DEPARTMENTAL

INDIAN RIVER COUNTY, FLORIDA
MEMORANDUM

TO:	Jason E. Brown, County Administrator
THROUGH:	Richard B. Szpyrka P.E., Public Works Director
FROM:	Keith McCully, P.E., Stormwater Engineer
SUBJECT:	Update on the ongoing Pilot Plant Study for a Full-Scale Managed Aquatic Plant Pollutant Removal System Treating Water from the North Relief Canal
DATE:	September 21, 2017

DESCRIPTION AND CONDITIONS

On August 16, 2016, the Board of County Commissioners entered into a contract with Van Ert, Nemoto and Associates, LLC ("VEN"), to perform a pilot plant study to investigate a managed aquatic plant pollutant removal system along the Indian River Farms Water Control District's (IRFWCD) North Relief Canal. The study is underway and the purpose of this Agenda Item is to provide a summary of results obtained through August 30, 2017. A brief PowerPoint presentation is part of the Agenda Item.

The pilot plant study consists of four distinct stages:

- Stage 1 – Site Selection, Preliminary Water Testing, and Pilot Plant Construction (complete)
- Stage 2 – Pilot Testing: Emergent Plant Down-Select (complete)
- Stage 3 – Pilot Testing: Optimal Plants and Parameters (ongoing)
- Stage 4 – Preliminary Full Scale Design Report (to be performed)

Stage 1

In Stage 1, the pilot plant site was selected and a permit to install the pilot plant system was obtained from IRFWCD. The site is located on the north bank of the North Relief Canal (NRC) just west of 58th Avenue, abutting Pine Ridge Club subdivision. VEN contacted Pine Ridge Club's Homeowners Association (HOA) and explained the project in detail to pertinent HOA members. Afterward, the HOA issued a formal Letter of Support to VEN stating it has no objection to the project location.

The pilot plant constructed in Stage 1 consisted of a dual treatment system that would compare pollutant removal abilities of a managed aquatic plant system using various aquatic plant modules, with an attached algae system's pollutant removal abilities. Stage 1 water quality testing (October 14, 2016 – November 17, 2016) measured a range of NRC water chemistry parameters, including nitrogen, phosphorous, micronutrients, heavy metals, and herbicides. The average total nitrogen (TN) and total phosphorous (TP) concentrations in the canal over the Stage 1 testing period were 0.70 mg/L and 0.12 mg/L, respectively. However, it is important to note that Stage 1 testing began shortly after hurricane Matthew and as stormwater runoff from

the hurricane decreased, nutrient levels decreased dramatically over the remainder of the Stage 1 testing period. In comparison, average TP levels in the NRC were similar to Egret Marsh influent data from 2010-2011 (0.10 mg/L), whereas the TN was lower than Egret Marsh's 2010-2011 yearly average (0.95 mg/L). It is notable that the percentage of bioavailable nitrogen (NH_4 and NOx) represents only a small fraction of the NRC's TN, suggesting the potential for periodic nitrogen limitation and deficiency in the NRC. We did not detect meaningful levels of herbicides or heavy metals in the NRC.

Stage 2

Stage 2's goal was to experimentally identify the most efficient aquatic plant combination/strategy for NRC nutrient reduction. The primary pilot plant focus was a series treatment train consisting of floating aquatic plants followed by a flat algal treatment cell, followed by a treatment cell containing emergent aquatic plants[1]. This system is identified by the acronym LEAPS, meaning Low Energy Aquatic Plant System. The LEAPS was operated in parallel with and compared to a separate attached algae pilot system.

During Stage 2 we compared the LEAPS' TN and TP removal efficiency to the standalone attached algae system. The LEAPS exhibited superior areal biomass production and N/P areal removal rates[2] (ARRs) compared to the attached algae system.[3] To confirm this trend, we continued the comparative testing of the two systems into Stage 3. On June 18, we discontinued operation of the standalone algae system due to consistent observations of diminishing quality and quantity of crop on the algae platform, coupled with additional data confirming the superior performance of the LEAPS system.[4]

Results also showed that the most efficient LEAPS consists of one or more water lettuce modules followed by an algal module. The Stage 2 study showed that the LEAPS module containing the emergent aquatic plants provided only minimal additional nutrient removal and it was therefore, eliminated from consideration during the Stage 3 study.

Stage 3 (Through August 30, 2017)

During Stage 3, we are focusing testing efforts on the LEAPS technology to determine the efficiency of the different modules as it relates to biomass production and the corresponding ARRs of Nitrogen and Phosphorous. The combined biomass-based ARR of the LEAPs system

[1] The emergent plants were installed so that the plant's roots were submerged in the water column, allowing them maximum access to the NRC nutrients.
[2] Aerial Removal Rate (ARR) = The TN or TP present in the harvested biomass (or removed based on water quality data) *divided by* the surface area of the treatment unit.
[3] LEAPS ARR_{TN} = 40.9 g/m^2/yr, ARR_{TP} = 7.0 g/m^2/yr ; Algae System ARR_{TN} = 27.6 g/m^2/yr, ARR_{TP}= 6.3 g/m^2/yr
[4] LEAPS ARR_{TN} = 52.2 g/m^2/yr, ARR_{TP} = 9.7 g/m^2/yr; Algae System ARR_{TN} = 33.3 g/m^2/yr , ARR_{TP}= 7.7 g/m^2/yr. Comparative areal removal rates were calculated from harvest data from 1/23/2017 to 6/18/2017; we discontinued the operation of the stand-alone algae system on 6/18. Note that the LEAPS areal removal rate calculations do not include the Emergent Plant Module as the system was not weighed or harvested during that time. Stage 2 composite tissue data was used to estimate TN and TP levels in biomass between systems

as of August 14, 2017, was 71.1 $g/m^2/yr$ TN and 13.3 $g/m^2/yr$ TP. These values compare favorably to the performance of the combined Egret Marsh Algal Turf Scrubber and Polishing Pond/Wetland System, which exhibited ARRs of 30.1 $g/m^2/yr$ TN and 8.4 $g/m^2/yr$ TP.[5] Within the LEAPS system, the first water lettuce tank exhibited considerably higher ARRs (98.1 $g/m^2/yr$ TN and 17.3 $g/m^2/yr$ TP) than the downstream water lettuce tank and algae floway; these data can be leveraged in a full-scale system design to maximize areal removal efficiencies while minimizing per pound removal costs.

In addition to biomass-based analyses, weekly composite water samples were collected allowing water quality monitoring of key nutrients and micronutrients in influent and treated effluent. Water quality based ARRs calculated for the LEAPS system from data collected over the Stage 2 and Stage 3 period (to August 28, 2017), were similar to the biomass based ARRs (Water Quality LEAPs ARR = 59.3 $g/m^2/yr$ TN, 13.4 $g/m^2/yr$ TP).

Collectively, the Stage 1-3 activities to date have allowed a down-selection of the most effective treatment options on the NRC and when Phase 3 is complete, the associated data can be leveraged to design a full scale system that maximizes areal removal rates of NRC nitrogen and phosphorous, while reducing treatment costs. Preliminary data suggests the most efficient pollutant reduction system should consist of a single water lettuce module followed by a non-sloped algal module as the system's major treatment units, followed by a final polishing pond/passive wetland system. The majority of the pollutant removals will occur in the water lettuce and algal modules, which will be regularly harvested to remove nutrients contained in their excess biomass.

FUNDING

Funding for the pilot plant study comes from Transportation Fund/Stormwater/Aquatic Plant Pilot Study – Account # 11128138-033190-16031.

RECOMMENDATION

None. Agenda item presented for information purposes only.

ATTACHMENTS

1. Copy of PowerPoint presentation

DISTRIBUTION

Michael Smykowski, Budget Division

APPROVED AGENDA ITEM FOR OCTOBER 3, 2017

[5] From the Egret Marsh Stormwater Park 319 Grant Final Report