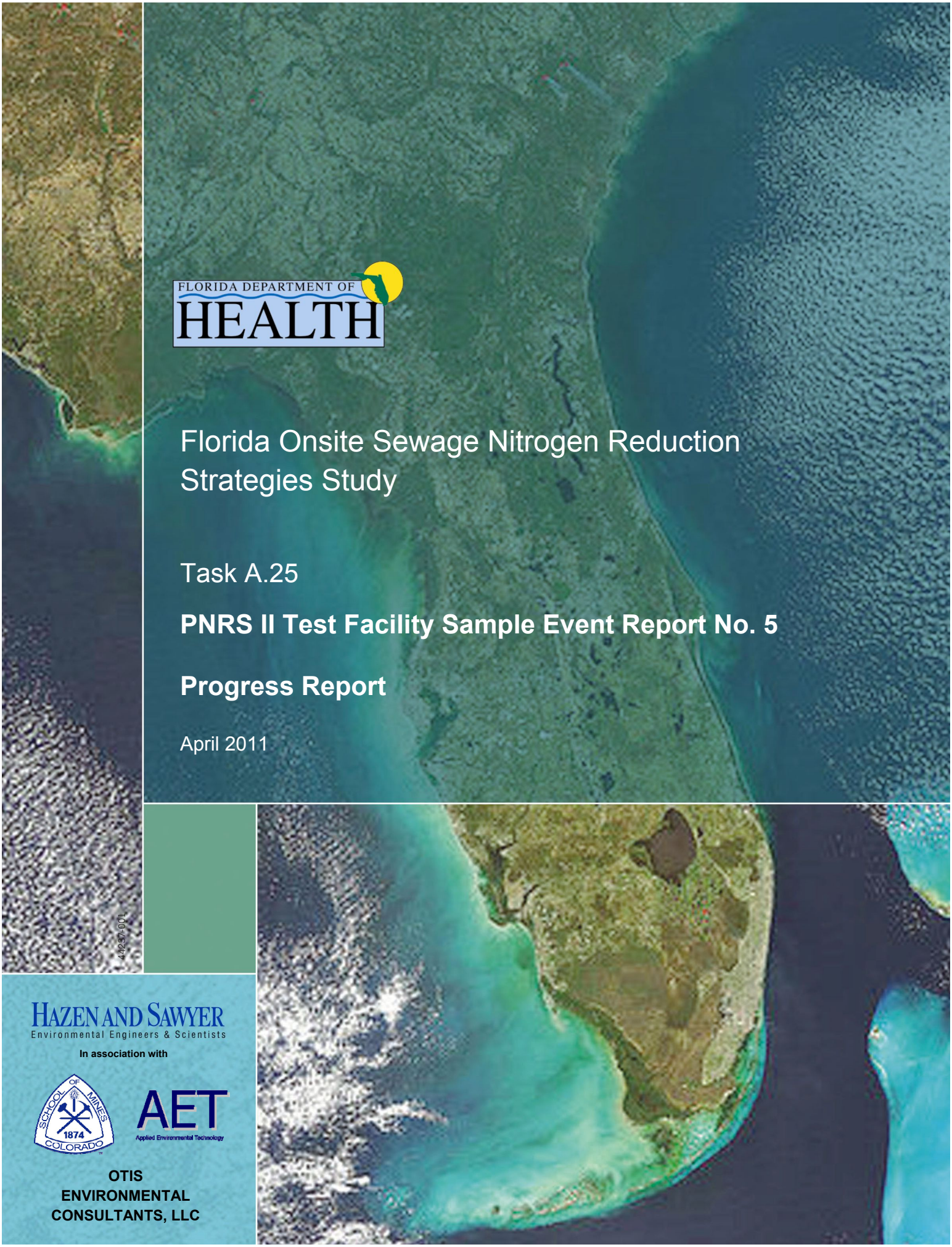

FLORIDA DEPARTMENT OF HEALTH

Florida Onsite Sewage Nitrogen Reduction Strategies Study

Task A.25

PNRS II Test Facility Sample Event Report No. 5

Progress Report

April 2011

4423-001

HAZEN AND SAWYER
Environmental Engineers & Scientists

In association with

SCHOOL OF MINES 1874 COLORADO

AET
Applied Environmental Technology

OTIS ENVIRONMENTAL CONSULTANTS, LLC

Florida Onsite Sewage Nitrogen Reduction Strategies Study

TASK A.25
PROGRESS REPORT

PNRS II Test Facility
Sample Event Report No. 5

Prepared for:

Florida Department of Health
Division of Environmental Health
Bureau of Onsite Sewage Programs
4042 Bald Cypress Way Bin #A-08
Tallahassee, FL 32399-1713

FDOH Contract CORCL

April 2011

Prepared by:

HAZEN AND SAWYER
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1.0 Background

Task A of the Florida Onsite Sewage Nitrogen Reduction Strategies Study includes the evaluation of passive treatment systems to remove nitrogen from septic tank effluent. The Passive Nitrogen Removal Study II (PNRS II) is a follow-up to the previous experimental evaluations of passive nitrogen removal technologies conducted in Passive Nitrogen Removal Study I. The objective of the PNRS II study is to extend the field pilot testing of the two-stage biofiltration process that was initiated in PNRS I. A unique test facility was constructed for the purpose of this evaluation. The Task A.15 PNRS II Quality Assurance Project Plan (QAPP) documents the objectives, experimental biofiltration systems, monitoring framework, sample frequency and duration, and analytical methods to be used at the PNRS II Test Facility.

2.0 Purpose

This sample event report documents data collected from the fifth PNRS II monitoring and sampling event which was conducted March 17, 2011. This monitoring event consisted of an assessment and evaluation of PNRS II operation, measurement of flowrates for all systems and flowrate adjustment if warranted, measurement of field parameters, and collection of biofilter influent and effluent samples and their analyses in a NELAC certified laboratory.

3.0 Materials and Methods

3.1 Project Site

The PNRS II Test Facility is located at the University of Florida Gulf Coast Research and Education Center (GCREC) in southeast Hillsborough County, Florida. The specially designed facility enables the simultaneous operation and performance testing of numerous biofilter treatment trains in parallel using the same wastewater source. The source of the influent wastewater is the septic tank effluent from the existing onsite wastewater system serving the GCREC. Details of the design and construction of the PNRS II test facility were presented previously in Task A.17, A.18, A.19, and A.24 documents.

3.2 Modifications of PNRS II Systems Monitoring and Sampling Locations and Identification

The results of Sample Event No. 1 through 4 and careful observation of PNRS II systems were used to formulate recommendations for modifications to the test systems at the GCREC pilot facility. The modifications that were made following Sample Event No. 4 are presented in this section. All recommendations were based on the overall goal of PNRS II: to provide functional specifications for modular biofiltration components for passive onsite nitrogen reducing wastewater treatment systems.

3.2.1 Lignocellulosic Containing Biofilters (DENIT-LS1, DENIT-LS2, DENIT-LS3, DENIT-LS4, UNSAT-IS1, UNSAT-IS2, UNSAT-IS3 and UNSAT-IS4)

The media within all the biofilters containing lignocellulosic media was replaced with new lignocellulosic material from a different source. The new lignocellulosic material was composed of sawdust and woodchip material (1-5 mm) originating from interior sections of Southern Yellow Pine and did not include bark; it was produced by sawing operations at a Florida sawmill. The one horizontal and three upflow I denitrification biofilters containing lignocellulosic media were rebuilt using the same configurations and media percentages as previous. The four in-situ simulator biofilters were rebuilt in different configurations as discussed in the next section.

3.2.2 In-situ Simulator Biofilters (UNSAT-IS1, UNSAT-IS2, UNSAT-IS3 and UNSAT-IS4)

All in-situ simulator biofilters were rebuilt with revised media configurations and the new lignocellulosic media. The new media configurations will assist in optimizing the design for PNRS II mini-mounds and in-tank vertical flow biofilters featuring unsaturated media overlying saturated media. The four in-situ biofilters were each rebuilt with a similar configuration of four media layers over a total media depth of 30 in. The three bottom layers of all in situ biofilters were identical: a 12-inch mixture of 60 percent expanded clay (1.53-3 mm) and 40 percent lignocellulosic media underlain by a 2-inch layer of pea gravel, underlain in turn by a 4-inch layer of elemental sulfur pastille. The media configuration in the upper 12 in. differs in each in-situ biofilter. The new top layer media configurations are:

- UNSAT-IS1
  - 4” Torpedo Sand (0.4 - 2 mm)
  - 8” Fine Sand (0.10 – 0.25 mm)
- UNSAT-IS2
  - 4” Expanded Clay (1.53 mm – 3.175 mm)
  - 8” Expanded Clay 1/8 as received (<3.175 mm)

- UNSAT-IS3
  - 4” Clinoptilolite 8x14 (1.4 - 2.38 mm)
  - 8” Clinoptilolite 16x50 (0.3 - 1.2 mm)
- UNSAT-IS4
  - 4” Torpedo Sand (0.4 - 2 mm)
  - 8” Fine Sand (0.10 – 0.25 mm)

The influent supplied to the in-situ biofilter array and surface loading rates were also changed. Influent to IS2 was changed to STE and IS4 influent was changed to nitrified effluent from single pass UNSAT-CL3. Influent to IS1 and IS3 are STE. The target surface loading rates to In-situ biofilters are 0.80 gal/ft^2-day to In-Situ 1, 3 and 4 and 1.2 gal/ft^2-day to In-situ 2. The dosing cycle was changed from 4 hour (6 dose/day) dosing cycle to 24 hour (24 dose/day) for all in-situ units. Sample ports were installed in IS1 and IS2 in the pea gravel separating the expanded clay & lignocellulosic mixture from the sulfur layer to enable sampling after treatment in the lignocellulosic layer but before the sulfur layer.

3.3 Monitoring and Sampling Locations and Identification

A schematic of the PNRS II test facility is shown in Figure 1. Septic tank effluent (STE) from GCREC is pumped from PNRS II-STE-T1 into the PNRS II systems through five points of entry: Hydro-1, Hydro-2, UNSAT-IS-1, UNSAT-IS2 and UNSAT-IS3. PNRS II biofilters are grouped into the four types of systems shown in Figure 1, Group I, II, III and IV systems. The nomenclature and reactor/sample identification used for the PNRS II test facility sampling events are listed in Table 1. The sample designations listed in Table 1 also largely correspond to the locations at which flow volumes are measured in each sample event.

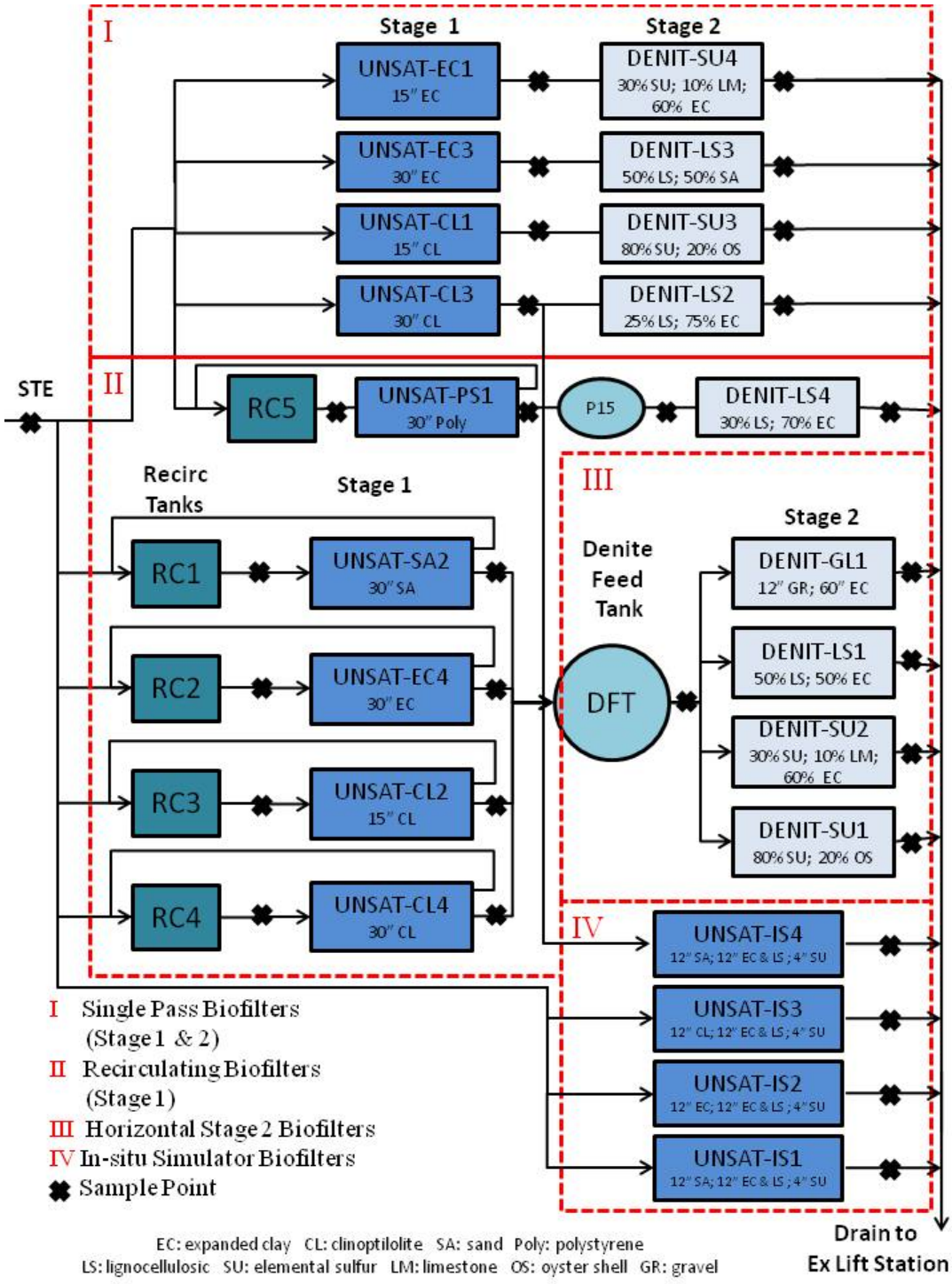

Figure 1
PNRS II Test Facility System Schematic

Table 1
PNRS II Sample Identification

Group (Figure 1)	Sample Location	Sample Identification
	STE PNRS II Storage Tank 1	PNRS II-STE-T1
I	Stage 1 Single Pass Biofilters	UNSAT-EC1
		UNSAT-EC3
		UNSAT-CL1
		UNSAT-CL3
	Stage 2 Single Pass Upflow Biofilters	DENIT-SU4
		DENIT-LS3
		DENIT-SU3
		DENIT-LS2
		DENIT-LS4
II	Recirculation Tanks	RC1
		RC2
		RC3
		RC4
		RC5
	Stage 1 Recirculating Biofilters	UNSAT-SA2
		UNSAT-EC4
		UNSAT-CL2
		UNSAT-CL4
		UNSAT-PS1
	Pump 15 Tank	P15-T
III	Denite Feed Collection Tank	DFT
	Stage 2 Horizontal Biofilters	UNSAT-SU1
		UNSAT-SU2
		UNSAT-LS1
		UNSAT-GL1
IV	In-Situ In-Tank Simulator Single Pass Biofilter	UNSAT-IS1
		UNSAT-IS2
		UNSAT-IS3
		UNSAT-IS4
	In-Situ In-Tank Simulator Single Pass Biofilter Sample Port (below EC & LS mixture and above SU layer)	UNSAT-IS1-SP
		UNSAT-IS2-SP
		UNSAT-IS3-SP
		UNSAT-IS4-SP

3.3 Operational Monitoring

Start-up of the PNRS II test facility occurred on May 17th, 2010 and all systems have operated continually since that time. The entire facility operation is checked at least once per week and a detailed log of operational observations and activities is maintained. In addition, the programmable logic controller (PLC) which controls many of the dosing and pump controls also records pump run times and flow data from flow meters at the facility,

and these data can provide useful insight into facility operations. Appendix A provides summary tables of the PLC recorded data of daily runtimes and flows for the test facility between January 13th and March 16th (Day 241 through Day 303 since start-up) used to check general pump operation and performance.

3.4 Water Quality Sample Collection and Analyses

Influent and effluent water quality samples from the PNRS II test systems for Sample Event 5 were collected March 17, 2011. A sample of STE was collected from the feed line connecting STE Storage Tank 1 (PNRS II-STE-T1) to Hydrosplitter 1 which supplies STE to the single pass Stage 1 biofilters (Figure 1). A manual dose event was initiated on the control panel until sufficient STE sample volume was collected in a clean sample container. Stage 1, 2, and in-situ simulator biofilter and recirculation tank effluents were each sampled by directing the entire flow from the biofilter into a large, clean sample container over a period of time sufficient to obtain the desired sample volume (approximately 3.5 liters). Sample containers were immediately placed in coolers on ice prior to subdivision of the composited sample.

The composite samples in the 3.5 liter sample containers were then subdivided into analysis-specific sample containers. The analysis-specific containers were supplied by the analytical laboratory and contained appropriate preservatives. The analysis-specific containers were labeled, placed in coolers and transported on ice to the analytical laboratory. Each sample container was secured in packing material as appropriate to prevent damage and spills, and was recorded on chain-of-custody forms supplied by the laboratory. Chain of custody forms, provided in Appendix D, were used to document the transfer of samples from field personnel to the analytical laboratory. One chain of custody form was filled out for each set of samples and placed inside the cooler.

Equipment blank, field blank, and field sample duplicates were taken. The equipment blank was collected using a previously cleaned STE sample collection bottle. The bottle was filled with distilled water provided by the laboratory and allowed to sit for eight minutes. The sample containers were then analyzed for the same parameters as the samples. The field blank was collected by filling sample containers with distilled water that had been transported from the laboratory into the field along with other sample containers. The field sample duplicates were collected immediately subsequent to the regular samples from the same composite sample. The duplicate sample containers for this event were filled with PNRS II T1-STE effluent, DENIT-SU4 effluent, DENIT-LS2 effluent, and DENIT-LS4 effluent. Additionally, laboratory split samples were collected immediately subsequent to the regular samples from the same composite samples. The laboratory split sample containers for this event were filled with PNRS II T1-STE effluent and UNSAT-IS2 effluent.

Field parameters were measured using portable electronic probes and included temperature (Temp), dissolved oxygen (DO), oxidation-reduction potential (ORP), pH, and specific conductance. Temperature (Temp), dissolved oxygen (DO), and oxidation-reduction potential (ORP) were measured with probe tips placed in flow through samplers located directly in the outlet pipe at each sample location. Specific conductance and pH were measured using external sample collection reservoirs. Field parameter results are listed in Appendix B. The influent and effluent samples were analyzed by the laboratory for: total alkalinity, total Kjeldahl nitrogen (TKN-N), ammonia nitrogen (NH_3-N), nitrate nitrogen, (NO_3-N), nitrite nitrogen (NO_2-N), carbonaceous biochemical oxygen demand ($CBOD_5$), total dissolved solids (TDS), total suspended solids (TSS), chemical oxygen demand (COD), and orthophosphate (PO_4). For some of the denitrification biofilters containing elemental sulfur media, influent and effluent sample analyses were also conducted for sulfate (SO_4) and hydrogen sulfide (H_2S). Table 2 lists the analytical parameters, analytical methods, and detection limits for these analyses.

Table 2
Analytical Parameters, Method of Analysis, and Detection Limits

Analytical Parameter	Method of Analysis	Laboratory Detection Limit (mg/L)
Total Alkalinity as $CaCO_3$	SM 2320B	2 mg/L
Total Kjeldahl Nitrogen (TKN-N)	EPA351.2	0.05 mg/L
Ammonia Nitrogen (NH_3-N)	EPA350.1	0.01 mg/L
Nitrate/Nitrite Nitrogen (NO_X-N)	EPA353.2	0.01 mg/L
Carbonaceous BOD ($CBOD_5$)	SM 5210B	2 mg/L
Total Dissolved Solids (TDS)	SM 2540C	10 mg/L
Total Suspended Solids (TSS)	SM 2540D	1 mg/L
Chemical Oxygen Demand (COD)	EPA 410.4	10 mg/L
Orthophosphate as P	EPA 300.0	0.01 mg/L
Total Phosphorus (TP)	SM 4500PE	0.01 mg/L
Fecal Coliform (fecal)	SM9222D	1 ct/100mL
Sulfate (SO_4)	EPA300.0	0.2 mg/L
Hydrogen Sulfide Unionized (H_2S)	SM4500S F	0.01 mg/L
Sulfide	SM4500S F	0.1 mg/L

3.5 Flow Monitoring

Flow rates for all PNRS II systems were calibrated at initial start-up. The flow rates are measured at each sampling event and adjusted as necessary to maintain flow rates consistent with the experimental design. Flow measurements and adjustments are made after collection of liquid samples and field parameter analyses.

A flow test was conducted March 23, 2011. These flow measurements are considered to represent those in effect leading up to and during the Sample Event 5. The measured volumes and relative errors between measured and target flow rates are presented in Appendix C, Table 1. For the Group I systems, measured STE inputs to four of the five Stage 1 biofilters were close to the 15% operational target that is considered acceptable for PNRS II flow rates. The measured influent volume of UNSAT-PS1 was – 59.5% of the target volume. The UNSAT-PS1 biofilter conversion to a recirculating biofilter system required that the tubing from the Hydrosplitter be connected to an elevated recirculation tank which is different from the other 4 single-pass biofilters connected to the same Hydrosplitter. Therefore, it has been observed that the influent volume significantly decreases to UNSAT-PS1 over time which is most likely caused by the difference in hydraulic head. With the abandonment of UNSAT-PS1, this problem should be fixed.

Measured effluent volumes for Stage 1 single pass biofilters (Stage 2 influent) for three of the five biofilters were within 16% of the target volume. DENIT-LS2 and DENIT-SU3 were -23.9% and -31.9% of the target volume respectively (Appendix C, Table 1). Possible reasons for the reduced volume into the directly connected Stage 2 biofilters include flow measurement methodology, leaks, clog in the pipe, etc. This issue will be further investigated.

For the Group II systems, all measured STE volumes to the Stage 1 recirculation tanks were within 16% of target volumes. Four of the five recycle flow volumes as recorded by the PLC were within 7% of target volumes based on the experimental design recycle ratio of 3.0. The recycle flow to recirculation system 4 was 0. An air lock was preventing the pump from running. The calculated recycle ratios (i.e. recycle flow volume divided by the STE flow volume) for three of the five recirculation systems were within 18% of the target recycle ratio of 3.0. Although the recycle rate to the UNSAT-PS1 was close to target, the recycle ratio was high due to the low influent STE flow that was previously discussed.

For Group III systems, the measured influent volumes to the Stage 2 horizontal denitrification biofilters were all within 4% of target.

For Group IV biofilters, the UNSAT-IS1 measured influent volume was within 10% of the target volume. The UNSAT-IS2 measured influent volume was low but within 20% of the target volume. UNSAT-IS1 and IS2 biofilters are currently dosed from the same peristaltic pump. The target hydraulic loading rates for IS1 and IS2 were 0.8 gal/SF-day and 1.2 gal/SF-day respectively. Therefore, the ability to provide different volumes to the two biofilters is accomplished by using different tubing diameters. As observed in this sample event, neither of the target loading rates was met. Therefore, IS1 and IS2 target hydrau-

lic loading rates were revised to 1.08 and 1.11 gal/SF-day which are the loading rates the tubing is able to provide. The UNSAT-IS3 and UNSAT-IS4 measured influent volumes were within 20% of target volumes.

After evaluating the influent flow test results, a few maintenance items were conducted:

- Peristaltic Pump 10 pump tubing to IS1 and IS2 was calibrated March 24th
- Peristaltic Pump 11 pump tubing to IS3 and IS4 was calibrated March 23rd
- Recirculation Pump 9 to recirculation system 4 was fixed on March 23rd
- Hydrosplitter tubing to UNSAT-PS1 recirculation tank (RC5) was revised to original position to Stage 1 single-pass influent located at the top of the UNSAT-PS1 biofilter on April 8th. The UNSAT-PS1 biofilter media will be replaced with clinoptilolite media.
- Hydrosplitters 1 and 2 were calibrated April 8th.

The flows were rechecked after modifications to the systems were made and are provided in Appendix C, Table 2.

Appendix A: PLC Data

Table A.1
Summary of PLC Recorded Daily Flows
(1/13/11 – 3/16/11)

Date Range		Average Recorded Flow (gpd)	Std. Dev.	MIN (gpd)	MAX (gpd)	Target Flow (gpd)	Relative Error[1] (%)
1/13/11-3/16/11	Pump 4 to Hydro 1	72	4.81	64	86	73.7	-3.0%
	Pump 14 to Hydro 2	57	5.16	25	62	58.9	-3.6%
	Pump 6 to Recirc. System 1	43	0.63	42	45	44.2	-3.1%
	Pump 7 to Recirc. System 2	44	0.75	42	46	44.2	0.2%
	Pump 8 to Recirc. System 3	44	0.65	41	45	44.2	-2.8%
	Pump 9 to Recirc. System 4	31	17.12	0	46	44.2	-30.7%
	Pump 15 to Recirc. System 5	91	5.43	89	119	88.4	2.8%

[1]Relative Error = (Recorded Flow – Target Flow)/ Target Flow *100

Table A.2
Summary of PLC Recorded Daily Runtimes
(1/13/11 – 3/16/11)

Date Range		Average Recorded Daily Runtime (min/day)	Std. Dev.	MIN (min)	MAX (min)	Target Daily Runtime (min)	Relative Error[1] (%)
1/13/11-3/16/11	Pump 4 to Hydro 1	18.0	0.28	17.0	20.0	17.6	2.4%
	Pump 14 to Hydro 2	10.7	0.9	5.0	11.0	10.4	2.4%
	Pump 6 to Recirc. System 1	6.4	0.5	6.0	7.0	6.0	6.3%
	Pump 7 to Recirc. System 2	6.4	0.5	6.0	8.0	6.0	6.6%
	Pump 8 to Recirc. System 3	6.4	0.5	6.0	7.0	6.0	6.3%
	Pump 9 to Recirc. System 4	6.4	0.5	6.0	8.0	6.0	6.9%
	Pump 15 to Recirc. System 5	12.9	3.4	0.0	15.0	14.0	-7.6%

[1]Relative Error = (Recorded Runtime – Target Runtime)/ Target Runtime *100
[2]Pump 4 Runtime was increased to increase UNSAT-PS1 STE influent volume to target level

Appendix B: Field Parameter Analyses

Table B.1
Field Parameter Results
(March 17, 2011)

Sample Identification	pH	Temperature (°C)	Specific Conductance (µS)	Dissolved Oxygen (mg/L)	ORP (mV)
STE					
STE-Tank 1	7.5	21.4	1,099	2.8	-231.7
STE-Tank 1-D	7.5	21.4	1,099	2.8	-231.7
Stage 1 Single Pass Biofilter Effluent					
UNSAT-EC1	7.1	9.6	1,048	6.6	25.7
UNSAT-EC3	7.1	10.8	1,059	6.1	22.2
UNSAT-CL1	7.4	5.8	1,193	6.2	10.7
UNSAT-CL3	7.5	10.6	1,130	7.5	8.2
Stage 2 Single Pass Upflow Biofilter Effluent					
DENIT-SU4	7.4	14.7	1,311	0.1	-231.6
DENIT-SU4-D	7.4	14.7	1,311	0.1	-231.6
DENIT-LS3	7.4	17.3	1,027	0.8	-294.6
DENIT-SU3	7.6	13.1	1,552	0.1	-285.2
DENIT-LS2	8.0	14.3	1,077	3.4	-99.1
DENIT-LS2-D	8.0	14.3	1,077	3.4	-99.1
DENIT-LS4	7.7	16.2	835	0.6	-195.5
DENIT-LS4-D	7.7	16.2	835	0.6	-195.5
Recirculation Tank Effluent					
RC1	7.4	17.0	894	0.18	-69.7
RC2	7.4	18.2	904	0.15	-67.3
RC3	7.5	17.6	925	1.49	-47.2
RC4	7.8	16.9	901	0.13	-68.6
RC5	7.4	16.5	888	0.52	-52.7
Stage 1 Recirculating Biofilter Effluent					
UNSAT-CL4	8.2	12.2	860	7.4	-98.2
UNSAT-CL2	7.2	11.7	900	2.9	-48.3
UNSAT-EC4	7.0	14.9	869	8.1	-20.2
UNSAT-SA2	7.0	14.1	859	6.07	-26.5

Sample Identification	pH	Temperature (°C)	Specific Conductance (µS)	Dissolved Oxygen (mg/L)	ORP (mV)
UNSAT-PS1	7.3	15.1	845	0.6	-49.9
P15-Tank	7.2	18.6	834	1.0	-3.5
Denite Feed Tank (Tank 3)					
DFT	7.2	18.8	891	7.5	5.6
Stage 2 Horizontal Biofilters Effluent					
DENIT-SU1	7.0	7.2	1,254	0.1	-281.9
DENIT-SU2	7.0	5.3	1,296	0.5	-268.9
DENIT-LS1	7.4	4.6	886	0.1	-271.5
DENIT-GL1	7.0	3.9	927	0.1	-259.0
In-situ Simulator Biofilter Effluent					
UNSAT-IS1 (STE)	7.3	10.7	999	0.6	-353.1
UNSAT-IS2-SP (STE)	6.6	24.1	990	0.5	-57.9
UNSAT-IS2 (STE)	7.4	11.8	977	3.1	-75.0
UNSAT-IS3-SP (STE)	7.6	6.2	1,269	6.7	-46.1
UNSAT-IS3 (STE)	7.7	13.4	1,481	NR[1]	-79.6
UNSAT-IS4-SP (Nitrified STE)	7.4	14.9	1,087	4.9	-67.5
UNSAT-IS4 (Nitrified STE)	7.0	12.2	1,346	2.3	19.1
Blanks					
Field Blank	7.9	17.3	55	9.3	-39.8
Equipment Blank	7.6	17.9	52	9.1	-26.0

[1]NR = No reading was taken.

Appendix C: Flow Test Results

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Table C.1
Flow Test Results

Group (Figure 1)	Biofilter/Flow	Target Input			Measured Input		Recycle Ratio		
		Target Input Volume	Dose/day	Target Input Volume	Measured Input Volume	Relative Error (%)	Target Recycle Ratio (RR)	Calculated Recycle Ratio (RR)	Relative Error (%)
		(mL/day)	(Dose/day)	(mL/dose)	(mL/dose)	(Measured Input -Target Input) / Target Input * 100	Volume Recycle / Volume STE	Volume Recycle / Volume STE	Measured RR - Target RR / Measured RR * 100
1	**Stage 1 Single Pass Biofilters (Hydrosplitter 1)**								
	Date				3/23/2011 10:00 - 11:00 am				
	UNSAT-PS1	55,656	24	2,319	940	-59.5%			
	UNSAT-CL3				1,880	-18.9%			
	UNSAT-CL1				2,510	8.2%			
	UNSAT-EC3				2,720	17.3%			
	UNSAT-EC1				2,680	15.6%			
	Mean				2,146	-7.5%			
	Stage 2 Single Pass Upflow Biofilters								
	Date				3/23/2011 9:00-10:00 am				
	DENIT-LS4	55,656	24	2,319	2,700	16.4%			
	DENIT-LS2				1,765	-23.9%			
	DENIT-SU3				1,580	-31.9%			
	DENIT-LS3				2,340	0.9%			
	DENIT-SU4				2,020	-12.9%			
	Mean				2,081	-10.3%			
2	**Stage 1 Recirculating Biofilters (Hydrosplitter 2)**								
	Date				(3/23/2011) STE 10:30 - 11:30 am				
	RC1 : UNSAT-SA2	55,656	24	2,319	1,940	-16.3%			
	RC2 : UNSAT-EC4				1,990	-14.2%			
	RC3 : UNSAT-CL2				1,980	-14.6%			
	RC4 : UNSAT-CL4				2,160	-6.9%			
	Mean				2,018	-13.0%			
	Stage 1 Recirculating Biofilters (Recycle)				Flowmeter R 3/23/2011				
	RC1 : UNSAT-SA2	166,968	24	6,957	7,097	2.0%	3:1	3.66	18.0%
	RC2 : UNSAT-EC4				7,255	4.3%		3.65	17.7%
	RC3 : UNSAT-CL2				7,097	2.0%		3.58	16.3%
	RC4 : UNSAT-CL4				0	-100.0%		0.00	-100.0%
	Mean				5,362	-22.9%		2.72	-12.0%
	RC5 : UNSAT-PS1	333,936	24	13,914	12,932	-7.1%	6:1	13.76	56.4%
	Stage 1 Recirculating Biofilters (Hydrosplitter + Recycle)								
	RC1 : UNSAT-SA2	222,624	24	9,276	9,037				
	RC2 : UNSAT-EC4				9,245				
	RC3 : UNSAT-CL2				9,077				
	RC4 : UNSAT-CL4				2,160				
	Mean				7,380				
	RC5 : UNSAT-PS1	389,592	24	16,233	13,872				
3	**Horizontal Denitrification Biofilters**								
	Date				3/23/2011 9:30 - 10:30 am				
	DENIT-SU1	7,409	24	308.7	315	2.0%			
	DENIT-SU2				315	2.0%			
	DENIT-GL1				295	-4.4%			
	DENIT-LS1				302	-2.2%			
	Mean				307	-0.6%			
4	**In-Situ Simulators**								
	Date				3/23/2011 8:30 - 9:30 am				
	UNSAT-IS1 (STE)	14,865	24	619	680	9.8%			
	UNSAT-IS2 (Nitrified STE)	22,298	24	929	735	-20.9%			
	UNSAT-IS3 (STE)	893	24	37	30	-19.4%			
	UNSAT-IS4 (Nitrified STE)				33	-11.3%			

Notes: Yellow-shaded cells are measured values; grey-shaded cells are calculated values

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Table C.2
Flow Test Results following Modifications
(Modifications are indicated in green)

Group (Figure 1)	Biofilter/Flow	Target Input			Measured Input		Recycle Ratio		
		Target Input Volume	Dose/day	Target Input Volume	Measured Input Volume	Relative Error (%)	Target Recycle Ratio (RR)	Calculated Recycle Ratio (RR)	Relative Error (%)
		(mL/day)	(Dose/day)	(mL/dose)	(mL/dose)	(Measured Input -Target Input) / Target Input * 100	Volume Recycle / Volume STE	Volume Recycle / Volume STE	Measured RR - Target RR / Measured RR * 100
1	**Stage 1 Single Pass Biofilters (Hydrosplitter 1)**								
	Date				4/8/2011 5:00 - 6:00 pm				
	UNSAT-PS1	55,656	24	2,319	2,350	1.3%			
	UNSAT-CL3				2,200	-5.1%			
	UNSAT-CL1				2,260	-2.5%			
	UNSAT-EC3				2,300	-0.8%			
	UNSAT-EC1				2,320	0.0%			
	Mean				2,286	-1.4%			
	Stage 2 Single Pass Upflow Biofilters								
	Date				3/23/2011 9:00-10:00 am				
	DENIT-LS4	55,656	24	2,319	2,700	16.4%			
	DENIT-LS2				1,765	-23.9%			
	DENIT-SU3				1,580	-31.9%			
	DENIT-LS3				2,340	0.9%			
	DENIT-SU4				2,020	-12.9%			
	Mean				2,081	-10.3%			
2	**Stage 1 Recirculating Biofilters (Hydrosplitter 2)**								
	Date				(4/8/2011) STE 3:30 - 4:30 pm				
	RC1 : UNSAT-SA2	55,656	24	2,319	2,290	-1.3%			
	RC2 : UNSAT-EC4				2,140	-7.7%			
	RC3 : UNSAT-CL2				2,330	0.5%			
	RC4 : UNSAT-CL4				2,310	-0.4%			
	Mean				2,268	-2.2%			
	Stage 1 Recirculating Biofilters (Recycle)				Flowmeter R 4/8/2011				
	RC1 : UNSAT-SA2	166,968	24	6,957	6,781	-2.5%	3:1	2.96	-1.3%
	RC2 : UNSAT-EC4				7,097	2.0%		3.32	9.5%
	RC3 : UNSAT-CL2				6,781	-2.5%		2.91	-3.1%
	RC4 : UNSAT-CL4				6,939	-0.3%		3.00	-0.3%
	Mean				6,900	-0.8%		3.05	1.2%
	RC5 : UNSAT-PS1	333,936	24	13,914	14,036	0.9%	6:1	5.97	-0.5%
	Stage 1 Recirculating Biofilters (Hydrosplitter + Recycle)								
	RC1 : UNSAT-SA2	222,624	24	9,276	9,071				
	RC2 : UNSAT-EC4				9,237				
	RC3 : UNSAT-CL2				9,111				
	RC4 : UNSAT-CL4				9,249				
	Mean				9,167				
	RC5 : UNSAT-PS1	389,592	24	16,233	16,386				
3	**Horizontal Denitrification Biofilters**								
	Date				3/23/2011 9:30 - 10:30 am				
	DENIT-SU1	7,409	24	308.7	315	2.0%			
	DENIT-SU2				315	2.0%			
	DENIT-GL1				295	-4.4%			
	DENIT-LS1				302	-2.2%			
	Mean				307	-0.6%			
4	**In-Situ Simulators**								
	Date				3/24/2011 dose @ 12:00 am				
	UNSAT-IS1 (STE)	20,160	24	840	840	0.0%			
	UNSAT-IS2 (Nitrified STE)	20,640	24	860	860	0.0%			
					3/23/2011 dose @ 9:42 am				
	UNSAT-IS3 (STE)	893	24	37	36.5	-1.9%			
	UNSAT-IS4 (Nitrified STE)				38.0	2.2%			

Notes: Yellow-shaded cells are measured values; grey-shaded cells are calculated values

Appendix D: Chain of Custody Forms

o:\44237-001\Wpdocs\Report\Draft

SOUTHERN ANALYTICAL LABORATORIES, INC.

110 BAYVIEW BOULEVARD, OLDSMAR, FL 34677 813-855-1844 fax 813-855-2218

SAL Project No. 1102050

Client Name	Contact / Phone:
Hazan and Sawyer	Josephin Edeback-Hirst 813-630-4498
Project Name / Location: PNRS II Wastewater System Analyses	jedeback@hazanandsawyer.com
Samplers: (Signature)	

Matrix Codes: DW-Drinking Water WW-Wastewater SW-SurfaceWater SL-Sludge SO-Soil GW-Groundwater SA-Saline Water O-Other R-Reagent Water

SAL Use Only Sample No.	Sample Description	Date	Time	Matrix	Composite	Grab	500mL P, Cool Alk, CBOD, TSS, TDS, NO_2, NO_3, OP	125ml P, H_2SO_4 TKN, NH_3, COD,	500mL P, ZnAcetate/NaOH Hydrogen Sulfide **No Headspace**	500mL P, Cool Alk, CBOD, TSS, TDS, NO_2, NO_3, OP, SO_4	500mL P, Cool Alk, CBOD, TSS, TDS, NO_2, NO_3,	125ml P, H_2SO_4 TKN, NH_3, COD, TP	ORP (Client meter)	Field pH	Field Temp	Field Cond	Field DO
01	PNRS II STE-T1	031711	1215	WW		X			1		1*	1	-231.7	7.5	11.4	1099	2.83
02	RC1	031711	1205	WW		X	1	1					-69.7	7.4	17.0	894	0.18
03	RC2	031711	1200	WW		X	1	1					-67.3	7.4	18.2	904	0.15
04	RC3	031711	1155	WW		X	1	1					-47.2	7.5	17.6	925	1.49
05	RC4	031711	1150	WW		X	1	1					-68.6	7.8	16.9	901	0.13
06	RC5	031711	1140	WW		X	1	1					-52.7	7.4	16.5	888	0.52
07	P15-T	031711	1100	WW		X	1	1					-3.5	7.2	18.6	834	1.00
08	UNSAT-IS1	031711	1245	WW		X		1		1				7.3	10.7	999	
09	UNSAT-IS2	031711	1240	WW		X		1		1				7.4	11.8	977	
10	UNSAT-IS3 - SP	031711	1235	WW		X		1		1				7.6	6.2	1269	
11	UNSAT-IS4 - SP	031711	~~1030~~ 1230 SH	WW		X		1		1				7.4	14.9	1087	
12	UNSAT-EC1	031711	1130	WW		X		1		1			+25.1	7.1	9.6	1048	6.61

	Date/Time:	Received:	Date/Time:
Containers Prepared/ Relinquished:	1400 03-11-11		1300 03-15-11
Relinquished:	1415 03 17 11	Received:	Date/Time:
Relinquished:	Date/Time:	Received:	Date/Time:
Relinquished:	Date/Time:	Received:	Date/Time:
Relinquished:	Date/Time:	Received:	Date/Time:

Seal intact?	Y N (N/A)
Samples intact upon arrival?	(Y) N N/A
Received on ice? Temp_____	(Y) N N/A
Proper preservatives indicated?	(Y) N N/A
Rec'd within holding time?	(Y) N N/A
Volatiles rec'd w/out headspace?	Y N (N/A)
Proper containers used?	(Y) N N/A

Instructions / Remarks

* include sulfate

UNSat - IS1, IS2, IS3, IS4 ORP and DO to be collected by Josephin and emailed to Patty SH

1102050

Chain of Custody

SOUTHERN ANALYTICAL LABORATORIES, INC.
110 BAYVIEW BOULEVARD, OLDSMAR, FL 34677 813-855-1844 fax 813-855-2218

SAL Project No. 1102050

Client Name	Contact / Phone:
Hazan and Sawyer	Josephin Edeback-Hirst 813-630-4498
Project Name / Location	jedeback@hazanandsawyer.com
PNRS II Wastewater System Analyses	
Samplers: (Signature) Sean Herman	

Matrix Codes: DW-Drinking Water WW-Wastewater SW-SurfaceWater SL-Sludge SO-Soil GW-Groundwater SA-Saline Water O-Other R-Reagent Water

SAL Use Only Sample No.	Sample Description	Date	Time	Matrix	Composite	Grab	500mL P, Cool Alk, CBOD, TSS, TDS, NO_2, NO_3, OP	125ml P, H_2SO_4 TKN, NH_3, COD,	500mL P, ZnAcetate/NaOH Hydrogen Sulfide **No Headspace**	500mL P, Cool Alk, CBOD, TSS, TDS, NO_2, NO_3,	500mL P, Cool Alk, CBOD, TSS, TDS, NO_2, NO_3, OP, SO_4	125ml P, H_2SO_4 TKN, NH_3, COD, TP	ORP (Client meter)	Field pH	Field Temp	Field Cond	Field DO
13	UNSAT-SA2	03/17/11	1025	WW		X	1	1					-26.5	7.0	14.1	859	6.07
14	UNSAT-EC3	03/17/11	1125	WW		X	1	1					+22.2	7.1	10.8	1059	6.08
15	UNSAT-EC4	03/17/11	1010	WW		X	1	1					-20.2	7.0	14.9	868	8.12
16	UNSAT-CL1	03/17/11	1120	WW		X		1			1		+10.7	7.4	5.8	1193	6.22
17	UNSAT-CL2	03/17/11	1005	WW		X	1	1					-48.3	7.2	11.7	900	2.88
18	UNSAT-CL3	03/17/11	1115	WW		X	1	1					+8.2	7.5	10.6	1130	7.49
19	UNSAT-CL4	03/17/11	1000	WW		X	1	1					-98.2	8.2	12.2	860	7.37
20	UNSAT-PS1	03/17/11	1145	WW		X	1	1					-49.9	7.3	15.1	845	0.61
21	DENIT-SU1	03/17/11	0816	WW		X		1			1	-281.9	~~-268.9~~ -268.9	7.00	7.2	1254	0.09
22	DENIT-SU2	03/17/11	0820	WW		X		1	1		1		-268.9	7.0	5.3	1296	0.47
23	DENIT-SU3	03/17/11	0920	WW		X		1			1		-285.2	7.6	13.1	1552	0.01
24	DENIT-SU4	03/17/11	0930	WW		X		1	1		1		-231.6	7.4	14.7	1311	0.08

Containers Prepared/ Relinquished:	Date/Time: 1400 03-11-11	Received:	Date/Time: 1300 03/15/11
Relinquished:	Date/Time: 1415 03/17/11	Received:	Date/Time:
Relinquished:	Date/Time:	Received:	Date/Time:
Relinquished:	Date/Time:	Received:	Date/Time:
Relinquished:	Date/Time:	Received:	Date/Time:

Seal intact? Y N (N/A)
Samples intact upon arrival? (Y) N N/A
Received on ice? Temp_____ (Y) N N/A
Proper preservatives indicated? (Y) N N/A
Rec'd within holding time? (Y) N N/A
Volatiles rec'd w/out headspace? Y N (N/A)
Proper containers used? (Y) N N/A

Instructions / Remarks

1102050

Chain of Custody.xls
Rev.Date 11/19/01

Chain of Custody

SOUTHERN ANALYTICAL LABORATORIES, INC.
110 BAYVIEW BOULEVARD, OLDSMAR, FL 34677 813-855-1844 fax 813-855-2218

SAL Project No. 1102050

Client Name	Contact / Phone:
Hazan and Sawyer	Josephin Edeback-Hirst 813-630-4498
Project Name / Location	jedeback@hazanandsawyer.com
PNRS II Wastewater System Analyses	
Samplers: (Signature)	

Matrix Codes: DW-Drinking Water WW-Wastewater SW-SurfaceWater SL-Sludge SO-Soil GW-Groundwater SA-Saline Water O-Other R-Reagent Water

SAL Use Only Sample No.	Sample Description	Date	Time	Matrix	Composite	Grab	500mL P, Cool Alk, CBOD, TSS, TDS, NO_2, NO_3, OP	125ml P, H_2SO_4 TKN, NH_3, COD,	500mL P, ZnAcetate/NaOH Hydrogen Sulfide **No Headspace**	500mL P, Cool Alk, CBOD, TSS, TDS, NO_2, NO_3, OP, SO_4	500mL P, Cool Alk, CBOD, TSS, TDS, NO_2, NO_3,	125ml P, H_2SO_4 TKN, NH_3, COD, TP	**ORP (Client meter)**	**Field pH**	**Field Temp**	**Field Cond**	**Field DO**
							PARAMETER / CONTAINER DESCRIPTION										
25	DENIT-LS1	031711	0830	ww		x	1	1					-271.5	7.41	4.6	886	0.09
26	DENIT-LS2	031711	0910	ww		x	1	1					-99.1	8.0	14.3	1077	3.42
27	DENIT-LS3	031711	0925	ww		x	1	1					-294.6	7.4	17.3	1027	0.81
28	DENIT-LS4	031711	0900	ww		x	1	1					-195.5	7.7	16.2	835	0.56
29	DENIT-GL1	031711	0840	ww		x	1	1					-259.0	7.0	3.9	927	0.07
30	DFT	031711	1105	ww		x			1	1		1	+5.6	7.2	18.8	891	7.54
31	T1-D	031711	1220	ww		x	1	1					-231.7	7.5	21.4	1099	2.83
32	SU-4D	031711	0935	ww		x	1	1					-231.6	7.4	14.7	1311	0.08
33	LS2-D	031711	0915	ww		x	1	1					-99.1	8.0	14.3	1077	3.42
34	LS4-D	031711	0905	ww		x	1	1					-195.5	7.7	16.2	835	0.56
35	FB	031711	1030	ww		x	1	1					-39.8	7.9	17.3	55.3	9.29
36	EB	031711	1045	ww		x	1	1					-26.0	7.6	17.9	52.2	9.09

Containers Prepared/ Relinquished:	Date/Time: 1400 03-11-11	Received:	Date/Time: 1800 03/5/11
Relinquished:	Date/Time: 1415 031711	Received:	Date/Time:
Relinquished:	Date/Time:	Received:	Date/Time:
Relinquished:	Date/Time:	Received:	Date/Time:
Relinquished:	Date/Time:	Received:	Date/Time:

Seal intact?	Y N N/A
Samples intact upon arrival?	Y N N/A
Received on ice? Temp_____	Y N N/A
Proper preservatives indicated?	Y N N/A
Rec'd within holding time?	Y N N/A
Volatiles rec'd w/out headspace?	Y N N/A
Proper containers used?	Y N N/A

Instructions / Remarks

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Chain of Custody

SOUTHERN ANALYTICAL LABORATORIES, INC.

110 BAYVIEW BOULEVARD, OLDSMAR, FL 34677 813-855-1844 fax 813-855-2218

SAL Project No. 1102042

Client Name	Contact / Phone:
Hazan and Sawyer	Josephin Edeback-Hirst 813-630-4498
Project Name / Location	jedeback@hazanandsawyer.com
PNRS II Wastewater System Analyses	
Samplers: (Signature)	

Matrix Codes: DW-Drinking Water WW-Wastewater SW-SurfaceWater SL-Sludge SO-Soil GW-Groundwater SA-Saline Water O-Other R-Reagent Water

SAL Use Only Sample No.	Sample Description	Date	Time	Matrix	Composite	Grab	~~500ml P~~; Cool 125 CP (HH) 3-7-11 Alk, CBOD, TSS, TDS, NO_2, NO_3, OP, SO_4	125ml P, H_2SO_4 TKN, NH_3, COD,					ORP (Client meter)	Field pH	Field Temp	Field Cond	Field DO
01	UNSAT-IS3	3/15/11	7:50am	WW		X	1	1					-79.6	7.74	13.4	1481	
02	UNSAT-IS4	3/15/11	7:45am	WW		X	1	1					19.1	6.99	12.2	1346	

Containers Prepared/ Relinquished:	Date/Time:	Received:	Date/Time:
HH	3-7-11 1530	Josephine Hirst	3-14-11
Josephine Hirst	3-15-11 09:20	[signature]	3-15-11 09:20
[signature]	3-15-11 12:16		

Seal intact? Y N N/A

Samples intact upon arrival? Y N N/A

Received on ice? Temp 0.9 Y N N/A

Proper preservatives indicated? Y N N/A

Rec'd within holding time? Y N N/A

Volatiles rec'd w/out headspace? Y N N/A

Proper containers used? Y N N/A

Instructions / Remarks

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Chain of Custody.xls
Rev.Date 11/19/01

Chain of Custody

Pace Analytical®
www.pacelabs.com

CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed accurately.

3527866

Page: of 1456103

Section A Required Client Information:

Company: Hazen and Sawyer
Address: 10002 Princess Palm Ave
Suite 200 Tampa, FL 33619
Email To: jedelacy@hazenand sawyer.com
Phone: 813-630-4998 Fax: 813-630-1967
Requested Due Date/TAT:

Section B Required Project Information:

Report To: Josh - Hirst
Copy To:
Purchase Order No.: 44237-001-100
Project Name: FDOH PNRS II SE #5
Project Number: 44237-001

Section C Invoice Information:

Attention:
Company Name:
Address:
Pace Quote Reference:
Pace Project Manager:
Pace Profile #:

REGULATORY AGENCY

☐ NPDES ☐ GROUND WATER ☐ DRINKING WATER
☐ UST ☐ RCRA ☐ OTHER

Site Location STATE: GCREC FL

Section D Required Client Information

SAMPLE ID (A-Z, 0-9 / ,-) Sample IDs MUST BE UNIQUE

Matrix Codes MATRIX / CODE

Drinking Water	DW
Water	WT
Waste Water	WW
Product	P
Soil/Solid	SL
Oil	OL
Wipe	WP
Air	AR
Tissue	TS
Other	OT

Requested Analysis Filtered (Y/N)

ITEM #	SAMPLE ID	MATRIX CODE (see valid codes to left)	SAMPLE TYPE (G=GRAB C=COMP)	COLLECTED COMPOSITE START DATE	COLLECTED COMPOSITE START TIME	COLLECTED COMPOSITE END/GRAB DATE	COLLECTED COMPOSITE END/GRAB TIME	SAMPLE TEMP AT COLLECTION	# OF CONTAINERS	Preservatives: Unpreserved	H_2SO_4	HNO_3	HCl	NaOH	$Na_2S_2O_3$	Methanol	Other	Analysis Test Y/N	TDS & TSS	NO_2-N	NO_3-N	Alkalinity	CBOD5	OP	SO4	COD	TP, TKN, NH3	Hydrogen Sulfide	Residual Chlorine (Y/N)	Pace Project No./ Lab I.D.
1	PNRS II STE-T1	WW	G	3/17/11	12:20			21.4	5									✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
2	UNSAT-IS 2	WW	G	3/17/11	1245			11.8	3									✓	✓	✓	✓	✓	✓	✓		✓	✓		
3																													
4	PNRSIISTE-T1 pH 7.5; 1099 uS																												
5	UNSAT-IS 2 pH 7.4; 977 uS																												
6																													
7																													
8																													
9																													
10																													
11																													
12																													

ADDITIONAL COMMENTS	RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME	SAMPLE CONDITIONS
	[redacted]	3/16/11	1:00pm	Josefin Hirst	3/16/11	1:00pm	
	Josefin Hirst	3/17/11	15:16	Kristy Clowes Pace	3/17/11	15:16	
	Bluestreak	3/17/11	1600	Platt	3/18/11	7:30	02 Y

ORIGINAL

SAMPLER NAME AND SIGNATURE

PRINT Name of SAMPLER: Josefin Hirst
SIGNATURE of SAMPLER: Josefin Hirst
DATE Signed (MM/DD/YY): 3/17/11

Temp in °C	Received on Ice (Y/N)	Custody Sealed Cooler (Y/N)	Samples Intact (Y/N)

*Important Note: By signing this form you are accepting Pace's NET 30 day payment terms and agreeing to late charges of 1.5% per month for any invoices not paid within 30 days.