HEATED WATER PLAN OF STUDY

Florida Power & Light Company
St. Lucie Nuclear Power Plant

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1.0 INTRODUCTION

The St. Lucie Nuclear Power Plant (St. Lucie Plant) [Industrial Wastewater Facility (IWWF) Permit No. FL 0002208] is located on a 1,132-acre site on Hutchinson Island in St. Lucie County, Florida. The plant consists of two nuclear-fueled electric-generating units. Unit 1 received an operating license in March 1976 and Unit 2 in April 1983. The St. Lucie Plant is located on the widest section of Hutchinson Island. The island is separated from the mainland on its western side by the Indian River Lagoon (IRL) and borders the Atlantic Ocean on the east (see Figure 1).

The source of once-through cooling water for the St. Lucie Plant is the Atlantic Ocean. At the location of the St. Lucie Plant on Hutchinson Island, the edge of the continental shelf extends approximately 21 miles offshore. Hutchinson Island is a barrier island that extends 22.5 miles between inlets (Ft. Pierce and St. Lucie Inlets) and attains a maximum width of 1.2 miles at the St. Lucie Plant site. Near shore, in the vicinity of the St. Lucie Plant, mean water depths typically range from 23 to 32 feet (ft) [National Oceanic and Atmospheric Administration (NOAA) Chart, 11472]. There is an offshore shoal, Pierce Shoal, approximately 2 to 3 miles offshore.

The St. Lucie Plant discharges its once-through cooling water back to open waters of the Atlantic Ocean via two discharge pipes. One discharge pipe is outfitted with a Y-port diffuser and the second with a multi-port diffuser.

The St. Lucie Plant is undergoing an extended power uprate (EPU) to increase its net electrical power generation by approximately 100 MW per unit. To accommodate the approximately 2° F increase in the discharge temperature that is projected to be associated with the EPU, a permit revision application was submitted by Florida Power & Light Company (FPL) to the Florida Department of Environmental Protection (FDEP) to change the St. Lucie Station's heated water discharge limitations in the IWWF permit. On December 23, 2010, this request was approved by the FDEP contingent upon the implementation of additional monitoring requirements. In conjunction with its approval of the facility's IWWF permit, the FDEP issued Administrative Order AO022TL. Condition 17 of this Administrative Order set forth field monitoring requirements to confirm the results of the heated water discharge plume modeling previously submitted by FPL:

> Condition 17. No later than 180 days after the effective date of this Order, the Permittee shall prepare and submit for the Department's review and approval a plan of study (Heated Water POS) and schedule to confirm the results of the mathematical model used for simulating the near and far field extent of the Facility's heated water discharge. The Heated Water POS shall be designed and implemented to demonstrate that the heated water discharge from the Facility: 1) does not raise the surface temperature near the Facility's open ocean outfalls to more than 97°F; and 2) does not heat adjacent coastal waters more than the limitations specified in Rule 62-302.520(4)(b), F.A.C. This study also shall evaluate whether and to what extent the heated water discharge raises the temperature of the cooling water entering the Facility above ambient temperature. The

> study shall commence within 90 days after completion of both uprate projects for Unit 1 and 2. The study shall last no less than 24 months from commencement. The results of the study shall be submitted in a report (Heated Water Report) to the Department for review and approval no later than 60 days after the approved Heated Water POS completion date. The schedule shall include milestones and the completion date.

Rule 62-302.520(4)(b), Florida Administrative Code (F.A.C.) states "Heated water with a temperature at the Point of Discharge (POD) more than 2° F higher than ambient (natural) temperature of the Receiving Body of Water (RBW) shall not be discharged into coastal waters in any zone during the months of June, July, August, and September. During the remainder of the year, heated water with a temperature at the POD more than 4° F higher than ambient (natural) temperature of the RBW shall not be discharged into coastal waters in any zone. In addition, during June, July, August, and September, no heated water with a temperature above 92° F shall be discharged into coastal waters. Further no heated water with a temperature above 90° F shall be discharged into coastal waters during the period October thru May." Coastal waters, as defined in Rule 62-302.520(3), in the Atlantic Ocean in the vicinity of the St. Lucie Plant include all waters shoreward of the 18-depth contour as shown on Coast and Geodetic Survey Charts. All waters seaward of this contour, as defined in Rule 62-302.520(3), are open waters. Rule 62-302.520(4)(c), F.A.C., states that for open waters "the surface temperature of the RBW shall not be raised to more than 97° F and the POD must be sufficient distance offshore to ensure that the adjacent coastal waters are not heated beyond the temperatures permitted in such waters."

In addition, Condition 14 of Administrative Order AO022TL required the completion of a feasibility study Ambient Monitoring Report (AMR) for installing permanent remote thermometers to monitor ambient temperatures. The purpose of the AMR was to determine the appropriate ambient Atlantic Ocean temperature to be used for mixing zone/thermal impact modeling. Since that time, FPL proposed that the determination of an appropriate ambient temperature could be satisfied as part of the HWPOS. The results of the HWPOS will determine whether or not a permanent remote ambient temperature monitoring station will need to be sited in the Atlantic Ocean.

2.0 PROJECT OBJECTIVES

The objective of the Heated Water Plan of Study (HWPOS) is to develop data to confirm the predictions of the mathematical thermal model for simulating the near-field and far-field extent of the St. Lucie Plant's heated water plume in the Atlantic Ocean. The HWPOS includes three components:

- Demonstrate that the discharge of cooling water from the St. Lucie Plant does not raise surface water temperatures in the vicinity of the open ocean outfalls to more than 97 degrees Fahrenheit (°F).
- Demonstrate that the open ocean cooling water outfalls do not heat adjacent coastal waters above the limitations specified in 62-302.520(4)(b), F.A.C.
- Evaluate whether, and to what extent, the St. Lucie Plant's cooling water discharge raises the temperature of the cooling water being drawn into the St. Lucie Plant above ambient temperature.

To achieve these objectives, heated water temperature monitoring stations will be established (or existing stations utilized) at several locations:

- Near the St. Lucie Plant open ocean discharge outfalls,
- At the 18-ft contour, and
- In the vicinity of the St. Lucie Plant intake structures as well as the intake and discharge canals.
- An ambient (background) temperature monitoring station and two velocity profiling stations will also be included in the study.

The proposed location of these stations is shown in Figure 2. The following subsections summarize the thermal modeling output information considered in the selection of station locations.

2.1 Surface Water Temperature Near the Discharge Structures

The first requirement of Condition 17 is to confirm that the surface temperature in the vicinity of the discharges is not raised above 97° F. Since "surface temperature" is not defined in 62-302.520, F.A.C., for the purposes of this study it is taken to be the uppermost 2 ft of the water column. Surface temperature measurements will be collected at a depth between 1 ft and 2 ft below the surface. Modeling results indicate that peak surface temperatures occur within 100 to 200 ft of the discharge from the Y-port diffuser. For the multi-port diffuser, maximum surface temperatures occur within 0 to 50 ft of the discharge pipe.

2.2 Coastal Waters

The second requirement of Condition 17 is to verify that coastal waters (shoreward of the 18-ft depth contour) are not heated beyond the limitations of Rule 62-302.520(4)(b), F.A.C. These regulations allow for a maximum coastal temperature increase of 2°F above ambient during summer months (June to

September) and 4°F above ambient for the remainder of the year. Three monitoring stations are proposed to meet this requirement. The first station will be located between the discharge pipes at the 18-ft contour. This is the closest point in coastal waters to the source of heated water. Two other stations will be located between 0.5 mile and 1.0 mile north and south along the 18-ft contour, at locations where the modeling results suggest the greatest possibility of heated water incursion into coastal waters.

This study is also designed to provide a comparison to the ambient temperature of the coastal waters. To make this comparison the HWPOS proposes to take advantage of the buoyant properties of the discharge plume. Warmer water is less dense than cooler water and therefore, if present, the plume would be expected to be found at the surface. At each station, temperatures will be recorded at three depths: surface, mid-depth, and near the bottom. If the plume crosses the 18-ft depth contour, it can be identified by the difference between the surface temperature and temperature at depth. The vertical profiling current meters will provide data to assess if conditions exist that would cause an incursion of heated water (i.e., currents with an onshore component). Also, incursion of heated water at more than one coastal station simultaneously would be highly unlikely. Therefore, the stations where incursion of heated water is unlikely can be used to determine if natural temperature stratification is present in the coastal ambient temperature profile. This information will be used to determine the temperature rise caused by the heated water incursion.

2.3 Potential for Re-entrainment of Heated Water

An ambient temperature monitoring station has been incorporated into the HWPOS to ensure that all necessary data are available to make the assessments required by Condition 17. Ambient temperature data will be used as the baseline against which intake temperatures will be compared. In this manner, any detected rise in the temperature of intake water relative to the ambient temperature will be evaluated. The coastal monitoring stations are not used for intake ambient monitoring because the velocity caps (intakes) are in deeper open waters.

3.0 STATION LOCATION

There are five types of monitoring stations included in the HWPOS:

- Surface Discharge Monitoring Stations
- 18-ft Contour Monitoring Stations
- Cooling Water Intake Monitoring Station
- Ambient/Background Monitoring Station
- Intake and Discharge Canal Monitoring Stations

The offshore monitoring stations will consist of single and multiple-temperature logger arrays located in water depths from 18 ft to approximately 30 ft (see Figure 2). The criteria used to select the station locations are discussed below.

3.1 Surface Discharge Monitoring Stations

Surface discharge monitoring stations will be located where the thermal plume modeling predicts maximum surface temperatures under zero ambient current conditions. Figure 2 shows the recommended locations for the proposed surface discharge stations (solid green dots). The surface monitoring stations near the Y-discharge will be installed along the centerline of the discharge pipes approximately 75 to 150 ft from the point of discharge (see Insert A, Figure 1). The final location will be determined during station deployment by measuring surface temperatures and placing the station at the location with the maximum observed temperature. For the multiport diffuser, one monitoring station will be located approximately 25-ft north of the centerline of the discharge pipe and about 400-ft offshore from the start of the diffuser. This location corresponds approximately to the point of maximum temperature as predicted by the thermal modeling (see Insert B, Figure 1). The final location will be determined during station deployment by measuring surface temperatures and placing the station at the location with the maximum temperature. The final station locations will be mapped using GPS navigation. Temperature loggers at these three stations will be installed at the surface only.

To define the surface temperature increase of the heated water it is important to note that the heated water rises above the ambient water and the near-surface temperature is the important measurement. Also, since the heated water moves up and down with tides and wave motion, the plume measurement needs to be relative to a moving surface. Therefore, to ensure that these stations are always measuring the water temperature within 1 to 2 ft of the surface, the thermometers will be mounted to the bottom of the surface buoys.

3.2 18-ft Contour Monitoring Stations

The 18-ft contour, as determined from Coast & Geodetic Survey charts, is the demarcation line between the Open Ocean and Coastal Waters as defined in Chapter 62-302.520, F.A.C. Therefore, three monitoring stations (one north of the Y-discharge pipe, one south of the intake structures, and one

between the St. Lucie Plant's discharge pipes) will be established at the 18-ft. contour (solid red dots, Figure 2). The monitoring station at the 18-ft contour midway between the two discharge pipes is designed to cover an onshore current condition. This is also the closest point in coastal waters to the source of heated water. The north and south monitoring stations will be located approximately 0.5 to 1 mile north and south of the discharge structures. These are the two segments of the shoreline where the thermal plume modeling shows the greatest possibility of plume encroachment into coastal waters when the offshore currents are predominately from the north or south. All three of these monitoring stations will have temperature loggers near the surface, at mid-depth, and near the bottom.

3.3 Cooling Water Intake Monitoring Station

In order to evaluate the potential re-entrainment of the heated plume, a monitoring station will be deployed near the water entrance to the intake velocity caps (open red circle, Figure 2). For this monitoring station, two temperature loggers will be located at a water depth equal to the intakes and one additional logger will be installed near the surface to determine if heated water passes above the velocity caps, without affecting the temperature of the water entering the plant.

For the intake temperature measurements the elevation above the seafloor is the critical reference as the intake structure is at a fixed elevation. Therefore, the intake thermometers will be mounted at the elevation corresponding to the mid-point of the velocity cap openings. For the surface temperature measurement the thermometers will be mounted to the bottom of the surface buoy.

3.4 Ambient/Background Monitoring Station

To meet the requirements of the Administrative Order, it will be necessary to record the temperature of the ambient water (i.e., water unaffected by the heated water discharge). To optimize the collection of ambient/background data, a temperature monitoring station will be established offshore and southeast of the intake structures (open green circle, Figure 2). The Ambient/Background Monitoring station location and instruments (thermometers) array was selected to address the following considerations:

- The monitoring station must be seaward of the most seaward 18-ft depth contour.
- The monitoring station should be near the intake structures.
- The monitoring station should be outside the hydraulic influence of the intake structure. Based on the quantity of water withdrawn, there should be at least 500 ft between the ambient monitoring station and the nearest intake structure.
- The intake structure is located in 24 ft of water. Therefore, the ambient monitoring station should be located in water at least 30-ft deep, so that the lowest thermometer can be mounted above the anchor structure at a depth about equal to the water depth at the intake (24 ft).
- To minimize potential influence of the discharge plume and simultaneously minimize the distance from the intake structure, the ambient monitoring station should be located southeast of the intake structure.

- Six thermometers will be installed at the ambient monitoring station at the following depths:
  - 2 ft below the surface (surface temperature)
  - 7 ft below the surface (top of the intake structures)
  - 12 ft below the surface (top of the intake opening)
  - 15 ft below the surface (middle of the intake opening)
  - 18 ft below the surface (bottom of the intake opening)
  - 24 ft below the surface (depth at the intake structures)

With this vertical array of instruments, if the thermal plume reaches the monitoring station, the vertical extent of the plume can be established and the appropriate ambient temperature can be determined.

3.5 Intake and Discharge Canal Monitoring Stations

To assist in evaluating the extent of recirculation of heated effluent to the plant intake, an additional temperature monitoring station will be located at the eastern end of the intake canal; near the headwall at the entrance to the intake canal (solid green dot, Figure 2). These thermometers (primary and backup) will be located at mid-depth near the inflow point, where the water is well mixed. The temperature loggers installed at this location will be mounted to a secure fixed structure. The design for the logger mount will be approved by FPL prior to installation.

Temperature data from the existing installed plant temperature instruments at the intake (permit monitoring station INT-1, not shown on Figure 2) and at the point-of-discharge (permit monitoring station EFF-2, yellow dot with red border shown in Figure 2) will also be obtained and used for this analysis.

4.0 INSTRUMENTATION

Real-time monitoring of water temperature data is not required for the HWPOS. Therefore, non-cabled, stand-alone, diver-serviced temperature loggers will be installed. Onset HOBO Pro V2 temperature data loggers will be used. The small size of the HOBO Pro V2 allows for easy installation and servicing in the field. The accuracy, precision, and range of the HOBO Pro V2 temperature data logger provides for excellent data collection for the expected temperatures of the project (see Appendix A – Equipment Specifications). The operational range for these temperature loggers is -40°Celsius (°C) to 70°C (-40° F to 158° F).

The temperature loggers will be factory calibrated and verified before deployment using NIST-traceable standard thermometer at several temperatures in the expected sample measurement range following appropriate FDEP SOPs. A NIST calibration certificate will be provided for each temperature logger.

The following procedure will be used to ensure that all temperature loggers are providing consistent temperature readings over a range of temperatures and to document any small systematic deviations. Then, corrections can be applied as necessary and appropriate to individual loggers to obtain consistent temperatures. Before the temperature loggers are deployed for the heated water study, all the loggers will be deployed simultaneously and in close proximity to one another for at least 24-hours; first in the discharge canal near the FPL discharge monitoring station and then in the ocean. The discharge canal is well mixed and will act as a warm water temperature bath. The ocean will act as the cool temperature bath. Immediately following deployment in these two locations, the data will be downloaded and the temperature from each thermometer will be compared to the temperature from the discharge monitoring station and to the average of all the temperature loggers.

5.0 MONITORING STATION BUOY ARRAY

The temperature array consisting of a surface buoy, multiple subsurface buoys, and an anchor will be used for each monitoring station (see Figure 3). This design provides less buoy surface area in the upper water column where most of the hydrodynamic forces induced by currents and wave action exist. The subsurface buoys, which are installed at regular intervals along the mooring cable, will provide the support needed to maintain the temperature loggers at their required depths in the water column and reduce the overall movement of the mooring. The number of subsurface buoys will be determined based on the number of temperature loggers to be installed. A minimum of three subsurface buoys will be used to maintain design requirements. The surface buoy provides easy location, day markings, and a suitable structure for lighting.

The anchor, cable, hardware and buoys used for the monitoring buoy array will be constructed so that the temperature loggers and array components will be able to withstand a reasonable degree of accidental entanglement due to high boat traffic, anchor or fishing line entanglement, divers/swimmers, etc., and intentional vandalism. An assessment of the monitoring station array construction will be made during the first month maintenance/service event and needed modifications will be implemented.

6.0 DATA COLLECTION

All data collection efforts for this project will follow FDEP approved quality assurance/quality control (QA/QC) procedures.

Because the HOBO Pro-V2 temperature loggers are small and relatively inexpensive, redundant loggers will be installed along with each primary logger. All temperature loggers will be installed, retrieved, maintained, and serviced using SCUBA divers. The Pro-V2 loggers will be removed from the mooring, and the recorded data will be downloaded to a computer on board the diving support vessel. Once the data download is completed and verified, the loggers will be reinstalled on the mooring.

7.0 MAINTENANCE AND SERVICING

Regular scheduled maintenance/servicing events are critical to keeping the thermal monitoring systems functioning properly and to ensure acceptable data recovery. Initially, monthly maintenance/servicing events will be conducted to ensure instrumentation/data is not being compromised, by accident or vandalism, to the point where the required data can't be retrieved to meet the study objectives. After the first 3 months, it will be determined if more or less frequently scheduled maintenance/servicing events will provide for confident data collection.

During each maintenance/servicing event, all buoy and mooring components will be checked for wear and replaced if necessary. The mooring station location will be verified using GPS navigation equipment, and repositioned if necessary. Additional contingency maintenance/servicing events (including temporary monitoring station removal, if necessary) will be conducted in the event of storms or other identified equipment problems.

8.0 CURRENT PROFILING

An Acoustic Doppler Current Profiler (ADCP) that can provide current direction and velocity at multiple levels (i.e., multiple depths throughout the water column) will be installed offshore south of the diffuser discharge (solid red rectangles, Figure 2). A second ADCP will be installed at the 18-ft contour between the discharge pipes. The current data will provide an indication of discharge water movements from the near shore location and the offshore location.

A Nortek Z-cell 1 megahertz (MHz) model ADCP will be used for this project (see Appendix A – Equipment Specifications). The Z-cell 1 MHz was chosen to achieve the best accuracy and resolution for the expected water depth of the study area.

The Nortek Z-cell ADCPs are factory calibrated and, with the exception of the internal compass, do not require field calibration, as long as the transducer heads are not physically deformed. Prior to deployment, a compass calibration will be performed and documented. Also, at the completion of the project, the ADCPs will be sent back to the factory for calibration verification.

9.0 OTHER REQUIREMENTS

9.1 Permit Requirements

The following permits (to be obtained by contractor) will be required for installation of the temperature monitoring arrays:

- FDEP Environmental Resource Permit with submerged Lands Lease
- U.S. Army Corps of Engineers (USACE) Nationwide Permit 5

9.2 Demobilization

After completion of the 24 month Heated Water Plan of Study all monitoring station arrays, canal temperature loggers, and ADCPs, plus any associated support equipment, will be removed from the study area. A diver survey of the offshore area will be conducted to verify nothing has been left on the bottom. All instruments will be tested and calibrations verified.

10.0 HEATED WATER REPORT

After completion of the 24-month field data collection effort for the Heated Water Study, a Heated Water Report will be submitted according to the schedule shown in Section 11. The report will discuss, at a minimum, the purpose and scope of the study, the methodology, data recovery, a descriptive and statistical summary of temperature and ADCP data in graphical or tabular format, and the results and conclusions (including an evaluation of the potential for re-entrainment of the heated plume). The contractor will also provide the data files to FPL in an electronic format.

11.0 SCHEDULE

The schedule for implementing the HWPOS is shown in Table 1, Projected Implementation Schedule. The HWPOS schedule is tied to the startup of St. Lucie Unit 2 following completion of the uprate (T_0), which is currently scheduled for 9/30/2012. The installation of the moorings is scheduled to coincide with the outage of one unit to take advantage of the lower discharge flow rate.

GOLDER ASSOCIATES INC.

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Senior Consultant and Principal

Isabel Johnson
Senior Consultant and Associate

GMP/veh

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TABLES

Table 1- Projected Implementation Schedule

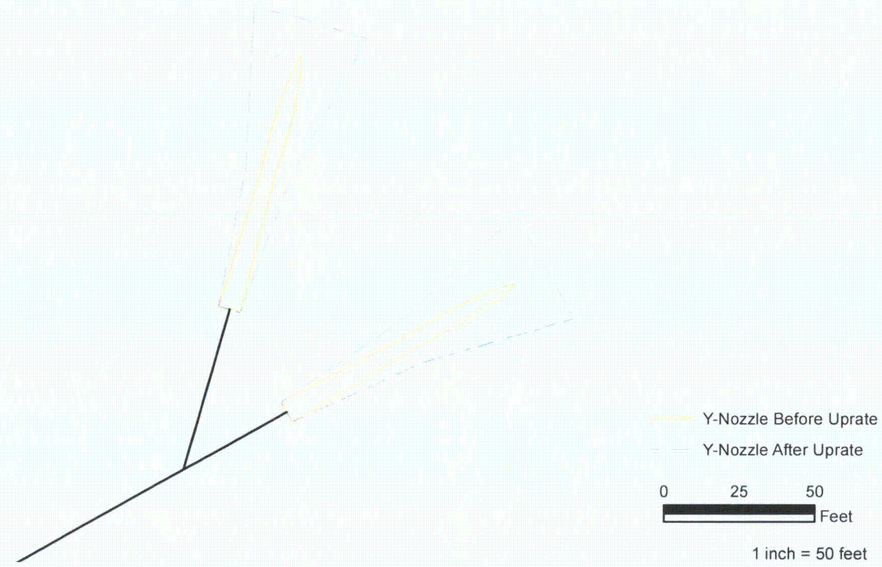
Item No.	Task or Milestone Description	Elapsed Time or Duration (Calendar Days)	Projected Start Date	Projected Completion Date	Remarks
1	FPL Submits HWPOS to FDEP	1	6/21/2011	6/21/2011	HWPOS due to FDEP $\leq$ 180 days from effective date of AO022TL
2	Estimated period of FDEP approval	90	6/21/2011	9/19/2011	
3*	FPL issues Notice to Proceed (Projected for Award of Contract)	1	1/31/2012	1/31/2012	
4*	Equipment Procurement and Preparation	147	2/1/2012	6/27/2012	
5*	Installation of Moorings	94	6/28/2012	9/30/2012	Reduced Flow Conditions
6*	Instrument Calibration, Installation and Testing	94	6/28/2012	9/30/2012	Reduced Flow Conditions
7*	Commence St. Lucie Second Unit EPU Operation	1	9/30/2012	9/30/2012	T_o Date
8*	Perform Post-EPU Heated Water Field Studies	730	9/30/2012	9/30/2014	HWPOS monitoring must commence $\leq$ 90 days from start date of 2nd EPU Unit (T_o) and continue for $\geq$ 24 months.
8A*	Perform Post-EPU Heated Water Field Studies (AO time range alternate)	730	12/29/2012	12/29/2014	HWPOS monitoring must commence $\leq$ 90 days from start date of 2nd EPU Unit (T_o) and continue for $\geq$ 24 months.
9*	Maintain HWPOS Equipment	730	9/30/2012	9/30/2014	
10*	Data Analysis and Evaluation	60	10/1/2012	11/30/2014	
11*	Heated Water Report Preparation/Review	119	10/1/2014	1/27/2015	Heated Water Report must be submitted to FDEP $\leq$ 120 days after completion of HWPOS.
12*	FPL Submits Heated Water Report to FDEP	1	1/28/2015	1/28/2015	

*Dates subject to change due to EPU or operating schedule changes. Dates shown are based upon current Unit 2 start-up date, as provided in the Approved Operating Schedule dated March 11, 2011

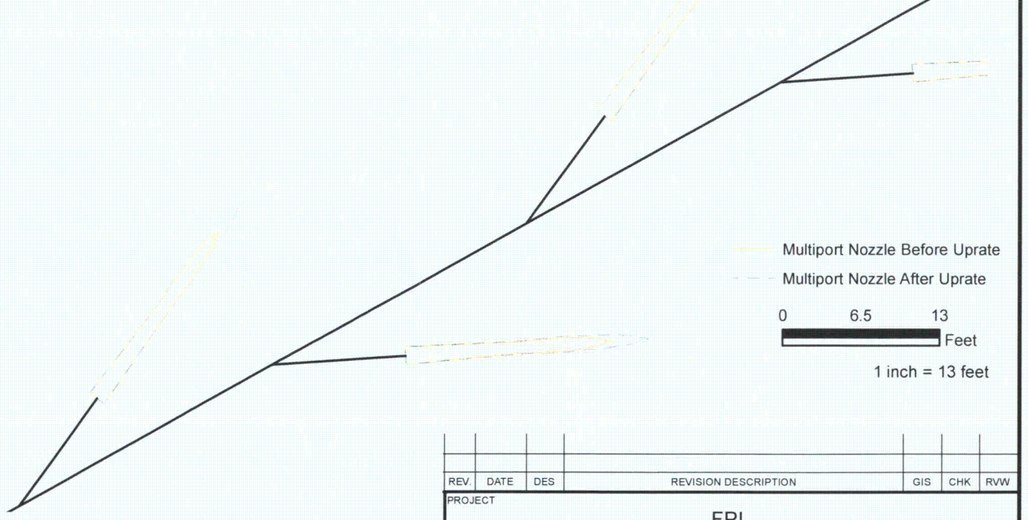
FIGURES

Map Document: 093876874002_Intake_Discharge_Stations_Plume.mxd / Modified 12/4/2009 3:43:30 PM / Plotted 12/18/2009 2:13:50 PM by rlamar

INSET A
Y-Nozzle



INSET B
Multiport Nozzle



NOTE

Thermal plume delineated by the 96 degree F. isotherm.

REFERENCES

1. Thermal Plumes, Golder Associates Inc., 2009.

REV.	DATE	DES	REVISION DESCRIPTION	GIS	CHK	RVW

PROJECT

FPL
ST. LUCIE

TITLE

ST. LUCIE NUCLEAR PLANT
AND THERMAL DISCHARGE PLUME

Golder Associates
Gainesville, Florida

PROJECT No.		103-87735	FILE No.	10387735_B001	
DESIGN	SJL	2/15/2011	SCALE: AS SHOWN	REV.	0
GIS	NRL	2/15/2011			
CHECK	GP	6/6/2011			
REVIEW	ICJ	6/6/2011			

FIGURE 1

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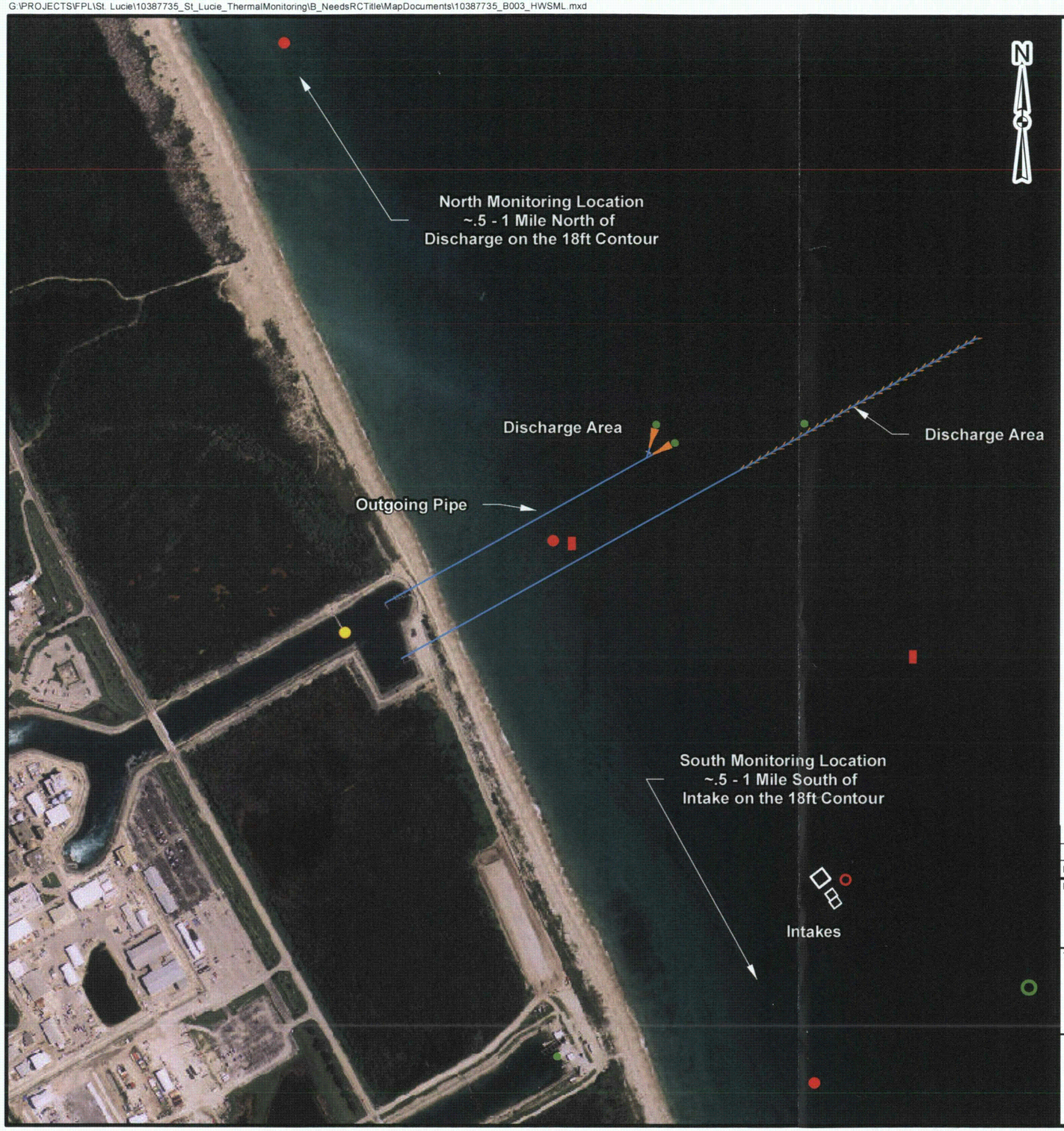


LEGEND

- Discharge Pipes (Approximate)
- Surface Temperature Monitoring Location
- Surface-Mid Water-Near Bottom Temperature Monitoring Location on the 18-ft Contour
- Temperature Monitoring Location at Level of Intake Entrance and at Surface
- Multi-Level Temperature Monitoring Location - 2', 7', 12', 15', 18', and 24'
- ADCP (Acoustic Doppler Current Profiler) Monitoring Location
- FPL Temperature Monitoring Location Monitoring Locations

NOTES

Updated Temperature Monitoring Locations as of 4/13/2011

REFERENCES

1. Discharge Pipes, Discharge Area, Monitoring Locations, Golder Associates Inc., 2010.

0 350 700
Feet

REV.	DATE	DES	REVISION DESCRIPTION	GIS	CHK	RVW

PROJECT

FPL ST. LUCIE
THERMAL MONITORING

TITLE

HEATED WATER SAMPLING MONITORING LOCATIONS

Golder Associates
Gainesville, Florida

PROJECT No.		103-87735	FILE No.	10387735_B003
DESIGN	SJL	12/15/10	SCALE: AS SHOWN	REV. 0
GIS	NRL	12/16/10		
CHECK	ICJ	4/29/11		
REVIEW	GP	4/29/11		

FIGURE 2

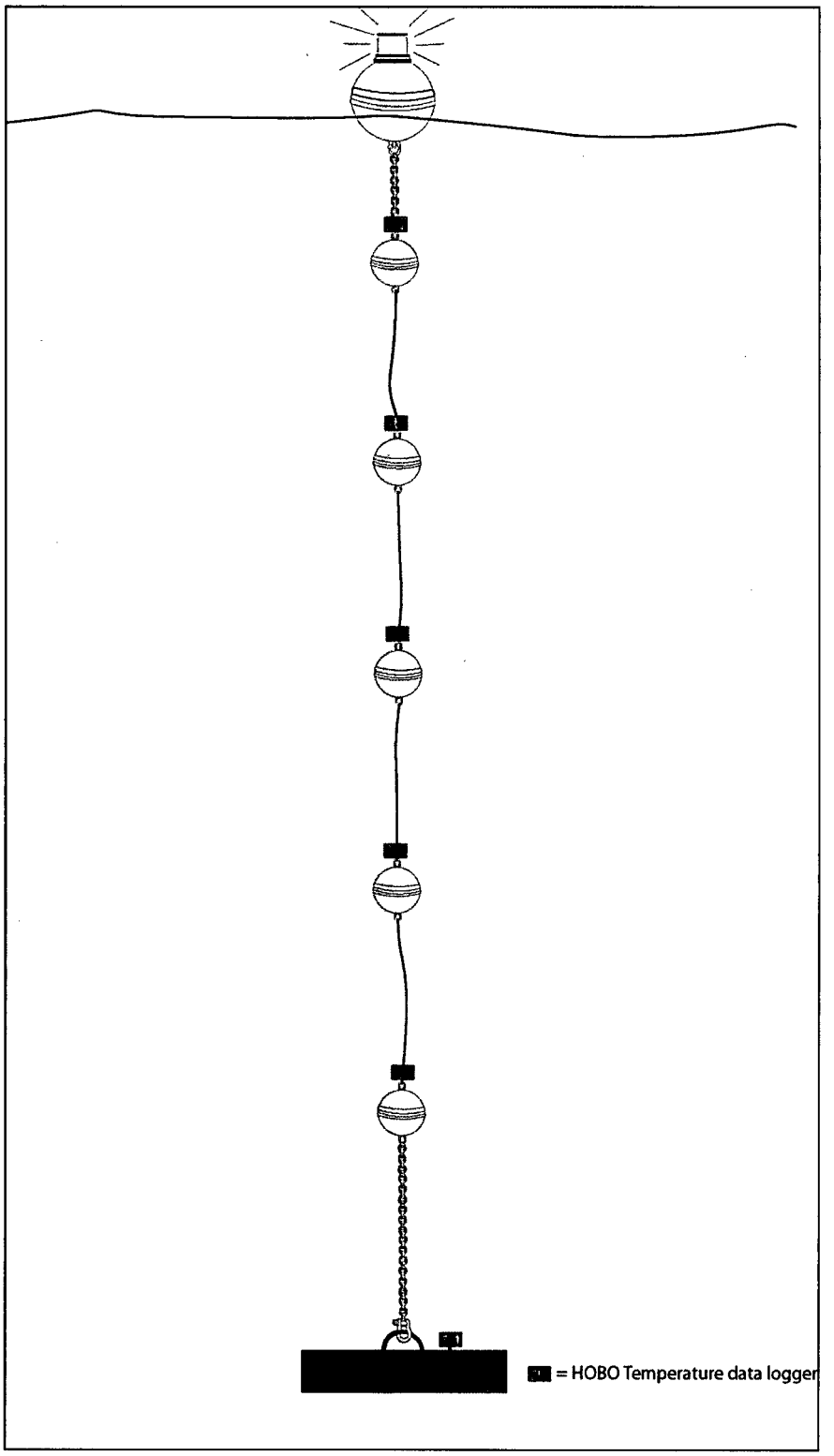


Figure 3.
Temperature Array Consisting of a Surface Buoy, Multiple Subsurface Buoys, and an Anchor

Source: CSA, 2011; Golder, 2011.
G:\Projects\103\103-87\103-87735\FINAL HWPOS\Final Figures\Fig 3.docx

Golder Associates

APPENDIX A
EQUIPMENT SPECIFICATIONS

APPENDIX A

EQUIPMENT SPECIFICATIONS

4/20/2011 Data Sheet for the U22-001

onset®

HOBO Pro v2 Water Temperature Data Logger - U22-001

Water Temperature (400 ft.)

Measures:

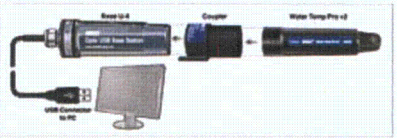
Temperature

Features:

- Research-grade measurements at an affordable price
- Waterproof to 120 meters (400 feet)
- Data readout in less than 30 seconds via fast Optic USB interface

Description:

The durable HOBO Water Temp Pro v2 has 12-bit resolution and a precision sensor for ±0.2°C accuracy over a wide temperature range. Designed with a durable streamlined case for extended deployment in fresh or salt water, the Water Temp Pro v2 is equipped with an Optic USB interface for data offload in the field, even when the data logger is wet. For accurate ambient air temperature measurement in sunlight a solar radiation shield is required (RS1 Solar Radiation Shield, assembly required; M-RSA pre-assembled Solar Radiation Shield).



Optical Interface for data transfer - click to zoom

Detailed Specifications:

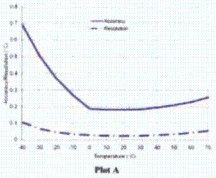
Operation range†: -40° to 70°C (-40° to 158°F) in air; maximum sustained temperature of 50°C (122°F) in water

Accuracy: 0.2°C over 0° to 50°C (0.36°F over 32° to 122°F), see Plot A

Resolution: 0.02°C at 25°C (0.04°F at 77°F), see Plot A

Response time: (90%) 5 minutes in water; 12 minutes in air moving 2 m/sec (typical)

Stability (drift): 0.1°C (0.18°F) per year



Plot A

Logger

Real-time clock: ± 1 minute per month 0° to 50°C (32° to 122°F)

Battery: 2/3 AA, 3.6 Volt Lithium, factory-replaceable ONLY

Battery life (typical use): 6 years with 1 minute or greater logging interval

Memory (non-volatile): 64K bytes memory (approx. 42,000 12-bit temperature measurements)

Weight: 42 g (1.5 oz)

Dimensions: 3.0 cm (1.19 in.) maximum diameter, 11.4 cm (4.5 in.) length; mounting hole 6.3 mm (0.25 inches) diameter

Wetted materials: Polypropylene case, EPDM® o-rings, stainless steel retaining ring

Buoyancy (fresh water): +13 g (0.5 oz.) in fresh water at 25°C (77°F); +17 g (0.6 oz.) with optional boot

Waterproof: To 120 m (400 ft.)

Shock/drop: 1.5 m (5 ft.) drop at 0°C to 70°C (32°F to 150°F)

Logging interval: Fixed-rate or multiple logging intervals, with up to 8 user-defined logging intervals and durations; logging intervals from 1 second to 18 hours. Refer to HOBOware software manual.

Launch modes: Immediate start and delayed start

Offload modes: Offload while logging; stop and offload

Battery indication: Battery voltage can be viewed in status screen and optionally logged in datafile. Low battery indication in datafile.

NIST certificate Available: for additional charge

The CE Marking identifies this product as complying with all relevant directives in the European Union (EU).

'**IMPORTANT:** The plastic case will become brittle at temperatures lower than -20°C. If the logger is deployed in a location where the temperature drops below -20°C, make sure the logger remains stationary and is not pulled on or struck. Return the logger to above -20°C before handling.

Nortek Aquadopp Technical Specifications

Water velocity measurement				
Acoustic frequency:	0.4MHz	0.6MHz	1.0MHz	2.0MHz
Maximum profiling range*:	60–90m	30–40m	12–20m	4–10m
Cell size:	2–8m	1–4m	0.3–4m	0.1–2m
Beam width:	3.7°	3.0°	3.4°	1.7°
Minimum blanking:	1m	0.50m	0.20m	0.05m
Number of beams:	3			
Maximum # cells:	128			
Velocity Range:	±10m/s (inquire for extended range)			
Accuracy:	1% of measured value ±0.5cm/s			
Max. Sampling rate:	1Hz			
Velocity uncertainty:	Consult software program			

*) The Aquadopp profiler measures the current profile in a user specified number of cells from the instrument out to a maximum range that depends on the acoustic scattering conditions. The lower range should be expected with clear water and small cells and the higher range with large cells and acoustically turbid water.

Cell zero (optional for 0.6MHz and 1MHz tranducers)	
Cell zero acoustic frequency:	2Mz
Maximum profiling range*:	0.4–0.9m
Number of beams:	3

Echo intensity	
Sampling:	Same as velocity
Resolution:	0.45dB
Dynamic range:	90dB

Standard sensors	
Temperature:	Thermistor embedded
Range:	–4°C to 30°C
Accuracy/resolution:	0.1°C/0.01°C
Time response:	10 min
Compass:	Magnetometer
Accuracy/resolution:	2°/0.1° for tilt <20°
Tilt:	Liquid level
Accuracy/resolution:	0.2°/0.1°
Maximum tilt:	30°
Up or down:	Automatic detect
Pressure:	Piezoresistive
Range:	0–100m (standard)
Accuracy/resolution:	0.5%/0.005% of full scale

Analog inputs	
Number of channels:	2
Voltage supply:	Three options selectable through firmware commands: •Battery voltage / 500 mA •+5V / 250 mA •+12V /100 mA
Voltage input:	0–5V
Resolution:	16 bit A/D

Data communication	
I/O:	RS232, RS422. Software supports most commercially available USB–RS232 converters
Communication Baud rate:	300–115200 (baud)
Recorder download baud rate:	600/1200 k.Baud for both RS232 and RS422

Data recording	
Capacity:	9 MB, can add 32/176/352/MB & 4GB Prolog
Data record:	32 bytes + 9xNcells
Mode:	Stop when full (default) or wrap mode
Software:	AquaPro
Operating system:	Windows®XP, Windows®7
Functions:	Deployment planning, data retrieval, ASCII conversion, online data collection, and graphical display

Power	
DC Input:	9–15VDC
Peak current:	3A
Max average consumption at 1Hz:	0.2–1.5W
Sleep consumption:	0.0003 mW (RS232), 0.005 mW (RS422)
Transmit power:	0.3–20W, 3 adjustable levels

Real time clock	
Accuracy:	+/- 1min/year
Backup in absence of power:	4 weeks

Internal batteries	
Type/capacity:	18 AA Alkaline cells/50Wh
New battery voltage:	13.5VDC
Duration (10-minute avg.):	80 days for 2MHz, 0.5m cells 50 days for 1MHz, 1.0m cells

Exact battery consumption and velocity uncertainty are complex functions of the deployment configuration. Please consult the AquaPro software for more exact predictions.

Materials	
Standard:	Delrin and polyurethane plastics with titanium screws
Intermediate and deepwater models:	Titanium and Delrin plastics

Connectors	
Bulkhead (Impulse):	MCBH-8-FS
Cable:	PMCIL-8-MP on 10-m polyurethane cable

Environmental	
Operating temperature:	–5°C to 35°C
Storage temperature:	–20°C to 60°C
Shock and vibration:	IEC 721–3–2
Depth rating:	300m

Dimensions			
	0.4MHz	0.6MHz	1MHz/2MHz
Weight in air:	3.4 kg	2.9 kg	2.2 kg
Weight in water:	0.2 kg	0.4 kg	0.2 kg
Length:	see dimensional drawings		
Diameter:	see dimensional drawings		

Options	
Batteries:	Lithium, Li-Io rechargeable
External batteries:	Alkaline, Lithium or Lithium Ion. See battery brochure for details
Transducer head:	Right angle head for 1 or 2MHz. Inquire for special configurations
Deep water systems:	Inquire for 3000m & 6000m versions
Communication:	Request special harness for RS422

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Golder Associates

At Golder Associates we strive to be the most respected global group of companies specializing in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organizational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

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