STATEMENT OF WORK
For Springs Protection Initiative:
Springs Protection Initiative Science (SPIS)-HYDRODYNAMICS AND HYDRAULICS (H&H) WORK GROUP

I. INTRODUCTION/BACKGROUND

Many Florida Spring systems have shown substantial change in ecological character. These changes include reduced flow rates, increased levels of nitrate, increased biomass and cover of algae and invasive aquatic plants, decreased abundance of native submerged aquatic vegetation, and changes in fish and invertebrate communities. Because of the ecologic and economic importance of springs, the District established the Springs Protection Initiative to protect and manage these important resources.

In addition to the changes described above, Silver River has also exhibited an altered stage-discharge relationship over the previous fifteen years. Despite record low discharges, water levels in the spring run have increased. Increased water levels are likely due to increased hydraulic resistance caused by an increase in percent cover or density of submersed vegetation. These water level changes affect the hydroperiod of the adjacent wetlands and are thus important to the setting of MFLs for Silver Springs.

In addition, the altered stage-discharge relationship and increase of vegetative resistance can substantially alter velocity within the spring run. Velocity is a fundamental physical parameter affecting many biogeochemical processes by its control of particle settling rates, sediment types and distribution, exchange of nutrients and metals with the sediments, residence time and flushing, channel storage, reaeration rates, and physiology and growth forms of plants. Of particular importance to Florida springs is that flow velocity can constrain the biomass of undesirable filamentous algae.

II. OBJECTIVES

This work has three main objectives:

a) to define the velocity and residence time distributions in the channel of the Silver River and quantify the location and magnitude of hyporheic (zone of mixing between shallow groundwater and surface water) and channel storage exchange
b) to identify critical shear stresses for the entrainment and detachment of filamentous algae

c) to develop hydraulic and hydrodynamic models of Silver River and the Lower Ocklawaha River that will predict stage, frictional resistance, residence time, and 3D velocity in the presence of aquatic vegetation

III. SCOPE OF WORK

Objective (a) will be achieved by the injection and monitoring of chemical tracers (Rhodamine WT or fluorescein dye) within the spring run. Tracer tests will be performed for a range of downstream water levels and injections will be made at locations with representative conditions of bare, benthic algal dominated, and macrophyte dominated bottom. Injections will also be made into macrophyte beds to characterize flow patterns within the submersed vegetation. Analysis of tracer results by non-linear regression will determine advective, dispersive, and hyporheic storage components of the observed tracer time-series.

Objective (b) will be achieved by use of in-stream flow devices to control velocity over areas of attached algae. Velocity profiles will be measured using a Sontek 3-D acoustic Doppler velocimeter (ADV) and shear stress will be calculated from the measured velocity gradients. Biomass of sloughed algae (both benthic and epiphytic) will be measured as a function of shear stress.

Objective (c) will be accomplished by application of an unsteady hydraulic model (HEC-RAS) to Silver River and two separate hydrodynamic models (EFDC) to Silver River and the Lower Ocklawaha River from Moss Bluff to Eureka. The HEC-RAS hydraulic model application will be used to predict water levels in Silver River as a function of spring discharge and vegetative friction and will include the flood plain for prediction of wetlands hydroperiods. The EFDC hydrodynamic model application for the Lower Ocklawaha River will be used to simulate water levels and flood plain inundation resulting from both surface water and groundwater inflows. This model will provide boundary conditions for detailed examination of Silver River and can be used as a predictive tool for examining altered hydraulic and hydrologic scenarios, such as the blockage of flow by hydrilla or the control of discharge at the Moss Bluff Dam. Finally, the EFDC hydrodynamic model application of Silver River will focus on the physics of vegetative drag and will provide high-resolution, 3D velocity fields within the main channel of Silver River.

IV. TASK IDENTIFICATION & REQUIRED RESOURCES

- Task SJR-1: Bathymetric surface of Silver River and Lower Ocklawaha River from Moss Bluff to Eureka. *Requires HydroSurveyor and Biosonics surveys (WRI); ground-truth surveys (Surveying); Statistical analyses (Nathan Johnson)*

- Task SJR-2a: Initial vegetation surface of Silver River and portion of Ocklawaha River. *Requires HydroSurveyor and Biosonics surveys and ground-truth surveys (WRI)*

- Task SJR-2b: Catalogue of submerged logs in Silver River derived from side-scan sonar. *Requires side-scan sonar surveys*

- Task SJR-3: Sonar-derived velocity map of Silver River and Lower Ocklawaha River. *Requires HydroSurveyor measurements (WRI)*

- Task SJR-4a: Initial ADCP velocity cross-sections in Silver River. *Requires ADCP measurements (WRI)*

- Task SJR-4b: Quarterly ADCP velocity cross-sections in Silver River. *Requires ADCP measurements (WRI)*

- Task SJR-5: Quarterly sonar monitoring of vegetation parameters (height, density) in Silver River. *Requires HydroSurveyor and Biosonics surveys (WRI)*

- Task SJR-6: Quarterly sonar monitoring of hydrilla cover and density in Silver River and the Lower Ocklawaha River. *Requires side-scan sonar (WRI)*

- Task SJR-7: Quarterly monitoring of vegetation parameters at selected MFL transects in Silver River using divers. *Requires diver (WRI contractual services), data analysis (Jodi Slater)*

- Task SJR-8: HEC-RAS model of Silver River and Lower Ocklawaha River. Dependent on completed bathymetry and vegetation surface, DEM of flood plain, model development and calibration

- Task SJR-9: Development and calibration of 1D model for predicting vertical velocity profiles in presence of vegetation. Dependent on observed vertical profiles (UF); ADCP velocity transects, completed bathymetry and vegetation surface, algorithm development and calibration (E&HS)

- Task SJR-10a: Code development and testing of vegetative drag and turbulence algorithms.

- Task SJR-10b: Calibration of EFDC hydrodynamic model of Silver River with vegetative drag and turbulence algorithms. Dependent on observed vertical profiles (UF); ADCP velocity transects ; dye tracer tests in SAV beds (UF); completed bathymetry and vegetation surface, algorithm development and calibration (E&HS)

- Task SJR-11: Model scenarios in support of Super Group.
- Task ATM-1: Silver River & Ocklawaha River hydrodynamic model development. Contract with Applied Technology & Management
- Task ATM-2: Ocklawaha River hydrodynamic model calibration. Contract with Applied Technology & Management
- Task ATM-3: Expert assistance with vegetative drag algorithms and EFDC calibration for Silver River. Contract with Applied Technology & Management
- Task ATM-4: Scenario analysis and final report. Contract with Applied Technology & Management
- Task UF-1: Collection of vertical velocity profiles in Silver River. UF-SPIS contract.
- Task UF-2: Flow-way experiments to determine critical shear stress of algae. UF-SPIS contract
- Task UF-3: Dye tracer experiments. UF-SPIS contract
- Task UF-4: Modeling syntheses and final report. UF-SPIS contract
- Task SJR-12: Final synthesis report and summary of all work.

V. TIME FRAMES & DELIVERABLES

Schematic of Project Time Frames

	Q1 14	Q2 14	Q3 14	Q4 14	Q1 15	Q2 15	Q3 15	Q4 15	Q1 16	Q2 16	Q3 16	Q4 16	Q1 17	Q2 17
SJR-1: Bathy Map														
SJR-2a: Veg Map														
SJR-2b: Submerged logs														
SJR-3: Velocity Map														
SJR-4a: ADCP X-sectns														
SJR-4b: Quarterly ADCP transects														
SJR-5: Quarterly Veg sonar														
SJR-6: Quarterly Hydrilla sonar														
SJR-7: Quarterly vegetation sampling at MFL transects														
SJR-8: HEC-RAS calibration														
SJR-9: 1D velocity model calibration														
SJR-10a: Drag and turbulence code development														
SJR-10b: EFDC Silver River calibration														
SJR-11: Model Scenarios														
ATM-1: EFDC grids														
ATM-2: EFDC calibrate														
ATM-3: EFDC calibrate														
ATM-4: Final Report														
UF-1: V profiles														
UF-2: Flow-way														
UF-3: Dye tracer														
UF-4: Synthesis														
SJR-12: Final Report														

	Data collection/Analysis
	Model Development/Runs
	Deliverable
	Final report

List of Key Deliverables with Dates

Deliverable	Date	Associated Task	Comments
Bathymetric Map	Jul. 2014	SJR-1	GIS Surface, Silver River and LOR
Veg. Map	Aug. 2014	SJR-2a	First map
Submerged Logs	Dec. 2014	SJR-2b	Silver River only
Velocity Map	Sep. 2014	SJR-3	Based on Hydrosurveyor
ADCP X-sections	July. 2014	SJR-4a	1st set should be most comprehensive
EFDC Grids	Sep. 2014	ATM-1	Both Silver River and Ocklawaha River
Measured Velocity Profiles	Sep. 2014	UF-1	Measured velocity profiles
ADCP X-sections	Quarterly	SJR-4b	Additional ADCP near time of veg. monitoring
Veg Sonar	Quarterly	SJR-5	Quarterly veg monitoring using sonar
Hydrilla Sonar	Quarterly	SJR-6	Quarterly monitoring of hydrilla
Veg at MFL Transects	Quarterly	SJR-7	Veg. monitoring using divers at selected MFL transects
HEC-RAS Calibration	Mar. 2015	SJR-8	In cooperation with UF
1D Velocity Model Calibration	Jun. 2015	SJR-9	Calibration of 1D velocity model
Measured Velocity Profiles	Sep. 2015	UF-1	2nd set of measured velocity profiles
EFDC Calibration, LOR	Sep. 2015	ATM-2	Calibration of EFDC LOR model
Dye Tracer Tests	Sep. 2015	UF-3	1st set of dye tracer results for EFDC calibration
Drag & Turbulence Coding	Jun. 2015	SJR-10a	Coding of algorithms and testing
EFDC Calibration, Silver R	Jun. 2016	SJR-10b	Calibration of EFDC Silver River model with vegetative drag
EFDC Model Review	Jun. 2016	ATM-3	Coordinated review of EFDC calibration
Flow-way Results	Sept. 2016	UF-2	Completion of UF flow-way tests
Dye Tracer Results	Sept. 2016	UF-3	Completion of UF dye tests
Model Scenarios	Dec. 2016	SJR-11	Completion of model scenarios
ATM Final Report	June 2017	ATM-4	In cooperation with Super Group

UF Final Report	June 2017	UF-4	In cooperation with Super Group
SJR Final Report	June 2017	SJR-12	In cooperation with Super Group

VI. BUDGET/COST SCHEDULE

External Costs by Task

Task/Deliverable	Contractor	FY2014	FY2015	FY2016	FY2017
Velocity profiles	UF (Kaplan)	26,370			
EFDC Set-up	ATM	120,000			
Dye Tracer Tests	UF (Kaplan)		82,149		
EFDC OR Calibration	ATM		85,000		
Flow-way/Tracer Results	UF (Kaplan)			54,803	
EFDC SR Calibration				85,000	
Final Report	UF (Kaplan)				29,871
Final Report	ATM				35,000
TOTALS		146,370	167,149	139,803	64,871

FTEs and Contract Dollars

Task Name	Start Date	End Date	Resource Names	Fixed Costs
SJR1: Bathymetric Map	3/1/2014	7/31/2014	Eng1[11.5],eng2[5.8]	
SJR2a: Vegetation Map	3/1/2014	8/31/2014	Eng[8.8]	
SJR2b: Submerged Logs	10/1/2014	12/31/2014	Eng[5.0]	
SJR3: Velocity Map	3/1/2014	9/30/2014	Eng[5.8]	
SJR4a: ADCP X-sections Measurements	3/1/2014	7/31/2014	Eng[9.5],eng2[2.0]	
SJR4b: ADCP X-sections Measurements	6/1/2014	7/31/2014	Eng1[1.0],eng2[0.4]	
SJR5: Vegetation Monitoring w/ Sonar	6/1/2014	7/31/2014	Eng1[1.0], eng2[0.4]	
SJR6: Hydrilla Monitoring w/ Sonar	6/1/2014	7/31/2014	Eng1[1.0],eng2[0.2]	
SJR7: Vegetation Monitoring w/ divers	6/1/2014	7/31/2014	Eng1[1.4],eng2[0.2]	
ATM1: EFDC Grids	4/1/2014	9/30/2014	Eng[5.8]	115,000
UF1: Velocity Profiles	4/1/2014	9/30/2014	Eng[3.8]	26,370

SJR4b: ADCP X-sections Measurements	9/1/2014	10/31/2014	Eng1[1.0],eng2[0.4]	
SJR5: Vegetation Monitoring w/ Sonar	9/1/2014	10/31/2014	Eng1[1.0], eng2[0.4]	
SJR6: Hydrilla Monitoring w/ Sonar	9/1/2014	10/31/2014	Eng1[1.0],eng2[0.2]	
SJR7: Vegetation Monitoring w/ divers	9/1/2014	10/31/2014	Eng1[1.4],eng2[0.2]	
SJR4b: ADCP X-sections Measurements	11/1/2014	12/31/2014	Eng1[1.0],eng2[0.4]	
SJR5: Vegetation Monitoring w/ Sonar	11/1/2014	12/31/2014	Eng1[1.0], eng2[0.4]	
SJR6: Hydrilla Monitoring w/ Sonar	11/1/2014	12/31/2014	Eng1[1.0],eng2[0.2]	
SJR7: Vegetation Monitoring w/ divers	11/1/2014	12/31/2014	Eng1[1.4],eng2[0.2]	
SJR4b: ADCP X-sections Measurements	2/1/2015	3/31/2015	Eng1[1.0],eng2[0.4]	
SJR5: Vegetation Monitoring w/ Sonar	2/1/2015	3/31/2015	Eng1[1.0], eng2[0.4]	
SJR6: Hydrilla Monitoring w/ Sonar	2/1/2015	3/31/2015	Eng1[1.0],eng2[0.2]	
SJR7: Vegetation Monitoring w/ divers	2/1/2015	3/31/2015	Eng1[1.4],eng2[0.2]	
SJR4b: ADCP X-sections Measurements	5/1/2015	6/30/2015	Eng1[1.0],eng2[0.4]	
SJR5: Vegetation Monitoring w/ Sonar	5/1/2015	6/30/2015	Eng1[1.0], eng2[0.4]	
SJR6: Hydrilla Monitoring w/ Sonar	5/1/2015	6/30/2015	Eng1[1.0],eng2[0.2]	
SJR7: Vegetation Monitoring w/ divers	5/1/2015	6/30/2015	Eng1[1.4],eng2[0.2]	
SJR4b: ADCP X-sections Measurements	8/1/2015	9/30/2015	Eng1[1.0],eng2[0.4]	
SJR5: Vegetation Monitoring w/ Sonar	8/1/2015	9/30/2015	Eng1[1.0], eng2[0.4]	
SJR6: Hydrilla Monitoring w/ Sonar	8/1/2015	9/30/2015	Eng1[1.0],eng2[0.2]	
SJR7: Vegetation Monitoring w/ divers	8/1/2015	9/30/2015	Eng1[1.4],eng2[0.2]	
SJR4b: ADCP X-sections Measurements	11/1/2015	12/31/2015	Eng1[1.0],eng2[0.4]	
SJR5: Vegetation Monitoring w/ Sonar	11/1/2015	12/31/2015	Eng1[1.0], eng2[0.4]	
SJR6: Hydrilla Monitoring w/ Sonar	11/1/2015	12/31/2015	Eng1[1.0],eng2[0.2]	
SJR7: Vegetation Monitoring w/ divers	11/1/2015	12/31/2015	Eng1[1.4],eng2[0.2]	
SJR-8: HEC-RAS calibration	7/1/2014	3/31/2015	Eng[23.1]	
SJR9: 1D Velocity model calibration	1/1/2015	6/30/2015	Eng[19.2]	

ATM2: EFDC calibration of LOR	10/1/2014	9/30/2015	Eng[5.8]	85,000
UF2: Observed Velocity Profiles	10/1/2014	9/30/2015	Eng[2.9]	40,000
UF2: Dye tracer tests	10/1/2014	9/30/2015	Eng[2.9]	42,149
SJR10a: Coding of veg algorithms	4/1/2014	6/30/2015	Eng[69.2]	
SJR10b: EFDC calibration of Silver R	7/1/2015	6/30/2016	Eng[38.5]	
ATM3: EFDC calibration review	10/1/2015	6/30/2016	Eng[5.8]	85,000
UF3: Flow-way results	10/1/2015	9/31/2016	Eng[2.9]	27,400
UF3: Dye tracer results	10/1/2015	9/31/2016	Eng[2.9]	27,400
SJR11: Model scenarios	7/1/2016	12/31/2016	Eng[38.5]	
ATM4: ATM Final Report	10/1/2016	6/30/2017	Eng[5.8]	35,000
UF4: UF Final Report	10/1/2016	6/30/2017	Eng[11.5]	30,000
SJR12: SJR Final Report	1/1/2017	6/30/2017	Eng[34.6]	