used for SWAN shall be the same as that for EFDC.

Model calibration and validation
The hydrodynamic component of EFDC shall be calibrated and validated using lake bathymetric data, water level time-series data and Apopka-Beauclair discharge data supplied by the District, along with water level and current velocity time-series derived from this study. Model input parameters required for calculation of water evapotranspiration rate will be obtained from the District's and other meteorological stations. Standard statistical measures shall be used for comparison between data and model time-series on water level, current, waves and SSC. In addition, spectral analysis shall be carried out to examine correlations between forcing (e.g., wind and waves) and response (e.g., SSC, pore pressure amplitudes and mud acceleration amplitudes). The sediment transport component of EFDC shall be validated with SSC time-series obtained as part of the proposed study. Wave data obtained from water pressure time-series shall be used for validation of SWAN.

Task 5. Model Analysis

Physical interpretation of model results

The University shall attempt a physical interpretation of the variation in SSC due to wind and water level using understanding of the processes in the lake incorporated in the model, and processes not included in the model. The main physical feature that is far more complex that what can be logically included in a numerical model is the stratigraphic description of the bed structure arising from long-term sedimentation processes in the lake. Some of the interpretations may require the development and/or use of adjunct analytic models.

Simulation modeling of future scenarios

The modeling system shall be used to generate the following scenarios:
(1) Spatiotemporal distribution over the entire lake of the surficial SSC as a function of wind speed (within measured magnitude range and direction).
(2) At selected locations, temporal evolution of the vertical profile of SSC to ascertain the degree of mixing of resuspended sediment in the water column as a function of wind speed (within measured magnitude range and direction).
(3) Spatiotemporal distributions of liquefaction and erodibility thresholds of bottom mud, fluid mud thickness and bottom scour depth as a function of wind speed.
(4) Items (1)-(3) under assumed storm velocities and durations.
(5) Items (1)-(4) at different (higher and lower than present) water levels. It may be necessary to incorporate expected changes in the detrital load as a function of water level, based on available data (or assumed scenarios related to) on detrital transfer.

Task 6. Technology Transfer

The University shall provide the District the well-documented model source code and input data files. The documentation for the model shall include:

- Model description - the documentation of underlying equations solved numerically by the model and some description of the numerical solution scheme.
- User's guide - the documentation of the various input and output files required to run and use the model and describe the various model parameters. The units of all input and output parameters shall be provided.

The University shall submit draft model code and documentation at the same time as submission of the draft final report. The University shall present a workshop at the District Palatka headquarters to train District staff in use of the model during the following 60 calendar day District review period. Final model source code and documentation shall be submitted with the final report.

Task 7. Reports

Quarterly reports shall be submitted briefly summarizing progress as support for invoices. The draft final report and draft documented model source code shall be submitted as the 7th quarterly report, twenty-one (21) months after contract execution. The District shall provide review comments within sixty (60) calendar days of receipt of the draft final report. University shall incorporate District comments and submit the final report and documented model source code within sixty (60) calendar days. Thirty (30) calendar days will be allowed for the District's acceptance of the final report.

Requirements For All Deliverables

- All reports shall follow the format described in the District's Style Guide for Written Communication (2005) for contractual reports provided by the District.
- All data collected for the project shall be delivered in Excel for Windows or ASCII format. The database shall be fully documented. The location, structure, units of measurement, and any other pertinent information for each data set or file shall be clearly identified within the database and in the paper copy documentation.
- All text products shall be provided to the District on CDs and as paper copy. Electronic versions of reports shall be provided as Microsoft Word files.
- All products, graphic or textual, shall be of publication quality.

VI. Schedule

The tasks and sub-tasks are itemized in Table 1 and the schedule for task completion is shown in Table 2.

Table 1. Tasks and sub-tasks

No.	Title
1	**Work Plan Development**
2	**Field Data Collection**
2A	Deployment of instrument arrays and measurement
2B	Bottom sediment collection
2C	Underway ADCP traverses at high wind speeds
3	**Data Analysis & Laboratory Measurements**
3A	Analysis of data from arrays
3B	Analysis of sediment core data
3C	Hydraulic testing of bottom sediment samples
3D	Field measurement of flocs and settling
4	**Model Development**
4A	Adaptation of existing models to Lake Apopka
4B	Model calibration and validation
5	**Model Analysis**
5A	Physical interpretation of model results
5B	Simulation modeling of future scenarios
6	**Technology Transfer**
6A	Delivery of draft model documentation and source code
6B	Model training workshop
6C	Final model documentation and source code
7	**Reports**
7A	Quarterly reports
7B	Draft final report preparation
7C	Final report (after review)

Table 2. Project Schedule

Fiscal Year	FY 2006-07			FY 2007-08												FY 2008-09										
Task	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**
Task 1	x																									
Task 2A	x	x	x	x	x	x	x	x	x	x	x	x														
Task 2B		x			x			x			x															
Task 2C		x			x			x			x															
Task 3A		x	x	x	x	x	x	x	x	x	x	x														
Task 3B		x	x	x	x	x	x	x	x	x	x	x														
Task 3C					x	x	x																			
Task 3D					x			x																		
Task 4A									x	x	x	x														
Task 4B										x	x	x	x	x												
Task 5A													x	x	x	x	x	x	x	x						
Task 5B																	x	x	x	x						
Task 6A																					x					
Task 6B																						x	x			
Task 6C																									x	
Task 7A			x			x			x			x			x			x								
Task 7B																			x	x	x					
Task 7C																								x	x	

Tasks shall be completed and any required deliverables submitted by the last day of the last month indicated with an “X” for each specific task, unless otherwise scheduled by the University and District Project Manager.

Budget

No.	Title	Amount ($)
	Fiscal year 2006-07	
1	Work Plan Development	8,900
2A	Deployment of instrument arrays and measurement	11,250
2B	Bottom sediment collection	4,100
2C	Underway ADCP traverses at high wind speeds	4,100
3A	Analysis of data from arrays	9,550
3B	Analysis of core data	11,100
FY 2006-07 Total		**49,000**
	Fiscal year 2007-08	
2A	Deployment of instrument arrays and measurement	33,620
2B	Bottom sediment collection	4,100
2C	Underway ADCP traverses at high wind speeds	4,100
3A	Analysis of data from arrays	21,000
3B	Analysis of core data	23,000
3C	Hydraulic testing of bottom sediment samples	12,908
3D	Field measurement of flocs and settling	11,700
4A	Model adaptation to Lake Apopka	23,000
4B	Model calibration and validation	29,850
5A	Physical interpretation of model results	39,100
FY 2007-08 Total		**202,378**
	Fiscal year 2008-09	
5A	Physical interpretation of model results	35,430
5B	Simulation of Future Scenarios	12,854
6	Technology Transfer	3,770
7B	Draft final report preparation	6,266
7C	Final report (after review)	3,000
FY 2008-09 Total		**61,320**
Grand Total		**312,698**