Restore Lagoon Inflow Research (Phase 3)
Interim Report

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The multi-phased Restore Lagoon Inflow (RLI) Research project scope includes the baseline monitoring, design, permitting, implementation, and modeling of a pilot scale system to provide temporary ocean inflow to the Indian River Lagoon (IRL). After completion of this third project phase in 2023, the remaining final phases involve temporarily pumping ocean water into the IRL at Port Canaveral under U.S. Army Corps of Engineers (USACE) permits to provide a real-world validation of preliminary modeling and analysis performed during the initial RLI phases. The results of the fully completed pilot scale research project will provide comprehensive information and analysis to the lead agency and appropriate decision-makers to help determine the viability and potential impact of full-scale, permanent ocean inflow system(s).

Interim Report

The IRL is a lagoon, which is a special type of estuary that is oriented parallel to the coast and characterized by shallow coastal waters. As a microtidal estuary with limited ocean exchange through five engineered and stabilized inlets, the IRL is particularly vulnerable to the accumulation of nutrients that are responsible for eutrophication, harmful agal blooms, and low oxygen (hypoxia).

Initiated by State Representative Thad Altman as a follow up to the 2017 “Conceptual Design for Artificial Flushing Projects in the Indian River Lagoon” study by the St. Johns District Water Management District, the Florida Institute of Technology (Florida Tech) began a multi-phase project to explore customized solutions for improving IRL water quality by restoring periodic historical ocean inflows and circulation. The goal of this research project is to investigate the implications of using enhanced ocean inflows to improve water quality and reduce the frequency and duration of harmful algal bloom outbreaks.

Phase 1, with funding of $800,000 from the Florida Legislature, gathered baseline data and conducted modeling on existing water quality, biological parameters, and hydrologic conditions at candidate locations for a potential temporary inflow pilot system. The Legislature authorized an additional $752,000 for Phase 2, which focused on ecosystem preliminary analysis and established the methodology to assemble an effective, temporary inflow pilot system. Efforts included agency and stakeholder engagement, conceptual engineering and optimization, expanded ecosystem modeling, and baseline data collection.

With the third phase of Legislative funding for 2022–2023 of $921,500, Florida Tech is building upon results from Phases 1 and 2 to further develop the engineering, design, and baseline water quality and hydrologic data and modeling to apply for all permits to assemble a temporary, small-scale, inflow structure at Port Canaveral. By procuring all required permits in Phase 3, the project risk is significantly diminished for an authorized agency to lead the remaining phases for this public infrastructure project.

Highlighted Preliminary Research Findings

The following are key preliminary findings from the first phases of the RLI Research project.

Stabilizing dissolved oxygen and reducing water temperature can improve natural nutrient removal. Under low-oxygen conditions (hypoxia), sediments were found to be a source of dissolved nutrients to overlying water. Enhanced inflow is predicted to stabilize dissolved oxygen concentrations and mitigate occurrences of hypoxia, which would improve binding of orthophosphate by sediments, reduce total nitrogen, and promote nutrient ratios that are less favorable for harmful algal bloom species.

Net nutrient reduction is predicted with enhanced inflow. Models and field data suggest that measurable impacts of the proposed pilot-scale inflow will be limited to the northern compartments of the IRL system. Increased dissolved oxygen concentrations and lower water temperatures from enhanced inflow are predicted to result in a net reduction of lagoon nutrient loading and will not result in a nutrient discharge to adjacent lagoon compartments or the ocean waters.

Water quality determines fish distribution and local population size. Significant negative associations between local fish population size and increases in chlorophyll-a concentrations were detected and include a decline in most species of interest following the 2011 "superbloom." Complementary genetic assessments of fish communities highlight the negative impacts of frequent harmful algal bloom outbreaks on Banana River Lagoon (BRL) fish diversity.

Coordination

This project builds upon and complements ongoing efforts to identify and implement restoration measures for the IRL and other Florida estuaries, including collaboration with the University of West Florida (UWF) to compare IRL data with current conditions in Pensacola and Destin near the Destin Harbor Pumping Station. The results from this study will help respond to ongoing public concern about lagoon health by providing data to improve understanding of ecosystem response to management efforts and determining whether enhanced ocean inflow could be a valuable tool to address declining IRL water quality and ecosystem degradation.

Florida Tech and UWF are collaborating on experiments to better characterize nutrient flux from sediments and nutrient sorption to sediments under aerobic and anaerobic conditions. Sediment experiments in the Santa Rosa Sound seagrass beds are being analyzed and compared to the IRL. The experiments evaluate the results of nutrient sorption and desorption as well as the seagrass and single cell organisms that may provide the mechanisms for these processes. These data continue to build upon the project baseline data and nutrient modeling initiated during Phases 1 and 2, which identified binding of nutrients to sediments as a potential key benefit from restoring lagoon inflow.

Data from the St. Johns River Water Management District and Harbor Branch Oceanographic Institute IRL Observation Network, along with watershed inputs from the Spatial Watershed Iterative Loading model developed by Applied Ecology and groundwater inflow predictions compiled by Florida Tech were used to setup and validate predictive hydrodynamic models. Evaluations of Acoustic Doppler Current Profiler (ADCP) units deployed in the BRL near the Barge Canal, Dragon Point, and Sykes Creek were incorporated into the models. Configuration of the Environmental Fluid Dynamics Code was updated to improve resolution of numerical model predictions of hydrodynamics, flushing rate, and water quality with and without the enhanced inflow from the temporary pilot project.

To enhance biological baselines established in Phases 1 and 2, collaborating scientists from Florida Fish and Wildlife Conservation Commission' Fish and Wildlife Research Institute, and East Coast Zoological Society are extending characterization of BRL phytoplankton, fish, and seagrass community dynamics. This spring, scientists from Hubbs SeaWorld Research Institute will lead a health assessment of bottlenose dolphins, and partners at Florida International University will conduct geospatial analyses to define temperature and salinity tolerances for key fish species.

Proposed Inflow Pilot Project

Based on data collected during Phases 1 and 2 and discussions with the agencies and stakeholders, the optimal location for the temporary inflow pilot project is in the northern BRL. The BRL is a sub-basin of the IRL that lies between Cape Canaveral and Merritt Island and extends from NASA Kennedy Space Center to Dragon Point. The proposed temporary inflow pilot project would extract water from the ocean side of the Canaveral Locks system and discharge to the cove to the west of Avocet Lagoon. The proposed configuration would be a pump station that pumps 0.5 cubic meters per second of ocean water through a pipe system above ground to the lagoon. This relatively low flow rate and constricted cove configuration would allow for an evaluation of enhanced inflow on IRL water quality and biology while limiting system cost and permitting considerations. Figure 1 shows the proposed pilot inflow location and potential pipe route, which were selected to minimize impacts to existing infrastructure, public access, and natural resources. To test for water quality and biological changes from the enhanced inflow, a reference site in the central BRL is proposed (Figure 2), which was identified through

modeling evaluation and field sampling to be comparable to the proposed outfall location and outside the influence of the pilot scale inflow system.

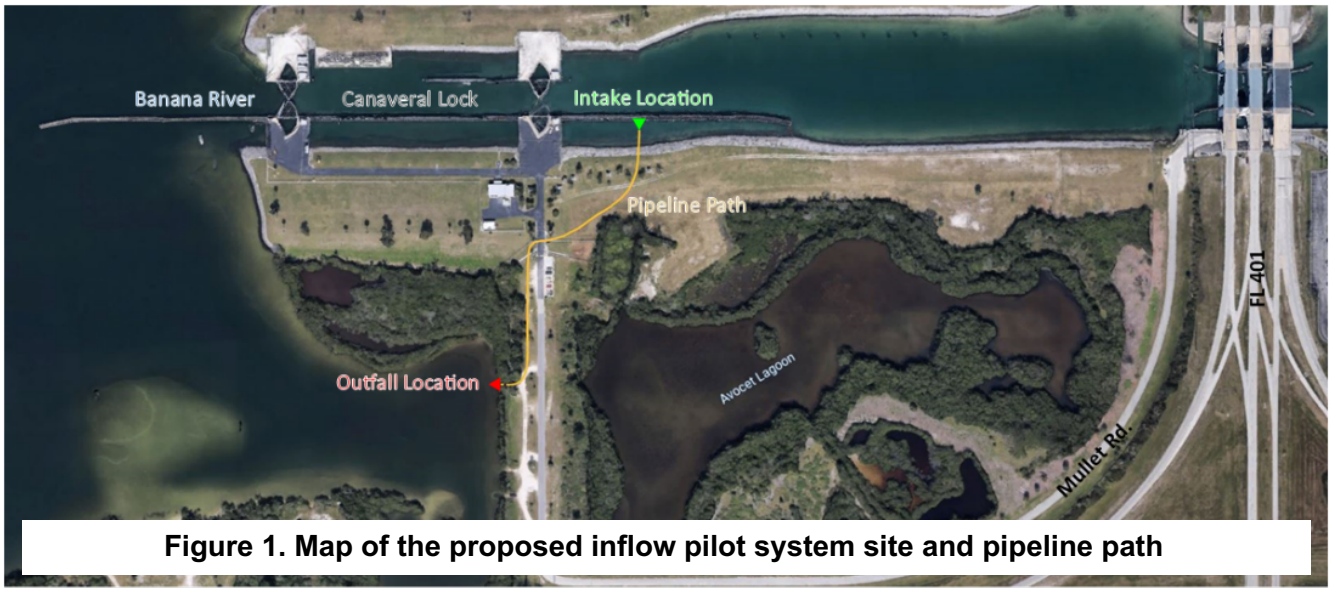

Figure 1. Map of the proposed inflow pilot system site and pipeline path

As part of Phase 3, Florida Tech, UWF, and Tetra Tech conducted literature review of similar pumping/inflow projects internationally (including the Destin Harbor Florida Pumping Station); improved model resolution; continued atmospheric, sediment, and water quality monitoring; optimized inflow design by removing 90 degree turns, modified the outfall, and designed a new intake structure with a walkway for maintenance; applied to USACE for Section 404 and Section 408 permits with approval of the Section 404 and response on the Section 408 permit anticipated in March 2023; and submitted the Environmental Resource Permit (ERP) with a response anticipated in April 2023. Though there are no guarantees for timeline, all project permitting is anticipated to be completed by summer 2023.

Once access is granted to the USACE lock facility for geotechnical drilling, via the USACE Section 408 process, Tetra Tech will complete borings to provide structural data required for the final system design. This final design will be submitted to the Florida Department of Environmental Protection and USACE as a 100% design for the ERP and Section 404 and 408 permitting processes.

Figure 2. Map showing proposed pilot pumping location in the North BRL (NBR) and reference site in the Central BRL (CBR)

Project Vision

The multi-phased RLI Research project scope includes the baseline monitoring, design, permitting, implementation, and modeling of a pilot scale system to provide temporary ocean inflow to the IRL. After completion of this third project phase in 2023, the remaining final phases involve temporarily pumping ocean water into the IRL for one year at Port Canaveral under USACE and ERP permits to provide a real-world validation of preliminary modeling and analysis performed during the initial RLI phases. The results of the fully completed pilot scale research project will provide comprehensive information and analysis to the lead agency and appropriate decision-makers to help determine the viability and potential impact of full-scale, permanent ocean inflow system(s).

The study results will also help to address several actions in the IRL National Estuary Program Comprehensive Conservation and Management Plan by improving understanding and management of the IRL system, and specifically achieve action Connected Waters-5 that calls for a pilot project to assess the benefits and risks of enhanced ocean exchange with the lagoon.

Phase 1 provided essential baseline monitoring and ecosystem modeling for the project. The project team carefully evaluated the parameters required to assess the effectiveness, environmental effects, and limitations of an inflow system. Phase 2 and now Phase 3 continue to build on these critical datasets that are invaluable not only for the inflow project but also for the research community and management agencies addressing related questions in the IRL and nearshore Atlantic Ocean. As the data collection continues, the project team is making adjustments in response to stakeholder input to ensure effective project design. Internal project and stakeholder meetings are focused on providing the lowest cost and least invasive approach to implement the temporary inflow pilot system, without sacrificing the validity and quality of the science produced by the research project. From this process, a design for the pilot scale project has been prepared and ERP and USACE permits have been submitted.

The remaining project phases to comprehensively validate preliminary RLI Research project findings in a real-world environment include preparation of bid specifications, procurement and construction of the temporary pilot inflow system, system operation and maintenance, comparative modeling and analysis, and a final report of the research project findings. The remaining multi-year procurement, assembly, and pump operations are anticipated to be led by a local or state agency to coordinate this public infrastructure project. Florida Tech is well-positioned and excited to assist in completing the associated research processes and provide educational opportunities to Florida Tech students.

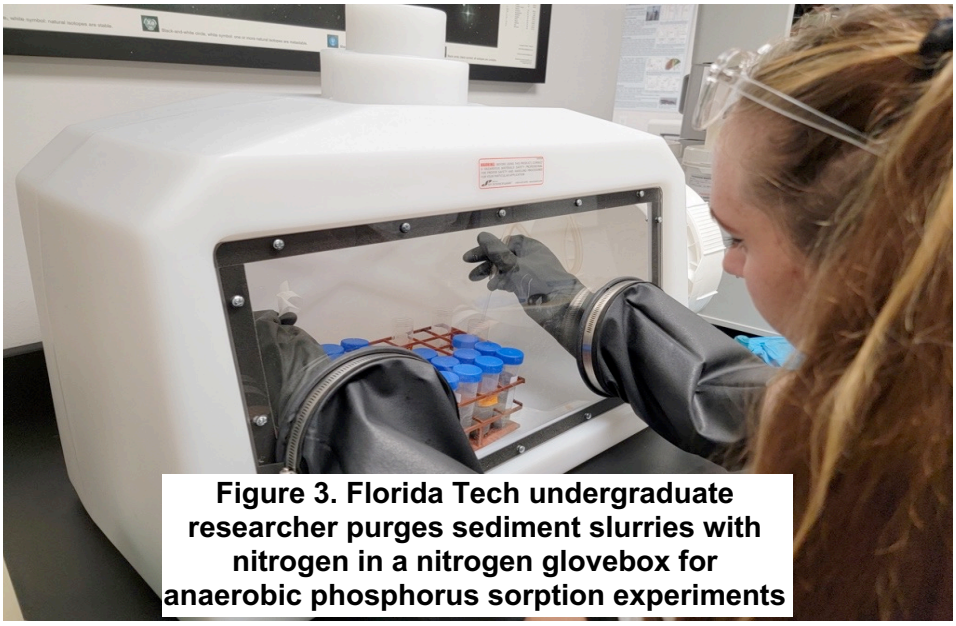

Figure 3. Florida Tech undergraduate researcher purges sediment slurries with nitrogen in a nitrogen glovebox for anaerobic phosphorus sorption experiments