

SolarBee/P.A.M Floc Log Test At Hilaman Park Golf Course

Final Monitoring Plan



**Prepared by
Borja Crane-Amores
May 21, 2007**

1.0 Study Objectives

Florida's nonpoint source and watershed restoration programs, though an essential long-term strategy for protecting our lakes, are not eliminating harmful algae blooms (HABs). In the 25 years since Florida's stormwater treatment rules were adopted, there are very few lakes that can be identified to where nutrient reduction of nonpoint sources through watershed protection activities eliminated a HAB problem.

The purpose of this monitoring program is to determine whether the SolarBee in combination with polyacrylamide (PAM) will significantly improve water quality and/or change algal species in a surface water body. The nutrients enrichment of Florida's surface water is a major problem statewide. Over 1000 water body segments are impaired for nutrients with TMDLs to be developed in the near future. Restoring water quality in such waters is an important but challenging objective that requires many restoration tools.

To achieve the project's objectives, a three phase monitoring program will be implemented.

- Phase 1. Background monitoring to determine existing water quality (April-May)
- Phase 2. SolarBee operational monitoring (June-July)
- Phase 3. SolarBee plus PAM operational monitoring (Aug-Sept)

2.0 SolarBee

SolarBee, Inc. Company Background: SolarBee was founded in 1978 by Joel Bleth and Willard Tormaschy, who are both fluid engineers native to Dickinson, ND. In their efforts to better understand the ecological benefits of long-distance circulation, SolarBee was created. The SolarBee purpose was to collect and review extensive water quality data on hundreds of ponds, lakes, and reservoirs in the US each year.

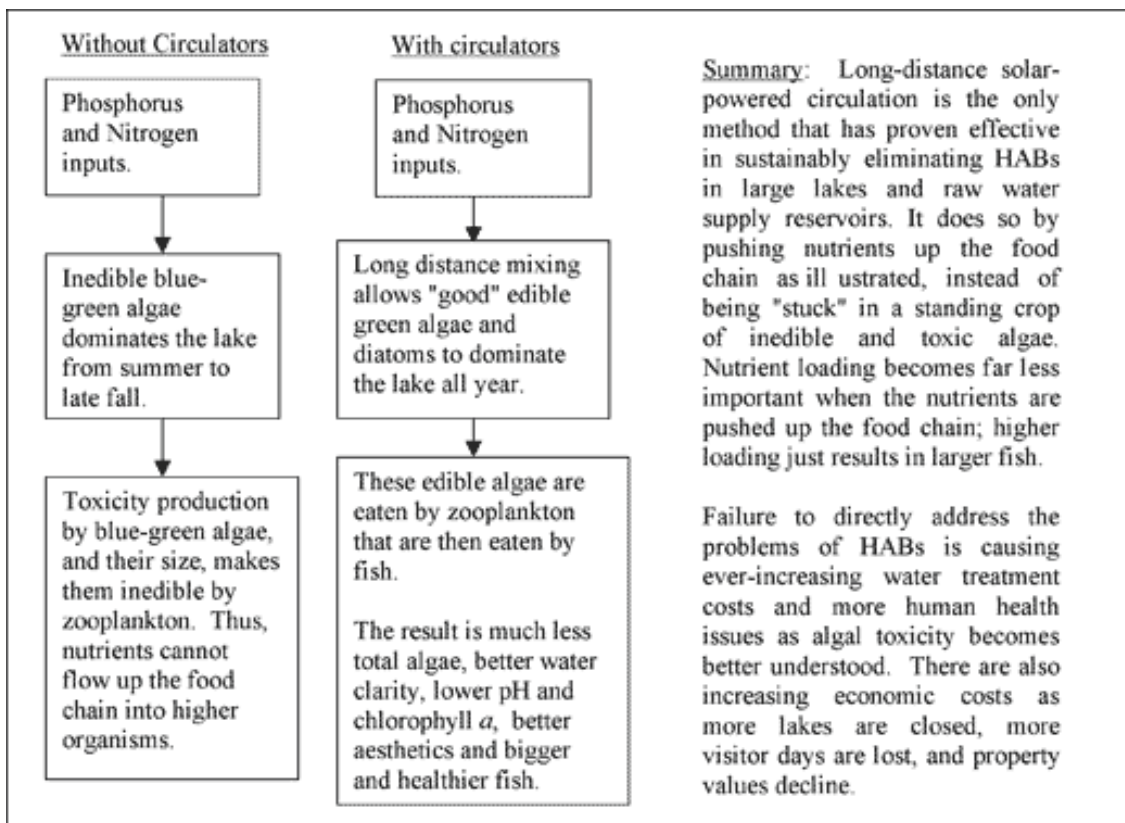
The SolarBee is a floating, up-flow machine that can move up to 10,000 gallons per minute and from depths up to 100 ft with a solar-powered pump. The machine can now run day and night with a brushless motor and on-board battery system. With more than 1,000 solar-powered circulation equipment installed nationwide in the past 9 years, SolarBees are now used throughout the United States to help in solving serious water quality and energy problems in fresh water lakes, wastewater lagoons, stormwater ponds, estuaries, potable and recycled water storage tanks and other reservoirs.



If successful the SolarBee should help improve surface water quality by:

- Reducing energy consumption in partial and total mix systems
- Improving performance of facultative pond systems
- Improving BOD, TSS and ammonia reduction
- Controlling odors (odor capping systems available)
- Improving sludge digestion and reduces the need for dredging
- Reducing short-circuiting and fecal coliform counts

Below is a summary diagram showing how long-distance solar-powered circulators can help to restore lakes to good water quality:



3.0 Polyacrylamide (P.A.M) Flocc/Log

Polyacrylamide is a synthetic water-soluble polymer made from monomers of acrylamide. There are several thousand kinds of Polyacrylamide. The most common types are Emulsion, Granular and Gel Block. What PAM does is binds soil particles together. Once the soil particles suspended in water they are bound together by PAM and then settle out, so that water has a harder time washing them out of the field.

PAM is highly effective in reducing soil erosion off of fields and can increase water infiltration into irrigated furrows. PAM has been shown to significantly reduce soil erosion by 90-95 percent when applied to irrigation water. PAM is also used to reduce agricultural erosion, increase soil infiltration and improve crop yields. Polyacrylamide test applications include raw slope stabilization, turbidity control of storm water discharge, Turbidity control of dewatering discharge and dust suppression on dirt roads.



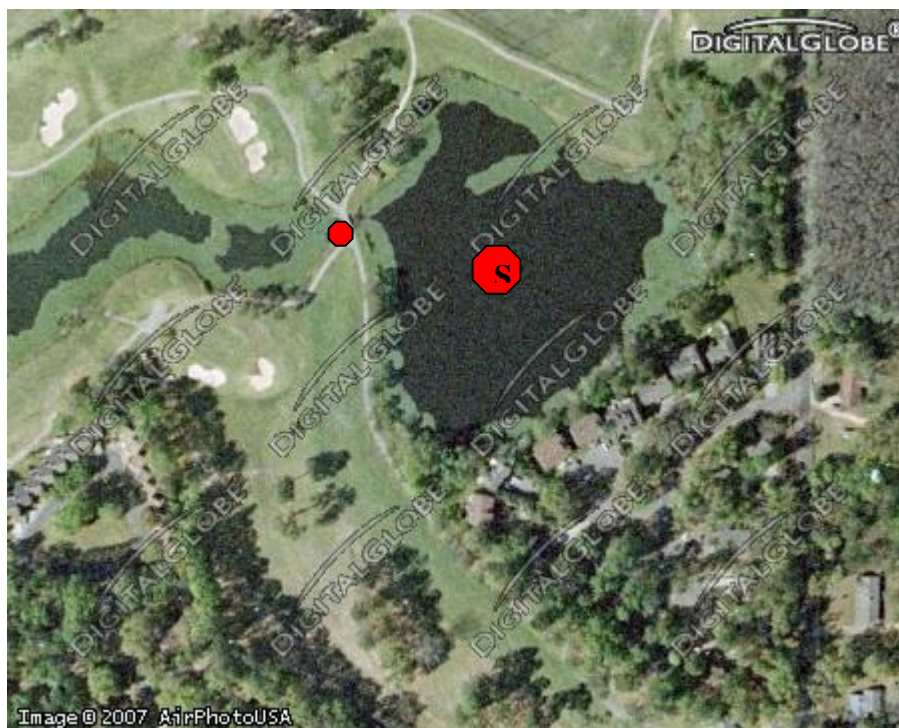
- PAM enhances BMPs but does not replace them.
- Only use anionic PAM which has no toxic effects.
- PAM can be blended for erosion, dust and turbidity control, but you must match PAM to soil types.

Features and Benefits:

- Removes solubilized soils and clay from water
- Prevents colloidal solutions in water within ditch systems
- Binds cationic metals within water, reducing solubility
- Reduces pesticide and fertilizer loss during rain events from runoff
- Increases soil permeability and water penetration to shallow plants in ditches
- Reduces operational and cleanup costs
- Reduces environmental risk and compliance

4.0 Monitoring Site

Monitoring will be conducted in a two lobe, flow-through lake system on Hilaman Lake Golf Course. The upper lobe, in which the SolarBee (designated S) will be placed, is approximately 7-8 acres in surface area. Because the lake is relatively high in nutrients (TP approx 150 ug/L, and TN approx 1.0 mg/) it would be the preferred test water body. Also this water body can be sampled from the downstream bridge without having to use a boat (Small red dot). A possible negative is that Lake Hilaman has more vegetation than the other candidate lakes and the water from the lake is used to irrigate the golf course.



The flow through Lake Hilaman, which is controlled by a weir, is not perceptible unless there are extreme hydraulic conditions which are rare. Inflow samples are normally taken at a narrow ditch before it gets to the upstream lobe, and since this water will not be affected by the nutrient reduction process, it will be easy to determine the effectiveness of the treatment. The upstream lobe is the

deepest part of the lake (max depth 10 feet, average depth 5 feet at mean pool elevation). No depth data exist on the shallower part of the lake. The golf course takes its irrigation water from the upstream lobe.

Total lake volume is estimated at approximately 10 million gallons. SolarBee flow rate is 14 MGD, so we would expect a complete turnover of the entire volume every 24 hours (all water in pond will flow past PAM Floc logs each day). Over all, this would be a great site because of the high P and N low flow, lots of existing data and will be good to determine the effects on native and non-native macrophytes.

5.0 Monitoring Plan Outline

Water Sample Collection and Laboratory Analyses

The YSI 6600-EDS data sonde will be used to measure temperature, pH, specific conductance, Turbidity and dissolved oxygen. The YSI sonde will be left at the site with weekly calibration checks on DO, SPCOND, Turbidity and pH. All recorded data from the data logger will be uploaded on to the computer. Calibration log sheets (pre & post), field sheets and any other paper work will be completed at the lab (D-112) or office.

In addition to the data sonde, water quality samples will be collected from Hilaman Lake site weekly over a period from April through October. Water samples will be collected at the bridge as the flow of water goes downstream. Water samples will be collected during dry and wet weather and will include dry base flow and wet weather discharge. Each of the collected samples will be filtered if needed and preserved in the field as appropriate for the parameters to be analyzed, placed on ice and delivered to the laboratory for analysis.

Water Quality Parameter List

1. Secchi Depth (Field)
2. Water Temperature (Field)
3. Special Conductance (Field)
4. Oxidation Reduction Potential (Field)
5. PH (Field)
6. Dissolved Oxygen (Field)
7. Dissolved Oxygen % Saturation (Field)
8. Turbidity (Field)
9. Alkalinity
10. Color
11. Chlorophlla
12. Total Organic Carbon
13. Total Phosphorus-Low Level
14. Total Kjeldahl Nitrogen
15. Nitrate-N + Nitrite-N
16. Ammonia-N

6.0 Quality Assurance

Instrument Calibration Procedures for the YSI 6600 Sonde

INSTRUMENT CALIBRATION PROCEDURES

The FDEP Tallahassee Watershed Monitoring Field Operations check YSI Probes for accuracy with a National Field Quality Assurance (NFQA) standards check.

Definitions

Initial Calibration (IC): The instrument or meter electronics are adjusted (manually or automatically) to a theoretical value or a known value of a calibration standard.

Initial Calibration Verification (ICV): The instrument or meter calibration is checked or verified directly following the initial calibration by measuring a calibration standard of known value as if it were a sample and comparing the measured result to the calibration acceptance criteria.

Continuing Calibration Verification (CCV): The instrument or meter calibration is checked or verified by measuring a calibration standard of known value as if it were a sample and comparing the measured result to the calibration acceptance criteria.

Chronological Calibration Bracket: The interval of time between verifications (maximum of 24 hours) within which environmental sample measurements must occur. The instrument or meter is calibrated (or verified) before sample measurements and verified after sample measurements.

Quantitative Calibration Bracket: The instrument or meter is calibrated or verified at two known values that encompass the range of observed sample measurements.

Acceptance Criteria: The numerical limits within which calibration verifications are acceptable.

Field Testing Acceptance Criteria

Parameter	Acceptance Criteria
pH (FT 1100)	+ 0.2 Standard pH Units of buffer
Specific Conductance (FT 1200)	+ 5% of standard value + 0.2oC of NIST-traceable value (with correction factors)
Temperature (FT 1400)	Verification over range of applicable values
Dissolved Oxygen (FT 1500)	+ 0.3 mg/L of theoretical value

General Calibration Considerations

Before sampling, the field technicians must verify that the equipment is in proper working condition, calibrated and the batteries are charged. Refer to equipment manufacturer's recommendations for calibration procedures. All field sampling measurements must be bracketed between acceptable calibration/verification results, at no more than 24 hour intervals. Calibrate the equipment before sampling following the specific procedures for pH, specific conductance and dissolved oxygen (DO). Temperature is also checked monthly. Turbidity is calibrated for groundwater sampling. The sample results are bracketed by verifying the calibration at the end of the sampling day.

Samplers are encouraged to check the calibration during the day and are required to perform an end of day check (continuing calibration verification).

Records of each meter calibration and calibration checks must be maintained in a calibration log book. Document the following information:

- Unique name or code of instrument used (YSI #1, etc.),
- Method used to calibrate (citation of or reference to the specific DEP SOPs used for calibration and verification procedures),
- Time and date of calibration,
- Time and date of initial and continuing calibration verifications,
- Standard(s) used (including units, expiration date and lot number),
- Resulting meter response (including units),
- Indication of pass or failure,
- Corrective actions,
- Name of analyst performing operation.

Each calibration and verification must be directly linked to affected samples (record project name and/or applicable sample sites on calibration record). Retain manufacturer instrument specifications for each meter.

If a meter fails calibration verification, immediately reattempt the verification (with a fresh aliquot of standard or buffer) within the chronological bracket time interval without changing the instrument calibration. If this verification on-site still fails, recalibrate the meter, perform an ICV, recollect the field readings, and perform a post verification (CCV). However, if a meter fails calibration verification and the field readings cannot be reanalyzed, report all results between the last acceptable calibration verification and the failed verification as “estimated”. Report all affected parameters with an “F” (this “F” qualifier is equivalent to the laboratory “J”). Include a description of the problem. The meter must be recalibrated and repaired if necessary.

Documentation on calibration standards (e.g., buffers, KCl, and other reagents) must be maintained in a log book.

- Note the vendor, date of receipt, expiration dates, and date of first use directly on the standard container and in a log book.
- Follow expiration dates (with the exception of turbidity standards, as they can be extended).
- If reagents or standards are prepared from stock chemicals, they must be analytical reagent grade or better. All calculations used to formulate the standards, date of preparation, the procedures used, and analyst performing the preparation must also be documented.

Calibration of YSI 6600

pH Meters

- Calibrated meters must read within ± 0.2 standard units of the actual buffer values.
- Calibrate daily in the field. If meter is calibrated in the office or lab, it is recommended that you check the pH 7 buffer on-site before field readings since calibration may change during transport.
- Record all initial calibrations (IC), initial calibration verifications (ICV), continuing calibration verifications (CCV), and maintenance in the log.
- Use buffer solutions (pH of 4, 7, 10 SU) purchased from commercial vendors for calibration. Buffers that extend beyond the 4.0-10.0 SU range may be needed for sites where ambient readings are below 4.0 and above 10.0 SU. The quantitative bracket requirement still applies. If an appropriate buffer is not available, the applicable sites must be “F” qualified accordingly.
- Do not reuse buffers.
- Rinse with DI water before and between each standard. Rinse with a small portion of buffer before calibrating (or verifying) with that buffer.

- Report readings in pH units to one decimal place (ex., 7.5 SU instead of 7.46 SU).
- Always start with the pH 7 buffer. Each meter/electrode system must be calibrated at a minimum of two points, at least three pH units apart, bracketing the expected sample pH (quantitative calibration bracket). Check historical data for expected pH or use pH paper on an aliquot to estimate sample pH.
- After initial calibration with the 2 buffers, immediately perform an initial calibration verification (ICV). To do this, read a (any) buffer as a sample. Value must meet the calibration acceptance criteria.
- After sample measurements, perform a continuing calibration verification (CCV). This can be done at the end of the day or immediately after sample collection (chronological calibration bracket). To do this, read a (any) buffer as a sample (be sure to meet the quantitative bracket requirements). Value must meet the calibration acceptance criteria.
- At the end of the sampling day, if samples ended up measuring outside of the first 2 calibration standards, you may use the third standard as a CCV to extend the quantitative bracket. For example, if you calibrated with pH 7 and 4 buffers and the samples measured 8.0 SU, perform the end of the day CCV using the pH 10 buffer.
- To ensure meter performance, check the theoretical slope on a weekly basis (if available on meter) and record it in the log. It should be greater than 90%. A slope of less than 90% indicates a bad electrode. If % slope cannot be determined on your meter, or the manufacturer's optimum specifications are different, follow the manufacturer's recommendation for maintaining optimum meter performance.

Specific Conductance Meters

- Calibrated meters must read within $\pm 5\%$ of the standards.
- Record all initial calibrations (IC), initial calibration verifications (ICV), continuing calibration verifications (CCV), and maintenance in the log.
- Calibrate daily in the field using potassium chloride (KCl) standards supplied by FDEP WMS. Refer to FDEP SOPs if using lab-prepared standards. If calibration is performed at the office or lab, it is recommended that you check a standard on-site before field readings since calibration may change during transport.
- Do not reuse standards.
- Rinse with DI water before and between each standard. Rinse with a small portion of standard before calibrating (or verifying) with that standard.
- Calibrate the instrument with the first standard.
- Verify the calibration of the instrument with the second standard, bracketing the range of expected sample values. Do this by rinsing with and reading the second standard (quantitative calibration bracket).

- When the sample measurements are expected to be 100 $\mu\text{mhos/cm}$ or greater, use two standards that bracket the range of expected sample conductivities. When the sample measurements are expected to be less than 100 $\mu\text{mhos/cm}$, a lower bracket is not required, but a 100 $\mu\text{mhos/cm}$ standard needs to be used for the calibration continuing verification (CCV).
- Conductivity varies with temperature so all meters must be temperature compensated.
- The meter must be checked with at least one conductivity standard in the sampling range at the end of the sampling day (chronological calibration bracket). The value must meet the calibration acceptance criteria. Samplers are encouraged to check a standard at each site.

Dissolved Oxygen Meter

- Calibrated meters must be accurate to ± 0.3 mg DO/L. Compare results to Table 5 for the solubility of oxygen in water at various temperatures. This “Solubility of Oxygen in Water at Atmospheric Pressure” chart (or similar) must be used in order to determine the results of any and all DO verifications.
- Record all initial calibrations (IC), initial calibration verifications (ICV), continuing calibration verifications (CCV), and maintenance in the log.
- Check to make sure there are no air bubbles, wrinkles or tears in the probe membrane. If so, replace the membrane and KCl filling solution. Check the leads, contacts, etc. for corrosion and/or shorts. Record this and any other maintenance in the log book.
- Calibrate the meter daily in the field using water saturated air. If calibration is performed at the office or lab, it is recommended that you check the DO on-site since calibration may change during transport. Allow the meter to warm up before calibrating DO.
 - Wet the inside of the calibration chamber with water. Pour out the excess water (leave a few drops) and insert the sensor into the chamber (this ensures 100-percent humidity). Be sure to gently remove any droplets of water from the membrane/sensor.
 - Allow adequate time for the DO sensor and the air inside the calibration chamber to equilibrate. Make sure the probe is not in direct sunlight, which prevents proper stabilization.
 - Measure the temperature in the calibration chamber, and observe the readings until the instrument stabilizes.
 - Compare DO meter reading with value obtained from Table 5 (this is the ICV). The value must meet the calibration acceptance criteria.
- Check the calibration of the DO meter with water saturated air at the end of the sampling day (chronological calibration bracket). If a DO meter fails the calibration verification, then recalibrate the meter prior to taking any more DO

measurements. Remember to qualify all DO readings with an “F” that could not be properly bracketed with an acceptable verification.

Thermometers/Thermistors

- Temperatures should agree within +/- 0.2o C. If the difference is shown to be constant (i.e. + 0.5o C) over the temperature range of the thermometric device, it may still be used provided that the difference is documented for 10 degree increments, and the correcting factor is used in all measurements.
- Temperature determinations can be made with any field-grade mercury-filled, alcohol-filled, or dial-type Celsius thermometer as well as an electronic thermistor that is accurate to +/-0.1 degree C”.
- The thermometer or thermistor should be allowed to equilibrate to the temperature of the sample before readings are recorded.
- Record temperature readings to one decimal place (ex., 25.9 o C instead of 25.86 o C).
- On a monthly basis, temperature sensors will be checked against a NIST-traceable (National Institute of Standards and Technology) thermometer with water of varying temperatures (minimum of two different temperatures) that are expected to be seen in the field. A warm water bath, ambient room temperature bath or an ice bath are suggested. The values must meet the calibration acceptance criteria, and should be recorded in the calibration log.

SURFACE WATER SAMPLING PROTOCOLS

Sampling Locations

The following requirements concerning sample location must be considered before and during sample collection. If any confusion exists as to where to sample, contact the FDEP QA Officer or project manager.

- Water must be at least 10 cm (0.10m) deep to collect samples for streams and rivers.
- When wading into a water body, enter the water carefully to avoid disturbing the sediments, or allow material to settle before collecting the sample.
- Grab water upstream from your body or upstream from the boat.
- When wading upstream from a bridge or dock, collect samples on the upstream side whenever possible.

Emergent vegetation

Presence of vegetation is not consideration for exclusion unless it causes sampling to be nearly impossible or un-safe. Otherwise, a site is deemed accessible as long as it can otherwise be reached by conventional methods.

TMDL Surface Water Sampling Techniques

Use the following protocols when collecting surface water samples.

Field Measurements

Measure total depth to the nearest 0.1m using metric tape or an electronic measuring device. Take and average two readings to ensure accuracy. If the total depth is less than 0.1 m (10 cm), the site is excluded due to insufficient water levels and no samples or field analyte measurements (pH, DO, specific conductance, and temperature) are taken. If the total depth is 0.1 – 0.24 meters, collect the field measurements at half the depth. If the depth is 0.25 and above, collect field measurements at 0.15 meters.

Report reading in pH units to one decimal place (ex, 7.5 SU instead of 7.46 SU). Record temperature readings to one decimal place (ex. 25.9 C instead of 25.86 C).

Secchi depth gives an indication of water clarity. The secchi disk is a circle, 20 cm in diameter, with alternating black and white quadrants on the upper surface. It is attached to a rope marked in 0.1 m increments.

- 1. Remove sunglasses.
- 2. Lower the secchi disk slowly (on the least shaded side of a boat) and record the depth at which it disappears to 0.1 m.
- 3. Lower the disk slightly farther.
- 4. Raise the disk until it reappears, and record this reappearance depth to 0.1 m.
- 5. Average these two depths for the secchi depth.
- 6. In clear or shallow water, the disk may be visible to the bottom. Note this on the field sheet and qualify with an “L” indicating the actual value is known to be greater than the reported value.
- 7. Record any factors that might affect the accuracy of this measurement, such as choppy water, in the comments section of the field log sheet.

Record stage height if it is available. This measurement can be obtained from staff gages, continuous recording gages, wire weight gages, tape down measurements, or any existing USGS gauging stations located in close proximity to the sampling sites. If no stage height is available, record “NA” in that space.

Label Sample Containers

Wear unpowdered latex gloves while handling the containers. Work with only one set of containers at a time. Label all the sample containers for a site, including each whirlpak, prior to filling sample containers. Place a station identification bar code label vertically on each sample bottle (Figure 5). The Lab places two labels on the containers. Write the time (24 hour format) and date at which a station is sampled on the analyte label. The other label is a laboratory production and container bar code label.

Sample Collection

Wear clean gloves to collect the samples. Record the sample collection depth on the field sheet. Use only the appropriate sample containers: do not use a sample bottle to collect and pour water into the whirlpaks or syringe for the orthophosphate or specific conductance sample. Do not rinse the bottles before collecting the samples. Leave some headspace in all bottles. The sample time for the water chemistry samples should match that of the water quality measurements.

If the total depth is 0.1 – 0.24 meters, then collect the field sample at half the depth. If the depth is 0.25 and above, collect samples at 0.15 meters. Avoid skimming the surface of the water during collection unless specifically required by the sampling plan. Very shallow water bodies may require careful techniques to avoid disturbing sediments.

Where practical, use the actual sample container as the collection device (direct grab). Sample containers attached to poles are also considered direct grabs.

The use of unpreserved sample containers is encouraged since the same container can be submitted for laboratory analysis after appropriate preservation. This procedure reduces sample handling and potential loss of analytes or contamination of the sample from other sources.

Direct Grab Samples

- 1. Fill the sample bottles following the collection order shown on the back of the custody sheet.
- 2. Slowly submerge the bottle neck first into the water to the appropriate depth.
- 3. Invert the bottle such that its neck is upright pointing into the water flow if any. Fill bottle, leaving some airspace.

- 4. Bring bottle to the surface. Pour out a little water if necessary, downstream from the sampling site. Cap tightly.
- 5. Repeat steps 2 through 4 for the remaining bottles. See below for whirlpaks and filtered sample.
- 6. Collect the chlorophyll and biology samples quickly to avoid degradation by light.
- 7. Preserve the nutrients bottle with sulfuric acid and the metals bottle with nitric acid within 15 minutes after sample was taken. Invert the bottle several times to ensure sufficient mixing of sample and preservative, check and adjust pH with additional preservative, if necessary.
- 8. Securely cap container, Place all bottles on ice within 15 minutes of collection.
- 9. Label and complete field notes, Pack samples and ship to Lab.

To collect a sample into a Whirlpak[®]

- 1. Wear unpowdered, disposable latex gloves.
- 2. Tear the top off of the Whirlpak[®] where it is perforated, and open the bag using caution not to touch the insides of the opening.
- 3. Immerse the bag, open end first, to the correct depth.
- 4. Collect the sample with a sweeping motion.
- 5. Bring a full bag to the surface to avoid collecting surface film.
- 6. Press out excess water from the bag until the Whirlpak[®] contains approximately 150 ml of sample water (at least 125 mL).
- 7. Seal the bag tightly with at least three folds at the top (do this by “whirling” the bag at least three times). Twist the wire ties together. Arrange the ends of the wires so they cannot puncture the bags. The bag should be firm and have ample head space.
- 8. Place both whirlpaks in Ziploc bag and place on ice.

The filtered orthophosphate/specific conductance sample

- 1. Leave the cap on the tip and remove the plunger from a new 60 ml disposable syringe. If a cap is not present, remove the plunger, but use caution not to touch the tip of the syringe.
- 2. Lower the syringe into the water, open end first, to the appropriate depth. Turn the syringe so the opening is pointing into the water flow, if any.
- 3. Bring full syringe to surface.
- 4. Slowly insert the plunger. Remove cap on tip of syringe. If cap is not present, insert plunger in a manner that attempts to eliminate excessive

- loss of the sample. Move syringe away from your sample site and push sample water out of the syringe.
- 5. Remove plunger and replace cap (if present) on syringe tip.
 - 6. Repeat steps 2 and 3.
 - 7. Carefully insert the plunger.
 - 8. Remove cap on tip (if present) and attach a new 0.45-micron disk filter to the syringe.
 - 9. Position the syringe with the filtered end facing upward, and flush the filter with approximately 20-30 ml of the sample water, disposing of this water away from the sample site. Holding the syringe in this position allows flushing of air inside the filter.
 - 10. Push the water out of the syringe, through the filter, and into the 125-ml bottle. Make sure no unfiltered water, such as water dripping on the outside of the syringe, gets into the bottle. Loosely cap the bottle.
 - 11. After emptying the syringe, disconnect the filter, remove the plunger, and replace the syringe cap (if present).
 - 12. Refill the syringe as above, remove the cap (if present), reattach the filter, and insert the plunger.
 - 13. Push filtered water into the bottle.
 - 14. Repeat until the 125-ml bottle is filled with a minimum of 100 ml of the filtered water.
 - 15. Cap bottle and dispose of syringe and filter.

Field Sheets

FDEP WMS will provide field sheets (Figure 12) along with the other paperwork and labels. Be sure that the most current version of the field sheet is used by observing the date printed on the form. Enter data using waterproof ink and retain a copy in the field notebook. See Section 10 for full details. Someone other than the field samplers must complete the bottom section of the field sheet labeled “Reviewed for Completion By:” This signature ensures that the field sheet has been completed in its entirety before submitting to the WMS.

Photo Documentation

For all Status sites, document conditions by taking photographs from the sample collection point facing north, south, east and west. For Trend sites, take photographs once a year or as needed based on changing conditions. For any sites that are excluded in the field, take photos to document the rationale (no photos are required for office recon exclusions).