MONITORING PLAN FOR DISPERSAL OF PINEY POINT EFFLUENT

1. Objectives

In order to comply with Special Condition 24(a) of EPA Permit No. OD 03-01 the monitoring plan objectives are to (1) determine the effluent dilution characteristics in the wake of the dispersal vessel; (2) track the longer-term location and mixing dynamics of the effluent plume; and (3) provide information on whether the effluent plume behaves as predicted by the model. To accomplish these objectives, a tracer dye, Rhodamine WT, will be added to effluent from the dispersal vessel.

2. Monitoring/Sampling Methodologies

Data collected during the plume tracking will be used to determine the location of the dispersal plume as it exits the dispersal vessel and mixes with the receiving waters. Measurements of dye concentration, as well as hydrographic measurements, will continue as the plume disperses and until the dye plume is no longer detectable. Dispersal vessel plume tracking will be conducted using an *in situ* sensor package deployed from a monitoring vessel (probably the the Florida Institute of Oceanography (FIO) research vessel (RV) *Bellows* and/or *Suncoaster)*. The suite of sensors will provide *in-situ* measurements of Rhodamine WT dye, salinity, temperature, density (calculated), turbidity, and chlorophyll fluorescence.

2.1. Effluent Stream Monitoring Aboard the Dispersal Vessel

Dye Addition

On the morning of the plume tracking, approximately 1 gal of Rhodamine WT dye stock solution[1] will be set up for metering over a 4-hr period into the effluent stream. Mixing of the dye into the effluent will occur during the addition of the dye into the effluent. Rhodamine WT

[1] Concentration of 8.3 lb dye per gal, or approximately 20% wt/vol. Purchased from Keystone Aniline Corporation.

dye will be added to the effluent stream of the dispersal vessel. In preparation for plume tracking, the following steps will be followed.

1. A Venturi valve will be installed on the dispersal line.
2. 1 gal of dye stock solution will be metered (approximately 16 ml/min) into the Venturi valve over the 4-hr duration of the dye injection.
3. A sampling port will be provided on the dispersal side of the effluent-overboard pipe.

Discrete Sampling from the Effluent Dispersal Lines

Immediately after the dispersal vessel begins discharging, FDEP staff will collect samples of the dye-laden effluent at a designated sampling port located at the furthest possible point downstream in the dispersal system. Samples will be collected at 30-min intervals beginning at Time=0 (T=0) and thereafter until the 4-hr dispersal has been completed (total of 9 samples: T=0 through T=8; see Table 1). During the monitoring these samples will be analyzed for dye concentration using an on-board spectrophotometer to verify that the dye is homogeneously mixed throughout the entire dispersal period.

Table 1. Discrete samples to be collected from the effluent stream of the dispersal vessel.

Parameter	Number of samples	Sample Containers	On-site Processing
Rhodamine WT	At initiation and 1 sample per 30-min interval (9 total)	500 mL polyethylene	Field fluorometer (Turner)

2.2. Initial, Background, and Plume Tracking

Plume tracking will include three stages 1) initial monitoring, 2) background monitoring, and 3) near- and far-field/transect monitoring. Over the course of the monitoring, both *in situ* and discrete samples will be collected.

Initial Monitoring

Objective: To disperse dye and confirm proper functioning of the *in situ* fluorescence sensors.

On the morning of the first day of the dispersal monitoring, initial monitoring will be conducted to confirm proper functioning of the *in situ* fluorescence sensors. The monitoring vessel will transit to a location offshore to conduct the initial monitoring. When on station, Rhodamine WT dye (less than 0.5 gal) will be slowly released into the wake of the monitoring vessel while the vessel is underway at 4 knots. After a trail of dye has been released, the *in situ* instrument package will be deployed and towed through the plume. Transects perpendicular to and along the centerline of the plume will be conducted to determine the quickest manner in which to achieve the necessary vessel maneuvers.

Background Monitoring

Objective: To obtain measurements of background fluorescence in the environment prior to dye release from the dispersal vessel and to obtain discrete background water samples from locations in ambient water around the area where the dispersal will occur.

Measurements of background hydrographic data and fluorescence, using the *in situ* instrument package in constant-depth towing mode, will be conducted along the track line to be used by the dispersal vessel, and where the dispersal vessel will begin discharging. This track line will begin at the predetermined location for rendezvous with the dispersal vessel and will follow the projected dispersal vessel track line.

During this background monitoring, a subset of discrete water samples for dye and chlorophyll fluorescence will be collected using the *in situ* instrument package water pumping system. The monitoring vessel will transit along the projected dispersal vessel track line and samples will be collected at five locations along this track line at a depth of approximately 1 m below the surface. The 1 m sampling depth for these background samples was selected because it is at the midpoint of the expected mixing zone (0 to 2 m). The exact location of the discrete sampling points will

be determined during the monitoring in relation to real-time measurements of beam attenuation, temperature, and salinity. These background measurements will be used to correct values of parameters used as effluent tracers. Table 2 lists the number and type of samples to be collected offshore.

Table 2. Discrete plume samples to be collected during the background and dispersal monitoring.

Parameter	Background Monitoring	Dispersal Monitoring	Sample Containers	On-site Processing/Preservation	Holding Time
Rhodamine WT	5 samples	10 samples Near-field: 6 (3 transects, 3 plume centerline) Farfield: 4	500 mL polyethylene	Store at 4˚ C or analyze on-board	28 days
Chlorophyll	5 samples	10 samples Near-field: 6 (3 transects, 3 plume centerline) Farfield: 4	500 mL polyethylene	Store at 1-4˚ C [or filter and store at 1-4˚ C]	6 hours [48 hours]

Near- and Far-field/Transect Monitoring

Objective: To determine plume structure and behavior in the near- and far-field following dispersal vessel dispersal by examining the influence of the tug propellers and the tug and dispersal vessel wake on the plume's vertical and horizontal distribution.

Near-field Monitoring

After departing from port, the dispersal vessel tug will be in continuous contact by radio with the monitoring vessel. The monitoring vessel will be conducting background-sampling activities at the appointed dispersal (rendezvous) location. The dispersal vessel will approach the monitoring vessel at a speed of 4 knots. When the dispersal vessel is approximately 0.5 miles from the rendezvous with the monitoring vessel, the FDEP Chief Scientist (aboard the monitoring vessel)

will notify the dispersal vessel to begin discharging and dye-dosing the effluent. At this point, FDEP staff will begin the dispersal dye injection (the target dye concentration is 1 ppm in the effluent stream) and will deploy overboard the first of 4 weighted and drogued buoys to mark the beginning of the plume. The drogues for each buoy will be tethered ~1 m below the bottom of its associated buoy so that any existing surface currents will carry the drogues along with the plume. To mark the plume track, FDEP staff will continue to deploy one drogued buoy at one-hour intervals for 3 hrs, until all four buoys have been deployed. The deployment and retrieval locations will be recorded by hand. Because the dispersal vessel will travel nearly 16 nautical miles during the 4-hr dispersal period, a buoy marking completion of the dispersal will not be deployed.

After the dispersal vessel deploys the first buoy prior to passing the research vessel indicating the beginning of dye release, the monitoring vessel, with the *in situ* instrument package deployed near the surface (1 m deep), will make a perpendicular transect through the wake of the dispersal vessel (at a distance of approximately 50 m from the dispersal vessel) to determine breadth of the plume at the surface at time T=0 (considered to be the initial dilution). When the greatest concentration of dye is detected during this first transect, the first set of discrete chlorophyll and dye-fluorescence samples will be collected. After completing the first transect, the monitoring vessel will deploy the *in situ* instrument package to a depth of 2 m and make a second transect 10 to 100 m up-plume (toward the dispersal vessel and the next buoy) from the first transect, so that the monitoring vessel is out of the mixing area created by its own wake. During this second transect, the second set of chlorophyll and dye-fluorescence samples will be collected in the highest concentration of dye. As time progresses, transect depths and sampling locations will be determined at the discretion of FDEP personnel. After completing the second transect, the monitoring vessel will conduct a third transect up-plume from the previous transect. During this transect, a third set of chlorophyll and dye-fluorescence samples will be collected.

Marking the end of each transect, the monitoring vessel will turn as soon as the *in situ* instrument package sensors detect no dye. Figures 1 and 2 show a schematic diagram of the buoy deployment and the track line between the buoys.

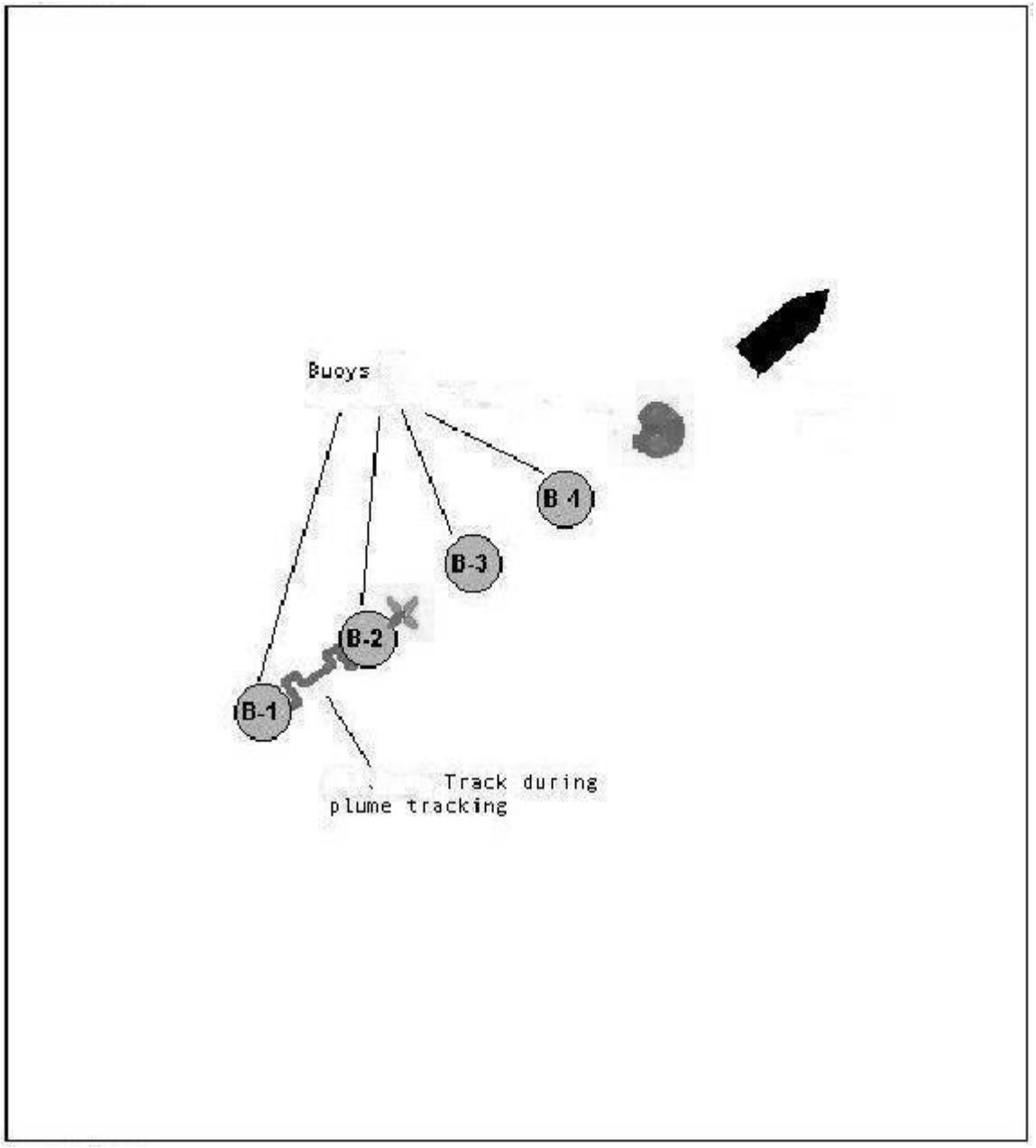
Immediately after completing the perpendicular transects through the plume, the monitoring vessel will conduct a transect up the center of the plume to better define the vertical extent of the plume (*i.e.*, define the bottom of the plume). The drogued buoys deployed by the dispersal vessel will be used to mark the axis of the transect. Beginning at the surface in the most concentrated area of the plume, the *in situ* instrument package will be lowered until a set of data extending from the ocean surface to the deepest detectable boundary of the plume are obtained. At three depths (at the surface, a mid-depth, and at the bottom of the plume), a single set of samples for chlorophyll and dye fluorescence analysis will be collected (total of three per plume center line transect).

These transect sets (three perpendicular and one along the centerline) will be repeated until the plume is no longer detectable. Depending on time and longevity of the dye plume, the FDEP Chief Scientist may decide to conduct vertical profiles (using the *in situ* instrument package in the vertical mode) at specified locations along the plume center line. These profiles will be used to further define the vertical extent of the plume. The FDEP Chief Scientist will make the decision on methods and sampling depths as the *in situ* data is observed.

The discrete samples to be analyzed for chlorophyll and dye fluorescence (for verifying *in situ* instrument package sensor measurements) will be collected using the submersible pumping subsystem of the *in situ* instrument package. The internal gear pump is located on the towed body. The pump provides a flow rate of approximately 14 Lpm (will be verified during monitoring), which translates into a 28-second transit time for the water to go from the pump inlet to the outlet onboard the sampling platform. This lag time will be verified using an onboard flow-through transmissometer.

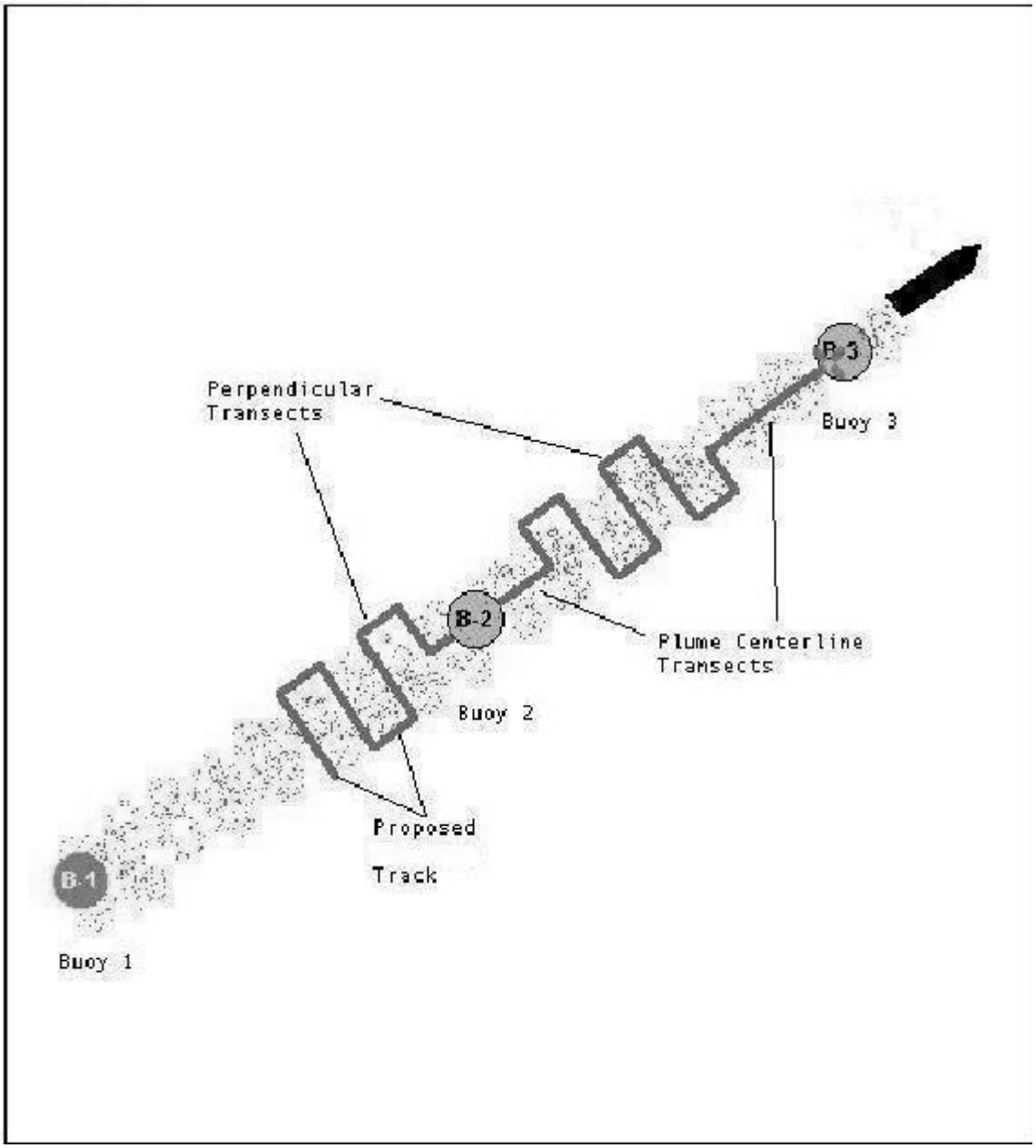
Software will be used to record the hydrographic data at the selected location of the

Figure 1. Schematic diagram of the plume-tracking track line showing four buoys deployed.[2]



[2] Figure modified from EPA's Cruise Ship Plume Tracking Survey Report, 2002.

Figure 2. Schematic diagram showing detail of track line between buoys.[3]



[3] Figure modified from EPA's Cruise Ship Plume Tracking Survey Report, 2002.

discrete samples. The software will calculate the hose-transit lag time that is required before collection of the actual water sample on deck. With 10-20 seconds left on the countdown, the sampling technician will be instructed to rinse the suite of bottles to be used for that sampling event. When the countdown is finished the sampling technician will be instructed to collect water. Table 2 lists the number and type of samples to be collected.

Far-Field Monitoring

Upon the conclusion of the near-field monitoring, the monitoring vessel will perform a zig-zag transect back through the plume in a down-plume direction. Dye concentrations will be recorded until no dye is detectable. At this point, the monitoring vessel will perform a zig-zag transect back through the plume in an up-plume direction until dye is no longer detectable. This pattern will be repeated until dye is no longer detected. This data will be used to establish the far-field dilution characteristics. Discrete sample collection for chlorophyll and Rhodamine WT will be as for the near-field monitoring, and will be collected at 350, 200, 150, and 100 m from the dispersal vessel.

Average values of depth and dye concentration will be taken along each transect from the point where dye values exceeded background levels until they returned to background levels. Plume width measurements will also be made using the same points for obtaining average depth and dye concentrations. Upon monitoring completion, the samples will be delivered in coolers containing ice to USF for final analysis.

2.3. Offshore Field Sampling Procedures

Plume tracking will be conducted using an *in situ* instrument package deployed from the monitoring vessel. The *in situ* sensor package includes the following instruments (see Table 3): a Seapoint Rhodamine WT fluorometer, a WET Labs WETStar chlorophyll fluorometer, a SeaBird TSG [which measures temperature, conductivity (for salinity), and sigma-T], a SBE 25 CTD [which measures pressure (for depth)], and a Wet Labs 25-cm (660-nm) transmissometer (which measures light transmission).

Table 3. Instruments deployed for the offshore plume sampling.

Parameter	Lab	Units	Instrument	Reference
Rhodamine fluorescence	USF	µg/L	Seapoint RWT Fluorometer	Seapoint manual (2000)
Conductivity	USF	mS/cm	SeaBird TSG	SeaBird TSG manual (1999)
Temperature	USF	˚C	SeaBird TSG	SeaBird TSG manual (1999)
Pressure	USF	m	SBE 25 CTD	SBE 25 CTD manual (1999)
Transmissometry	USF	m^{-1}	WET Labs 25-cm (660-nm)	WET Labs 25-cm manual (1998)
Bottom depth	USF	m	Unknown	Unknown
Navigational position	USF	degrees	Northstar 941x	Northstar 941x manual (XXXX)
Sigma-T	USF	No units	SeaBird TSG	Fofonoff and Millard (1983)
Chlorophyll	USF	mg/L	WET Labs WETStar fluorometer	WETStar manual (XXXX)

The Rhodamine WT fluorometer measures dye concentrations (ppb) directly. These *in-situ* fluorescence measurements will be electronically recorded continuously throughout multiple passes through the plume. The station/sample location number, GPS coordinates, date and time, depth of the water column, and any observations associated with the sampling at each sampling location will be made in the field logbook.

The *in situ* instrument package will be deployed approximately 10 ft off the port side of the monitoring vessel using the crane and boom deployed perpendicular to the vessel's axis. This deployment position ensures that the *in situ* instrument package will operate out of the vessel's wake. A winch and vessel speed will be used to control the depth of the towed sensor package. The sensor package can be raised or lowered using the winch at a rate of 0 to 1.0 m/sec.

Depending on the vessel's speed and winch operation, the *in situ* instrument package can operate in two different modes: vertical profile, or constant-depth towing. In vertical profiling mode, data is acquired as a function of depth while the vessel remains stationary. During constant depth towing mode, the *in situ* instrument package is towed at a constant depth while the vessel is underway. The plume tracking may utilize the *in situ* instrument package in either mode.

Discrete Sample Collection.

During operations, discrete water samples will be collected for dye and chlorophyll fluorescence using a water pumping system integrated with the *in situ* instrument package cable assembly. This assembly consists of an instrument package and pump, which is towed and powered by an electrical-mechanical cable (200 ft long) with a Teflon tube down the middle of the cable to provide synoptic sampling capabilities. The maximum operational depths versus vessel speed are listed in Table 4.

Table 4. *In situ* instrument package modes and vessel speeds.

Vessel speed (& mode)	Maximum depth (m) when pumping
0 knots (vertical profile)	45
2 knots (constant depth)	40

Density Profiles.

In support of the plume tracking, density profiles within the area will be measured. The density profiles will be collected using the *in situ* instrument package CTD.

Sample Storage Conditions.

Discrete Rhodamine WT dye and chlorophyll samples collected aboard the monitoring vessel and dispersal vessel will be stored at 4º C (chlorophyll samples may be filtered), or analyzed on-board. Additional sample storage conditions are presented in Table 5.

Table 5. Analyte, Sampling Method, Volume, Preservation, and Holding Times.

Analyte (Analytical Laboratory)[(a)]	Matrix	Method	Container Type	Preservation	Holding Time
Laboratory Analyses					
Rhodamine dye (USF)	Water	Laboratory fluorometer (Turner)	500 mL polyethylene	Store at 4˚ C	28 days
Chlorophyll (USF)	Water	Exctraction and laboratory spectrophotometer	500 mL polyethylene	Store at 1-4˚ C [or filter and store at 1-4˚ C]	6 hours [48 hours]
Field Analyses					
Temperature	Water	SeaBird TSG	NA	NA	*In situ*
Pressure (depth)	Water	SBE 25 CTD	NA	NA	*In situ*
Transmissometry/Turbidity	Water	WET Labs 25cm (660-nm) transmissometer	NA	NA	*In situ*
Conductivity	Water	SeaBird TSG	NA	NA	*In situ*
Chlorophyll	Water	WET Labs WETStar fluorometer	500 mL polyethylene	Store at 1-4˚ C [or filter and store at 1-4˚ C]	6 hours [48 hours]

(a)USF: University of South Florida – College of Marine Science
NA = Not applicable.