City of Coral Gables Assessment of Water Quality and Habitat Conditions in the Coral Gables Waterway to Inform Management and Restoration

Scope of Work

Submitted to:

City of Coral Gables

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May 8, 2020

(revised Final per City of Coral Gables comments received at September 25, 2019 meeting, scopes of work and follow-up meetings with City)

SUMMARY

The Nutrient Enrichment Problem: Coastal systems (brackish canals and estuaries) throughout the State of Florida are nutrient enriched (nitrogen and phosphorus) to varying degrees as recently seen in a most extreme form in the St. Lucie River estuary in Martin County, Florida and the persistent *Anadyomene* macroalgae bloom in the west-central portion of Biscayne Bay. The elevation of nutrient levels is primarily related to changes in watershed land-use associated with increasing population (leading to increasing septic system discharges and fertilization) and impermeable surface area (leading to increased stormwater runoff) within the coastal zone over the past half century. The regional effects of nutrient loading span the spectrum from environmental to socio-economic impacts and have direct consequences to the culture, economy, and the tax base of Florida's coastal communities such as the City of Coral Gables and Miami-Dade County more generally. Moreover, as sea level rises and is exacerbated by climate change, hydraulic gradients of the coastal groundwater system will gradually be altered. This will also affect the controlled surface water inflows to the coastal canal systems such as is the ones found throughout the City of Coral Gables. As such, low-lying residential septic systems and stormwater drainages performance and capacity will be more frequently compromised (e.g., Miami-Dade County 2018), likely resulting in environmental, public health, and economic consequences.

Overview: The collaborative nutrient loading assessment of the Coral Gables waterway system discharging to Biscayne Bay, as summarized below, is designed to provide a detailed quantification of nutrient loads at critical junctures in the brackish waterway/canal system as a contributor and driver of water quality impairment in the Coral Gables Waterway and the Biscayne Bay Habitat Focus Area. In the short term, the assessment is to serve as a guide to municipal managers for the cost-effective management of nutrient sources in the watershed to improve water quality in the canal system and the quality of the discharge to Biscayne Bay. In the long term, the proposed assessment of the Coral Gables waterway system is intended to assist the City of Coral Gables with watershed nutrient management and infrastructure planning for adaptation to ongoing rising sea levels and planning for potential future accelerated rise rates. Gradually increasing sea levels in low-lying areas may have a direct effect on the efficacy of: 1) nearshore stormwater management infrastructure discharging directly to the canal system and 2) residential septic systems adjacent to the waterway and associated tributary canals. Given the potential impacts of each on down-gradient receiving waters such as the waterway and Biscayne Bay, accurate assessment of the key nutrient sources controlling the regime of the waterway system and estimating projections of future conditions is critical for effective management of both the waterway system and Biscayne Bay as two distinct but interconnected systems.

The overall scope of this project is to be performed as a collaborative effort between scientists from multiple public and non-profit institutions with local presence in Miami and the City of Coral Gables specifically and will be phased based on the availability of funds from the City or external grants. Upon completion of all three phases of the project, the City of Coral Gables will be initially provided a detailed assessment of the watershed specific loads affecting the Coral Gables waterway system to serve as a guide for targeting watershed nutrient management. In later phases the team will produce a system-specific numerical model designed as a tool for testing hypothetical scenarios that will inform decisions regarding infrastructure planning. Phase 1 of the project will span one hydrologic year and will capture the inter-annual variation in water quality (nutrient, dissolved oxygen, chlorophyll-a concentrations, and

wastewater tracers and microbial indicators) within the canal system due to seasonally dependent precipitation/temperature conditions as well as tidal variations driven by changing lunar phases. The project is also intended to serve as a pilot for assessing the other canal systems discharging directly to Biscayne Bay.

Project Description: The collaboration between the various project partners will require a multi-stage approach to link nutrient generating activities on land within the watershed to effects on the water quality of the brackish waters of the Coral Gables Waterway and the associated tributary canals leading to Biscayne Bay. The quantitative investigation of the system will focus on areas throughout the waterway / canal system that are dominated by brackish conditions (mix of salt and freshwater) down-gradient of the G-93 SFWMD water control structure. Time-series dissolved oxygen and chlorophyll-a measurements using moored sensors deployed at strategic locations coupled to traditional water quality monitoring will be used to accurately quantify the degree of habitat/water quality impairment. Flow and nutrient concentrations will be measured, estimated and modelled to determine pollutant load estimates to identify which portions of the watershed are contributing the most load from different land use types and explore the potential contribution of associated septic systems. These activities are aimed to generate enough baseline data to gauge the vulnerability of these systems to future sea level rise in the decades to come. Pollutant load estimates will be complemented by measurements of nutrient flux at select critical junctures in the waterway/canal system, and nutrient concentrations/loads in the system, to test modelled outputs and evaluate watershed loading estimates. Work completed under each project phase will be summarized in task specific technical memoranda submitted to appropriate City staff for review and comment. The complete set of findings generated through this study will be synthesized into a report and shared with City staff for review prior to periodic updates to Waterway and Sustainability Advisory Boards.

Task work completed *will be summarized in task specific technical memoranda*. This scope of work details Phase 1/Year 1 Tasks, and is part of a proposed 2-year project. The scopes of work for later years will be based on progress and interim results from Year 1 work, and other leveraged resources that will be sought to support the overall goals of the project. In addition to what is specified below, all data will be centralized and archived at FIU Institute of Environment. The Institute server utilizes strict security measures to archive data. Each technical task is described in detail below and are as follows:

Task 1) Design and implement a water quality monitoring program to understand nutrient loading impacts on water quality in the Coral Gables Waterway and Tributary Canals, including stormwater outfalls

Task 2) Characterizing the Nutrient Loads into and from Watershed

Task 3) Undertake field data collection at select critical junctures of the waterway system for tidal stage and velocity measurements to inform model development

Task 4) Education and Outreach / Policy Development

Task 5) Data Synthesis, Reporting and Project Management

PROJECT TASK DESCRIPTION

Task 1) Design and implement a water quality program to improve our understanding of nutrient loading impacts on water quality in the Coral Gables Waterway and Tributary Canals, including stormwater outfalls

Sustaining the health and value of a brackish canal system, such as the Coral Gables Waterway, requires a quantitative understanding of the biological and physical processes which control nutrient related water quality and the role of watershed inputs in the nutrient budget. An essential step in managing these coastal systems is to monitor their water quality, both for assessing current status and trends and for validation of future water quality management models. The results of a directed water quality observation effort are needed to determine the relative role of different nutrient sources and their loadings to the Coral Gables Waterway and to assess the type of management action and level of effort required to improve conditions. The collaborative water quality observations to be undertaken throughout the Coral Gables Waterway system will focus on retrieving water samples from critical junctures in the canal / waterway system throughout the residential community of Coral Gables from the upstream SFWMD control structure (G-93) located at Red Road to the mouth of the Coral Gables Waterway discharging to Biscayne Bay.

The focus of this task is to establish a spatially-extensive and temporally-intensive network of water quality monitoring stations as a basis for cost-effective and robust monitoring to quantify the impact of watershed based nutrient loading to the Coral Gables Waterway system. The goals of the water quality monitoring design are to ultimately: 1) identify and understand the largest contributors to water quality impairment and 2) make recommendations for water quality mitigation and implementation of best management practices. Water quality monitoring including DO/CHLA mooring deployments will be undertaken by a team of scientists from FIU, University of Massachusetts-Dartmouth, NOAA and Miami Waterkeeper. ***Task Deliverable –*** *Quarterly email updates indicating sampling dates completed and a Technical Memorandum summarizing the wet and dry season water quality results as well as the results of stormwater sampling. Results will be plotted and a spreadsheet file will be provided to the City (project team members will also retain data files). Regarding the dissolved oxygen and chlorophyll mooring deployments, a Technical Memorandum will be submitted to the City approximately 2-months after the deployment. Each memorandum will provide details on measurement approach as well as plots of the DO / CHLA levels for each of the seven moorings deployed, accompanied by a table summarizing data. The DO/CHLA data will also be provided to the City in digital format and be retained by project team. Regarding deployment of ISCO samplers by FIU scientists, a Technical memorandum will be produced at the end of the sampling year summarizing the water quality data collected. Plots and tables of the data will be provided to the City along with a spreadsheet file of the water quality data which will also be retained by FIU.*

A. Systematic, spatially-extensive water sampling will be undertaken at 13 stations located strategically along the CGW from the SFWMD control structure (G-93) at Red Road to the mouth of the Coral Gables Waterway where it discharges to Biscayne Bay (MD-DERM long-term monitoring station CG-01) as depicted in Figure 1a, and 2 additional outfall stations discharging into the Snapper Creek canal. One station will be situated immediately up-gradient of the G-93 SFWMD control structure at Red Road and one station will be located immediately down-

gradient. Both will serve as upper boundary condition stations along with MD-DERM station CG-01 (lower boundary station) at the mouth of the waterway system, with one station located at the Bird Rd. stormwater outfall as well as one station situated immediately down gradient of the 66-inch outfall (CGMS-08) passing under Riviera Road.

Sampling will be conducted monthly during the dry season (November to May) and bi-weekly during the wet season (June through October), because the wet season will have the highest variability in water quality [and following a minimum sampling regime of 3 wet weather samplings (e.g., shortly after significant rainfall events, on the ebb tide) and 2 dry weather samplings, to follow the Coral Gables Monitoring and Assessment Plan – Phase I Municipal Separate Storm Sewer System (MS4) Permit]. Previous water quality sampling in 2016-2017 indicated stratification of the water column, thus water samples will be collected from surface and bottom water at all stations. This proposed sampling effort builds on volunteer water quality monitoring that was undertaken in the waterway system in 2016-2017 as a coordinated effort between a University of Massachusetts-Dartmouth (UMD) Coastal Systems Program (CSP) scientist living locally full time in Coral Gables, NOAA-AOML scientific staff, students and teachers from the Ransom-Everglades School and the FL SeaGrant Monitoring Coordinator. Sampling in 2016-2017 was undertaken synoptically during a narrow 3-hour window when samples were collected by multiple sampling teams all going out in the morning during the ebbing tide. The proposed sampling effort will mirror historic sampling to be able to cross compare new water quality data against data generated in 2016-2017. It is envisioned that 4 sampling teams will be needed, and samplers may include staff from NOAA, UM, Miami Waterkeeper, FIU students and city residents as part of citizen science campaigns. All participants will be trained to sample in a unified manner. Teams will be divided by location with NOAA/UM team covering the upper portion of the waterway, U Mass/FIU and others covering the middle portion of the waterway, and Miami Waterkeeper/FIU covering the lower portion, with Ransom Everglades students assisting with sampling during the academic year. FIU will cover additional sampling, as needed (stormwater outfalls, including Snapper Creek).

Water sampling teams will be supplied with the necessary sampling equipment to conduct field measurements of physical parameters as well as collect ebb tide (morning) water samples for subsequent nutrient analysis by the NOAA AOML Analytical Facility on Virginia Key and FIU CREST-CACHE analytical facilities, and at UM facilities for additional parameters. Salinity will be measured in the field and confirmed in the lab. This will inform the observer as to the degree of stratification in the water column. Additionally, physical parameters will be measured, including total depth, Secchi depth (light penetration), temperature, salinity, surface state, weather conditions, wind speed and direction. Samples will be pre-processed and/or filtered the day of sample collection and immediately chilled for transport to the NOAA, FIU and UM laboratories for chemical analysis. All samples will be analyzed within their appropriate holding times and remaining samples preserved as appropriate until the project completion.

Laboratory analyses at NOAA will include: nitrate + nitrite, ammonium, soluble reactive phosphorous, silica, total dissolved nitrogen, total dissolved phosphorous, chlorophyll-a/pheophytin, and salinity; laboratory analyses at UM will include: viable enterococci, and qPCR microbial source tracking assays [16S ribosomal genetic markers for fecal *Bacteroides* specific to

human (an indicator of untreated sewage e.g., septic tanks and untreated sewage pipe breaks) and dog hosts] + E. coli at a subset of stations (minimum schedule - 2 dry and 3 wet samplings at all stations for maximum of 200 samples); and laboratory analyses at FIU will include: nitrate + nitrite, ammonium, soluble reactive phosphorus, total nitrogen and phosphorus, total dissolved nitrogen and phosphorus, and salinity (at a subset of stations, TP/TN - minimum schedule - 2 dry and 3 wet samplings at all stations), TSS and BOD; dissolved metals (i.e. zinc, copper and lead); and additional wastewater tracers including caffeine, sucralose and a set of other indicators of provenance (current method includes carbamazepine, triclosan, diphenhydramine and 5 hormones; at a subset of stations; ~150 samples). Data are QA/QC'ed to discern any possible artifacts caused by improper sampling technique, lab analytical or instrument error. Chains of Custody (COCs) will accompany all samples and copies of COCs will remain on file with the respective designated monitoring coordinator, who will also retain copies of field data sheets. Upon contract execution, estimated grab sample count (735) is based on a maximum of 17 sampling events [1/month November-May), 2/month June-October, 15 stations sampled per event, 2 samples (surface and bottom)] = 510 + 10% QA (51 samples) = 561 + 174 samples [at a subset of stations for lab cross-calibration (108) and 50 stormwater outfall samples (10 sites, 2 dry and 3 wet samplings)] + 10% QA (16 samples) = 735 samples .

B. Dissolved oxygen levels near atmospheric equilibrium are important for maintaining healthy animal and plant communities. Short-duration oxygen depletions can significantly affect communities even if they are relatively rare on an annual basis and are an important indicator of habitat and water quality impairment. Conversely, short to medium scale increases in chlorophyll-a are important indicators of water quality and habitat impairment and a sign of concomitant problems with dissolved oxygen and nutrient enrichment. To gage the degree to which the Coral Gables Waterway system is impaired, a network of moorings (7 total) will be deployed by UMass team members with local presence in Coral Gables for temporally-intensive measurement of dissolved oxygen and chlorophyll (Figure 1b). Nearly continuous (15-minute intervals) recording moorings will be deployed 30 cm off the sediment bottom and at some locations will be paired with a mooring at 0.5m below the water surface. Moorings will generally be co-located at a subset of the spatially-extensive water quality stations to measure dissolved oxygen, chlorophyll-a, temperature and salinity at 15-minute intervals and evaluate potential habitat impairment in the system. Moorings will be deployed at critical locations (areas that are structurally likely to support low oxygen conditions) throughout the system during both the wet season and the dry season to establish variability in conditions based on high frequency measurements. Each deployment will last a minimum of 30-60 days during both wet and dry seasons. For Year 1 monitoring, moorings will be deployed in either the wet or the dry season depending on contract start date.

C. Scientists from Florida International University will deploy 2 additional ISCO autosamplers (to complement the 2 existing autosampler stations, funded separately) for temporally-intensive nutrient/carbon sampling of water at 0.5m below the water surface at a subset of the spatially-extensive water quality station network stations. Two existing autosamplers are located near CGW-8 and CGW-3. For the new deployments, one sampler will be placed near the CG-1 station and a second ISCO autosampler at the Bird Rd. or other stormwater outfall. Monthly grab samples (described above) are coupled with the temporally-intensive water sampling.

Autosamplers deployed by FIU are an in-kind contribution benefit to the City. Estimated number of samples is 360. Water samples are analyzed for TN and TP. Another FIU contribution is a CREST water quality buoy, deployed at Blue Rd. The buoy sensors record depth, conductivity, salinity, temperature, pH, chlorophyll-a, dissolved oxygen, flow speed and direction and turbidity. Buoy sensors can also be calibrated for other parameters. The buoy is deployed in the approximate location of CGW-8.

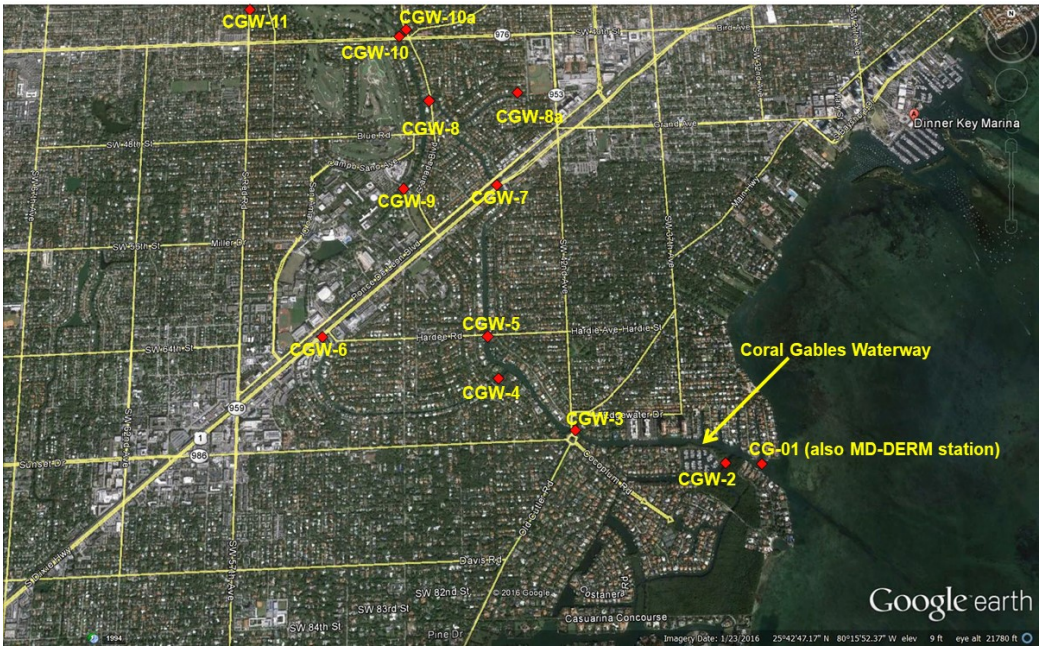

Figure 1a. Proposed Water quality monitoring stations located in the main stem of the Coral Gables Waterway and associated tributary canals within the City of Coral Gables, FL. Canals discharge to Biscayne Bay at the mouth of the Coral Gables Waterway where a MD-DERM long term monitoring station is located (CG-01). CG-8a and CG-10a are both located proximal to major stormwater outfalls. CG-12 and CG-13 are not shown.

Figure 1b. Proposed dissolved oxygen / chlorophyll-a mooring locations in the main stem of the Coral Gables Waterway and associated tributary canals within the City of Coral Gables, FL.

D. An additional potential partner with whom we are in discussions is the Miami-Dade Department of Environmental Resources Management. We are currently discussing 2 types of pilot studies as part of this water quality program. The completion of these studies is contingent on DERM funding and support available and permission/approved permits.
    a. Septic study: We are also in discussions about establishing a piezometer (shallow groundwater) study to evaluate the flux of contaminants entering and leaving the drainfield at 0.5 and 1m depth, to determine the net contaminant load. Sampling sites will be identified in areas with shallow groundwater and in consultation with the City.
    b. Analyses of NO_3-^{15}N of water samples: An additional type of tracer we are in discussions to apply is NO_3-^{15}N of water at potential source and receiving locations throughout the waterway. NO_3-^{15}N of water has been used to determine presence of nitrate-based fertilizer.

Task 2) Characterizing the Nutrient Loads into and from Watershed

This task will be focused on developing a GIS-based land use specific nutrient loading tool to be able to correlate nutrient loads to water quality data in specific segments of the overall waterway system, conducted by FIU with contributions from the team. As applicable, this task will leverage land use analysis and pollutant loading modeling completed for the City of Coral Gables (Coral Gables MS4 Year 3 Annual Report, Permit No. FLS00003, Hazen and Sawyer, December 2014) and will be based on Storm

Water Management Model (SWMM). SWMM is a is a one-dimensional, process-based, dynamic rainfall-runoff model to simulate surface runoff quantity and quality from urban catchments (Niazi et al., 2017; Rossman and Huber, 2016a; Rossman, 2015). SWMM is a distributed model that incorporates spatial variability in topography, drainage directions, land cover and land uses, and soil type to quantify runoff from catchments/subbasements. The runoff component of SWMM can simulate a single or continuous rainfall event to generate runoff and pollutant loads from a collection of sub-catchments. The routing component transports the runoff through a network of pipes, channels, storage units, pumps, and regulations. The software is commonly applied to design drainage system components, map flood plains, generate pollutant loads, and evaluate the effectiveness of best management practices for reducing pollutant loadings. Quantification of the nitrogen and phosphorus input to the Coral Gables Waterway system will be based on the SWMM5 version PCSWMM which includes 1-D-2-D integrated modeling to develop Year 1 pollutant loadings. Groundwater level output from the Miami-Dade model will be used as initial conditions for rainfall-runoff volumes, with groundwater levels under SLR used to provide preliminary estimates of the influence of SLR. From this water quality model, a full land-use loading model will be developed for each component of the waterway / canal system to determine the spatial distribution of different potential loading sources. The amount of nitrogen and phosphorous loading to the various segments of the waterway / canal system from each land use category (e.g. wastewater {septic, sewer}, fertilizers {residential, golf courses}, impervious surfaces, water body surface, natural surfaces) will be calculated and compared to waterway nutrient concentration data collected from the monitoring program. A distinction will be made between nutrient loads attributable to residential parcels serviced by septic systems and residential (or commercial) parcels that are connected to the MD-WASD sewer system. Appropriate City of Coral Gables Departments will be engaged to request the most up to date land use data. A total N and P load generated by the land use analysis within the boundary of the City will be determined for the Coral Gables Waterway system as it discharges to Biscayne Bay. In addition, nutrient load entering the waterway system from above the SFWMD G-93 control structure will be calculated using water sample concentration data from the monitoring program and SFWMD flow records for the control structure. The total load entering the waterway system through the G-93 control structure will be compared to the land-use based load from within the City boundary to determine the relative magnitude difference between the two loading values. ***Task Deliverable –*** *Quarterly email updates and a Technical Memorandum summarizing the land use analysis approach including a breakdown of the nutrient loads by land use category and load external to the City entering the system from up-gradient of the G-93 control structure. Finalized electronic files developed will be provided to the City and also be retained by project team members*.

Task 3) Undertake field data collection at Critical Junctures of the Waterway System for tidal stage and velocity measurements to inform model development

Currently, we have 2 tidal gauges (funded under a separate project) and 1 flow meter (instrumented with the CREST water quality buoy) deployed for continuous monitoring at 2 locations. These data will begin to: 1) inform the development of a numerical hydrodynamic/water quality model and serve as a robust calibration/validation step for the numerical model. Measurements of tidal elevation will be used to relate ebb and flood tide volumetric flow to tidal stage during a given tidal cycle. Tidal stage will also be used to quantify tidal forcing and damping for development of the 1-D hydrodynamic model and will also be used to validate that the hydrodynamic model can properly recreate stage conditions in the

system. The gauges are deployed relative to a common datum. The tide gauge and velocity data will also be used to develop an initial characterization of volumetric and nutrient exchange under different tidal conditions. Coupling flow data and ISCO autosampling at CGW-8, we are collecting data to determine nutrient flux with tidal exchange at this location. We will task the buoy for a short deployment at a second ISCO autosampler location coastward (e.g, CGW-3) to also determine nutrient flux with tidal exchange at this location. These are a subset of samples specified in Task C.

Task 4) Education and Outreach / Policy Development

The goal of this task is to: 1) develop policy recommendations in collaboration with the City to drive water quality improvement and restoration of the waterway system and 2) gain a better understanding of what policy recommendations are effective at improving water quality. Results of the study tasks will be communicated to City and public stake holders to enhance the knowledge and understanding of elected officials and Coral Gables residents regarding Coral Gables Waterway and Biscayne Bay's water quality, how the Bay is affected by inputs from Coral Gables Waterway and the importance of maintaining the health of both ecological systems. This task will encourage beneficial management of both Coral Gables waterway and Biscayne Bay water quality and habitat issues. Collectively, these activities will: 1) increase the knowledge of elected officials and residents on the Coral Gables Waterway and the Biscayne Bay watershed, 2) increase their understanding of how land-based sources of pollution can have a direct impact on both systems, 3) enhance awareness among public officials and residents about the importance of current and future monitoring and watershed based management specific to the Coral Gables Waterway system, 4) educate officials and public about the economic importance of clean water in the Coral Gables Waterway and Biscayne Bay and 5) educate local leaders on strategies to reduce nutrient inputs to the linked waterway / Bay system in the near term as well as the long term vis a vis sea level rise (SLR). Educational materials developed as part of this task include: 1) informational materials that describe the involvement and field research experiences of students and citizen scientists, and 2) outreach materials presented in lay-person language to inform the students, citizen scientists an community members of the research and results. As part of watershed mapping, data layers will also be created to map where policy recommendations have been implemented and/or actively implemented by residents. Education, Outreach and Policy Development will be led by Miami Waterkeeper science staff with support from other team members as appropriate (FIU, U Mass, NOAA). ***Task Deliverable –*** *Quarterly email updates will be provided in addition to educational materials developed to communicate information developed under previous tasks. Finalized electronic files developed will be provided to the City and also be retained by project team members*. *Policy recommendations developed will also be presented in the Final Report.*

Task 5) Reporting and Project Management

This task includes: the cost of data post-processing and synthesis and preparation of a Year 1 Technical Report summarizing the findings of Tasks 1-4 as well as the costs of managing the overall project. The Year 1 Technical report will summarize the field work completed and the associated results, and GIS-based water quality model and pollutant loadings, and preliminary recommendations for next steps that the City of Coral Gables may want to consider in its near to long-term planning process for mitigating the

effects of nutrient loading to the waterway systems as well as adapting to sea level rise. This report will also include a presentation to the City of Coral Gables as well as other pertinent stakeholders to explain the objectives behind the investigation as well as its conclusions and potential next steps. Findings will be discussed with City of Coral Gables technical staff prior to being presented to the City Commission or provided to the general public. Overall project management will be undertaken by FIU, however, development of the project report will be a collaborative effort with each team member responsible for summarizing the work completed under their respective tasks. ***Task Deliverable –*** *Quarterly email updates will be provided to the City and a Final Report presenting all data collected from all tasks completed along with a summary/synthesis of Modeling results will be submitted to the City. The Year 1 Technical Report will also provide preliminary recommendations for nutrient management. A draft electronic copy of the report will be provided to the City for review and comment. One hard copy and one electronic copy of the Year 1 Technical Report will be provided to the City.*

References

Miami-Dade County. 2018. Septic Systems Vulnerable to Sea-Level Rise. Miami-Dade County. 66p.

Niazi, M., Nietch, C., Maghrebi, M., Jackson, N., Bennett, B. R., Tryby, M., & Massoudieh, A. (2017). Storm water management model: performance review and gap analysis. *Journal of Sustainable Water in the Built Environment*, *3*(2), 04017002.

Rossman, L. A. (2015). *Storm water management model user's manual, version 5.1*. Cincinnati: National Risk Management Research Laboratory, Office of Research and Development, US Environmental Protection Agency.

Rossman, L. Huber W (2016a) Storm Water Management Model Reference Manual Volume III– Hydrology. *US Environmental Protection Agency, Office of Research and Development*.

PROJECT BUDGET – PHASE 1/YEAR 1

FIU (Lead Organization)	
Salaries & Wages	$33,048
OPS (Other Personnel)	$17,000
Total Fringe	$15,197
Domestic Travel	$1,000
Materials & Supplies/Other Operating Expenses	$49,454
FIU Direct Costs	$115,699
Subawardees	
University of Miami	$79,912
University of Massachusetts	$38,780
Miami Waterkeeper	$17,875
Total Direct Costs	$252,266
Total Indirect Cost Base	$183,574
Total Indirect Cost (26.0%)	$47,729
TOTAL	$299,995

PROJECT SCHEDULE

Assuming a project start date of June 15, 2020, **Phase 1 (Year 1)** will be initiated immediately to begin water quality monitoring to build a baseline of water column nutrient conditions that reflects both dry and wet conditions in the canal system. Deployment of moorings to measure dissolved oxygen and chlorophyll conditions will begin as well (specific dates TBD). Water quality monitoring will extend from June 15, 2020 to June 14, 2021 (Year 1) and will include either the wet or the dry weather DO/CHLA characterization. In year 1, the GIS based nutrient loading analysis of the watershed to the waterway system will also be undertaken. Elements of hydrodynamic field data collection include continuous tidal stage measurements at 2 locations (separate contract) and velocity measurements at 1 location (CREST buoy). Outreach and education efforts will also be included, and punctuated at appropriate times to coincide with completion of critical field tasks.

Phase 2 (Year 2 **-** contingent upon availability of funding**)** of the overall project will extend water quality monitoring starting June 15, 2021 and extending to June 14, 2022 (Year 2). During that time a second mooring deployment will be considered for measurements of dissolved oxygen and chlorophyll conditions in either the wet or the dry season depending on which was completed in Year 1 (specific dates TBD). GIS-based nutrient loading analysis of the watershed will also be completed. Specific scope

of work will be developed based on initial year 1 analyses and project needs in consultation with the City (including elements of Phase 3 hydrodynamic or ecological field data collection that may include velocity profile measurements, quantification of benthic nutrient recycling, relation to benthic resources in the Bay, preliminary model testing, as time and funding allows). Based on available data and information, recommendations will be provided toward nutrient load reduction and guidance/policy for the City of Coral Gables relative to nutrient management in Coral Gables will be made. Outreach and education efforts will also be included, and punctuated at appropriate times to coincide with completion of critical field tasks.

Statement of Work - University of Miami

Project Period: One year – June 2020 to June 2021

Objective: Design and implement a water quality assessment program to improve the understanding of nutrient loading and microbial contaminant impacts on water quality in the Coral Gables Waterway and Tributary Canals.

Scope: A total of 17 sampling events with one per month during dry season, two per month during wet season, 13 stations sampled per event, 2 samples (surface and bottom) per station. (autosamplers, 3 day composites at 2 sites, May-June and Oct-Nov (80 samples) + monthly surface grabs (8 samples) = 442 samples + 10% QA (44 samples) + 88 samples + 10% QA (8 samples) = 582 samples)**.** The samples will be measured for a suite of nutrient parameters and fecal indicating bacteria, along with appropriate positive and negative controls. Nutrient analytes will consist of: Ammonia, Nitrate+Nitrite, Silica, Phosphorous, Total Dissolved Nitrogen, Total Dissolved Phosphorous, and Chlorophyll a. Bacterial analytes will consist of: viable enterococci (by culture-based mEI agar plate counts), and 16S ribosomal genetic markers for fecal *Bacteroides* specific to human and dog hosts respectively (by qPCR microbial source tracking assays). A subset of samples will include E. coli using EPA-approved methods.

Tasks/Scientific Goals: Determine amount of nutrient loading and fecal-associated microbial contaminants present in the waterways and canals of Coral Gables. Characterize the relative abundance of host-specific fecal bacteria from humans-sources (representing sanitary infrastructure inputs) and canine sources (a proxy representing terrestrial runoff inputs) in these waterways and canals. Assess various potential impacts on water quality in these waterways, then provide interpretation of results and recommendations to the Stakeholders based on the finding of this study.

Products/deliverables: The Nutrients program, in addition to assisting FIU with sample collection and auto-samplers, will analyze 30 samples per sampling trip for Ammonia, Nitrate+Nitrite, Silica, Phosphorous, Total Dissolved Nitrogen Total Dissolved Phosphorous, and Chlorophyll a.

The Microbiology and Molecular program will evaluate all samples for the abundance of fecal Enterococci as per the EPA method 1600, and will run assays of microbial source tracking (MST) markers for human fecal contamination (using the “HF183” human-specific *Bacteroides* assay) and for dog fecal contamination (using the “DogBact” canine-specific *Bacteroides* assay) as per the protocols of the California Microbial Source Identification Manual. The Quality Assurance and Quality Controls for the fecal bacterial assessments will be as per EPA method 1600 for the viable enterococci, and as per EPA method 1696 for the qPCR MST assessments. A subset of samples will include E. coli using EPA-approved methods.

All data will be analyzed and compiled in a biannual report, with a final report including observations, discussion, and evaluation of potential impacts.

Budget and Justification (UM)

	DRAFT BUDGET				
		YEAR 1			
		months	%	AMOUNT	TOTALS
Research Staff					
1	Maribeth Gidley	2.2	37%	13,274	13,274
2	Ian Smith	2.5	21%	9,659	9,659
Staff					
1	James Nowotny	1.0	8%	2,334	2,334
Total Salaries				**25,267**	**25,267**
Faculty Fringe Benefits				0	0
Staff Fringe Benefits				10,155	10,155
Total Salaries and Fringe Benefits				**35,422**	**35,422**
Travel Domestic					0
Travel Foreign					0
Other Direct Costs					
Supplies				28,000	28,000
Modified Total Direct Costs				63,422	63,422
Facilities & Administrative Costs			26.0%	16,490	16,490
Total Project Costs				**79,912**	**79,912**
					79,912

Statement of Work - UMD School for Marine Science and Technology

Project Period: June 2020 – June 2021

Objective:

Design and implement a water quality monitoring program to establish baseline dissolved oxygen/chlorophyll levels, nutrient related water quality conditions and facilitate understanding of nutrient loading impacts on water quality in the Coral Gables Waterway (CGW) and Tributary Canals, including major stormwater outfalls

Scope:

This statement of work represents a funded component of a broader yet to be funded overall effort that is a collaboration between the various project partners (FIU as lead institution, NOAA, University of Massachusetts-Dartmouth {UMASSD}, Miami WaterKeeper) aimed at implementing a multi-stage approach to link nutrient generating activities on land within the boundaries of the City of Coral Gables to effects on the water quality of the brackish waters of the Coral Gables Waterway and the associated tributary canals leading to Biscayne Bay.

The broader effort is a quantitative investigation of the estuarine system focused on areas throughout the waterway / canal system that are dominated by brackish conditions (mix of salt and freshwater) down-gradient of the G-93 SFWMD water control structure. Time-series dissolved oxygen and chlorophyll-a measurements using moored sensors deployed at strategic locations coupled to traditional water quality monitoring will be used to accurately quantify the degree of habitat/water quality impairment. Flow and nutrient loads will be measured at critical junctures in the waterway/canal system to empirically determine the nutrient concentrations/loads in key basins of the system, an to confirm the watershed loading estimates and identify which portions of the watershed are contributing the most load from sediments, different land use types and associated septic systems and to gauge the vulnerability of these systems to future sea level rise in the decades to come. Work completed as part of the yet to be funded broader effort will be summarized in task specific technical memoranda submitted to appropriate City staff. The complete set of findings generated through completion of the broader study will be synthesized into a report and shared with City staff for review prior to presentation to the City Commission and the public. The report will be a guidance document by which the City of Coral Gables can prioritize its landside nutrient management to improve water quality in the CGW and near shore waters of Biscayne Bay.

Background:

Coastal systems (brackish canals and estuaries) throughout the State of Florida are nutrient enriched (nitrogen and phosphorus) to varying degrees as seen in a most extreme form in the St. Lucie River estuary in Martin County, Florida and the persistent *Anadyomene* macroalgae bloom in the west-central portion of Biscayne Bay. NOAA scientists continue to document increasing trends for nutrients and chlorophyll in Biscayne Bay with particular concern over water and habitat quality conditions in the nearshore waters in the vicinity of canal discharges. Additionally, the recently formed Biscayne Bay Task Force aims to develop actionable recommendations regarding nutrient management for restoration of Biscayne Bay. The City of Coral Gables, as responsible principal steward of the waterway system, is

focused on understanding the extent of water quality impairment in the waterway system, the drivers of said impairment and finding cost effective measures for improving water quality in the waterway system.

Tasks/Scientific Goals:

In regard to UMASSD role as represented on the science team by members of the Coastal Systems Program, CSP scientists will be providing technical lead and limited field support for the following:

A) Dissolved oxygen levels near atmospheric equilibrium are important for maintaining healthy animal and plant communities. Short-duration oxygen depletions can significantly affect communities even if they are relatively rare on an annual basis and are an important indicator of habitat and water quality impairment. Conversely, short to medium scale increases in chlorophyll-a are important indicators of water quality and habitat impairment and a sign of concomitant problems with dissolved oxygen and nutrient enrichment.

   To gage the degree to which the Coral Gables Waterway system is impaired, a network of autonomous moorings (7 total) will be deployed for temporally-intensive measurement of dissolved oxygen and chlorophyll. Nearly continuous (15-minute intervals) records will be collected 30 cm off the sediment bottom and at some locations will be paired with a mooring at 0.5 m below the water surface. Moorings will generally be co-located at a subset of the spatially-extensive water quality stations to measure dissolved oxygen, chlorophyll-a, temperature and salinity to evaluate potential nutrient related habitat impairment in the system. Moorings will be deployed at critical locations (areas that are structurally likely to support low oxygen conditions) throughout the system during both the wet season and the dry season to establish variability in conditions based on high frequency measurements. Each deployment will last a minimum of 30-60 days during both wet and dry seasons.

In regard to Dr. Samimy's role, he will be providing logistical / field support for the following:

A) Spatially extensive water sampling undertaken at 13 stations located strategically along the CGW from the SFWMD control structure (G-93) at Red Road to the mouth of the Coral Gables Waterway where it discharges to Biscayne Bay (MD-DERM long-term monitoring station CG-01). One station will be situated immediately up-gradient of the G-93 SFWMD control structure at Red Road and one station will be located immediately down-gradient. Both will serve as upper boundary condition stations along with MD-DERM station CG-01 (lower boundary station) at the mouth of the waterway system, with one station located at the Bird Rd. stormwater outfall as well as one station situated immediately down gradient of the 66-inch outfall (CGMS-08) passing under Riviera Road.

   Sampling will be conducted monthly during the dry season (November to May) and bi-weekly during the wet season (June through October), because the wet season will have the highest variability in water quality. Additionally, sampling on the ebb tide will be conducted shortly after significant rainfall events approximately twice per year, as determined by the participating scientists and related to the City of Coral Gables MS4 Permit conditions (to be funded separately). Previous water quality sampling in 2016-2017 indicated stratification of the water column, thus water samples will be collected from surface and bottom water at all stations. The sampling effort will mirror historic sampling to be able to cross compare new water quality data against data generated in 2016-2017.

B) To gage the degree to which the Coral Gables Waterway system is impaired, a network of moorings (7 total) will be deployed for temporally-intensive measurement of dissolved oxygen and chlorophyll. Nearly continuous (15-minute intervals) recording moorings will be deployed 30 cm off the sediment bottom and at some locations will be paired with a mooring at 0.5m below the water surface. Moorings will generally be co-located at a subset of the spatially-extensive water quality stations to measure dissolved oxygen, chlorophyll-a, temperature and salinity at 15-minute intervals and evaluate potential habitat impairment in the system. Moorings will be deployed at critical locations (areas that are structurally likely to support low oxygen conditions) throughout the system during both the wet season and the dry season to establish variability in conditions based on high frequency measurements. Each deployment will last a minimum of 30-60 days during both wet and dry seasons.

Products/deliverables:

Regarding the dissolved oxygen and chlorophyll mooring deployments, CSP scientists with other members of the science team will develop a Technical Memorandum to be submitted to the City 2-3 months after the dry season deployment and similarly after the wet season deployment (whichever is done first). The memorandum will provide details on measurement approach as well as plots of the DO / CHLA levels for each of the seven moorings deployed during each season accompanied by a table summarizing data, with a brief discussion of the results. The DO/CHLA data will also be provided to the City in digital format and be retained by project team.

Dr. Samimy will contribute to quarterly email updates indicating sampling dates completed and a Technical Memorandum summarizing the wet and dry season water quality results as well as the results of stormwater sampling. Results will be plotted and a spreadsheet file will be provided to the City (project team members will also retain data files).

Regarding the dissolved oxygen and chlorophyll mooring deployments, Dr. Samimy will contribute to a Technical Memorandum to be submitted to the City approximately 2-months after the dry season deployment and similarly after the wet season deployment (whichever is done first). Each memorandum will provide details on measurement approach as well as plots of the DO / CHLA levels for each of the seven moorings deployed during each season accompanied by a table summarizing data. The DO/CHLA data will also be provided to the City in digital format and be retained by project team.

BUDGET

Salaries & Wages	$22,645
Total Fringe	$2,988
Domestic Travel	$2,250
Materials & Supplies	$2,895
Total Direct	$30,632
Total Indirect (26.0%)	$8,002

TOTAL	$38,780

BUDGET JUSTIFICATION

A. Senior Personnel:
Dr. Brian L. Howes (UMD P.I.), Dr. Roland Samimy and Dr. David R. Schlezinger (Sr. Research Associate) are requesting from the City of Coral Gables via Florida International University (as Prime) **$21,614.02**

B. Other Personnel:
Funds are also requested for a Sr. Analyst of **$1,031.25**

C. Fringe Benefits (Howes, Schlezinger, Sr. Analyst):
Breakdown and percentages

Fringe percentage = 37.91% on Schlezinger & Sr Analyst and 2.43% on Howes

Health and Welfare @$16.50 per man week on Schlezinger & Sr. Analyst

Total Benefits: $9,834 x 0.37.91= $2905.50 + 2318 x 2.43% = $56.33 + H&W of $82.50 = **$2,988.00** (Total Benefits)

D. Equipment:
UMD will be providing 5 moored sondes for the execution of the effort (2 provided by NOAA).

E. Travel:
Funds are requested for Dr. Schlezinger to travel to deploy (1), download midway (1), and recover (1) the mooring array and data. The 3 round trips and associated costs are $750/trip = **$2,250**

F. Participant Support:
Not Applicable

G. Other Direct Costs:
1. Mooring Materials/Supplies: **$2,749**.

H. Total Direct Costs:

$22,645.00 (Salary: Howes, Samimy, Schlezinger, Sr. Analyst)

$ 2,988.00 (Total Fringe)

$ 2,250.00 (Travel)

$ 2,895.00 (Supplies)

$30,632.00

I. **Facilities and Administration Costs:**

FIU Allowable IC rate = 26.0% = **$8,002.00**

Total UMD Sub-Contract Cost Phase I = $38,780.00

MIAMI WATERKEEPER

Statement of Work
Miami Waterkeeper

Project Title: City of Coral Gables Assessment of Nutrient and Habitat Conditions in the Coral Gables Waterway to Inform Management and Restoration

Project Period: Phase 1: June 2020 – June 2021

Objective: Develop and execute an educational outreach campaign that will support the scientific research of the partner institutions with the goal of assessing the health of the Coral Gables Waterway.

Scope: The collaborative nutrient loading assessment of the Coral Gables waterway system discharging to Biscayne Bay is designed to provide a detailed quantification of nutrient loads at critical junctures in the brackish waterway/canal system as a contributor and driver of water quality impairment in the Coral Gables Waterway and the Biscayne Bay Habitat Focus Area. A clear scientific assessment of the waterway will inform the residents and community leaders of primary pollution issues in the system. Miami Waterkeeper staff will develop and lead a community education and outreach effort associated with this project in order to increase community awareness of the waterway's impairment and to empower community members to take action to address pollution inputs. Miami Waterkeeper will coordinate student researchers, develop educational community resources, and prepare policy recommendations based on scientific results.

Background: Miami Waterkeeper (MWK) is a local, non-profit organization dedicated to defending, protecting, and preserving South Florida's watershed through citizen engagement and community action rooted in sound science and research. We work to ensure swimmable, drinkable, fishable water for all.

The Coral Gables Waterway is a unique system that runs through much of Coral Gables and empties into Biscayne Bay. The mouth of the Coral Gables Waterway has been experiencing an algae bloom which could be contributing to a localized seagrass die-off. In an effort to learn more about pollution inputs that could be contributing to high elevations of nutrients in the Waterway, this proposal was developed. Miami Waterkeeper will be undertaking the community outreach and education component of the project - building out educational materials and policy recommendations based on scientific results from the study. Miami Waterkeeper has a track record of success in leading education and outreach efforts related to water resources. Our staff has significant experience in developing engagement programming and hands-on educational lessons. For the last two years, MWK has partnered with Ransom Everglades School to conduct monthly water patrols in the Coral Gables and Coconut

Grove waterways. We have an established program for training the students and leading safe and productive field experiences.

Tasks/Scientific Goals:

- Sampling will be conducted monthly during the dry season (November to May) and bi-weekly during the wet season (June through October). Miami Waterkeeper staff and interns, Ransom Everglades students, and residents will sample 3 sites at the southern end of the waterway. Not only does this support the collection of important data, but it also provides experiential learning opportunities for students and community members.
- Miami Waterkeeper will train the students in sampling protocol, and coordinate the boat and student researchers who will conduct the sampling.
- Methodologies and research results will be evaluated and analyzed in order to understand the health of the waterway and ultimately guide policy decisions.

Products/deliverables:

- Field sampling technique trainings and lessons on threats to local ecosystems
- Field research experiences for students and citizen scientists
- Outreach materials to inform the students, scientists, policy materials, and community members of the research and results.
- Policy recommendations based on the study's findings.

Budget Justification
Miami Waterkeeper Phase 1

1. **Senior Personnel:**

   Dr. Rachel Silverstein, Executive Director, is requesting 1 month salary totaling $6,000 for scientific research coordination, execution of field sampling with Ransom Everglades School students and community education.

2. **Other Personnel:**

   Collin Schladweiler, Outreach Coordinator, is requesting 25% of one month's salary $1,500 for field sampling and community education.
   Elizabeth Kelly, Research Coordinator, is requesting 50% of one month's salary $2,000 for scientific research coordination and field sampling.

3. **Fringe Benefits:**
   Breakdown and percentages
   5.5% ($523) for social security, medicare, and federal unemployment
   10% ($950) for employee health insurance
   1% ($95) retirement plan

4. **Equipment:**
   Sampling instruments and consumables to be supplied to us from the other partners (ie. NOAA).

5. **Travel:**
   Mileage: $182 per year
   Boat usage during academic school year (dry season): donated by Ransom Everglades School
   Boat rental during summer months (wet season): $5,000

6. **Participant Support:**

7. **Other Direct Costs:**

8. **Total Direct Costs:** $16,250

9. **Facilities and Administration Costs:** $1,625 (10%)

   Total: **$17,875.00**