COASTAL WETLANDS REHYDRATION DEMONSTRATION PROJECT
DRAFT MONITORING PLAN

TABLE OF CONTENTS

List of Tables

List of Figures

COASTAL WETLANDS REHYDRATION DEMONSTRATION PROJECT
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1.0 Introduction

This document outlines the Coastal Wetlands Rehydration Demonstration Project (CWRDP) monitoring plan. The CWRDP Monitoring Plan outlines specific recommendations for water quality and biological data collection based on monitoring plans implemented during other wastewater reuse pilots, the operations schedule of the plant, and physical site conditions dictated through design and construction. The plan provides sampling locations, parameter lists, methods and frequencies. The plan has been designed to provide the data and information necessary to evaluate the CWRDP's performance in meeting its goals and objectives.

2.0 Project Background

The Central and Southern Florida Project Restudy has determined that there will be insufficient water available in the natural system to restore the Biscayne Bay Coastal Wetlands (BBCW). The Comprehensive Everglades Restoration Plan (CERP) proposed using wastewater reuse from the South District Waste Water Treatment Plant (SDWWTP) to supplement the flows that will be provided to the BBCW from other future restoration project elements. Since this particular element of the CERP has been placed on hold, Miami-Dade County has proposed to undertake the CWRDP.

The CWRDP is designed to take up to 1 mgd of secondary effluent from the SDWWTP and subject it to further treatment using the wetlands rehydration demonstration plant (WRDP) at the SDWWTP. Effluent from the WRDP will then be routed to a constructed freshwater wetland. A small sidestream (approximately 30 gpm) of the WRDP effluent will be used to test additional sidestream treatment processes. The WRDP and the sidestream processes will be evaluated according to various water quality parameters and their ability to remove unwanted nutrients. Constructed wetlands receiving WRDP effluent will be monitored to provide data characterizing changes to water quality and the ecological responses, if any, to the reclaimed water. Detailed treatment processes and the surrounding environmental conditions are available in the Coastal Wetlands Reuse Rehydration Demonstration Project, Phase I, Technical Memorandum (CDM, February 2007).

3.0 Objectives and Monitoring Approach

The CWRDP monitoring plan has been designed to yield data and information that will facilitate the following objectives:

1. Enhance the current monitoring programs in areas surrounding the SDWWTP in order to establish a surrounding area baseline prior to full-scale wastewater reuse application;

2. Demonstrate the WRDP's ability to consistently attain low nutrient water quality and determine how close it can come to meeting the target levels;
3. Evaluate the ecological responses of the receiving constructed wetlands from the highly treated WRDP effluent; and
4. Test the added treatment capabilities and benefits of the sidestream processes.

In order to achieve these objectives, the monitoring activities will be divided into the following four categories:

- The ***Surrounding Area Baseline Monitoring (Category A)*** will be conducted to further characterize the areas surrounding the SDWWTP. Specifically, stations within the C-1 and L31E Canals, the BBCW area lying immediately east of the SDWWTP, the coastal wetland fringe east of the SDWWTP, and Biscayne Bay will be monitored. A detailed description of the vegetation, sediment, and water quality monitoring is presented in Section 5.0.

- The ***WRDP Water Quality Monitoring (Category B)*** will be conducted to demonstrate the WRDP's ability to consistently attain low nutrient water quality and determine how close it can come to meeting the target levels. Water quality data will be collected at the WDRP influent (SDWWTP deep well injection discharge) and effluent. This monitoring will be conducted throughout the life of the project.

- The ***Constructed Wetland Monitoring (Category C)*** will be conducted to evaluate the water quality, soil, vegetation and biological responses within the constructed wetlands to the highly treated WRDP effluent. This monitoring will persist through both the start-up and demonstration phases of the constructed wetlands' operation schedule.

- The ***Sidestream Process Testing (Category D)*** will be conducted on several sidestream pilot technologies: reverse osmosis; ion exchange; granulated activated carbon; and advanced oxidation. Water quality monitoring will be performed at the influent and effluent of each tested process to determine corresponding improvements in water quality associated with these additional treatment technologies.

4.0 Water Quality Targets

The water quality datasets generated from each monitoring category will be compared against a common set of water quality targets. These water quality targets were established by the 2004 Waste Water Reuse Pilot Project Delivery Team and reported in the Final Report South Dade Advanced Wastewater Treatment Alternatives, (USCOE, 2004).

In formulating these standards, the Project Delivery Team (PDT) considered three water quality goals: the State of Florida standards for reuse of reclaimed water; the State of Florida water quality standards for discharge to receiving wetlands; and the 'anti-

degradation' standards based Class III/ Outstanding Florida Water (OFW), which are more stringent than the reuse and wetlands application standards. Micronutrient targets are indicated as "lowest possible". These targets are outlined in Tables 1 and 2, as presented in Coastal Wetlands Reuse Rehydration Demonstration Project, Phase I Technical Memorandum.

Table 1. Water Quality Targets

Parameter	Effluent Water Quality Standards / Goals[a]				
	Irrigation Reuse	Wetlands Application	Class III Goal OFW	BBPI[b]	WWRU PDT[c]
Total Nitrogen (mg/L)	NA	3	0.27	-	-
Total Kjeldahl Nitrogen (mg/L)	-	-	0.22	-	0.36
Nitrite/ Nitrate (mg/L)	-	-	0.01	0.01	0.01
Ammonia Nitrogen (mg/L)	-	-	0.02 - 0.05	0.05	0.05
Total Phosphorus (mg/L)	NA	1.000	0.005	0.005	0.005
Orthophosphate (mg/L)	-	-	0.002	-	
CBOD-5 (mg/l)	20 (2)	5	NA		
Turbidity, NTU	5 (1)		0.5		
Total Coliform (cfu/100ml)	<1.0	<1.0	<1.0	-	<10.0
Fecal Coliform (cfu/100ml)				-	
DO Surface (mg/L)^	-	-	5.0 to 7.3	-	6.43
DO Bottom (mg/L)^	-	-		-	
Surface Salinity (ppt)^	-	-	No change > 5 ppt	-	-
Bottom Salinity (ppt)^	-	-		-	-
Total Suspended Solids (mg/L)	5.0**	5.0	3.5	-	-
pH	-	-	6.5 to 7.5*	-	-
Conductivity	-	-	-	-	-
Temperature	-	-	-	-	-
Metals (See **Table 2**)					
Microconstituents / Emerging Pollutants of Concern (EPOCs)	-	-	Lowest Possible Level***	-	-
Cryptosporidium and Giardia	-	-		-	-

* Appropriate limits for pH in the estuarine zone will require further evaluation.

** Single sample maximum

*** Although, there are currently no established numerical criteria or antidegradation targets for these parameters, available information shall be gathered on the removal efficiency of various treatment technologies and detectable levels after advanced treatment for these parameters for comparative assessment. In practical terms, the objective would be to identify the technology that reduces such contaminants to the lowest level.

^ Monitored separately by depth as per DERM, but not separated for CWRDP.

(a) Task 5 – Final Report South Dade Advanced Wastewater Treatment Alternatives, (USCOE, 2004)
(b) Biscayne Bay Partnership Initiative (BBPI)
(c) Waste Water Reuse Pilot Project Delivery Team (WWRU PDT)

Source: Final Report South Dade Advanced Wastewater Treatment Alternatives Literature Search/Survey of Wastewater Treatment Facilities. (US Army Corps of Engineers, Contract No. DACW 17-01-D-00B, 2004)

Table 2. Water Quality Targets- Metals

Treatment Objectives: Method Detection Limit (MDL) and Practical Quantitation Limit (PQL) for Metals of Interest					
Metals	**Methodology Required or Equivalent**	**Required MDL (ug/l)**	**Required PQL (ug/l)**	**Sea Water Composition (ug/L) 1,2**	**Target Levels (ug/L)**
Aluminum**	EPA 200.9	7.8	30	10	10
Antimony	EPA 200.9	0.8	3	0.5	0.8
Arsenic, tot	EPA 200.9	0.5	2	3	3
Barium**	EPA 200.7	1	44	30	30
Cadmium	EPA 200.9	0.05	0.2	0.1	0.1
Chromium, total	EPA 200.9	0.1	0.4	0.05	0.1
Copper	EPA 200.9	0.7	3	3	3
Iron	EPA 200.7	7	3	10	10
Lead	EPA 200.9	0.7	3	0.03	0.7
Manganese	EPA 200.9	0.3	1	2	2
Mercury, total	EPA 1631C	0.0001	0.0005	0.03	0.03
Mercury, methyl	EPA 1630 Draft	0.00002	0.00005		0.03
Nickel	EPA 200.9	0.6	2	2	2
Selenium**	EPA 200.9	0.6	2	4	4
Silver	EPA 200.9	0.5	2	0.04	0.5
Thallium	EPA 200.9	0.7	3	>0.01	0.7
Tin	EPA 200.9	1.7	7	3	3
Zinc	EPA 200.7	2	8	10	10
Bolded Metals: Indicates typical parameters monitored in waste water					
Bolded and Italic Metals Metal added due to its inclusion in the Class III Surface Water FDEP Rule					
Italic Metals: Total Mercury is monitored in waste water and is part of the Class III Surface Water FDEP Rule. Methyl and total mercury at low levels are not part of the Class III Surface Water FDEP Rule, but were added to this quality goals list to be consistent with current District monitoring.					
1 - Geological Survey Water Supply Paper 1473, *Study and Interpretation of the Chemical Characteristics of Natural Water*, Second Edition, p. 11 (1971) 2 - Horne R.A. , Marine Chemistry *The Structure of Water and the Chemistry of the Hydrosphere, Wiley-Interscience*, 1969					

Source: Final Report South Dade Advanced Wastewater Treatment Alternatives Literature Search/Survey of Wastewater Treatment Facilities. (US Army Corps of Engineers, Contract No. DACW 17-01-D-00B, 2004)

5.0 Surrounding Area Baseline Monitoring (Category A)

The primary objective of the Surrounding Area Baseline Monitoring (Category A) is to enhance the existing monitoring programs and outline supplemental monitoring efforts necessary to close existing data gaps that currently prevent a comprehensive characterization of the area surrounding the SDWWTP. The surrounding area baseline monitoring will be conducted throughout the duration of the project to develop a database for establishing anti-degradation criteria prior to the eventual discharge of the highly treated effluent.

A review of readily available water quality data was performed to characterize the existing conditions of the area surrounding the SDWWTP. The area includes the C-1 and L-31 canals, the Cutler Flow Way, the BBCW, and the waters of Biscayne Bay. Data gaps within these areas of interest were identified as a course of the review. The findings were

reported in Appendix D of the Coastal Wetlands Reuse Rehydration Demonstration Project, Phase I, Technical Memorandum (CDM, 2007). Appendix D contains information that will be necessary to provide an environmental conditions characterization of the surrounding areas.

5.1 Status of Existing Data and Data Gaps

Multiple water quality datasets for the surrounding canals, the coastal wetland fringe, and the Bay were reviewed and summarized. The sub-sections below review selected relevant datasets and discuss the data gaps identified during the review of readily available data.

5.1.1 Water Quality

Relevant water quality data was extracted from the Biscayne Bay Water Quality Status and Trends Project (BBWQSTP) conducted by the Miami-Dade Department of Environmental Resources Management (DERM). Stations within the project area included stations in the C-1 Canal, the L31-E Canal south of the project area, and areas within Biscayne Bay. The periods of data collection varied per station, but included monthly samples taken from 1988 to 2003. Parameters consistent with the current project's water quality goals include TKN, Nitrate/Nitrite, Ammonia, Total Phosphorus, Orthophosphate, TSS, DO, pH, Salinity, Total Coliform and Fecal Coliform, Lead, Zinc and Cadmium.

The expansion of the BBWQSTP is planned as part of the Biscayne Bay Coastal Wetlands Water Quality Monitoring Plan, currently in draft. However, changes to the BBWQSTP are unlikely to occur between now and when the BBCW Project Implementation Report is finalized. There is another portion of the BBCW project, the C-1 Cutler Flow Way, that may occur sooner as part of Acceler8. However, the monitoring plan for this project is not yet available and is expected to occur as part of the permitting process.

Water quality data was also obtained from MDWSD monitoring wells on the SDWWTP property. Data derived from the wells on the north side of the property were reviewed and include parameters for chlorides, conductivity, total dissolved solids and Biscayne Aquifer water levels. This data provides information concerning upwelling conditions around the deep well injection casings. This dataset may not be appropriate to determine existing conditions within the areas surrounding the project, but has proven useful in characterizing the water of the Biscayne Aquifer south of the project area.

5.1.2 Vegetation

Vegetation data was available for the BBCW in a report entitled, *Inventory of Vascular Plants of Biscayne National Park* (Institute for Regional Conservation, 2004). Transects were run within the BBCW in the areas east of the SDWWTP. However, more detailed information is needed for the surrounding area baseline. This information was not included in the original Baseline Assessment Report.

5.1.3 Data Gaps

Water quality, sediment, and vegetation data gaps exist within the Cutler Flow Way, the BBCW immediately east of the SDWWTP, the surrounding canals and Biscayne Bay. Additional stations and supplemental parameters added to existing monitoring stations are needed to fill these data gaps.

5.2 Surrounding Area Baseline Monitoring Program

This section refers to a list of additional monitoring parameters that are recommended for incorporating into the sample analysis regimes at the existing monitor stations surrounding the project area. It also outlines proposed additional stations and parameters needed to close the data gaps in the baseline characterization of the areas surrounding the WRDP and constructed wetlands. It is anticipated that the Category A monitoring activities will run from the project's inception (2007) through its completion in 2012.

Existing stations that will be utilized for surrounding area baseline monitoring include BA-14, BA-15, BL01, BL02, BL03, GL03, GL02 and BB39A. (See Figure 1.)

The proposed additional stations are:

BL20 – Located just to the northwest of the SDWWTP, along the C-1 Canal
LC01 – Located on the L31-E Canal, approximately 0.5 miles north of the confluence of the C-1 and the L31E Canals
BC01 – Located approximately 0.25 miles southeast of the northeastern corner of the SDWWTP
BC02 – Located approximately 0.5 miles southeast of the northeastern corner of the SDWWTP
BC03 – Located approximately 1.25 miles southeast of the northeastern corner of the SDWWTP, along the intertidal zone of Biscayne Bay
C1GW1– Located within the Cutler Flow way, just east of the constructed wetlands
C2GW4– Located within the Cutler Flow way, just west of the constructed wetlands

This results in a 15 station matrix for the surrounding area baseline (Category A) monitoring program (see Figure 1.) Table 3 presents a summary of the sampling matrix of the existing monitoring stations, parameters and frequencies. Table 4 presents a sampling matrix of additional surrounding area baseline monitoring stations, parameters and frequencies.

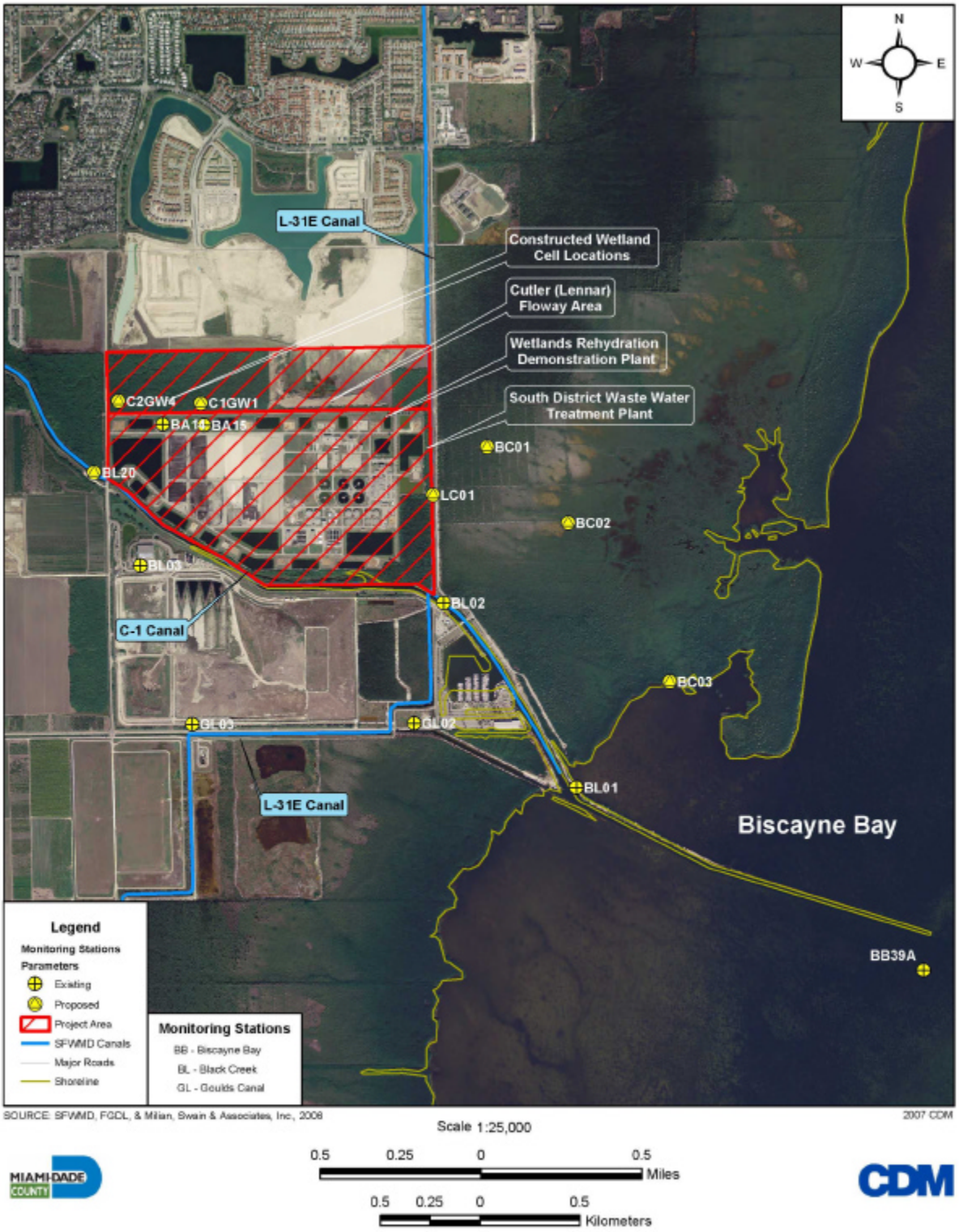

Figure 1 - Coastal Wetlands Rehydration Demonstration Pilot Project Surrounding Area Baseline Monitoring Station Locations

Table 3. Existing Surrounding Area Baseline Monitoring Station Summary

Agency	Monitoring Station	Groundwater /Surface water	Currently Monitored Parameters	Current Monitoring Frequency	Proposed Additional Parameters
MDWSD	BA-14, BA-15	Groundwater	Chlorides, Conductivity, TDS, and Biscayne Aquifer levels.	Quarterly	TN, TKN, Nitrite/Nitrate, NH_3, TP, Ortho-TPO_4, CB & fecal coliform, DO, Salinity, TSS, pH, Cryptospo
					Metals(See Table 2)
SFWMD/ DERM	BL01	Surface water	*Physical parameters, Turbidity, Total & fecal coliform, TP, NH_3, NOx-N	Monthly	TN, TKN, Ortho-TPO4, CBOD-5, TSS, Cryptospo
			Cu-SW, Pb-SW, Zn-SW, Cd-SW	Quarterly	Metals(See Table 2 except Cu, Pb, Zn, Cd)
	BL02	Surface water	*Physical parameters, Total and fecal coliform, TP, NH_3-N, NOx, Color, Turbidity	Monthly	TN, TKN, Ortho-TPO_4, CBOD-5, TSS, Cryptospo
					Metals(See Table 2)
	BL03	Surface water	*Physical parameters, Total and fecal coliform, TP, NH_3-N, NOx, Color, Turbidity, Ortho-TPO_4, TSS, BOD, COD, Phenols	Monthly	TN, TKN, TDS, CBOD-5, Cryptosporidium and G
			TKN	Bi-monthly	—
			TDS, TSS, BOD, COD, Hardness, Cu-FW, Pb-FW, Zn-FW, Cd-FW	Quarterly	—
			Sb, As, Ba, Be, Cr, Hg-FW, Mn, Ni, Se, Ag, Tl, Cn, VOC, Semi-VOCC, Oil-Grease	Annually	Metals(See Table 2, except Sb, As, Ba, Be, Cr, Mn FW, Pb-FW, Zn-FW, Cd-FW), and Microconstitue
	BB39A	Surface water	*Physical parameters, Total and fecal coliform, TP, NH_3-N, NOx, Color, Turbidity	Monthly	TN, TKN, Ortho-TPO_4, CBOD-5, TSS, Cryptospo
			Cu-SW, Pb-SW, Zn-SW	Quarterly	Metals(See Table2 except Cu, Pb, Zn), Microco
DERM	GL02	Surface water	*Physical parameters, Total and fecal coliform, TP, NH_3-N, NOx, Color, Turbidity, Ortho-TPO4, TSS, BOD, COD, Phenols	Monthly	TN, TKN, Ortho-TPO_4, CBOD-5, DO, Salinity, TS Cryptosporidium and Giardia,
					Metals(See Table 2)
	GL03	Surface water	*Physical parameters, Total and fecal coliform, TP, NH_3-N, NOx, Color, Turbidity, Ortho-TPO4, TSS, BOD, COD, Phenols	Monthly	TN, TKN, TDS, CBOD-5, DO, Salinity, pH, Crypt Giardia,
			TKN	Bi-monthly	—
			TDS, TSS, BOD, COD, Hardness, Cu-FW, Pb-FW, Zn-FW, Cd-FW	Quarterly	—
			Sb, As, Ba, Be, Cr, Hg-FW, Mn, Ni, Se, Ag, Tl, CN, VOC, Semi-VOCC, Oil-Grease	Annually	Metals(See Table 2, exceptSb, As, Ba, Be, Cr, Mn FW, Pb-FW, Zn-FW, Cd-FW)

Physical parameters include: Temperature, Salinity, Dissolved Oxygen, Conductivity, Depth, pH, and Oxidation/reduction potential
x-FW = D.E.R.M. Freshwater metals detection methods x-SW = D.E.R.M Salt water metals detection methods

Table 4. Proposed Additional Surrounding Area Baseline Monitoring Stations

Proposed Monitoring Station	Location Description	Groundwater/ Surface water	Proposed Parameters for CWR
LC01	Located on the L31-E Canal, approximately 0.5 miles north of the confluence of the C-1 and the L31E Canals	Surface water	Nutrients, physical parameters and bacteria complete list)
			Metals(See Table 2) and Microconstituents
BL20	Located just to the northwest of the SDWWTP, along the C-1 Canal	Surface water	Nutrients, physical parameters and bacteria complete list)
			Metals(See Table 2) and Microconstituents
BC01	Located approximately 0.25 miles southeast of the northeastern corner of the SDWWTP	Surface water	Nutrients, physical parameters and bacteria complete list)
			Metals(See Table 2)
BC02	Located approximately 0.5 miles southeast of the northeastern corner of the SDWWTP	Surface water	Nutrients, physical parameters and bacteria complete list)
			Metals(See Table 2) and Microconstituents
		Groundwater	Nutrients, physical parameters and bacteria complete list)
			Metals(See Table 2)
BC03	Located approximately 1.25 miles southest of the northeastern corner of the SDWWTP, along the intertidal zone of Biscayne Bay	Surface water	Nutrients, physical parameters and bacteria complete list)
			Metals(See Table 2)
C1GW1	Located within the Cutler Flow way, just east of the constructed wetlands	Groundwater	Nutrients, physical parameters and bacteria complete list)
C2GW4	Located within the Cutler Flow way, just west of the constructed wetlands		Metals(See Table 2)

5.2.1 Baseline Water Quality Monitoring

Nutrient and physical parameters of surface water in the area surrounding the SDWWTP will be sampled monthly at stations BC01, BC02, BC03, LC01, BL01, BL02, BL03, BL20, GL03, GL02 and BB39A; samples from these stations will be analyzed for metals annually. Tables 1 and 2 outline the exact parameter lists. The sampling frequencies of the existing monitoring stations are congruent with the frequencies required for the CWRDP monitoring plan and will thus remain unaffected. Supplemental parameters must be added to stations BL01, BL02, BL03, GL02, GL03 and BB39A to match those listed in the water quality target goals listed in Tables 1 and 2. Table 3 identifies these supplemental parameters.

Groundwater quality samples from the Biscayne Aquifer in the surrounding area will be collected and analyzed for nutrients and physical parameters on a quarterly basis at stations BA-14, BA-15, and BC02; samples from these stations will be analyzed for metals annually. Grab samples from these stations will be analyzed for the parameters listed in Tables 1 and 2.

Groundwater wells at stations C1GW1 and C2GW4 will also be monitored quarterly for nutrients and physical parameters and annually for metals (Tables 1 and 2). The data from these wells will not only serve to close data gaps for the Surrounding Area Baseline Monitoring Program, but will also facilitate evaluations of groundwater flow once operations at the constructed wetland area commence.

It has been determined that the top of the Biscayne Aquifer is at zero meters, National Geodetic Vertical Datum (NGVD). Therefore, the groundwater monitoring well clusters at stations BC02, C1GW1 and C2GW4 will consist of two wells, with one installed to -0.33m and the second to -2.33m NGVD. Well depths were chosen that would reveal project groundwater migration while minimizing the risk of those parameters eluding detection due to dilution by the Biscayne Aquifer. The proposed naming convention for the wells installed at the stations cited above will list the station name followed by an "a", to indicate wells installed to -0.33m, or a "b" to indicate wells installed to -2.33m. For example, BC02a and BC02b refer to the proposed wells at the BC01 station installed to -0.33m and -2.33m, respectively.

5.2.2 Baseline Sediment Monitoring

Baseline sediment samples will be collected at Start-up and annually thereafter at the following stations: BC02, C1SD1, and C2SD2. C1SD2 and C2SD1 will be sampled as part of the constructed wetland monitoring program (Category C). Samples will be collected in triplicate by cylindrical coring. Each core will be sectioned into the 0-10 and 10-30 cm soil intervals. The triplicate samples will be homogenized based on sample interval and then submitted for analysis.

Sediment analysis will include the following parameters: TP, Total Inorganic P (1 M HCl extraction), TN (TKN, NH4, and NOx), TOC, S, Al, Fe, bulk density and microconstituents. The sediments will also undergo an initial and final toxicity

characteristic leaching procedure (TCLP Analysis) including extractions and analysis for TCLP Volatiles, Semi Volatiles, Pesticides, Herbicides, and Metals. If micronutrients are detected in sediment samples obtained during the initial sediment sampling, then analysis for micronutrients in sediment samples will continue annually throughout the duration of the study. Otherwise, microconstituents will be dropped from the sediment sample analysis. See Table 5 for a summary of sediment monitoring.

Table 5. Sediment Monitoring Parameters and Frequencies

Parameter	Method	Frequency	Locations
Sulfur	Soil cores, sampled in triplicate	Once at Start-Up and annually thereafter	Coastal Wetland Station BC02 Constructed Wetland Stations C1SD1, C1SD2, C2SD1, and C2SD2
Total Nitrogen (TKN, NH4, NOx)			
Total Phosphorus			
Aluminum			
Iron			
Total Inorganic Phosphorus (1M HCl Extraction)			
Bulk density			
Total Organic Carbon			
TCLP			
Microconstituents		Once at Start-Up, annually thereafter upon if target compounds are detected	

5.2.3 Baseline Vegetation Monitoring

Vegetation surveys of the surrounding area will be conducted at stations BC01, BC02, and BC03. A line intercept methodology will be applied to 100m long transects. These transects will be monitored semi-annually to identify changes in the natural vegetation independent of the effects of reuse water. Table 6 outlines the vegetative monitoring parameters and frequencies. Submergent and emergent vegetation will be sampled as part of the constructed wetland monitoring program (Category C).

6.0 Wetlands Rehydration Demonstration Plant (WRDP) Monitoring (Category B)

The ***WRDP Water Quality Monitoring*** (Category B activities) will be conducted to demonstrate how close the WRDP's effluent can come to attaining the water quality levels outlined in Tables 1 and 2 on a consistent basis. The WRDP process entails the application of submerged aerated filters (for nitrification), denitrification filters, ballasted flocculation with $FeCl_3$, ultrafiltration membranes, and ultraviolet disinfection to SDWWTP secondary effluent prior to its release to the constructed wetlands.

Table 6. Vegetation Monitoring Parameters and Frequencies

Parameter		Sample Type	Frequency	Locations
Species Frequency		Line intercept	At Start-Up and Semi-annually thereafter	Coastal Wetland Stations BC01, BC02 and BC03
Submergent Aquatic Veg.	Above/below ground biomass; mortality, percent cover, planning densities	Daoust and Childers (1998); Havens (2003)		Three sampling points per vegetation zone in the Constructed Wetlands C1V1…C1V12 in Cell 1 and C2V1…C2V12 in Cell 2.
Emergent Aquatic Veg.				

The WRDP plant monitoring will entail the collection and analysis of influent and effluent water quality samples from the WDRP at stations designated as WWIN and WWOUT. Frequencies of the WRDP monitoring program will be finalized when the operational plan for the project is completed (see Table 7). The operational plan will look at the performance of the individual processes and technologies. This monitoring will be conducted throughout the life of the project.

7.0 Constructed Wetland Monitoring (Category C)

Upon the completion of the wetland construction, the two one-hectare (2.5 acre) cells will receive freshwater from the Biscayne Aquifer for up to two years. This 'Start-Up' period will allow biota and other environmental components to become established. This establishment process, as well as the environmental conditions in the surrounding areas (including the coastal wetlands and Bay) will be monitored during the Start-Up monitoring period. The objectives of the 'Start-Up' Monitoring are to observe the stabilization of soils, surface and groundwater quality, and biota within the constructed wetland cells prior to receiving WDRP-treated effluent. After the two-year Start-Up period, the constructed wetlands will receive WDRP-treated effluent. This 'Demonstration' period will last three to five years. During the Demonstration period, data will be collected from the wetland cells and compared via a paired watershed model configuration.

A traditional paired watershed approach utilizes at least two wetland systems for comparison. One system operates as a control, the other experimental. The study is be divided into two periods, the calibration period and an experimental period. The calibration period is to establish reliable predictions of responses within the soil, vegetation, and water quality parameters within both systems. Once the calibration stage is complete, the one of the two systems is exposed to the experimental conditions. The response is then measured from the calibrated prediction. The results are evaluated for significance through statistical tests.

The following sub-sections will outline the parameters, locations and frequencies for the following sample constituents:

- ? Wetland Surface Water
- ? Groundwater
- ? Sediments
- ? Vegetation
- ? Macroinvertebrates and Fish
- ? Periphyton

For the purposes of this document, it is assumed that the sampling parameters and locations of the Category C monitoring activities, which includes 'Start-Up' and the 'Demonstration' phases of the project, will be identical. It is also assumed that the sampling schedules will flow seamlessly between the two phases of the Category C monitoring activities. This may change based on the final operational plan.

7.1 Constructed Wetland Surface Water Quality Monitoring

Wetland surface water quality for this project will be compared to the target outlined in Tables 1 and 2. In addition to those target parameters, flow rate of the WDRP and the constructed wetlands will be measured. The frequency of wetland surface water sample collection (grab and auto-flow composite) will be determined as per the final plant design and operational schedule. Table 7 outlines a summary of the constructed wetlands surface and groundwater quality monitoring stations.

From within each constructed wetland cell, surface water grab samples and data will be collected from four stations, with one station established in each of the four vegetative zones. The constructed wetland surface water monitoring stations are as follows: C1SW1, C1SW2, C1SW3, and C1SW4 in Cell 1; and C2SW1, C2SW2, C2SW3, and C2SW4 in Cell 2 (See Figure 2).

Auto-flow-proportional autosamplers will be used to obtain samples of inflow and discharge from each constructed wetland cell. Samples will be analyzed for total phosphorous, total nitrogen and NOx. Auto-flow sampling stations will be located at the Agri-Drain type culverts of each cell adjacent to the spreader canals: The auto-flow sample stations are as follows: C1AF1, at the inflow culverts of Cell 1; C1AF2 at the center berm of Cell 1; C1AF3 at the outflow culvert of Cell 1, C2AF1, at the at the inflow culverts of Cell 2; C2AF2 at the center berm of Cell 2; C2AF3 at the outflow culverts of Cell 2. Dataloggers at these stations will record pH, specific conductivity, temperature and turbidity.

7.2 Constructed Wetland Groundwater Quality Monitoring

Four groundwater monitoring well clusters will be installed to monitor the movement and quality of the groundwater underneath and next to the constructed wetland cells. The clusters will consist of two wells that will be installed to -0.33 and -2.33m NGVD. Figure 3 displays a cross-sectional view of the constructed wetland cells, the Biscayne Aquifer and groundwater monitoring well clusters.

Two of the well clusters (C1GW1 and C2GW4) will be installed just east and west of the constructed wetland cells and monitored for nutrients and physical parameters on a quarterly basis and annually for metals. As described in Section 5.0, stations C1GW1 and C2GW4 will serve to close data gaps in the surrounding area baseline characterization and to facilitate the evaluation of groundwater flow during the operations of constructed wetlands. The two clusters positioned immediately beneath the constructed wetlands (C1GW2 and C2GW3) will be located in the center of each constructed wetland and monitored quarterly as well. These wells will adhere to the naming convention as described in Section 5.0 to indicate wells installed to -0.33 and -2.33m NGVD.

Groundwater monitoring wells will be purged and sampled using a peristaltic pump. Groundwater samples will be collected and analyzed twice prior to wetland construction, once in October and once in May, to represent conditions in the wet and dry seasons, respectively. Thereafter, groundwater sampling and analysis will occur on a quarterly basis. Groundwater quality goals for this project are in accordance with the targets outlined in Tables 1 and 2. See Table 7 for a summary of the constructed wetlands surface and groundwater quality monitoring stations.

Table 7. Constructed Wetland Surface and Groundwater Quality Monitoring Summary

Sample Type	Parameter	Frequency	Locations
Groundwater Grab	Nutrients, physical parameters and bacteria (See Table 1 for complete list)	Quarterly	C1GW2, C2GW3
	Metals (See Table 2),		
Auto-flow Composite	TP, TKN, NOx-N	T.B.D.	C1AF1, C1AF2, C1AF3, C2AF1, C2AF2, C2AF3
Surface Water Grab	Nutrients, physical parameters and bacteria (See Table 1 for complete list)	T.B.D.	C1SW1, C1SW2, C1SW3, C1SW4, C2SW1, C2SW2, C2SW3, C2SW4 WWIN and WWOUT (WDRP in/outflow) C1AF3 and C2AF3
	Metals (See Table 2), Microconstituents	T.B.D.	

7.3 Constructed Wetland Sediment Monitoring

Constructed wetland sediment samples will be collected in triplicate from sample stations C1SD2 and C2SD1 (See Figure 4). Sediments will be collected by cylindrical coring to preserve the microstructure and microecology of the soil. Each core will be sectioned into the 0-10 and 10-30 cm soil intervals. The three intervals will be combined and submitted for analysis. Samples will be analyzed for selected nutrients, bulk density, total organic carbon and undergo toxicity characteristic leaching procedure (TCLP Analysis) including extractions and analysis for TCLP Volatiles, Semi Volatiles, Pesticides, Herbicides, and Metals. If microconstituents are detected in sediment samples obtained during the initial

collections of the Start-Up period, then analysis for microconstituents in sediment samples will continue throughout the duration of the study. Refer to Table 5 for a summary of sediment monitoring.

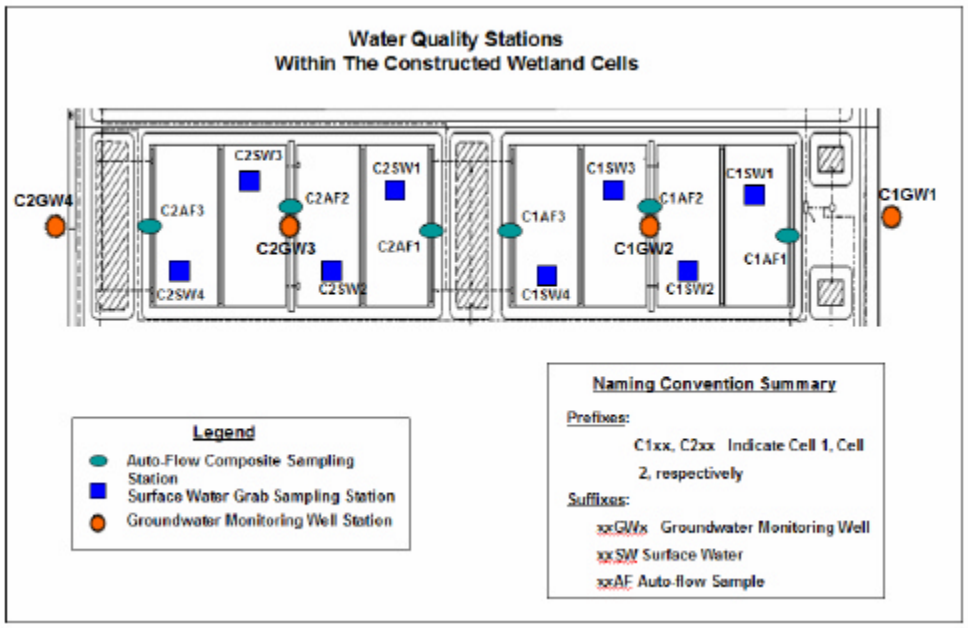

Figure 2. Water Quality Sampling Stations within the constructed wetland cells.

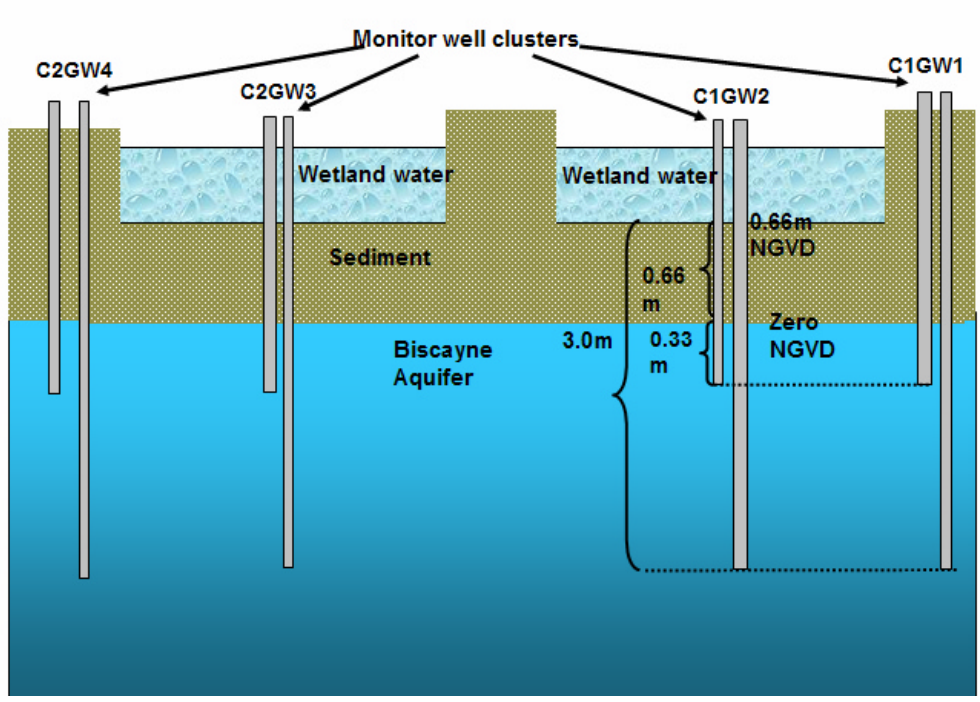

Figure 3. Cross-sectional view of the constructed wetland cells, the Biscayne Aquifer and groundwater monitoring well clusters.

7.4 Constructed Wetland Vegetation Monitoring

Planted species densities and visual percent cover in the constructed wetland cells will be sampled semi-annually to capture conditions of the wet (October) and dry (May) seasons. The naming convention for these sampling locations will continue to reference each cell (1 and 2) and will appear as follows: C1V1, C1V2, C1V3, C1V4, C1V5, C1V6, C1V7, C1V8, C1V9, C1V10, C1V11, and C1V12 for vegetations stations in Cell 1; and C2-V1, C2V2, C2V3, C1V4, C1V5, C1V6, C2V7, C2V8, C2V9, C2V10, C2V11, and C2V12 for vegetation stations in Cell 2. Figure 4 shows the relative positioning of these stations within the wetland cells.

The methods outlined in *Controls of emergent macrophyte composition, abundance, and productivity in freshwater Everglades wetland communities* (Daoust, R. and Childers, D. 1998; Wetlands 19:262-275) will be employed to measure above and belowground productivity and to calculate percent mortality of emergent vegetation. Submerged aquatic vegetation biomass will be assessed as per the methods outlined in *Submerged aquatic vegetation correlations with depth and light attenuating materials in a shallow subtropical lake (*Hydrobiologia 493:173-186; Havens, K.E. 2003). Samples from the three stations will be combined and submitted a one for analysis at the laboratory.

In addition, counts of exotic species and native species not initially planted within the constructed wetland assemblage will also be maintained. See Table 6 for a summary of vegetation monitoring parameters.

7.5 Macroinvertebrates and Fish

Macroinvertebrates and fish species will be collected within each cell six months into the Start-Up period and annually thereafter. Hester Dendy, nets, seines, traps and electroschocking methods will be applied dependant upon, species, densities, and site accessibility. These species groups will be analyzed for algal toxin breakdown products, traces metals, PCBs, alkylphenols, synthetic steroids and microconstituents. Table 8. contains the parameters and frequencies associated with these sampling events. This section may be supplemented by mesocosm and microcosm experiments.

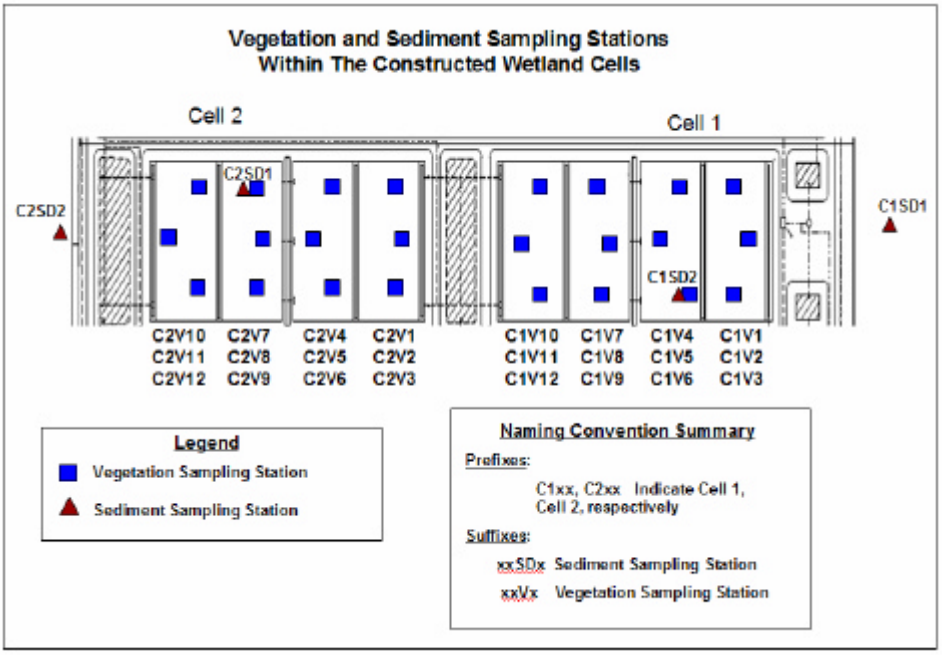

Figure 4. Vegetative and Sediment Sampling Stations within the Constructed Wetlands.

Table 8. Macroinvertebrate and Fish Monitoring Parameters

Analyte Category	Sample Type	Frequency
Algal toxins/breakdown products	Spp. T.B.D.	Six months into the Start-Up period and annually thereafter
Trace Metals (i.e., ultra trace mercury)		
PCBs/Organochlorine Pesticides		
Alkylphenols		
Synthetic Steroids		
Microconstituents		

7.6 Periphyton

Periphyton within each constructed wetland cell will be monitored for biomass and net primary productivity using the methods outlined by McCormick, P. V., Shuford III, R.B.E., Kennedy, W.C., 1998. (*"Spatial and seasonal patterns of periphyton biomass and productivity in the Northern Everglades"*, Florida, USA. Hydrobiologia 362: 185-208). Samples will also be taken for taxonomic analysis to identify the dominant species present within the periphyton assemblage. Florida Department of Environmental Protection Standard Method FS 7200 - General Biological Community Sampling will be used to process these samples.

The periphyton communities will be sampled from the vegetation monitoring stations outlined in section 7.4. Collections will take place semi-annually to represent conditions in the wet and dry seasons. Periphyton monitoring parameters and sampling methods are listed in Table 9.

Table 9. Periphyton Sampling Information

Parameter	Standard Method	Vegetation type	Frequency
Biomass NPP	McCormick et al. (1999)	Periphyton	Semi-Annually
Taxonomy Species ID	FDEP FS 7200	Macrophytes	
Enumeration		Periphyton	
Biovolume		Periphyton	

8.0 Sidestream Testing (Category D)

Once the WRDP is fully operational, four sidestream pilot technologies, reverse osmosis, ion exchange, granulated activated carbon, and advanced oxidation, will be implemented for short-term testing. The tests will be conducted to determine the pilot technologies' operational capabilities in removing additional nutrients and microconstituents from WDRP effluent. Testing conditions, volumes of WRDP effluent used and time durations for each test are expected to vary for each technology and as refinements are made to the testing procedures. Repeated trials and alterations to testing procedures are expected to occur until conclusions can be drawn and verified. Grab samples of the sidestream pilot effluent will be collected and analyzed on schedules that meet the demands of the individual technology and testing scenarios. Target analytes for individual sample analysis may also vary.

9.0 Mesocosm/Microcosm Studies

The availability of effluent from the WRDP and the sidestream technologies presents opportunities for mesocosm/microcosm experiments to be conducted. It is anticipated that industry experts and/or research institutions, such as Florida International University, will choose this opportunity to perform controlled biological tests using these various effluent sources.

10.0 Microconstituents

In 2004 the U.S. Geological Survey, in cooperation with the Comprehensive Everglades Restoration Plan Wastewater Reuse Technology Pilot Project Delivery Team, initiated a study to assess the presence of microconstituent compounds in the South District Wastewater Treatment Plant influent and effluent (Lietz and Meyer, 2006). Discrete and 24-hour composite samples were collected from four locations along the Plant's treatment train to evaluate the fate of microconstituents along the treatment stages. Samples were

collected on four separate events occurring in both the wet and dry seasons. The compounds detected in that study fall into the following categories:

1. Antibiotics
2. Hormones
3. Organic wastewater compounds
4. Pharmaceuticals

As many microconstituent compounds are currently unregulated, standard methods for analysis do not exist. Additionally, detection methods for these compounds continue to be refined by industry experts. The CWRDP monitoring plan calls for sample analysis for these microconstituents compounds using the methods presented in *Evaluation of Emerging Contaminants of Concern at the South District Wastewater Treatment Plant Based on Seasonal Sampling Events, Miami-Dade County, Florida, 2004* (Lietz and Meyer, U.S. Geological Survey, 2006) unless more up to date methods are identified as per the commencement of the project.

11.0 Photodocumentation

Digital images of the constructed wetland cells will be captured quarterly and catalogued. Photo stations along the levies and at stations within the cells will be designated prior to the initial vegetation survey or upon completion of the wetland construction. For each point, specific camera angles will be designated to show temporal changes over set fields of vision. The collective set of photo stations should cover most or all of each vegetation type the constructed wetland cells.

12.0 Analytical Methods

Standard methods for detection of nutrients, common ions and metals will be employed in the analysis of all samples from the surrounding area, the WRDP water quality monitoring, constructed wetland monitoring, and sidestream process testing unless indicated otherwise in preceding sections of this document. Microconstituents will be analyzed according to compound categories using USGS protocols as described in Section 10.0.

13.0 Quality Assurance Program

All samples will be presented and handled in accordance with:

- Florida Department of Environmental Protection standard operating procedures; and
- the South Florida Water Management District's Water Quality Field Sampling methods

An equipment blank will be collected at the beginning and end of each sampling day for surface water and groundwater. Two replicate samples will be collected per quarter. Two split samples will be collected per site, per quarter. Each of the two split sample sets will be sent to two different laboratories and results will be evaluated. Known and blind blanks, spikes, and duplicates will be sent to participating analytical laboratories as part of

a pre-qualification trial to ensure quality lab performance. Each lab must meet appropriate accuracy, precision, and reliability data quality objectives for each analyte category in a pre-determined concentration range.

14.0 Data Display, Dissemination and Reporting

Project reports will include sections for executive summary, introduction, methods, and results. The project introduction section will include a description of the project background, the monitoring areas, the period covered by the report, and maps of the monitoring stations.

The methods section will include a QA/QC summary, discussion of problems encountered and statistical analysis of the data. The summary will include QA/QC data, calibration data, field notes, and descriptions of the quality control issues encountered and identification of the samples affected.

The results section will include the statistical analysis of the datasets and include maximum, minimum, mean, median, standard deviation as well as trend analysis. The results section will discuss water quality data as related to the Targets outlined in Tables 1 and 2. Further comparisons will be made to the surrounding are baseline data. Ultimately, conclusions will be drawn based on the project results and subsequent analysis and be presented for peer review.

15.0 Project Implementation Program

Project implementation will be a multi-agency effort involving the Miami Dade Water and Sewer Department (WASD), the Miami Dade Department of Environmental Resources Management (DERM), the South Florida Water Management District (SFWMD), Biscayne National Park (BNP), and Florida International University (FIU). The surrounding area baseline monitoring will be conducted jointly by the WASD, SFWMD and DERM. Many of the stations are overlapping and the sampling frequency and analysis are the same. The WRDP monitoring will be conducted by the WASD, as will the constructed wetlands monitoring and sidestream testing. FIU will be conduct microcosm and mesocosm experiments on-site and in a laboratory setting. A partnership with the United States Geological Survey or its equal will be sought to perform the analysis of micronutrient samples.