TASK 3.4
LAMB ISLAND DAIRY REMEDIATION
FINAL REPORT

SFWMD Contract No. C-13410

Submitted by:

HSA Engineers & Scientists

HSA Project No. 8005-7106-00

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1486-A Skees Road

West Palm Beach, FL 33411

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GLOSSARY AND ACRONYMS

AF	Acre-Feet
AgNMA	Agricultural Nutrient Management Assessment
Bion Corporation	Bion worked extensively with dairy farmers in Florida and other States in developing treatment systems for dairy farm animal wastes. The typical Bion system was comprised of several serial gravity settling ponds followed a larger pond called the "eco-reactor" where coagulant salts (ferric or aluminum) were added to precipitate phosphorus with sufficient volume to allow the flocculated materials to settle and be retained.
CFS	Cubic Feet per Second
CY	Cubic Yards
CN	Curve Number
D&M	Dames & Moore
EAS	Engineering & Applied Sciences
EB	Equipment Blank
ET	Evapotranspiration
FCEB	Field Cleaned Equipment Blank
FDEP	Florida Department of Environmental Protection
HIA	High intensity area – area where cows are held between milking. It was not an uncommon practice to have a density of 10 cows per acre in the HIA.
HSA	HSA Engineers & Scientists
LIMS	Laboratory Information Management System
mg/L	Milligrams per Liter
M^3	Cubic Meters

NELAC	National Environmental Laboratory Accreditation Conference
NGVD	National Geodetic Vertical Datum
NRCS	Natural Resources Conservation Service
Ortho-P	Ortho phosphorus (OPO_4)
P	Phosphorus
ppm	Parts Per Million
RPD	Relative Percent Difference
RS	Replicate Sample
RSD	Relative Standard Deviation
SCS	US Soil Conservation Service
SFWMD	South Florida Water Management District
SOP	Standard Operating Procedures
SRP	Soluble reactive phosphorus
Terrace Berm	A shallow berm ranging from 6 to 12 inches above grade level intended to retain incremental amount of sheet flow storm water runoff on pasture lands.
TMDL	Total Maximum Daily Load
TOB	Top of Berm
TP	Total phosphorus content as measured by EPA method 365.2.

1.0 INTRODUCTION AND BACKGROUND

The Lamb Island Dairy site, also known as Ferrell Dairy, includes approximately 808 acres in the southeast corner of Section 36 of Township 35 South, Range 33 East and in the southwest corner of Section 31 of Township 35 South, Range 34 East of Okeechobee County, Florida. Between the years of 1982-1988 there were approximately 1000-1100 head of cows on the property, both lactating and dry. The South Florida Water Management District (SFWMD) acquired the site in 1994, in accordance with the Kissimmee River Restoration and Headwaters Revitalization Program to restore the historical river flood plains in Cypress Slough. Per a lease agreement with the SFWMD, the previous property owner was allowed to keep beef animals on the property. All animals were removed from the site in late 1998.

In 1990, site dairy operations were required to be in accordance with the Florida Department of Environmental Protection (FDEP) Dairy Rule, with a total phosphorus (TP) concentration discharge limit of 1.2 mg/L (ppm). A Works of District Permit was issued for the site in 1997; with a lower discharge limit of 0.35 mg/L TP since the land had been converted to improved pasture. The Lake Okeechobee Protection Program has established a Total Maximum Daily Load (TMDL) of 140 metric tons/year for Lake Okeechobee. This relates to an in-lake concentration goal of 0.04 mg/L TP.

The objective of this project was to reduce, to the extent most practicable, the storm water TP load discharges from the Lamb Island Dairy property (site). HSA Engineers & Scientists (HSA) was retained by the SFWMD to implement one or more remedial alternatives as recommended by an Agricultural Nutrient Management Assessment (AgNMA) to minimize phosphorus (P) discharges from the site. The implemented alternatives were aimed at reducing P discharges while taking into consideration cost effectiveness as well as minimizing long-term operation and maintenance requirements.

2.0 REVIEW OF EARLIER STUDIES AND DESCRIPTION OF THE PREVIOUS WASTE MANAGEMENT PROGRAM

A waste management system was designed and installed at the site by the USDA-Natural Resources Conservation Service (NRCS) to meet the FDEP Dairy Rule requirements. The waste management system included perimeter ditches and berms around the High Intensity Area (HIA). A 1-acre 1st stage primary settling pond (Pond 1) received the high concentration wastewater solids from the milking parlor complex (barn wash, cow spray, and runoff from the HIAs and from the perimeter ditch around the HIAs). Pond 1 water was pumped into a 2-acre facultative treatment and storage pond (Pond 2). Pond 2 water was pumped into a 5-acre facultative treatment and storage pond (Pond 3). Pond 3 water was pumped into an eco-reactor for chemical and biological treatment. Grass was grown in the eco-reactor and harvested periodically for feed. Excess water was pumped to a spray field west of Lamb Island Road. **Figure 1** provides a plan view of the site and also shows the layout of the historical waste management system.

In 2000, Dames & Moore (D&M) conducted a waste management assessment (URS 2002) on the Dairy including characterization of the serial waste storage ponds, HIAs, eco-reactor and irrigation ditches as part of a closure plan. The primary P sources were identified as barn washwater, cow spray and runoff from HIAs and perimeter ditches. The D&M report included a description of the Bion waste management and wastewater treatment system that was installed at the Dairy. The Bion system included treating wastewater in the settling ponds, as described above, and adding ferric salts before the eco-reactor. The report analyzed different remedial alternatives with pros and cons, costs and time frames for implementation of the various alternatives.

A SFWMD Project Team developed recommendations for the reduction of phosphorus-contaminated discharges from the former Lamb Island Dairy (SFWMD, 2000). The report included seven alternatives, listed below in order of their preliminary ranking by the SFWMD staff.

1. Construct contour terraces on the pastures to retain runoff, increase ET, and utilize for forage production. Collect runoff from the terrace closest to the slough and treat chemically. Incorporate soil amendments into the pastures to reduce phosphorus in surface runoff and subsurface lateral flows;

2. Construct contour terraces on the pastures to retain runoff, increase ET, and utilize for forage production. Collect runoff from the terrace closest to the slough and land apply to the sprayfield. Incorporate soil amendments into the pastures to reduce phosphorus in surface runoff and subsurface lateral flows;

3. Construct contour terraces on the pastures to retain runoff, increase ET, and utilize for forage production. Collect runoff from the terrace closest to the slough and treat chemically;

4. Construct contour terraces on the pastures to retain runoff, increase ET, and utilize for forage production. Collect runoff from the terrace closest to the slough and land apply to the sprayfield;

5. Construct a berm around the herd pastures to contain all surface runoff and chemically treat the runoff prior to discharge;

6. Construct a berm around the herd pastures to contain all surface water runoff and treat for phosphorus removal via a small STA or application of water to the sprayfield for nutrient uptake by forage grasses; and,

7. Construct a berm around the herd pastures and contain all surface runoff to prevent discharge to Cypress Slough.

Common to all of the seven alternatives listed above was the recommendation for in-situ bioremediation of the residual manure wastes contained in all of the existing ponds using anaerobic microbial enzymes. According to the Dames and Moore report, in-situ bioremedation would be accomplished by consolidating all existing manure into one

lagoon, the injection of the microbes/enzymes into this treatment area, and the periodic mixing of the waste materials to ensure adequate distribution of the microbes throughout the waste materials.

All of these remedial design recommendations are focused on the approximate 400 acres contained in the eastern half of the former Lamb Island Dairy Farm. The portion of the farm west of Lamb Island Dairy Road possessed relatively low soil and storm water runoff phosphorus content (SWET, 2002 and SFWMD, 2000) and consequently active hay farming of the western portion of the property was the only remedial measure recommended for that portion of the property. Hay farming activities were contracted directly by the SFWMD and were not part of the subject contract.

3.0 DETAILED REMEDIATION SYSTEM DESIGN

After conferring with the SFWMD during several meetings and preparing 30% and 90% complete preliminary design packages for review and consideration, the final design was established and consisted of the following basic elements:

- Construct a surface water containment berm around the HIAs and high P soils, gravity flow of storm water runoff to the existing eco-reactor and swale for biological (wetland) treatment;
- Construct a containment berm at the edge of farm to collect and store a pre determined amount of outer pasture runoff;
- Construct terrace berms in the outer pasture runoff containment area;
- Construct a wetland at the southern end of the outer pasture runoff containment area for biological (wetland) treatment;
- Alum amendment of the dairy wastes (residual manure solids) contained in ponds 1 and 2 leaving inactivated material in-place;
- Fill/grade pond 1;
- Fill/grade pond 2 or suitable to maintain a crop;
- Alum amendment of the impounded waters contained in the settling pond (Pond 3) and cooling pond to inactivate and precipitate water column phosphorus content;
- Dewatering and backfilling the onsite perimeter ditch; and,
- Hay cropping of all available land areas.

The basic components of the final design are shown in **Figure 1**. A brief narrative review of the planned construction activities and the supporting documentation used to develop the remedial design components is provided below.

3.1 Storm water runoff collection system

The remedial design includes collecting storm water runoff in two areas, (1) the HIA; and (2) the outer pasture (**Figure 1**).

3.1.1 HIA Runoff Collection

An approximate 40-acre surface water containment area was created by constructing an earthen berm around the original HIA and other high-P soils. The HIA collection system includes using the existing berms on the north side of the eco-reactor. Ditches on the upstream side of the berm convey the runoff by gravity to the eco-reactor cell 1.

The top of berm (TOB) elevation is 44 feet NGVD (± 0.3 feet) with the design maximum water elevation set at 43 feet. This containment area will store up to 8.0 inches of storm water runoff or a resulting volume of 26.7 acre-feet (32,950 m^3). The net contributing drainage area (excluding Pond 3) is 40 acres. This area encompasses the HIA and other high-P soils identified in the AgNMA (SWET, 2002).

Project team member, Engineering and Applied Sciences (EAS), estimated the storm water runoff from the land area located east of Lamb Island Dairy Road. The adICPR Model utilizing the U.S. Soil Conservation Service (SCS) Method was used to calculate runoff volume and peak discharges (EAS, 2002). For these runoff calculations, the input data included hydrologic soil group, land use, Curve Number (CN), rainfall amount and SFWMD rainfall distribution, and time of concentration. A monthly rainfall forecast was developed using the SCS Method and historical rainfall data included in the CREAMS-WT model for the site.

The SCS Method was used to calculate the storm event associated with 8.0 inches of runoff using the equation:

$$Q= (P-0.2*S)^2 / (P+0.8S) \text{ and, } S = (1000/CN) -10$$

A CN of 89 was used and the storm event (P) associated with 8.0 inches of runoff (allowable containment area depth) was calculated to be 9.3 inches of rainfall. Rainfall curves included in the "Surface Water Design Aids" section of Volume IV of the SFWMD *Environmental Resources Permit Manual* (2000) were used to estimate the equivalent design storm event. The equivalent design storm is the 25-year return period/72-hour event duration. *The site specific factors (i.e., matching new berm heights to existing eco-reactor berms) results in an atypical design frequency (design storm event).*

Aside from the 40 acre collection system, the HIA containment area includes an additional estimated 21.5 acres of storage contained in the eco-reactor (6.5 acres) and the existing swale (15 acres) located downstream of the eco-reactor. Berms were constructed on the south and east sides of the swale routing runoff to a discharge location at the southern end of the swale (KREA 44). The swale berms were also designed to accommodate 9.3 inches of rainfall in the eco-reactor and the swale.

The SCS Method was used to determine the amount of runoff from the eco-reactor and the swale. Using a storm event of 9.3 inches of rainfall and a CN of 98 resulted in 9.1 inches of runoff or approximately 4.9 acre-feet (6,050 m^3) of storm water runoff from the

eco-reactor. The runoff from the swale was calculated using the SCS Method with a CN of 89 and a storm event of 9.3 inches resulting in 8.0 inches of runoff or approximately 10 AF (12,340 m^3) of storm water runoff from the swale. The berms around the swale were constructed with a TOB elevation of 40 feet NGVD. The maximum water elevation is set at 39 feet NGVD providing for storage of runoff from the eco-reactor and swale from a 9.3 inch storm event and allowing for one foot of freeboard in the containment area.

The containment berm heights vary depending on the existing original ground elevation and the berm dimensions are approximately two feet wide at the top with 4:1 side slopes. These side slopes were specified to allow for maintenance of the berms using standard equipment. The internal eco-reactor berms were improved as necessary to provide a TOB elevation of at least 43 feet NGVD. These berms were previously constructed with 2.5:1 side slopes and maintenance of the internal berms is not anticipated.

Ditches were constructed on the upstream side of the berms to convey the runoff by gravity to the eco-reactor or other discharge location. Positive flow conditions are required for all ditches and the minimum physical slope will be maintained at 0.0005 ft/ft. The ditch configuration will be a minimum of 10 feet wide with side slopes of 3:1 or flatter.

3.1.2 Outer Pasture Runoff Collection

An approximate 109-acre surface water containment area was created by constructing earthen berms along the eastern and southern sides of the property. Ditches on the upstream side of the berm will convey the runoff by gravity to a new discharge location on the south side of property (**Figure 1**).

The containment area size is based on maintaining an optimum water height of 18 inches (WSI, 2002) in the constructed wetland at the southern end of the outer pasture containment area. The berms surrounding the constructed wetland were constructed without ditches and therefore material was borrowed. Based on the existing site topography, the most cost effective method to construct the wetland was a combination of lowering the ground surface elevation and constructing berms and ditches around the outer pasture containment area to store and convey runoff to the constructed wetland. Soils were scraped/excavated from approximately 14 acres in the constructed wetland creating an average grade elevation of approximately 36.25 feet NGVD. The bottom of the existing lounging pond (approximately 2-acres) remained at between 35-36 feet NGVD. The maximum water height in the wetland/containment area was maintained at 37.75 feet NGVD with a TOB elevation of 38.75 feet NGVD. The resulting capacity of the containment area is approximately 27.2 acre-feet (33,565 m^3) of storm water runoff. **Figure 2** shows the maximum retention capacity of the containment area. The contributing area includes the former pasture area outside the HIA. This area includes the low to moderate-P soils identified in the AgNMA (SWET, 2002).

Based on the storage capacity of 27.2 AF, the outer pasture containment area will store an average of 3.0 inches of runoff [(27.2 AF ÷ 109 acres)*(12inches/foot)]. The SCS Method was used to determine the storm event associated with the containment area volume. A CN of 89 was used and the storm event (P) associated with 3.0 inches of runoff (allowable containment area depth) was calculated to be 4.2 inches of rainfall.

The containment berm heights vary depending on the existing original ground elevation and the berm dimensions are approximately two feet wide at the top with 4:1 side slopes. These side slopes were specified to allow for maintenance of the berms using standard equipment.

Ditches were constructed on the upstream side of the containment berms to convey the runoff by gravity to the constructed wetland at the southern end of the containment area. Positive flow conditions are required for all ditches and the minimum physical slope will be maintained at 0.0005 ft/ft. The ditch configuration was roughly 10 feet wide with side slopes of approximately 3:1.

Two terrace berms (6-12 inch berm height) were constructed across the pasture area as shown on **Figure 3**. The terrace berms are designed to increase runoff retention, ET, and P uptake in the pasture area.

3.1.3 Flow control structures

Runoff from the HIA flows by gravity through the former eco-reactor and swale system via a series of metal culverts with riser inlets. Runoff from the HIA containment area ultimately flows by gravity through a culvert at the existing discharge location (KREA 44) and the outer pasture area runoff will ultimately flow by gravity through a culvert at a new discharge location. A site plan showing the monitoring stations is provided as **Figure 3**. At the recommendation of the SFWMD staff, a culvert (instead of an overflow weir) was used to maintain one foot of freeboard and to set the maximum water level within the HIA containment area at 43 feet NGVD before storm waters are allowed to discharge from the containment area. The culvert was installed to drain runoff into the existing ditch located on the east side of the eco-reactor. Boards have been installed in the culvert risers spanning from the culvert invert elevation to the control elevation.

Manning's equation was used to determine the minimum culvert diameter required to drain the accumulated runoff from the containment areas within 72 hours. Using Manning's equation, it was calculated that a 24-inch diameter culvert with a slope of 0.005 (0.05 feet of fall per 10-feet of run) would be adequate to provide for drainage of the containment area within 72 hours. At the recommendation of the SFWMD staff, a 36-inch culvert was used for the HIA emergency overflow structure and at the two discharge locations to provide additional flow capacity.

3.2 STORM WATER RUNOFF TREATMENT

3.2.1 Antecedent Storm Water Quality

Prior to starting remedial construction, samples of standing and flowing surface waters at various internal sites within the former Lamb Island Dairy property were collected on two separate occasions during September 2003. Field sampling activities were planned to coincide with substantial regional rainfall events. Using the topographical survey map previously supplied by the SFWMD, sampling locations were established in depressions and low elevation runoff channels in order to assess the relative amount of P contained in the surface runoff at various internal sites. Ortho-P, total dissolved P, and TP samples were collected at all sites. The sampling locations and results are shown on **Figure 4**.

3.2.2 Storm Water Treatment System

The overall goal of the treatment system is to reduce P discharging from the site. The constructed system design included treatment by overland (or sheet) flow in the pasture area with additional treatment efficiency achieved by adding terraces and creating a wetland in the outer pasture area (see **Figure 3**). Therefore, the storm water treatment system design included:

- Collection and retention of storm water runoff within the HIA containment area and wetland treatment in the existing eco-reactor ponds and swales;
- Collection and retention of storm water runoff within the outer pasture;
- Construction of terraces in the outer pasture; and,
- Construction of a wetland in the southern end of the outer pasture.

From the 40-acre HIA containment area, water flows by gravity to the existing 6.5-acre eco-reactor. Within the eco-reactor, a total of four discrete cells are maintained and the water sequentially flows by gravity from one cell to the other. From the eco-reactor retention area, water then flows by gravity over a riser/culvert into an existing swale prior to discharge off the property. The wetland treatment system area is comprised of approximately 21.5 acres including:

- Eco-reactor Cell 1 (1.4 acres);
- Eco-reactor Cell 2 (1.1 acres);
- Eco-reactor Cell 3 (0.98 acres);
- Eco-reactor Cell 4 (3.0 acres); and,
- Existing swale (15 acres).

Water levels in the eco-reactor cells and swale are maintained at depths of 12 to 18 inches using new riser culverts as internal water control structures. It is anticipated that emergent vegetation such as cattails and potentially some SAV will be established within 2 to 3 years (volunteer growth) within the eco-reactor cells and within the boundary of the existing swale system.

The outer pasture containment area included three terrace areas:

- Terrace 1 (40 acres);
- Terrace 2 (31 acres); and,
- Terrace 3 (22 acres).

Terrace berms (6-12 inch berm height) were constructed by disking and then grading the areas shown on **Figure 3**. The terraces receive direct rainfall, runoff from upstream terraces, and may also receive overflow from the HIA during extreme wet conditions. The TOB elevation of Terrace 1 is 40.75 feet NGVD and the TOB for Terrace 2 is 39.25 feet. Terrace 3 was constructed by grading and improving the existing swale and the TOB elevation is 37.75 feet NGVD.

An approximate 16-acre constructed wetland was created on the southern end of the outer pasture area. This area includes a 2-acre former lounging pond. The other 14 acres in this area were cleared and graded to a bottom elevation of approximately 36.25 feet NGVD. Water levels in the wetland will be maintained at 37.75 feet NGVD.

4.0 REMEDIAL SYSTEM CONSTRUCTION ACTIVITIES

Remedial system construction started in April 2004 with the procurement of materials and mobilization of equipment to the site. Fralix Construction performed all onsite construction activities. Mixon Land Surveying staked out the property for major feature locations and elevations. Prior to any construction activities underground clearance was obtained for any utilities onsite. Silt fencing was installed around the perimeter of the site where construction activities were taking place per construction plans and specifications. **Figure 1** shows the site plan and major feature locations.

By mid April 2004 construction of the HIA containment area berm and ditch had begun. Berm construction proceeded from the west end of the property towards the eastern side of the property. An emergency overflow culvert was installed on the south side of the HIA area near the northeast corner of the former eco-reactor. By late April the HIA containment area berm was substantially complete and the outer perimeter berm was near completion with the exception of grass seeding of the berms. Concurrent to berm construction, the constructed wetland area at the southern end of the site was being excavated to increase the retention volume in this area and the soil was used as fill material for ponds 1 and 2, and for material to construct the berms around the constructed wetland.

Construction activities continued during May through mid July 2004. Construction of the HIA containment area berm, and outer pasture berm were constructed except for final grading and seeding (see **Figure 1**).

By late July, within the wetland treatment system, a total of four discrete cells were constructed with culverts and risers connecting each cell. Board heights can be maintained in each riser to a maximum elevation of 43 feet NGVD. From the wetland

treatment system, water then flows by gravity through a 24-inch diameter culvert with riser boards set at 43 feet NGVD into a swale prior to discharge off the property. The discharge culvert was installed, including a new 36-inch diameter culvert and riser, with the riser boards set at 39 feet NGVD. A 36-inch diameter discharge culvert with riser was also placed on the southern most side of the outer pasture containment berm. Board elevations were set at 37.75 feet NGVD. Disking and then grading the areas shown in **Figure 1** constructed three terrace berms. All berm embankments were then compacted and were seeded with Bahia grass. The approximate 16-acre constructed wetland on the southern end of the pasture was cleaned up and graded to a bottom elevation of approximately 36.25 feet NGVD. Due to seasonal weather patterns (i.e. Hurricane Jeane, Ivan, Charley and Hurricane Frances) an abnormally large quantity of rain fell on site in late August and early September 2004, which resulted in breaches of the outer pasture berm. All breaches were immediately repaired and additional areas of the berm were further improved to ensure berm integrity.

By the middle of October 2004, all breaches in the berms had been repaired and the areas seeded with Bahia grass had grown in well with a few areas of spotty growth. In all other areas the vegetation had grown extremely fast. All major constructed features remain in good condition. No major rain events occurred during this seasonally dry quarter with only occasional frontal systems dropping a negligible amount of rain. All storm water runoff appeared to be retained on-site and no runoff was observed discharging from the site.

Six quarterly scheduled sampling events were completed from November 18, 2004 through November 29, 2005. **Figure 3** shows the location of the six surface water sampling location and the groundwater monitoring location just south of Pond 3. **Table 1** shows water quality results for all sampling locations. The laboratory results, sample chain of custody, and field-sampling notes are contained in the project Quarterly Reports. All sampling was conducted in accordance with FDEP Quality Assurance Rule, Chapter 62-160.210 F.A.C., the associated FDEP SOPs, and HSA's Quality Assurance Manual.

Captioned photographs showing the progress of the various phases of construction work are provided in **Appendix A.**

5.0 TREATMENT OF RESIDUAL MANURE WASTE

Treatability studies were conducted to determine the effectiveness of alum treatment on P concentration in pond waste. The process included weighing a 50 g sample of the manure collected from Pond 1 and Pond 2, adding 200 ml of deionized water, mixing with different doses of alum, and settling for 45 minutes. The samples were analyzed using a colorimetric analytical method and a Hach spectrophotometer to measure absorbance and to determine the soluble reactive phosphorus (SRP) concentration of the raw and treated manure (see **Appendix B** for details of the manure treatability study).

Based on the results of the manure treatability study, the residual manure was planned to be amended with alum using 2.5 ml of alum per pound of manure as the maximum dose with the final target of 150 micrograms per liter of Ortho-P in the amended wastes.

During development of the preliminary and detailed design, HSA reviewed the sampling and survey data recently collected at the site by the SFWMD. Based upon these data, a majority of the P containing waste existing at the site is located in Pond 1. Up to 8,500 cubic yards (CY) of waste is contained in Pond 1, while Pond 2 and Pond 3 contain up to 1,500 CY and 4,325 CY, respectively. The waste located in Pond 3 was in a very thin layer and it would be difficult and very costly to completely dewater this pond and remove the waste materials. Therefore, the manure waste alternative implemented included amending the manure waste in Pond 1 and Pond 2 with alum.

By Early May 2004 dewatering of Pond 1 and 2 had begun. A dewatering pump was installed on the north side of Pond 2 and the standing water was pumped into Pond 3. Pond 1 was also dewatered into Pond 3. The HIA ditches (see **Figure 1)** were dewatered into Pond 3 and existing stockpiles of fill material near the HIA ditches were used to fill the ditches and grade the area. After dewatering was completed, the eastern portion of Pond 1 was filled, with material excavated from the created wetland, starting at the western end of the pond to confine the waste material to a smaller area for alum treatment.

On May 7, 2004 the first 4,000 gallon shipment of alum was delivered to the site and added to Pond 1. Alum was slowly applied and mixed using an excavator bucket. A PTO driven chopper pump was installed on the northeast side of Pond 2 and waste material was then pumped into Pond 1 until it was filled to capacity. During pumping, alum was slowly added to the pump intake to enhance mixing. The remaining waste material in Pond 2 was crowded into a smaller area for treatment. Further addition of alum was continued during May in Pond 1 and 2. On-site testing was completed using a Hach Dr 2100 Spectrophotometer for SRP using the ascorbic acid method to determine treatment progress and areas that required additional alum amendment. After on-site testing reported treated manure sample SRP concentrations below 150 parts per billion (ppb), confirmatory samples were collected on June 17, 2004, from six locations at two different depths in Pond 1 and Pond 2. The confirmatory samples were submitted to the SFWMD Lab located at Skees Road in West Palm Beach, Florida. The analytical results are summarized in **Table 2**. Resulting analyses confirmed average TP values below 150 ppb. A total of approximately 8,800 gallons of alum were added to Ponds 1 and 2. A copy of the analytical results is provided in **Appendix C**.

The volume of waste contained in Pond 1 was approximately 8,500 CY. Assuming one cubic yard of wet manure waste is equal to 1,700 pounds (URS 2000), the weight of the residual solids in Pond 1 is approximately 6,600,000 kg. Based on the SFWMD data provided for Pond 1 solids, the average TP concentration is 3,012 mg/kg and the average percent moisture is 71%.

The estimated amount of TP in Pond 1 is:

= [(6.6*10^6 kg) × (3,012 mg/kg) × (0.29) × (1 g/1,000 mg) × (1 lb/ 454 g)]
= 12,700 lb P

The volume of waste in Pond 2 was approximately 1,500 CY. The weight of the residual solids in Pond 2 is approximately 1,200,000 kg. Based on the SFWMD data provided for Pond 2 solids, the average TP concentration is 4,290 mg/kg and the average percent moisture is 62%.

The estimated amount of TP in Pond 2 is:

= [(1.2*10^6 kg) × (4,290 mg/kg) × (0.38) × (1 g/1,000 kg) × (1 lb/ 454 g)]
= 4,310 lb P

Ponds 1 and 2 were amended with a total of approximately 8,800 gallons of alum. Using the pre-treatment TP concentrations and the average TP concentrations after alum treatment, approximately 17,009 pounds of P was inactivated. A summary of the alum treatment analytical results is provided in **Table 2.**

6.0 TREATMENT OF POND WATER

The planned pond remediation measures included amending the water column in pond 3 with alum. In addition, the old borrow pit/cooling pond at the southwest area of the property was intended to be treated with alum. Treatability studies were conducted to determine the effectiveness of alum treatment on P concentration in the pond water. The process included adding alum doses ranging from 5 to approximately 30 mg/L (as aluminum) to pond water samples, allowing the floc to settle, and analyzing a sample of the water column for SRP. The results (**Appendix B**) indicated that as the alum dose increased the SRP concentration measured in the treated mixture decreased. A doses of 10 mg/L as Al resulted in a non-detectable concentration of SRP. The plan was to titrate the pond water with alum up to an anticipated maximum of 15 mg/L to achieve a treated SRP value of less than or equal to 0.15 mg/L as P. Samples of the treated water would then be collected and analyzed in the field using Standard Method 4500-P E., or equivalent, to confirm the effective dosage.

Background groundwater and surface water samples were collected before the pond water treatment. On June 15 and June 22, 2004, groundwater samples were collected from the monitoring well adjacent to the south side of Pond 3 (see **Figure 3**), and were submitted to Jupiter Laboratory (Jupiter) for TP, Ortho-P, and total aluminum analysis. On June 17, 2004, surface water samples were collected from Pond 3 and Pond 4 (see **Figure 3**), and were submitted to Jupiter for TP and Ortho-P analysis. The analytical results are presented on **Table 3.**

On June 22, 2004, approximately 3,500 gallons of alum was mixed into Pond 3 by Aquatic Biologists, Inc. using four small boats equipped with chemical mixing

equipment. Pond 4 (the former cattle lounging pond) was treated with approximately 500 gallons of alum in the same manner. SRP testing in the field was performed using a Hach Dr 2100 Spectrophotometer (ascorbic acid method). On June 24, 2004, confirmatory samples were collected and submitted to the SFWMD Lab for Ortho-P analysis. The analytical results reported Ortho-P concentrations exceeding the target of 150 ppb (see **Table 3**) in samples collected from Pond 3. The samples collected from Pond 4 were reported below the target concentration. On July 1, 2004, additional samples were collected from Pond 3 and were submitted to Jupiter for Ortho-P analysis (see **Table 3**). The Ortho-P concentrations from the July 1 sampling event were reported above the target concentration; therefore, additional pond water treatment was required.

On July 15, 2004, an additional 2,500 gallons of liquid alum was sprayed onto the surface of Pond 3 and mixed into the water column with a small boat and motor. On July 16, 2004, surface water samples were collected from Pond 3 and submitted to Jupiter for Ortho-P analysis. Ortho-P was reported below the target concentrations in the six samples collected (see **Table 3**). The analytical results for the pond water treatment are provided in **Appendix D**.

Approximately 31 million gallons of surface water was treated in Pond 3. Using a pre-treatment Ortho-P concentration of 1.2 mg/L and a treated water average concentration of 0.068 mg/L, approximately 295 pounds of P was inactivated in Pond 3, a 94% reduction. Pond 4 contains approximately 0.8 million gallons of water. **Table 3** shows the P content of Pond 4 surface waters before and after Alum treatment. Approximately 4 pounds of P was inactivated in Pond 4, a 97% reduction.

7.0 POST CONSTRUCTION YEAR OF SYSTEM PERFORMANCE MONITORING

7.1 Objective

After construction of the remedial system was completed, the site was monitored over a one-year period as part of this contract to assess system performance relative to reducing the phosphorus load of the storm waters. The elements of the monitoring were summarized in the site wide monitoring plan, Task 2.2 deliverable. HSA prepared this monitoring plan for the SFWMD to describe the materials and methods to be used to collect water samples and associated data in order to assess the effectiveness of the constructed phosphorus reduction remedial measures.

Post construction monitoring commenced on November 18, 2004, and sampling continued with a total of 16 sampling events completed through November 29, 2005. **Table 1** provides a summary of the sampling dates and the associated test results for the analyses completed.

7.2 Sampling Locations

There are a total of seven water quality-monitoring locations (six surface water and one shallow groundwater monitoring well) that were sampled. Sampling locations are shown on **Figure 3.** The shallow groundwater well (GW-1) is completed 10 feet deep below land surface, and is a 1.5-inch diameter PVC well with four feet of slotted screen (0.010-inch slot size) at the bottom of the well. It was constructed to obtain shallow water table data. The HSA field team representatives accessed the site through the locked gates (combination locks) located on the western side of the property. The surface water sampling sites included:

- SW1 – located at the inflow to the eco-reactor;
- SW2 – located at the discharge site of the eco-reactor;
- SW3 – located at the off - farm discharge station that represents the treated storm water runoff, if any, from the HIA/eco-reactor system;
- SW4 – located downstream of the first two outer pasture terrace berms and immediately upstream of the constructed wetlands;
- SW5 – located at the off - farm discharge station that represents treated storm water runoff from the outer pasture area; and,
- SW6 – located within pond 3; tested to determine the TP and SRP trend over the first year after alum treatment

7.3 Quality Assurance Samples Collected

Replicate samples were collected on a frequency of 22% of all samples collected on the site, well above the 10% minimum that was indicated in the sampling plan to be collected. A total of 13 replicate samples were collected out of the total of 57 samples collected from the site over the first year of monitoring. The results of the replicate analyses are provided in **Table 4**. The RPD for the sample collected on June 15, 2004 was approximately 30%, exceeding the maximum allowable RPD of 20%; therefore the TP data was flagged. The RPD for the reminder of the TP data and 17 sets of Ortho-P data were within the maximum RPD of 20%.

Table 5 provides the results of the equipment blanks (EB) collected during the year of monitoring. Equipment blanks were collected at a frequency of 10%, equal to the planned amount. The results of one EB sample (collected on May 16, 2005) was reported at a TP concentration above the detection limit (1.6 mg/L for TP). The TP data from May 16, 2005 are flagged due to the elevated TP concentration reported in the EB sample.

7.4 Sampling Techniques

Sample collection was performed in accordance with the FDEP surface water sampling and groundwater-sampling SOPs outlined in the FDEP QA001/01, and were consistent with HSA's Quality System. Surface water samples were collected using grab sampling techniques at a six inch depth by use of a dip pole or, if accessible, by directly collecting

the sample into a clean, laboratory bottle. Monitoring well samples were collected after purging the well with a peristaltic pump, in accordance with the FDEP groundwater SOP (FS2200), followed by filling the sample bottle directly from the pump discharge stream. TP samples were preserved with sulfuric acid to a pH of less than 2. Aluminum samples were preserved with nitric acid to a pH of less than 2. Ortho-P samples were field filtered through a 0.45-micron filter, cooled and submitted to the laboratory unpreserved. All samples were submitted to an FDEP and NELAC certified commercial laboratory.

An internal field audit was conducted during field sampling on November 29, 2005. In general, the sampling personnel collected the surface water samples and the groundwater samples in accordance with prescribed FDEP SOPs. A copy of the Field Audit Form is included in **Appendix E**.

7.5 Review of Samples Collected and Test Results

On June 15 and June 22, 2004, background groundwater samples were collected before the pond water treatment. The average background TP concentration was 0.29 mg/L and the average background total aluminum concentration was 2.24 mg/L. TP and total aluminum were collected quarterly from the onsite monitoring well. Samples were collected from the monitoring well on the following quarterly sampling event dates:

- November 18, 2004;
- February 18, 2004;
- May 16, 2005;
- August 16, 2005; and,
- November 29, 2005.

As shown in **Table 1**, TP concentration averaged 0.24 mg/L in the groundwater sample collected over the five quarterly samples. The total aluminum concentration in the monitoring well averaged 3.48 mg/L. **Figure 5** provides a graph of the groundwater data.

TP and Ortho-P samples were collected when there was flow or no flow (standing water) associated with any of the six surface water-sampling sites. Flow was only observed at sampling location SW-5, the outer pasture discharge location. Four of the 16 monitoring trips were scheduled in advance and 11 of the trips were reserved to respond to intense rainfall events in the area. SFWMD recording rainfall stations S-65C and S-65D are the closest SFWMD rainfall stations to the Lamb Island Dairy. For the 11 rain event driven sampling trips, the SFWMD's web site was monitored and rainfall of one-half inch or more triggered a sampling trip within 48 hours of occurrence. TP and Ortho-P results for each of the six surface water sample sites are discussed below:

> **SW1.** A graph of the TP and Ortho-P values collected during the monitoring year is provided in **Figure 6.** The average TP concentration for this station was equal to 2.57 mg/L and the average Ortho-P value was 1.98 mg/L. As shown in **Figure 6,** TP concentrations at this site appeared to increase slightly over the course of the year and the Ortho-P decreased steadily during the first year of monitoring.

SW2. A graph of the TP and Ortho-P values collected during the monitoring year is provided in **Figure 7.** The average TP concentration for this station was equal to 1.19 mg/L and the average Ortho-P value was 0.87 mg/L. As shown in **Figure 7,** both TP and Ortho-P concentrations at this site decreased throughout the first year of post construction monitoring.

SW3. A graph of the TP and Ortho-P values collected during the monitoring year is provided in **Figure 8.** The average TP concentration for this station was equal to 2.92 mg/L and the average Ortho-P value was 1.63 mg/L. As shown in **Figure 8,** TP and Ortho-P concentrations at this site increased moderately over the course of the year.

SW4. Only one sample was collected at this station as it was submerged during much of the year and the sampling crew could not obtain a sample at the specified sampling location. TP concentration for the one sample collected at this station was equal to 4.4 mg/L and the Ortho-P value was 4.2 mg/L.

SW5. A graph of the TP and Ortho-P values collected during the monitoring year is provided in **Figure 9**. The average TP concentration reported during "flow" events was 2.80 mg/L, while the TP averaged 2.94 during "non-flow" events. The average Ortho-P concentration during "flow" events was 2.02 mg/L and 1.91 during "non-flow" events.

SW6. A graph of the TP and Ortho-P values collected during the monitoring year is provided in **Figure 10.** The average TP concentration for this station was equal to 0.84 mg/L and the average Ortho-P value was 0.54 mg/L. As shown in **Figure 10,** TP and Ortho-P concentrations reported from samples collected from Pond 3 decreased slightly over the course of the year.

The fluctuations in P in the pond water after treatment are likely due to inputs of surface water to the pond from HIA runoff during retention periods after high rainfall events.

7.6 Data Validation

By definition, the TP concentration should be greater then the Ortho-P concentration. A ± 10% level of uncertainty was used to compare the TP and Ortho-P data sets. The data sets reported for the October 28, 2005, appear biased; with Ortho-P reported at higher concentrations then TP for all three sets of samples. All data from the October 28, 2005, sampling event were flagged. The TP and Ortho-P concentrations reported for samples collected from SW-1 on March 4, 2005, and September 20, 2005, were within the ± 10% level of uncertainty.

7.7 Stage

There are three new staff gauges installed on the farm. During each of the 15 sampling trips, water levels were measured at each of these gauges. The gauge locations are shown in **Figure 1** and include:

- **Gauge 1, Overflow culvert gauge**: Water level was observed and compared to the elevation of the board setting in the bypass/overflow culvert. As shown in **Table 1,** no flow was observed at the station during any of the first year monitoring and field sampling trips;
- **Gauge 2, Off – farm discharge culvert adjacent to sampling station 3:** Water level was observed and compared to the elevation of the board setting in the riser culvert. As shown in **Table 1,** no flow was observed at the station during any of the first year monitoring and field sampling trips; and,
- **Gauge 3, Off – farm discharge culvert adjacent to sampling station 5:** Water level was observed and compared to the elevation of the board setting in the riser culvert. As shown in **Table 1**, flow was observed and measured at the top board in the riser culvert on four different sampling and monitoring trips. These flows coupled with the concentration were used to compute the offsite P loadings as described below.

8.0 FIRST YEAR ESTIMATE OF SYSTEM PERFORMANCE

In order to assess phosphorus storm water reduction attributed to construction of the remedial system, the amount of phosphorus that would have been discharged off the property without the remedial system (pre-condition) was compared to the results of the first year system monitoring and reduced runoff estimates.

Average rainfall data from nearby stations S-65C, S-65CW and S-65D were used as an estimate of the amount of rainfall the property received. **Figure 11** provides the rainfall hydrograph for the first year monitoring (i.e., post remedial system construction) for the period inclusive of November 18, 2004 until November 29, 2005. A total of approximately 55.3 inches of rainfall was reported during the monitoring period.

The annual pre-condition load was estimated using the phosphorus loads calculated using Creams-WT (SFWMD, 2000). The rainfall reported for years 1993 (55.0 inches), 1994 (55.9 inches), and 1996 (56.6 inches), was similar to the monitoring period, and therefore, the average of the loads calculated for these years was used to estimate the pre-condition load. Using this approach, the annual pre-condition load is 2,343 kg or 5,165 lb. (see **Table 6**).

The overall goal of the HIA/Swale retention area was to reduce P discharging from the site by limiting the discharge, thus increasing time for P removal by biological and physical processes. The HIA/Swale design includes collection of storm water within the 43-acre containment area (see **Figure 3**). During the monitoring period (November 18, 2004 through November 29, 2005) there were **no discharges observed from SW3**.

The overall goal of the Outer Pasture Area is the same as HIA/Swale retention area. During the monitoring period there were four discharges observed from the Constructed Wetland area structure SW5 located at the south end of the 109-acre Outer Pasture Containment Area (see **Figure 3).** During site sampling events discharge was calculated by measuring the height of the water flowing over the boards and using the standard weir equation:

$$Q=3.33LH^{\wedge 1.5}$$

Where:

Q = flow, cfs
L = width of the boards, feet
H = height of water over boards, feet

Calculated flows were then multiplied by the duration of the storm event to arrive at the total discharge from SW5 as shown in **Table 6**. A storm event was defined as the cumulative amount of rain that fell before and after the observed discharge beginning and ending between two consecutive days of no rainfall (see **Figure 11**). The first storm event of 10.9 inches was estimated to be discharging off the property for six days. A ratio of the amount of rain and the time of discharge was used to estimate the duration of subsequent discharges from SW5. TP loads for each storm event where discharge was observed are calculated in **Table 6** using TP concentration values obtained at the time of sampling during the discharge.

As shown in **Table 6**, approximately 23 lbs of P discharged from the farm. Using the annual pre-condition P load estimate, 5,142 lbs of P were retained on the farm (99.5% retention).

9.0 CONSTRUCTION COSTS

The cost to implement the remedial activities was equal to $282, 493.00.

10.0 REFERENCES

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TABLES

Table 1. Groundwater and Surface Water Sample Sites Test Results

Sampling Locations

Site Name	SW-1			SW-2			SW-3			SW-4			SW-5			SW-6 **			GW-1 **	
Site Description	HIA Eco-Reactor Influent			Eco-Reactor Effluent			HIA/Swale Discharge Location			Influent to Created Wetland			Outer Pasture Discharge Location			Pond 3			Groundwater Monitoring Well	
Sample Date	TP	Ortho-P	Status	TP	Ortho-P	Status	TP	Ortho-P	Status	TP	Ortho-P	Status	TP	Ortho-P	Status	TP	Ortho-P	Status	TP	Aluminum
11/18/04	2.1	2	NF	1.6	1.4	NF	2.5	2.4	NF	4.4	4.2	NF			D	0.82	0.62		0.085	3.1
2/18/05	1.8	1.8	NF	0.81	0.68	NF	1.6	1.6	NF			D			D	0.79	0.51		<0.10	3.3
3/4/05	1.2	1.3	NF	0.94	0.61	NF	1.4	1.3	NF			D			D					
5/16/05	1.5*	1.3	NF			IW	1.7 *	1.3	NF			D			D	0.42 *	0.38		<0.10 *	5.3
6/8/05	3.7	2.7	NF	1.4	<0.62	NF	1.9	<0.62	NF			IN	2.2	1.5	F					
6/15/05	3.1*	2.8	NF	1.3 *	0.96	NF	4.5 *	1.8	NF			IN	3 *	2.7	NF					
6/28/05	3.5	3.5	NF	1.2	0.93	NF	1.7	1.3	NF			IN	3	2.9	F					
7/13/05							3.3	1.9	NF			IN	3.2	2.9	F					
8/16/05	1.7	1.2	NF			IW	1.1	0.9	NF			IN	1.5	1.1	NF	0.9	0.65		0.5	1.8
8/30/05	4.6	2.3	NF			D	5	1.9	NF			IN	5.7	2	NF					
9/7/05	4.1	2	NF			D	4.6	2.5	NF			IN	3.6	2	NF					
9/16/05	2.4	1.87	NF			D	2.6	0.634	NF			IN	2	1.95	NF					
9/30/05	1.9	2	NF			D	15.0 *	1.9	NF			D			D					
10/21/05	2.3	1.7	NF			D	6.5	2.2	NF			D			D					
10/28/05	1.3 *	1.7 *	NF			D	1.7 *	2.1 *	NF			IN	0.63 *	0.79 *	F					
11/29/05	1.5	1.2		1.2	0.9	NF	2.8	2.2	NF			D	1.9	1.7	NF				0.12	3.9
N	12	14		6	7		12	15		1	1		8	9		3	4		4	5
AVG	2.57	1.98		1.19	0.87		2.92	1.63		4.40	4.20		2.89	2.08		0.84	0.54		0.20	3.48
													2.80	2.43	F					
													2.94	1.91	NF					

Notes:
Quarterly Monitoring Dates: 11/18/2004, 2/18/2005, 5/16/2005, & 8/16/2005
All values shown in mg/L
N = Number of Samples
NF = No Flow at time of sampling.
F = Surface Water Flow at time of sampling.
D = Location Dry
IN = Inaccessible
IW = Insufficient Water
Blank Cells = No Sample Collected
* = Flagged Data: 5/16 - Elevated TP reported in EB sample
6/15 - RPD>20%
9/30 - Statistical Outlier
10/28 - (TP ± 10%) < (Ortho-P ± 10%)
** = Samples collected only during Quarterly Monitoring.

Table 2
Analytical Results Summary
Treatment of Residual Manure Waste

Pond 1 Manure Post-Treament Residual Phosphorus Data

Date	P1-A1 TP	P1-A2 TP	P1-B1 TP	P1-B2 TP	P1-C1 TP	P1-C2 TP	P1-D1 TP	P1-D2 TP	Target Ortho-P
06/17/04	0.078	0.088	0.091	0.051	0.033	0.092	0.095	0.167	0.15

Pond 2 Manure Post-Treatment Residual Phosphorus Data

Date	P2-E1 TP	P2-E2 TP	P2-F1 TP	P2-F2 TP	Target Ortho-P
6/17/04	0.129	0.028	0.136	0.033	0.15

Notes:
All values given in mg/L

Table 3
Analytical Results Summary
Treatment of Pond Water

Pond 3 Water Phosphorus Data

Date	P3 Raw TP	P3 Raw Ortho-P	P3-E Ortho-P	P3-W Ortho-P	P3-A Ortho-P	P3-B Ortho-P	P3-C Ortho-P	P3-D Ortho-P	P3-E Ortho-P	P3-F Ortho-P
6/17/04 *	2.6	1.2								
6/24/04+					0.532	0.559	0.508	0.524	0.56	0.507
7/1/04+			0.32	0.34						
7/16/04^					0.08	0.061	0.068	0.06	0.068	0.073

Pond 4 Water Phosphorus Data

	P4 Raw Pre-Treatment		P4-A Post-Treatment	P4-B Post-Treatment
Date	TP	Ortho-P	Ortho-P	Ortho-P
6/17/04*	2.5	0.58		
6/24/04+			0.016	0.014

Background Groundwater Well Data

	TMPW-1		
Date	TP	Ortho-P	Total AL
6/15/04	0.33	< 0.025	1.16
6/22/04	0.25	< 0.025	3.32

Notes:
All values given in mg/L
* Phosphorus data prior to any alum treatment
+ Phosphorus data after first alum treatment
^ Phosphorus data after second alum treatment

Table 4. Replicates Analysis Results

Analytical Results for Total Phosphorous

Site Name	SW-1		SW-3		SW-5		SW-6		GW-1		
Site Description	HIA Eco-Reactor Influent		HIA/Swale Discharge Location		Outer Pasture Discharge Location		Pond 3		Groundwater Monitoring Well		
Sample Date	TP	DUP	TP	DUP	TP	DUP	TP	DUP	TP	DUP	**Relative Percent Difference**
2/18/05									<0.10	<0.10	-
5/16/05							0.42	0.44			2.33
6/8/05					2.2	2.1					2.33
6/15/05			4.5	2.4							30.43
6/28/05					3.0	3.0					0.00
7/13/05					3.2	3.1					1.59
8/16/05					1.5	1.4					3.45
8/30/05					5.7	5.2					4.59
9/7/05					7.6	7.3					2.01
9/16/05					2.0	2.5					11.11
9/30/05	1.9	2.0									2.56
10/21/05			6.5	5.3							10.17
10/28/05	1.3	1.3									0.00
11/29/05					1.9	1.9					0.00

Analytical Results for Ortho-Phosphorous

Sample Date	Ortho-P	DUP	Ortho-P	DUP	Ortho-P	DUP	Ortho-P	DUP	**Relative Percent Difference**
5/16/05							0.38	0.38	0.00
6/8/05					1.5	1.6			3.23
6/15/05			1.8	1.8					0.00
6/28/05					2.9	2.9			0.00
7/13/05					2.9	2.9			0.00
8/16/05					1.1	1.1			0.00
8/30/05					2.1	2.11			0.24
9/7/05					0.11	0.11			0.00
9/16/05					1.95	1.95			0.00
9/30/05	2.0	1.4							17.65
10/21/05			2.2	2.2					0.00
10/28/05	1.7	1.7							0.00
11/29/05					1.7	1.7			0.00

Analytical Results for Aluminum

Sample Date	Aluminum	DUP	**Relative Percent Difference**
2/18/05	3.3	3.1	3.13

Notes:
Quarterly Monitoring Dates: 11/18/2004, 2/18/2005, 5/16/2005, & 8/16/2005
All values shown in mg/L
Blank Cells = No Sample Collected

Table 5. Equipment Blank Analytical Results

	Analytical Results									
	Equipment Blank 1		Equipment Blank 2		Equipment Blank 3		Equipment Blank 4		Equipment Blank 5	
Sample Date	TP	Ortho-P	TP	Ortho-P	TP	Ortho-P	TP	Ortho-P	TP	Ortho-P
11/18/04	<0.01	<0.01								
2/18/05			<0.1	<0.025						
3/4/05					<0.1	<0.025				
5/16/05							1.6	<0.025		
8/16/05									<0.02	<0.064

Notes:
Quarterly Monitoring Dates: 11/18/2004, 2/18/2005, 5/16/2005, & 8/16/2005
All values shown in mg/L
Blank Cells = No Sample Collected

Table 6
Phosphorus Loadings in Outer Pasture and HIA Area

Pre-Condition

Monthly Summation of Rainfall Data from LAMB_R (inches)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1988	3.52	2	3.68	1.8	1.2	4.79	6.98	11.48	8.43	1.22	3.1	2.4	50.6
1989	1.68	0.31	4.3	2.06	2.31	6.61	5.93	0.76	6.62	6.05	0.46	2.54	39.6
1990	0.19	3.95	0.53	0.68	1.67	12.71	6.49	5.92	4.52	5.74	0.74	0.57	43.7
1991	4.33	2.25	4.27	3.74	5.95	6.19	6.84	9.08	4.17	3.48	1.39	0.74	52.4
1992	0.9	3.46	1.57	2.35	1.05	13.2	1.82	7.85	5.64	1.79	2.62	0.73	43.0
1993	**6.92**	**3.85**	**7.9**	**2.06**	**10.33**	**2.03**	**4.82**	**6.67**	**3.87**	**5.33**	**0.1**	**1.07**	**55.0**
1994	**2.28**	**3.19**	**2.58**	**7.97**	**1.09**	**2.69**	**2.82**	**10.96**	**10.34**	**5.34**	**3.38**	**3.25**	**55.9**
1995	2.08	1.83	3.21	4.01	2.66	5.06	5.97	9.81	7.63	7.79	0.5	0.06	50.6
1996	**2.28**	**1.53**	**9.62**	**4.99**	**10.26**	**10.15**	**5.25**	**4.83**	**2.23**	**3.74**	**0.28**	**1.46**	**56.6**
1997	1.52	1.17	3.89	3.49	2.75	7.07	6.48	7.19	7.02	0.85	3.65	5.49	50.6
1998	4.64	5.88	5.24	3.24	1.64	0.88	9.98	8.84	7.27	1.6	3.79	0.61	53.6
1999	2.08	0.22	0.93	2.04	4.76	14.3	6.4	11.83	8.05	7.88	0.4	1.92	60.8

Monthly Summation of Daily Edge-of-Field Phosphorus Loads (kg)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1988	465.4	32.4	11.6	0	0	0	581.1	2,138.40	2,568.70	0	32.9	436.4	6267.0
1989	146.8	0	43.3	0	5.4	418.4	124.4	0	685.6	1,241.30	0	3.3	2668.5
1990	0	13.7	0	0	0	335.8	262.6	783.5	70	584.4	0	0	2050.0
1991	101.6	0.5	13.8	1.1	110.8	180.7	110.9	802.9	124.5	222.7	0	0	1669.4
1992	0	4.3	0	0	0	370	0	142	265	92	64.6	0.5	938.4
1993	**407.8**	**56.1**	**403.7**	**0**	**686**	**28.2**	**6.1**	**215.6**	**13**	**234.7**	**0**	**0.1**	**2233.2**
1994	**1.1**	**4**	**4**	**414.6**	**0**	**0**	**0**	**619.5**	**1,222**	**445.1**	**69.3**	**50.8**	**2857.3**
1995	6.3	0	11.8	1.7	2.5	0	0	240.2	584.4	586.9	0.6	0	1434.3
1996	**1.8**	**0.5**	**616.9**	**202**	**384.7**	**625.3**	**9.4**	**0**	**0**	**96.5**	**0**	**0**	**1937.1**
1997	0	0	0	0	0	17.3	23.3	158.4	316.8	0.2	112.7	273.3	902.0
1998	185.5	136.1	72	4.6	0	0	237.7	354.7	415.8	2.4	441.8	0	1850.6
1999	0.6	0	0	0	0	758.6	467.3	575.6	511.3	700.4	0	9.1	3022.9

Average = **2,343** kg
5,165 lb

Source: Estimated annual average runoff volumes using Creams-WT (SFWMD, 2000)

Table 7
Alum Treatment of Lamb Island Dairy Pond Manure Waste and Pond Surface Water

Pond 1
Manure Treatment

Pond 1 volume* (CY)	Pre-Treatment Total P* (lbs)	Avg. TP Concentration Pre-treatment* (mg/Kg)	Avg. TP Concentration Post-treatment^ (mg/L)	P remaining (lbs)	P Inactivated (lbs)	P Inactivated %
8500	12,700	3012	0.087	1.25	12,699	99.99%

Pond 2
Manure Treatment

Pond 2 volume* (CY)	Pre-Treatment Total P* (lbs)	Avg. TP Concentration Pre-treatment* (mg/Kg)	Avg. TP Concentration Post-treatment^ (mg/L)	P remaining (lbs)	P Inactivated (lbs)	P Inactivated %
1500	4,310	4290	0.082	0.21	4,310	99.995%

Pond 3
Water Treatment

Pond 3 volume* (Mgal)	Pre-Treatment Total P (lbs)	Avg. Ortho-P Concentration Pre-treatment^ (mg/L)	Avg. Ortho-P Concentration Post-treatment^ (mg/L)	P remaining (lbs)	P Inactivated (lbs)	P Inactivated %
31	312	1.2	0.068	18	295	94.33%

Pond 4
Water Treatment

Pond 4 volume* (Mgal)	Total P (lbs)	Avg. Ortho-P Conc. Before treatment^ (mg/L)	Avg. Ortho-P Conc after treatment^ (mg/L)	P remaining (lbs)	P Inactivated (lbs)	P Inactivated %
0.8	3.9	0.58	0.015	0.10	3.8	97.41%

* From Task 1.5 Lamb Island Dairy 90% Design
^ From Task 2.3 Quarterly Report 1

Table 6
Phosphorus Loadings in Outer Pasture and HIA Area

Monitoring Period

Outer Pasture/Wetland Area:

SW5 Storm Events		Runoff			Edge-of-field Load	
Date	Discharge duration	Ht. of water	Discharge from SW5		P_{out}	
	(days)	(feet)	(cfs)	(MGD)	(mg/L)	(lb)
6/8/05	6.0	0.02	0.04	0.03	2.2	2.9
6/28/05	3.4	0.08	0.30	0.19	3	16.4
7/13/05	0.8	0.08	0.30	0.19	3	4.0
10/28/05	3.1	0.01	0.01	0.01	0.63	0.1
				Total		**23.3**

HIA/Swale Area:

Monitoring Period Rainfall		Discharge from SW3
duration	Inches	
(Days)		
376	55.3	no discharge

Phosphorus Retention = Pre-Condition P - Discharged P
= 5165 - 23.3 lb
= 5141.9 lb Retained
= 99.5%

Note:

The amount of P retained reflects the results measured after completion of the site remediation system compared to pre-construction storm water runoff conditions.

FIGURES

SET 1 1/4" IRON PIPE W/ALUMINUM CAP IN CONC. STAMPED "S.F.W.M.D. B.M. SAM 3 2002" NORTHING = 1111330.03 EASTING = 665535.72 ELEV. = 42.485'

FOUND 1/2" IRON ROD 0.9' BELOW TOP OF PAVEMENT NORTHING: 1111368.21 EASTING: 663945.17

SET 1 1/4" IRON PIPE W/ALUMINUM CAP IN CONC. STAMPED "S.F.W.M.D. B.M. SAM 2 2002" NORTHING = 1111313.62 EASTING = 664012.20 ELEV. = 42.215'

SET 1 1/4" IRON PIPE W/ALUMINUM CAP IN CONC. STAMPED "S.F.W.M.D. B.M. SAM 4 2002" NORTHING = 1111386.71 EASTING = 668275.07 ELEV. = 41.135'

SLOPE TO GRADE

N=1111211.39 E=664000.65

MIN. 0.05% SLOPE

CROSS SECTION NO. 1

CROSS SECTION NO. 2

PROPOSED DITCH

PROPOSED BERM

SET 5/8" IRON ROD W/RED PLASTIC CAP STAMPED "S.F.W.M.D. TRAVERSE POINT" NORTHING = 1110524.52 EASTING = 664047.47 ELEV. = 46.685'

CROSS SECTION NO. 3

N=1110451.34 E=664016.30

POND 3 ALUM AMENDED POND WATER

POND 2 TO BE DEWATERED TO POND 3 AND FILLED TO EXISTING GRADE

DEWATER TO POND 3 FILL TO EXISTING GRADE

SET 5/8" IRON ROD W/RED PLASTIC CAP STAMPED "S.F.W.M.D. TRAVERSE POINT" NORTHING = 1110922.90 EASTING = 665428.80 ELEV. = 47.825'

TIE INTO EXISTING DITCH

N=1110426.63 E=664705.54

MIN. 0.05% SLOPE

PROPOSED STAFF GAUGE

N=1110343.96 E=665350.81

S-7 (PROPOSED) TOP RISER ELEVATION = 43.0 EAST INVERT ELEVATION = 40.0 WEST INVERT ELEVATION = 39.9 36" DIAMETER C.M.P.

N=1110361.16 E=664154.99

S-4 (PROPOSED) TOP RISER ELEVATION = 43.0 EAST INVERT ELEVATION = 40.0 WEST INVERT ELEVATION = 39.9 24" DIAMETER C.M.P.

N=1110324.63 E=664567.41

CROSS SECTION NO. 11

S-3 (PROPOSED) TOP RISER ELEVATION = 43.0 EAST INVERT ELEVATION = 40.0 WEST INVERT ELEVATION = 39.9 24" DIAMETER C.M.P.

S-2 (PROPOSED) TOP RISER ELEVATION = 43.0 EAST INVERT ELEVATION = 40.0 WEST INVERT ELEVATION = 39.9 24" DIAMETER C.M.P.

N=1110295.36 E=664887.16

CROSS SECTION NO. 12

CROSS SECTION NO. 13

CROSS SECTION NO. 14

CROSS SECTION NO. 15

N=1110328.72 E=665330.28

N=1110358.49 E=665250.28

S-1 (PROPOSED) TOP RISER ELEVATION = 43.0 EAST INVERT ELEVATION = 40.0 WEST INVERT ELEVATION = 39.9 24" DIAMETER C.M.P.

SLOPE TO GRADE

CROSS SECTION NO. 23

N=1110400.28 E=666113.87

PROPOSED SPOIL MATERIAL (TYP)

CROSS SECTION NO. 16

TERMINATE AT DITCH

S-5 (PROPOSED) TOP RISER ELEVATION = 43.0 NORTHEAST INVERT ELEVATION = 40.0 SOUTHWEST INVERT ELEVATION = 39.9 24" DIAMETER C.M.P.

N=1109925.67 E=664786.62

REMOVE EXISTING 18" C.M.P. AND REPLACE

N=1109994.92 E=665242.81

N=1109892.87 E=665103.83

CROSS SECTION NO. 44

CROSS SECTION NO. 60

PROPOSED TERRACE BERM

CROSS SECTION NO. 61

PROPOSED DITCH

PROPOSED BERM

MIN. 0.05% SLOPE

SWALE

N=1109274.48 E=664828.73

TERMINATE AT DITCH

CROSS SECTION NO. 43

CROSS SECTION NO. 70

CROSS SECTION NO. 71

PROPOSED TERRACE BERM

CROSS SECTION NO. 72

PROPOSED DITCH

N=1109268.23 E=666129.65

TIE INTO BERM

SLOPE TO GRADE

N=1109048.42 E=664052.73

DISCHARGE POINT

PROPOSED STAFF GAUGE

N=1108729.30 E=664391.59

N=1108937.81 E=664140.24

ALUM AMENDED POND WATER

S-6 (PROPOSED) TOP RISER ELEVATION = 39.0 NORTHEAST INVERT ELEVATION = 36.0 SOUTHWEST INVERT ELEVATION = 35.9 36" DIAMETER C.M.P. REMOVE EXISTING C.M.P. AND REPLACE

FOUND 1" IRON PIPE IN CONC. W/S.F.W.M.D. ALUMINUM CAP STAMPED "BM L.I.D. 44 1988" NORTHING = 1108735.26 EASTING = 664019.09 ELEV. = 35.685'

SET 1 1/4" IRON PIPE W/ALUMINUM CAP IN CONC. STAMPED "S.F.W.M.D. B.M. SAM 1 2002" NORTHING = 1108735.26 EASTING = 664019.09 ELEV. = 36.775'

CROSS SECTION NO. 41

CROSS SECTION NO. 42

CROSS SECTION NO. 51

CROSS SECTION NO. 52

N=1108618.08 E=664546.90

N=1108485.15 E=664800.21

N=1108466.19 E=664791.47

CROSS SECTION NO. 80

CROSS SECTION NO. 81

CROSS SECTION NO. 82

IMPROVE EXISTING SWALE

N=1108480.14 E=666177.41

CROSS SECTION NO. 40

N=1108088.71 E=664811.40

DISCHARGE POINT

PROPOSED STAFF GAUGE

S-8 (PROPOSED) TOP RISER ELEVATION = 37.75 NORTH INVERT ELEVATION = 35.0 SOUTH INVERT ELEVATION = 35.9 36" DIAMETER C.M.P.

CROSS SECTION NO. 39

N=1107924.88 E=664840.25

N=1107798.19 E=665122.21

SET 1 1/4" IRON PIPE W/ALUMINUM CAP IN CONC. STAMPED "S.F.W.M.D. B.M. SAM 6 2002" NORTHING = 1107763.63 EASTING = 665047.85 ELEV. = 35.955'

N=1107944.95 E=665656.67

N=1108313.00 E=666160.56

SLOPE TO GRADE

N=1111356.91 E=666467.69

DEWATER TO POND 3 FILL TO EXISTING GRADE

CROSS SECTION NO. 21

CROSS SECTION NO. 22

PROPOSED DITCH

PROPOSED BERM

MIN. 0.05% SLOPE

N=1110859.15 E=667157.95

SLOPE TO GRADE

REGRADE SWALE

N=1110415.28 E=667131.27

TERMINATE AT DITCH

MIN. 0.05% SLOPE

CROSS SECTION NO. 63

CROSS SECTION NO. 62

PROPOSED TERRACE BERM

CROSS SECTION NO. 61

N=1109857.53 E=667092.68

CROSS SECTION NO. 32

MIN. 0.05% SLOPE

CROSS SECTION NO. 34

CROSS SECTION NO. 33

N=1109613.35 E=667076.28

SET 1 1/4" IRON PIPE W/ALUMINUM CAP IN CONC. STAMPED "S.F.W.M.D. B.M. SAM 5 2002" NORTHING = 1109531.45 EASTING = 667077.23 ELEV. = 36.615'

N=1109472.10 E=666140.13

SILT FENCE (CONSTRUCTION AREA LIMIT)

CROSS SECTION NO. 35

PROPOSED DITCH

PROPOSED BERM

MIN. 0.05% SLOPE

CROSS SECTION NO. 36

CROSS SECTION NO. 37

N=1109329.23 E=664991.08

SUGGESTED CONSTRUCTION SEQUENCE

1.) SILT FENCING

2.) CLEARING AND GRUBBING

3.) BERM CONSTRUCTION/CULVERT INSTALLATION
- A.) OUTER PASTURE/SWALE
- B.) HIA
- C.) ECO-REACTOR
- D.) SEED BERMS

4.) DEWATER AND FILL HIA DITCHES

5.) AMEND MANURE SOLIDS
- A.) DEWATER POND 2
- B.) PUMP SOLIDS FROM POND 2 TO POND 1
- C.) AMEND SOLIDS WITH ALUM
- D.) INSTALL FILTER FABRIC IN POND 1
- E.) KNOCK DOWN EXISTING BERMS AND BACKFILL PONDS 1 AND 2

6.) POND WATER ALUM AMENDMENT

LEGEND

- SURFACE CONTOUR
- PROPOSED SPOT ELEVATION
- PROPOSED DITCH
- PROPOSED BERM
- SLOPE
- POND
- PROPOSED SPOIL MATERIAL
- SILT FENCE
- CONSTRUCTION LIMIT
- POND 1 – DEWATER TO POND 3 ALUM AMEND SOLIDS FILL TO EXISTING GRADE
- POND 2 – DEWATER TO POND 3 TRANSFER SOLIDS TO POND 1 FILL TO EXISTING GRADE OR SUITABLE FOR MAINTAINING A CROP
- DEWATER FILL TO EXISTING GRADE
- POND 3/COOLING POND – ALUM AMEND POND WATER
- PROPOSED SPOIL MATERIAL FOR BERM CONSTRUCTION AND FILL FOR POND 1 EXCAVATE TO 36' NGVD

NOTES:

1.) SEED ALL BERMS.

2.) SLOPE AT THE END OF BERM TO MATCH THE EXISTING GRADE.

3.) DITCH WIDTH VARIES, SEE CROSS SECTIONS.

N

0 feet 160

SCALE

DESIGNED BY:

HSA ENGINEERS & SCIENTISTS

REVISION DESCRIPTION

DATE | DRAWN | REV.#

ENGINEER: TERRENCE HORAN

DRAWN: MISTI LIFE

CHECKED:

DATE: 01/27/04

SCALE: 1"=160'

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
ENGINEERING & CONSTRUCTION DEPARTMENT
PHONE: 561-686-8800
3301 GUN CLUB ROAD
WEST PALM BEACH, FLORIDA 33406

LAMB ISLAND DAIRY
OKEECHOBEE COUNTY, FLORIDA

SITE PLAN

CONTRACT NO. C-13410

DRAWING NO. 8005716000[002]

Figure 1.

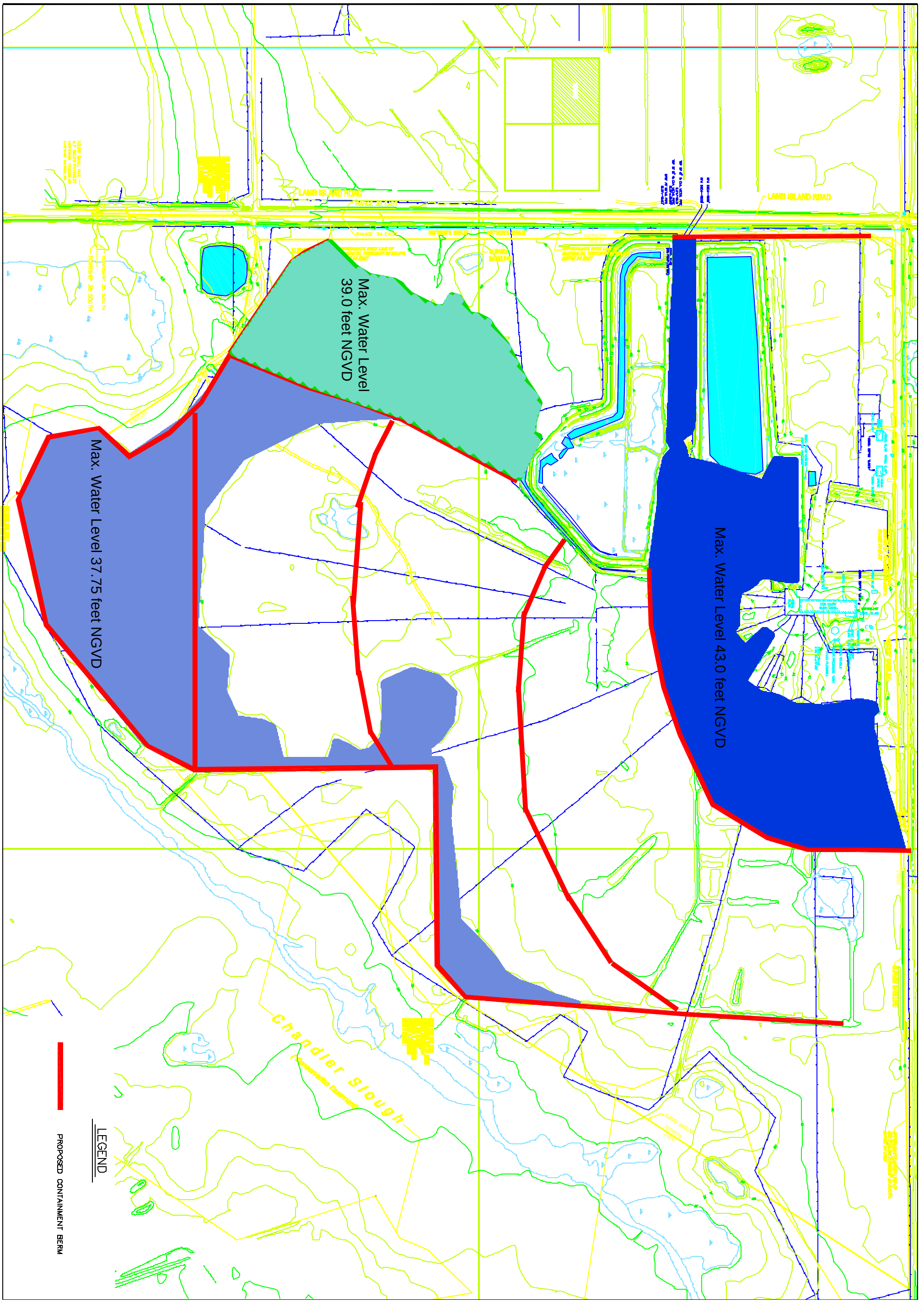


Figure 2. Containment Area Detention Capacity

HIA CONTAINMENT AREA

HIA Ditches Filled and Graded

Pond 1

GW Monitoring Well

Pond 3

Pond 2

Staff Gauge No. 1

SW6

Culvert

Culvert

HIA Containment Berm

SW1

Overflow Culvert

Eco-Reactor

SW2

Terrace Berm

Culvert

OUTER PASTURE CONTAINMENT AREA

Terrace Berm

Edge of Farm Containment Berm

Staff Gauge No. 2

Discharge Culvert

SW4

Terrace Berm

SW3

CONSTRUCTED WETLAND

Staff Gauge No. 3

Discharge Culvert

SW5

North

Scale: 1" = 500'

Figure 3 Site Plan and Monitoring Stations

LEGEND

SW5 Surface Water Sampling Location

Surface Water Flow Direction

Alum Amended Pond Waters

Pond 1 & 2 Backfilled With Soil After Alum Amending Animal Wastes

Culvert

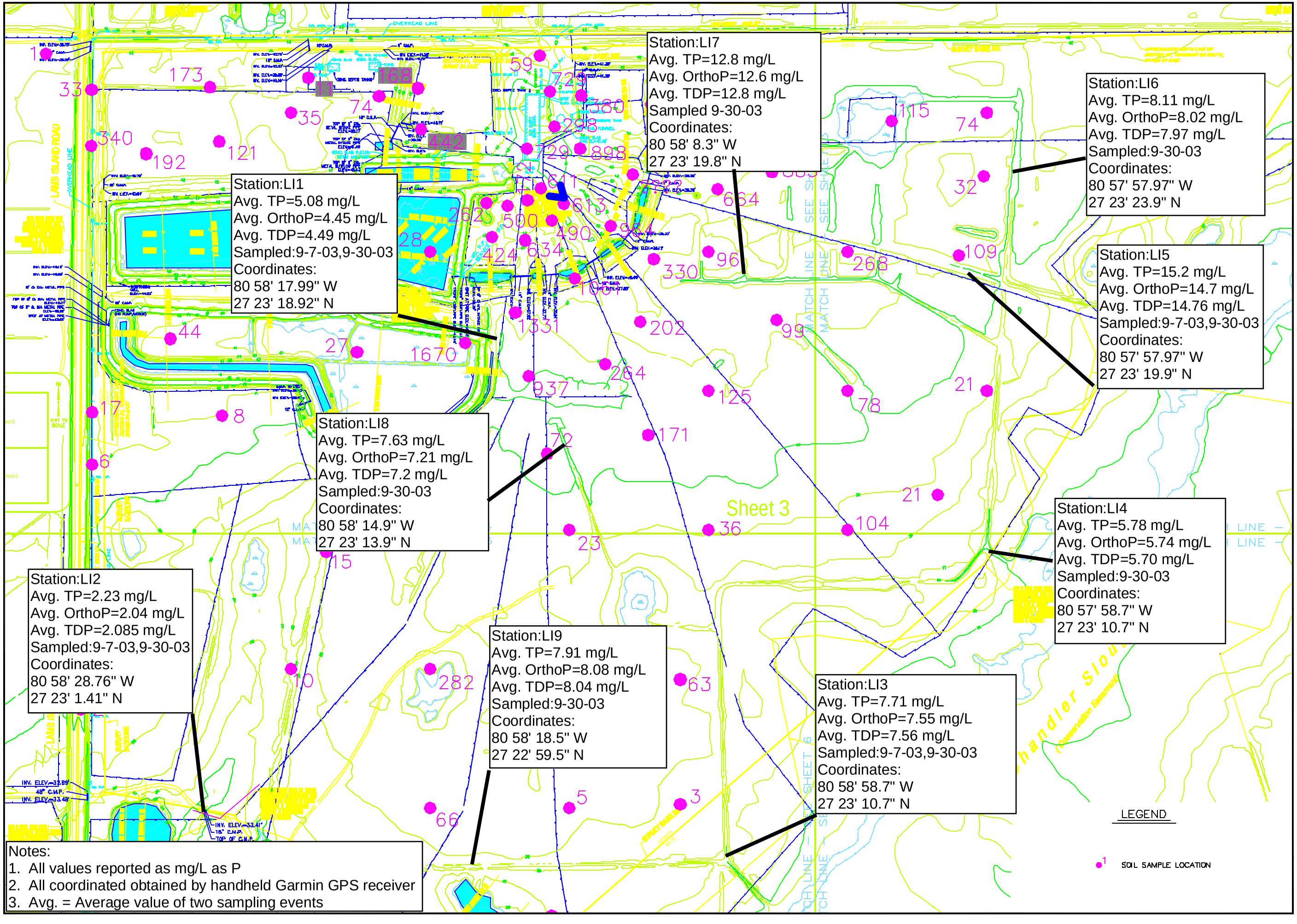
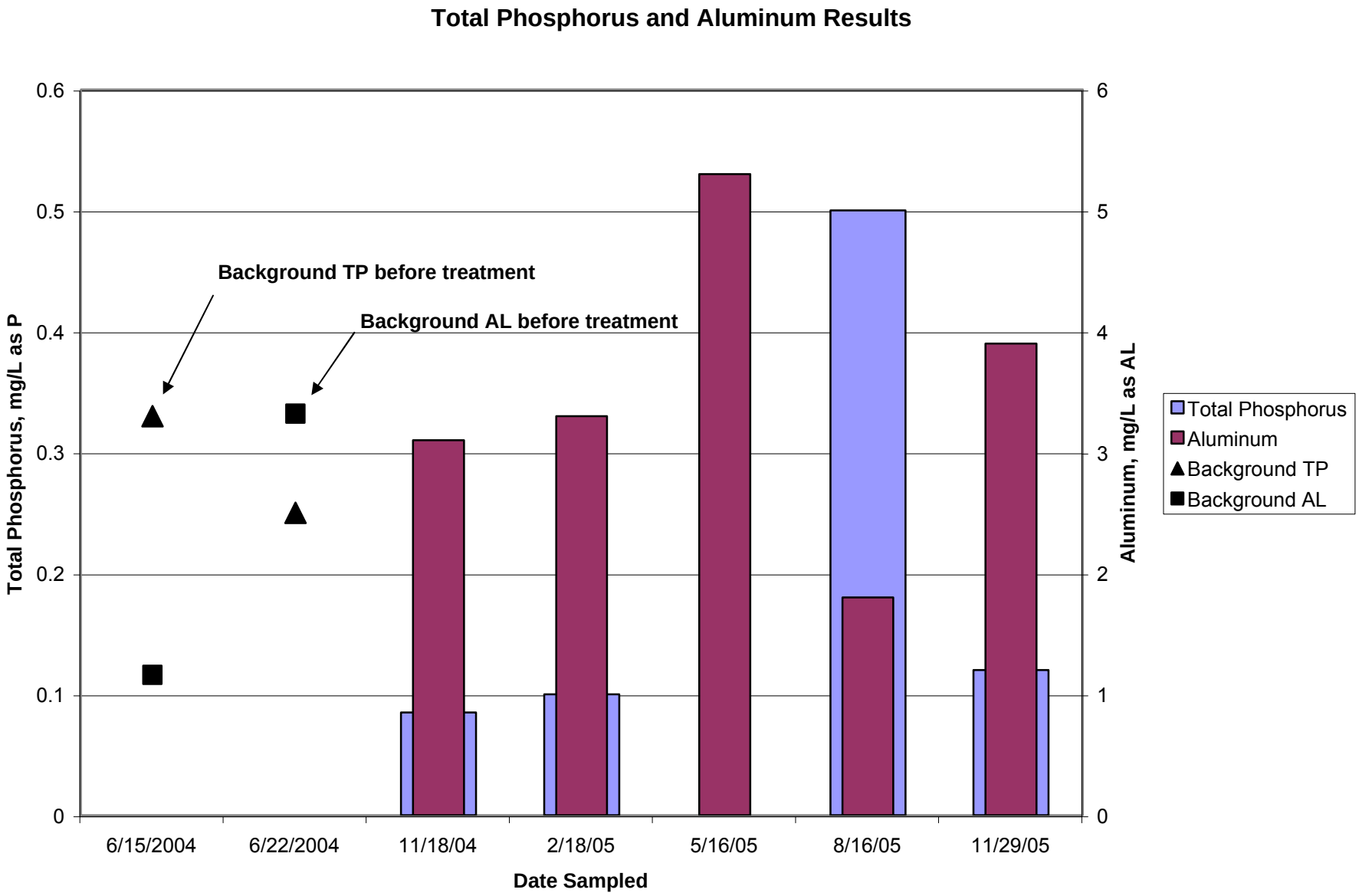


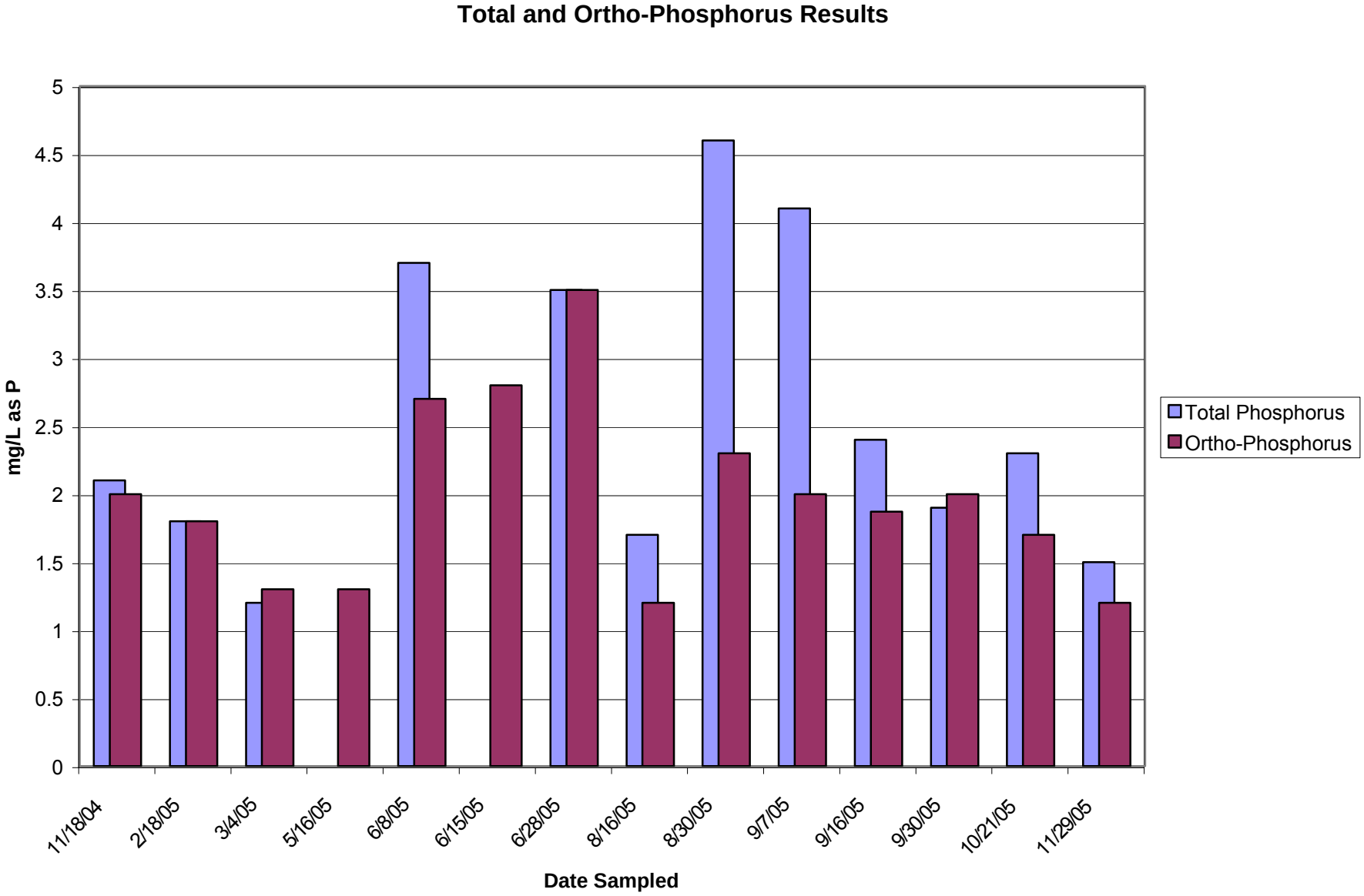
Figure 4. Water Quality Sampling Stations

Figure 5. Groundwater Monitoring Well



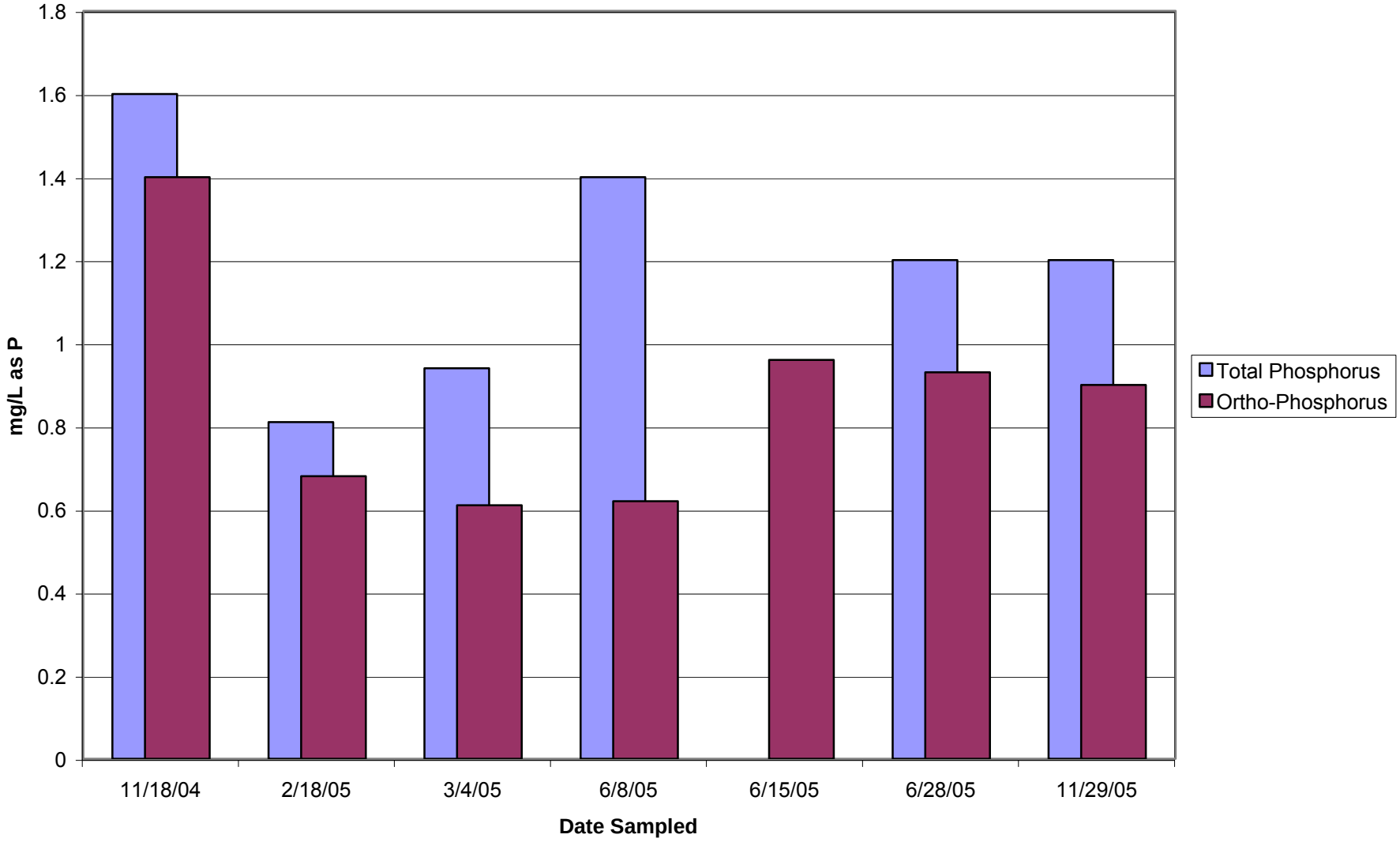
Note:
TP Flagged data from 5/16/05 removed from graph. See Table 1 for results.

Figure 6. SW-1, HIA Eco-Reactor Influent



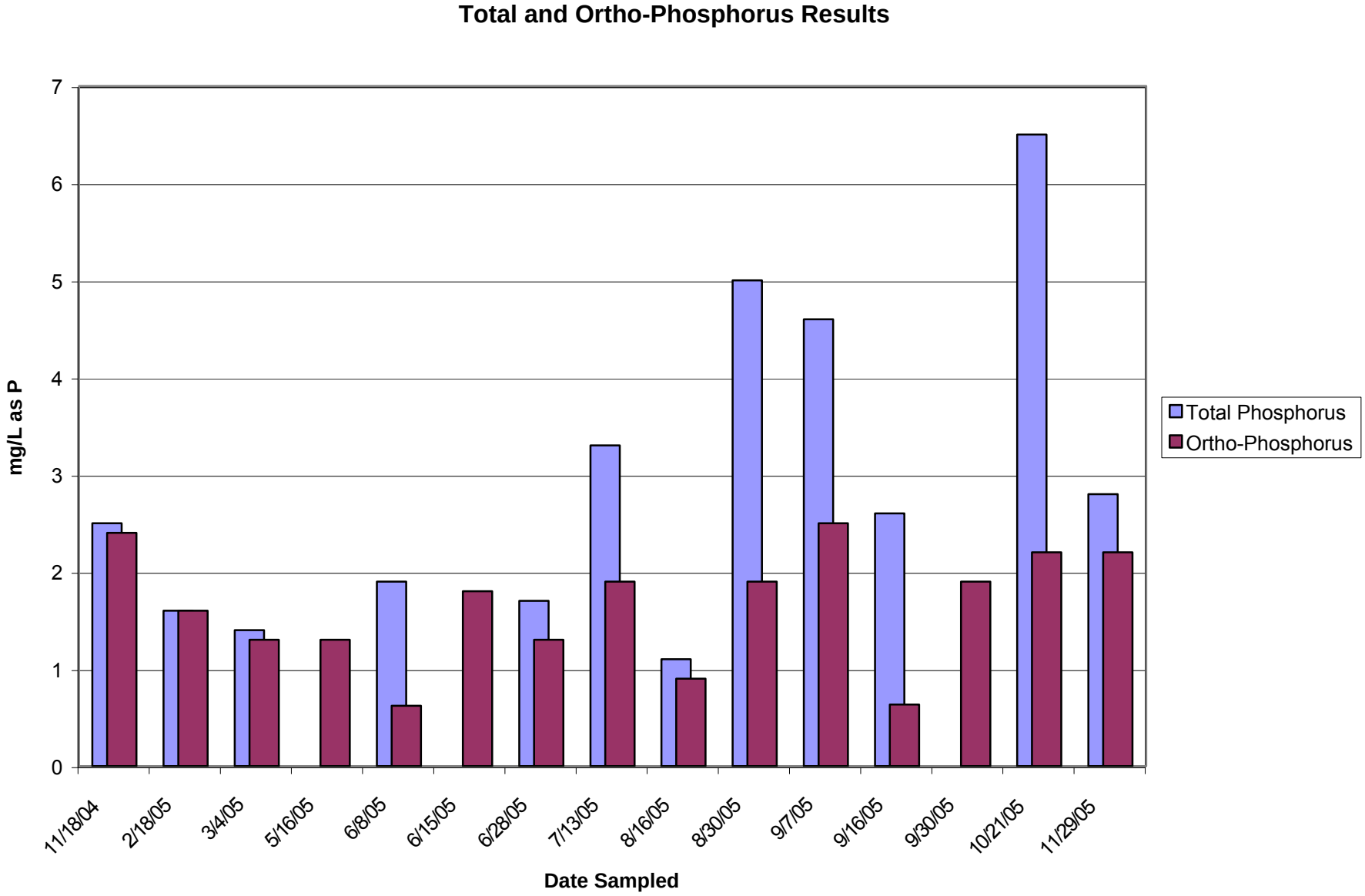
Note:
TP Flagged data from 5/16/05 and 6/15/05, and both TP and Ortho-P flagged data from 10/28/05 removed from graph. See Table 1 for results.

Figure 7. SW-2, Eco-Reactor Effluent



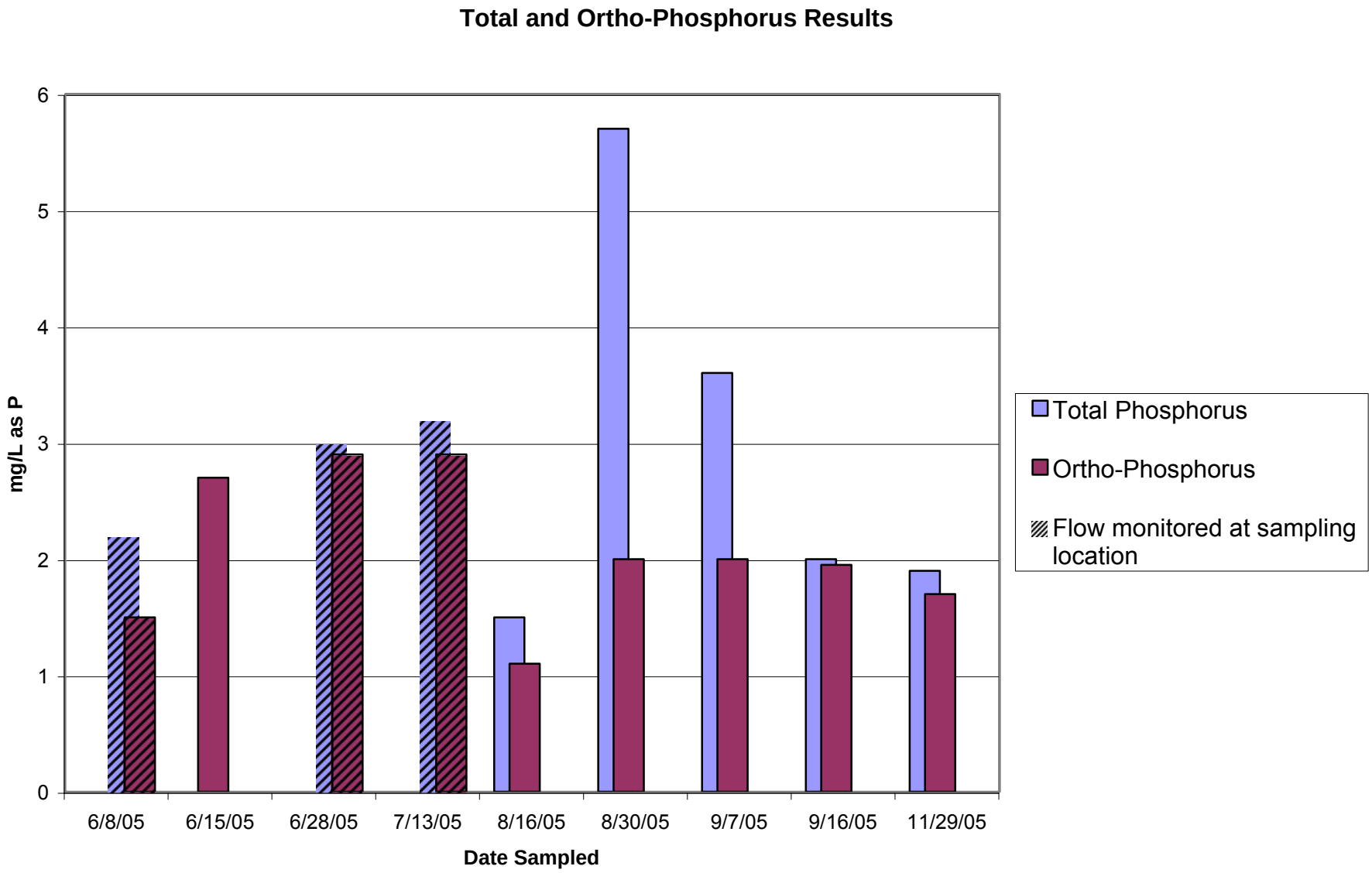
Note:
TP Flagged data from 6/15/05 removed from graph. See Table 1 for results.

Figure 8. SW-3 HIA/Swale Discharge Location



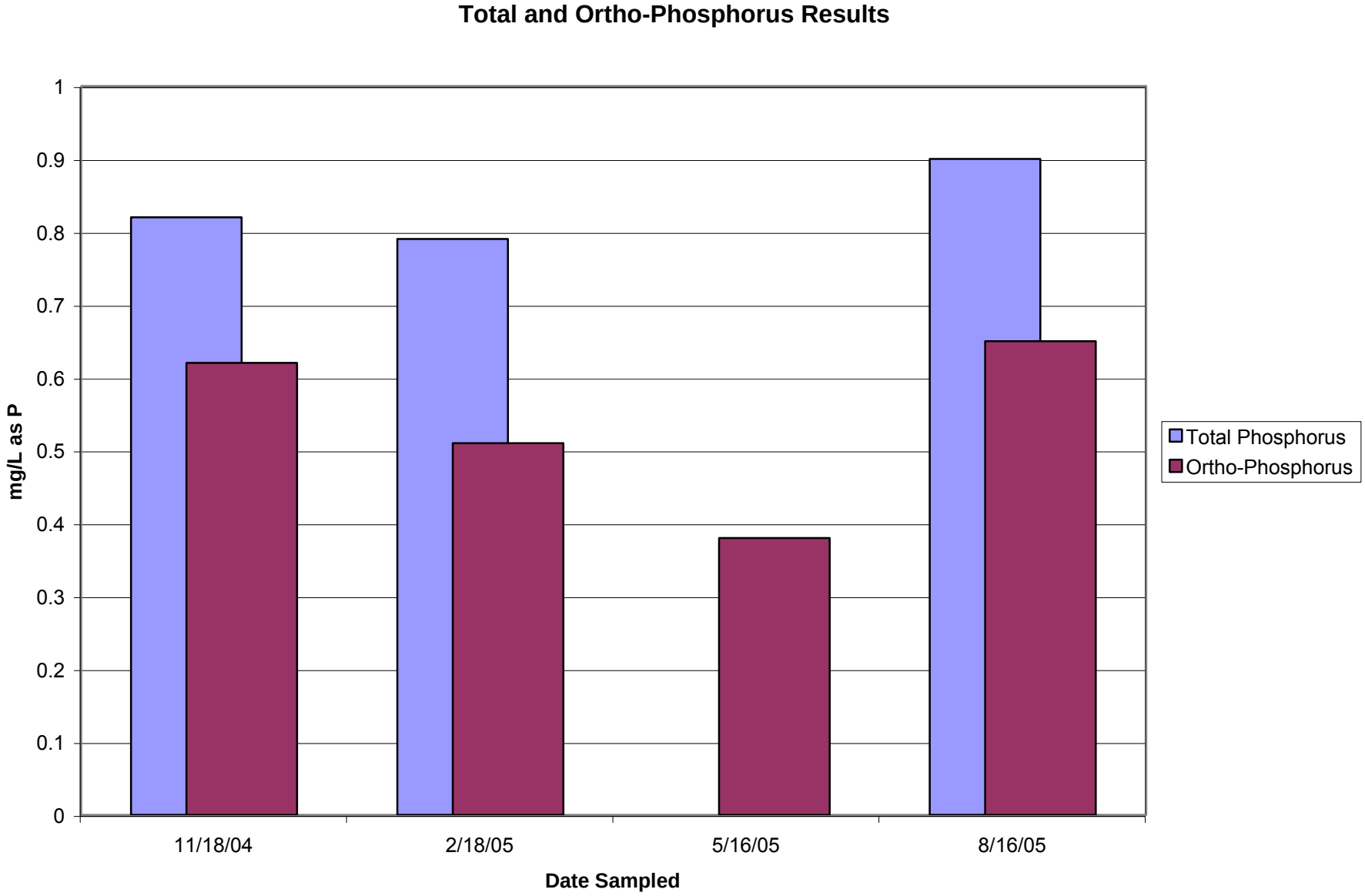
Note:
TP Flagged data from 5/16/05, 6/15/05, 9/30/05 and both TP and Ortho-P flagged data from 10/28/05 removed from graph. See Table 1 for results.

Figure 9. SW-5, Outer Pasture Discharge Location



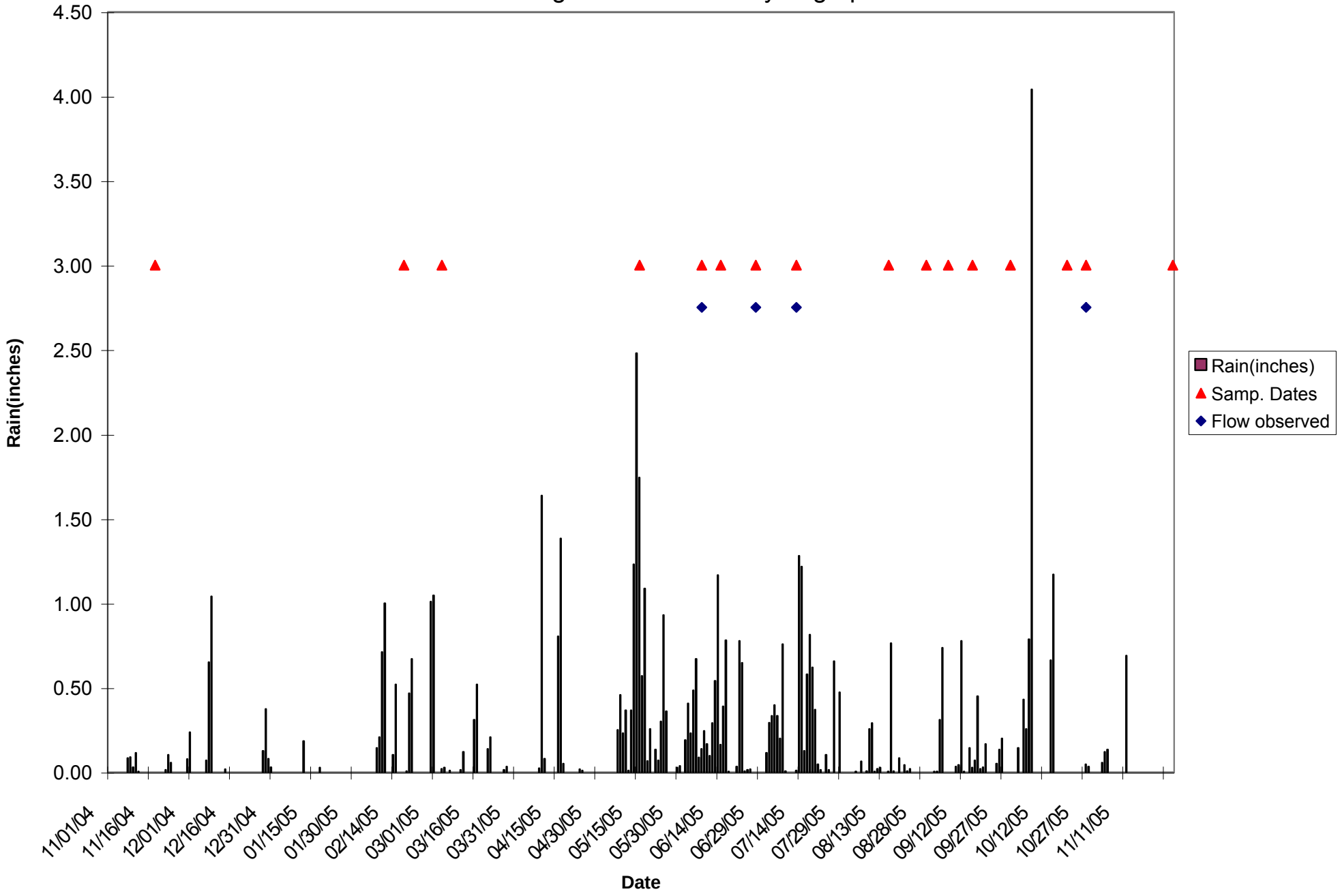
Note:
TP flagged data from 6/15/05 and both TP and Ortho-P flagged data from 10/28/05 removed from graph. See Table 1 for results.

Figure 10. SW-6, Pond 3



Note:
TP Flagged data from 5/16/05 removed from graph. See Table 1 for results.

Figure 11.
Monitoring Period Rainfall Hydrograph



APPENDIX A

PHOTOGRAPHS DURING CONSTRUCTION

Figure 1. Pond 1

Figure 2. Alum amendment and mixing

Figure 3. Pumping into Pond 1

Figure 4. Discharge of pump into Pond 1

Figure 5. Pond 3 Alum amendment

Figure 6. Pond 3 Alum amendment

Figure 7. Filter fabric cover over Pond 1

APPENDIX B

ALUM TREATABILITY STUDY RESULTS

Lamb Island Dairy Chemical testing September 25-26, 2002

For testing of SRP used Hach Spectrophotometer and diluted 1ml sample in 100 ml DI Water.

Pond 1 Testing Results:

200ml pond 1 water

µl of Alum	P (mg/L
Raw - 0	0.21
60	0.03
100	0.08
150	0.04
200	0.07
250	0.05
300	0
60 - repeat	0.03

Observations:

60 µl – slight color change, little settling
100 µl – floc throughout with tea color, slight settling
150 µl – floc throughout, good settling, yellowish color
200 µl – better settling weak tea color
250 µl – Excellent settling weaker tea color, some suspended floc
300 µl – Water clear total settling

Re-run of pond 1 water sampling at 30, 60 and 100 µl of alum:

µl of Alum	pH	P (mg/L
30	7.09	0.26
60	6.44	0.07
100	6.82	0.14

Observations:

60 µl – Better settling at 60 µl almost clear
100 – floc throughout with yellow color

Pond 1 Sludge:

50g of sludge was mixed with 200 ml water. Each mixture was then mixed with a volume of alum below and allowed to settle for 45 minutes:

µl alum	pH	P (mg/L
Raw sludge - 0	6.98	0.14
100	5.84	0.03
150	5.29	0.02
200	4.82	0.05
250	4.61	0
300	4.43	0
55		0.02

Pond 2 Water:
200 ml of pond 2 water was mixed with a volume of alum below and allowed to settle:

µl alum	pH	P (mg/L
Raw – 0	8.15	0.10
30	7.51	0.01
60	7.19	0.02
100	7.09	0.02
150	6.87	0
200	6.55	0.02
250	6.42	0.03
60 – repeat		0.02

Observations:

30 µl – cloudy floc throughout slight settling
60 µl – Larger particulate floc throughout, slight settling
100 µl – very similar to 60, better clarity
150 µl – clear top 2/3rds defined floc, visible settling
200 µl – water clear, more settling
250 µl – Larger, more floc on bottom

Pond 2 Sludge:
50 g of sludge was mixed with 200 ml of water. Various volumes of alum shown below were mixed with each mixture of sludge.

µl of alum	pH	P (mg/L
Raw – 0	7.86	0.21
100	6.85	0
150	6.5	0

Observations:

100 µl – good settling, still cloudy
150 µl – 250 µl – clear water total settling

Results for treated sludge amended to soil

50 g of sludge treated with 250µl of alum was amended to 250g of soil
Results:

	P (mg/L)
	0.09

100g sludge treated with 250µ of alum was amended to 500g soil and mixed with 400 ml of DI water. Results:

	P (mg/L)
	0.13

50g of sludge treated with 55µ of alum was amended to 250g of soil:

	P(mg/L)
	0.14

Raw Soil Analysis:

10 g of soil was mixed with 100ml of DI water

P - .02 mg/L
P2O5 - .04 mg/L
PO4 - .05 mg/L

250g of soil was mixed with 200 g of DI water and allowed to filter through a Whatman 25 filter for a few minutes and overnight. Results:

	P (mg/L)
Immediate sample	0.08
Overnight sample	0.18

HCA Amended soil Analysis:

250 g of soil was amended with various amounts of HCA(High Clay Aluminum) and mixed with 100 ml DI water. Results:

Grams of HCA	P (mg/L)
2	0.11
4	0.04
8	0.07
16	0.22

Alum Amended soil Analysis:

250 grams soil was amended with various amounts of alum below and mixed with 100 ml of DI water. Results:

µl Alum added	P (mg/L)
60	0.05
150	0.13
250	0.13

APPENDIX C

MANURE TREATMENT RESULTS

Residual Manure Waste Treatment Analytical Data
South Florida Water Management District Laboratory

Project	Station	Samplenum	Presampnum	DateCollected	TimeCollecte	ProgramTyp	SampType	ColMethod	Matrix	TestName	Value	Units
LAB2	P1-A1	L25043-1	P19722-1	17-Jun-04	10:00	EXP	SAMP	G	SW	TPO4	0.078	mg/l
LAB2	P1-A2	L25043-2	P19722-2	17-Jun-04	14:00	EXP	SAMP	G	SW	TPO4	0.088	mg/l
LAB2	P1-B1	L25043-3	P19722-3	17-Jun-04	10:30	EXP	SAMP	G	SW	TPO4	0.091	mg/l
LAB2	P1-B2	L25043-4	P19722-4	17-Jun-04	14:25	EXP	SAMP	G	SW	TPO4	0.051	mg/l
LAB2	P1-C1	L25043-5	P19722-5	17-Jun-04	11:10	EXP	SAMP	G	SW	TPO4	0.033	mg/l
LAB2	P1-C2	L25043-6	P19722-6	17-Jun-04	14:45	EXP	SAMP	G	SW	TPO4	0.092	mg/l
LAB2	P1-D1	L25043-7	P19722-7	17-Jun-04	11:25	EXP	SAMP	G	SW	TPO4	0.095	mg/l
LAB2	P1-D2	L25043-8	P19722-8	17-Jun-04	14:59	EXP	SAMP	G	SW	TPO4	0.167	mg/l
LAB2	P2-E1	L25043-9	P19722-9	17-Jun-04	12:03	EXP	SAMP	G	SW	TPO4	0.129	mg/l
LAB2	P2-E2	L25043-10	P19722-10	17-Jun-04	15:20	EXP	SAMP	G	SW	TPO4	0.028	mg/l
LAB2	P2-F1	L25043-11	P19722-11	17-Jun-04	12:46	EXP	SAMP	G	SW	TPO4	0.136	mg/l
LAB2	P2-F2	L25043-12	P19722-12	17-Jun-04	15:40	EXP	SAMP	G	SW	TPO4	0.033	mg/l

Residual Manure Waste Treatment Analytical Data
South Florida Water Management District Laboratory

Project	Station	MDL	SigFig	MeasureDate	MeasureTime	RemarkCode	RemarkComments	SampleComments
LAB2	P1-A1	0.002	0.078	30-Jun-04	15:06			
LAB2	P1-A2	0.002	0.088	30-Jun-04	15:07			
LAB2	P1-B1	0.002	0.091	30-Jun-04	15:09			
LAB2	P1-B2	0.002	0.051	30-Jun-04	15:10			
LAB2	P1-C1	0.002	0.033	30-Jun-04	15:11			
LAB2	P1-C2	0.002	0.092	30-Jun-04	15:12			
LAB2	P1-D1	0.002	0.095	30-Jun-04	15:25			
LAB2	P1-D2	0.002	0.167	30-Jun-04	15:26			
LAB2	P2-E1	0.002	0.129	30-Jun-04	15:27			
LAB2	P2-E2	0.002	0.028	30-Jun-04	15:28			
LAB2	P2-F1	0.002	0.136	30-Jun-04	15:30			
LAB2	P2-F2	0.002	0.033	30-Jun-04	15:31			

APPENDIX D

POND WATER TREATMENT RESULTS

Jupiter
Environmental Laboratories, Inc.

JUN 22 2004

NB

Address: HSA Engineers & Scientists
1486-A Skees Road
West Palm Beach, Fl 33411
Attn: Terry Horan

Page: 1 of 1
Date: 6/21/2004
Log # 11060-01

Sample Description COC # 17738
Project: 8005710600
Project Address: Lamb Island
Water Analysis

Label: TMPW-1
Date Sampled: 6/15/2004
Date Received: 6/15/2004 14:40
Collected By: Client

Parameter

	Results	Units	Method	Dilution Factor	Detection Limit	Extraction Date	Analysis Date	Analyst
Phosphate-Ortho	U	mg/l	4500P-E	1	0.025	6/17/2004	6/17/2004	ESC
Phosphorus, Total	0.33	mg/l	365.2	1	0.1	6/19/2004	6/19/2004	ESC
Aluminum	1.16	mg/l	200.8	1	0.02	6/21/2004	6/21/2004	MH

U = Below Laboratory Detection Limits

Respectfully Submitted,

Pam Shore
Quality Assurance Director

All Analyses were performed using EPA, ASTM, USGS, or Standard Methods.
CompQAP # 960152 EPA #FL01040 HRS #E86546 #E86515
NELAC CERTIFIED

BAR CODE

Chain of Custody Record

LAB USE ONLY

J.E.L. Log # 11060

P.O. # _____

Quote# _____

Jupiter Environmental Laboratories

A

Company Name HSA

Address 1486-A SKEES Rd.

City WPB State FL. Zip 33411

Sampling Site Address Lamb Island

Attn: TERRY HORAN Fax/Email

Project Name Lamb Island Project # 8005710600

Sampler Name/Signature Ronald Durham

LAB ANALYSIS

#	Sample Label (Client ID)	Collected Date	Collected Time	Matrix Code*	# of Cont	Parameters: ORTHO-P	TP	ALUMINUM	Field Filtered (Y/N)	Integrity OK (Y/N)	Comments
1	TMPW-1	6/15/04	12:20	GW	3	✓	✓	✓			
2											
3											
4											
5											
6											
7											
8											
9											
10											

ORIGINAL

Matrix Codes*

S	Soil/Solid Sediment	SW	Surface Water
GW	Ground Water	SL	Sludge
WW	Waste Water	O	Other (Please Specify)
DW	Drinking Water		

Pres Codes**

A-	none	I-	Ice
B-	HNO_3	O-	Other
C-	H_2SO_4	M-	MeOH
D-	NaOH		
E-	HCl		

Relinquished by	Date	Time	Received by	Date	Time
Ronald Durham	6/15/04	12:25	[signature]	6/15/04	1440

QA/QC level with report

None ___1___2___3___ See price guide for applicable fees

T.A.T. Request

X Standard

___ Rush

FDEP___

SFWMD___

Date Required _____

Temp Control: CC Ice ___°C

Jupiter Environmental Laboratories, Inc.
150 Old Dixie Highway, Jupiter, FL 33458
(561) 575-0030 • Fax (561) 575-4118 • jupiterlabs@bellsouth.net

C.O.C.# 17738

Jupiter
Environmental Laboratories, Inc.

Client # 3650
Address: HSA Engineers & Scientists WPB
1486-A Skees Road
West Palm Beach, FL 33411
Attn: Terry Horan

Page: 1 of 4
Date: 6/25/2004
Log # 11084-01

Sample Description: COC # 17770
Project # 8005710600
Location: Lamb Island
Matrix: Water

Label: P-3 Raw
Date Sampled: 6/17/2004
Date Received: 6/17/2004 3:00:00
Collected By: Client

Description	Results	Units	Method	Dilution Factor	Detection Limit	Extraction Date	Analysis Date	Analyst
Phosphate-Ortho								
Phosphate-Ortho	1.20	mg/L	/365.2	50	1.25	6/19/2004	6/19/2004	ESC

U = Below Laboratory Detection Limit

Soil results are reported in dry weight

All Analysis were performed using EPA, ASTM, USGS or Standard Methods.
CompQAP #960152 EPA #FL01040 HRS #E86546
NELAC Certified

Respectfully Submitted,

Pam Shore
Quality Assurance Director

Jupiter
Environmental Laboratories, Inc.

Client # 3650
Address: HSA Engineers & Scientists WPB
1486-A Skees Road
West Palm Beach, FL 33411
Attn: Terry Horan

Page: 2 of 4
Date: 6/25/2004
Log # 11084-02

Sample Description: COC # 17770
Project # 8005710600
Location: Lamb Island
Matrix: Water

Label: P-3 Raw
Date Sampled: 6/17/2004
Date Received: 6/17/2004 3:00:00
Collected By: Client

Description	Results	Units	Method	Dilution Factor	Detection Limit	Extraction Date	Analysis Date	Analyst
Phosphorous By ICP-MS								
Phosphorous	2.60	mg/L	/365.10	1	0.1	6/24/2004	6/24/2004	ESC

U = Below Laboratory Detection Limit

Soil results are reported in dry weight

All Analysis were performed using EPA, ASTM, USGS or Standard Methods.
CompQAP #960152 EPA #FL01040 HRS #E86546
NELAC Certified

Respectfully Submitted,

Pam Shore
Quality Assurance Director

Jupiter
Environmental Laboratories, Inc.

Client # 3650
Address: HSA Engineers & Scientists WPB
1486-A Skees Road
West Palm Beach, FL 33411
Attn: Terry Horan

Page: 3 of 4
Date: 6/25/2004
Log # 11084-03

Sample Description: COC # 17770
Project # 8005710600
Location: Lamb Island
Matrix: Water

Label: P-4 Raw
Date Sampled: 6/17/2004
Date Received: 6/17/2004 3:00:00
Collected By: Client

Description	Results	Units	Method	Dilution Factor	Detection Limit	Extraction Date	Analysis Date	Analyst
Phosphate-Ortho								
Phosphate-Ortho	0.580	mg/L	/365.2	10	0.25	6/19/2004	6/19/2004	ESC

U = Below Laboratory Detection Limit

Soil results are reported in dry weight

All Analysis were performed using EPA, ASTM, USGS or Standard Methods.
CompQAP #960152 EPA #FL01040 HRS #E86546
NELAC Certified

Respectfully Submitted,

Pam Shore
Quality Assurance Director

Jupiter
Environmental Laboratories, Inc.

Client # 3650
Address: HSA Engineers & Scientists WPB
1486-A Skees Road
West Palm Beach, FL 33411
Attn: Terry Horan

Page: 4 of 4
Date: 6/25/2004
Log # 11084-04

Sample Description: COC # 17770
Project # 8005710600
Location: Lamb Island
Matrix: Water

Label: P-4 Raw
Date Sampled: 6/17/2004
Date Received: 6/17/2004 3:00:00
Collected By: Client

Description	Results	Units	Method	Dilution Factor	Detection Limit	Extraction Date	Analysis Date	Analyst
Phosphorous By ICP-MS								
Phosphorous	2.50	mg/L	/365.10	1	0.1	6/24/2004	6/24/2004	ESC

U = Below Laboratory Detection Limit

Soil results are reported in dry weight

All Analysis were performed using EPA, ASTM, USGS or Standard Methods.
CompQAP #960152 EPA #FL01040 HRS #E86546
NELAC Certified

Respectfully Submitted,

Pam Shore
Quality Assurance Director

BAR CODE

Chain of Custody Record

LAB USE ONLY

J.E.L. Log # 11084

P.O. # _____

Quote# _____

Jupiter Environmental Laboratories

Company Name HSA

Address 1486-A SKEES Rd.

City W.P.B. State FL Zip 33411

Sampling Site Address Lamb Island

Attn: TERRY HORAN Fax Email 561-689-9005

Project Name Lamb Island Project # 8005710600

Sampler Name/Signature Ronald Durbin

						LAB ANALYSIS										
						AT										
						AC										
						ORTHO. P										
						TP										
																Comments
1	P-3 RAW	6/7/04	1345	SW	1	✓										
2	P-3 RAW		1345		1		✓									
3	P-4 RAW		1400		1	✓										
4	P-4 RAW		1400		1		✓									
5																
6																
7																
8																
9																
0																

S Soil/Sand/Sediment GW Groundwater
GW Ground Water SL Sludge
WW Waste Water O Other (Specify)
DW Drinking Water

A- none I- Ice
B- HNO_3 O- Other
C- H_2SO_4 M- NaOH
D- NaOH
E- HCl

Ronald Durbin			Yuk Linda	6/8/04	1500

QA/QC level with report
Circle 1 2 3 See price guide for applicable fees

T.A.T. Request
Standard
Rush

FDEP
SFWMD
Date Required

Temp Control:
Ice °C

Page 1 of 1

Jupiter Environmental Laboratories, Inc.
1A Old Dixie Highway, Jupiter, FL 33458
(561) 575-3223 • Fax (561) 575-4518 • jupiterlabs@bellsouth.net

C.O.C.# 17778

CLIENT COPY

Jupiter
Environmental Laboratories, Inc.

Address: HSA Engineers & Scientists
1486-A Skees Road
West Palm Beach, Fl 33411
Attn: David Hightower

Page: 4 of 4
Date: 7/2/2004
Log # 11114-04

Sample Description COC # 17771
Project: 80057106
Project Address: Lamb Island
Water Analysis

Label: TMPW-1
Date Sampled: 6/22/2004
Date Received: 6/23/2004 8:00
Collected By: Client

Parameter	Results	Units	Method	Dilution Factor	Detection Limit	Extraction Date	Analysis Date	Analyst
Phosphate-Ortho	U	mg/l	365.2	1	0.025	6/25/2004	6/25/2004	ESC
Phosphorus, Total	0.25	mg/l	365.2	1	0.10	6/29/2004	6/29/2004	ESC
Aluminum	3.32	mg/l	200.8	1	0.02	6/28/2004	6/28/2004	MH

U = Below Laboratory Detection Limits

Respectfully Submitted,

Pam Shore
Quality Assurance Director

All Analyses were performed using EPA, ASTM, USGS, or Standard Methods.
CompQAP # 960152 EPA #FL01040 HRS #E86546 #E86515
NELAC CERTIFIED

CODE	SUBMITTED MO	DA	YR	COLLECTOR	NUMBER		TYPE
. . .	06	25	04	DH	. . .		EXP MON

CHEMISTRY FIELD DATA LOG

LIMS NUM	NB	SAMPLE NUMBER	DATE/TIME COLLECTED MO	DA	YR	TIME	STATION	TYPE	MTRX	METH	UD	DS	WE	FIELD WATER QUALITY DATA DEPTH	TEMP	PH	COND	DO	SSD	SALINITY	REDOX	TDEPTH	COMMENTS
		13	6	24	04		P3-A		SW	G				.	7.25	.		.	.	.		.	
		14	6	24	04		P3-B		SW	G				.	7.19	.		.	.	.		.	
		15	6	24	04		P3-C		SW	G				.	7.72	.		.	.	.		.	
		16	6	24	04		P3-D		SW	G				.	7.85	.		.	.	.		.	
		17	6	24	04		P3-E		SW	G				.	7.99	.		.	.	.		.	
		18	6	24	04		P3-F		SW	G				.	7.96	.		.	.	.		.	
		19	6	24	04		P4-A		SW	G				.	6.0	.		.	.	.		.	
		20	6	24	04		P4-B		SW	G				.	5.26	.		.	.	.		.	
														.	.	.		.	.	.		.	
														.	.	.		.	.	.		.	
														.	.	.		.	.	.		.	
														.	.	.		.	.	.		.	
														.	.	.		.	.	.		.	
														.	.	.		.	.	.		.	
														.	.	.		.	.	.		.	

Please circle the tests to be performed on the above samples.

Laboratory use only

WHITE (500ml)

69	BOD
15	LPH
14	LCOND
12	TURB
16	TSS
77	VSS
55	F
114	TDS

MAGENTA (125ml) H_2SO_4 pH < 2

21	TKN
25	TPO4
100	TOC

ORANGE (125ml)

13	COLOR
73	DIC
23	OPO4
19	NO2
32	CL
33	SO4
27	SIO4

LIGHT BLUE (125ml) H_2SO_4 pH < 2

26	TDPO4
22	TDKN
89	DOC

GREY (60ml) H_2SO_4 pH < 2

18	NOx
20	NH4

BEIGE (250ml)

67	ALKA
168	APA
58	TIC

YELLOW (IL)

63	CARO
61	CHLA
112	CHLA2
62	CHLB
113	CHLC
64	PHEO

BRIGHT BLUE (250/60ml) HNO_3 pH < 2

96	TOTAG	110	TOTMN
66	TOTAL	116	TOTNI
106	TOTAS	107	TOTPB
108	TOTBA	169	TOTSB
170	TOTBE	101	TOTSE
103	TOTCD	172	TOTSN
72	TOTCR	171	TOTTL
104	TOTCU	105	TOTZN
177	TOTFE		

GREEN (250/60ml) HNO_3 pH < 2

52	TDSAG	48	TDSMN	30	CA
39	TDSAL	50	TDSNI	31	MG
40	TDSAS	46	TDSPB	28	NA
41	TDSBA	173	TDSSB	29	K
174	TDSBE	51	TDSSE		
42	TDSCD	176	TDSSN		
43	TDSCR	53	TDSSR		
45	TDSCU	175	TDSTL		
178	TDSFE	54	TDSZN		

BROWN (125ml) HNO_3 pH < 2

102	TOTHG

RED (125ml) HNO_3 pH < 2

49	TDSHG

BIOLOGICAL

TC

FC

FS

Received by (Initials) _____ Date _____

Login Group _____ Sample _____

Test List Code _____

WQM-2 Revised 11/30/99

David Lightner — Relinquished by (Signature)

6/25/04 — Date

9:00 — Time

Samples on ice. _____

Project	Station	Samplenum	Presampnum	DateCollected	TimeColle	ProgramT	SampTyp	ColMetho	Matrix	TestName	Value	Units	MDL
LAB2	P3-A	L25043-13	P19722-13	24-Jun-04	12:00	EXP	SAMP	G	SW	OPO4	0.532	mg/L	0.004
LAB2	P3-B	L25043-14	P19722-14	24-Jun-04	12:00	EXP	SAMP	G	SW	OPO4	0.559	mg/L	0.004
LAB2	P3-C	L25043-15	P19722-15	24-Jun-04	12:00	EXP	SAMP	G	SW	OPO4	0.508	mg/L	0.004
LAB2	P3-D	L25043-16	P19722-16	24-Jun-04	12:00	EXP	SAMP	G	SW	OPO4	0.524	mg/L	0.004
LAB2	P3-E	L25043-17	P19722-17	24-Jun-04	12:00	EXP	SAMP	G	SW	OPO4	0.56	mg/L	0.004
LAB2	P3-F	L25043-18	P19722-18	24-Jun-04	12:00	EXP	SAMP	G	SW	OPO4	0.507	mg/L	0.004
LAB2	P4-A	L25043-19	P19722-19	24-Jun-04	12:00	EXP	SAMP	G	SW	OPO4	0.016	mg/L	0.004
LAB2	P4-B	L25043-20	P19722-20	24-Jun-04	12:00	EXP	SAMP	G	SW	OPO4	0.014	mg/L	0.004

INITIAL

BAR CODE

Chain of Custody Record

LAB USE ONLY

J.E.L. Log # 11169

P.O. # _____

Quote# _____

Jupiter Environmental Laboratories

Company Name	HSA Engineers & Scientists
Address	1450-A Skees Rd.
City	West Palm State FL Zip 33411
Sampling Site Address	Okeechobee
Attn:	David Hightower Fax/Email 561-686-9005
Project Name	Lake Island Project # 3005-7106
Sampler Name/Signature	David Hightower

#	Sample Label (Client ID)	Collected Date	Collected Time	Matrix Code*	# of Cont	Parameters	Pres Codes	LAB ANALYSIS											Field Filtered (Y/N)	Integrity OK (Y/N)	Comments
								A													
								Ortho P													
1	P3 - E	7/1/01	15:00	SW	1			✓													
2	P3 - W	7/1/01	15:00	SW	1			✓													
3																					
4																					
5																					
6																					
7																					
8																					
9																					
10																					

ORIGINAL

Matrix Codes*

S	Soil/Solid Sediment	SW	Surface Water
GW	Ground Water	SL	Sludge
WW	Waste Water	O	Other (Please Specify)
DW	Drinking Water		

Pres Codes**

A-	none	I-	Ice
B-	HNO_3	O-	Other
C-	H_2SO_4	M-	MeOH
D-	NaOH		
E-	HCl		

Relinquished by	Date	Time	Received by	Date	Time
David Hightower	7/1/01	16:30	E. Dalton	7/1/01	16:30

QA/QC level with report

None ✓ 1 2 3 See price guide for applicable fees

T.A.T. Request

✓ Standard

___ Rush

FDEP___

SFWMD___

Date Required _____

Temp Control:

_____ °C

Jupiter Environmental Laboratories, Inc.
150 Old Dixie Highway, Jupiter, FL 33458
(561) 575-0030 • Fax (561) 575-4118 • jupiterlabs@bellsouth.net

C.O.C.# 17684

Jupiter
Environmental Laboratories, Inc.

Client # 3650
Address: HSA Engineers & Scientists WPB
1486-A Skees Road
West Palm Beach, FL 33411
Attn: David Hightower

Page: 1 of 2
Date: 7/7/2004
Log # 11169-01

Sample Description: COC # 17684
Project # 80057106
Location: Lamb Island
Matrix: Water

Label: P3-E
Date Sampled: 7/1/2004
Date Received: 7/1/2004 4:30:00 P
Collected By: Client

Description	Results	Units	Method	Dilution Factor	Detection Limit	Extraction Date	Analysis Date	Analyst
Phosphate-Ortho								
Phosphate-Ortho	0.320	mg/L	/365.2	1	0.025	7/3/2004	7/3/2004	ESC

U = Below Laboratory Detection Limit

Soil results are reported in dry weight

All Analysis were performed using EPA, ASTM, USGS or Standard Methods.
CompQAP #960152 EPA #FL01040 HRS #E86546
NELAC Certified

Respectfully Submitted,

Pam Shore
Quality Assurance Director

Jupiter
Environmental Laboratories, Inc.

Client # 3650
Address: HSA Engineers & Scientists WPB
1486-A Skees Road
West Palm Beach, FL 33411
Attn: David Hightower

Date: 7/7/2004
Log # 11169-02

Sample Description: COC # 17684
Project # 80057106
Location: Lamb Island
Matrix: Water

Label: P3-W
Date Sampled: 7/1/2004
Date Received: 7/1/2004 4:30:00 P
Collected By: Client

Description	Results	Units	Method	Dilution Factor	Detection Limit	Extraction Date	Analysis Date	Analyst
Phosphate-Ortho								
Phosphate-Ortho	0.340	mg/L	/365.2	1	0.025	7/3/2004	7/3/2004	ESC

U = Below Laboratory Detection Limit

Soil results are reported in dry weight

All Analysis were performed using EPA, ASTM, USGS or Standard Methods.
CompQAP #960152 EPA #FL01040 HRS #E86546
NELAC Certified

Respectfully Submitted,

Pam Shore
Quality Assurance Director

BAR CODE

Chain of Custody Record

LAB USE ONLY

(55)

J.E.L. Log # 11239

P.O. # _____

Quote# _____

Jupiter Environmental Laboratories

Company Name: HSA Engineers & Scientists

Address: 1486 - A Skees Rd.

City: West Palm Beach State: FL Zip: 33411

Sampling Site Address: Okeechobee

Attn: David Hightower Fax/Email: 561 - 688 - 9005

Project Name: Lamb Island Project #

Sampler Name/Signature: David Hightower

#	Sample Label (Client ID)	Collected Date	Collected Time	Matrix Code*	# of Cont
1	P3 - A	7/16/04	1205	SW	1
2	P3 - B	7/16/04	1210	SW	1
3	P3 - C	7/16/04	1215		1
4	P3 - D	7/16/04	1220		1
5	P3 - E	7/16/04	1225		1
6	P3 - F	7/16/04	1230		1
7					
8					
9					
10					

LAB ANALYSIS

Press Codes	Parameters											Field Filtered (Y/N)	Integrity OK (Y/N)
A	O. Hg - P												
	✓												
	✓												
	✓												
	✓												
	✓												
	✓												

Comments

ORIGINAL

Matrix Codes*

S	Soil/Solid Sediment	SW	Surface Water
GW	Ground Water	SL	Sludge
WW	Waste Water	O	Other (Please Specify)
DW	Drinking Water		

Pres Codes**

A-	none	I-	Ice
B-	HNO_3	O-	Other
C-	H_2SO_4	M-	MeOH
D-	NaOH		
E-	HCl		

Relinquished by	Date	Time	Received by	Date	Time
David Hightower	7/16/04	15:35		7/16/04	1535

QA/QC level with report

None X 1 2 3 See price guide for applicable fees

T.A.T. Request

X Standard

___ Rush

FDEP___

SFWMD___

Date Required _____

Temp Control:

___ ___ °C

Jupiter Environmental Laboratories, Inc.
150 Old Dixie Highway, Jupiter, FL 33458
(561) 575-0030 • Fax (561) 575-4118 • jupiterlabs@bellsouth.net

C.O.C.# 18188

JUL 2 6 2004

AB

Jupiter
Environmental Laboratories, Inc.

Client # 3650
Address: HSA Engineers & Scientists WPB
1486-A Skees Road
West Palm Beach, FL 33411
Attn: David Hightower

Page: 1 of 6
Date: 7/20/2004
Log # 11239-01

Sample Description: COC # 18188
Project # Lamb Island
Location: Okeechobee
Matrix: Water

Label:
Date Sampled: 7/16/2004
Date Received: 7/16/2004 3:35:00
Collected By:

Description	Results	Units	Method	Dilution Factor	Detection Limit	Extraction Date	Analysis Date	Analyst
Phosphate-Ortho								
Phosphate-Ortho	0.080	mg/L	/365.2	1	0.025	7/17/2004	7/17/2004	ESC

U = Below Laboratory Detection Limit

Soil results are reported in dry weight

All Analysis were performed using EPA, ASTM, USGS or Standard Methods.
CompQAP #960152 EPA #FL01040 HRS #E86546
NELAC Certified

Respectfully Submitted,

fw Pam Shore
Quality Assurance Director

Jupiter
Environmental Laboratories, Inc.

Client # 3650
Address: HSA Engineers & Scientists WPB
1486-A Skees Road
West Palm Beach, FL 33411
Attn: David Hightower

Date: 7/20/2004
Log # 11239-02

Sample Description: COC # 18188
Project # Lamb Island
Location: Okeechobee
Matrix: Water

Label: P3-B
Date Sampled: 7/16/2004
Date Received: 7/16/2004 3:35:00
Collected By: Client

Description	Results	Units	Method	Dilution Factor	Detection Limit	Extraction Date	Analysis Date	Analyst
Phosphate-Ortho								
Phosphate-Ortho	0.061	mg/L	/365.2	1	0.025	7/17/2004	7/17/2004	ESC

U = Below Laboratory Detection Limit

Soil results are reported in dry weight

All Analysis were performed using EPA, ASTM, USGS or Standard Methods.
CompQAP #960152 EPA #FL01040 HRS #E86546
NELAC Certified

Respectfully Submitted,

for Edward E Dale
Pam Shore
Quality Assurance Director

Jupiter
Environmental Laboratories, Inc.

Client # 3650
Address: HSA Engineers & Scientists WPB
1486-A Skees Road
West Palm Beach, FL 33411
Attn: David Hightower

Page: 3 of 6
Date: 7/20/2004
Log # 11239-03

Sample Description: COC # 18188
Project # Lamb Island
Location: Okeechobee
Matrix: Water

Label: P3-C
Date Sampled: 7/16/2004
Date Received: 7/16/2004 3:35:00
Collected By: Client

Description	Results	Units	Method	Dilution Factor	Detection Limit	Extraction Date	Analysis Date	Analyst
Phosphate-Ortho								
Phosphate-Ortho	0.068	mg/L	/365.2	1	0.025	7/17/2004	7/17/2004	ESC

U = Below Laboratory Detection Limit

Soil results are reported in dry weight

All Analysis were performed using EPA, ASTM, USGS or Standard Methods.
CompQAP #960152 EPA #FL01040 HRS #E86546
NELAC Certified

Respectfully Submitted,

for Edward Dalton

Pam Shore
Quality Assurance Director

Jupiter
Environmental Laboratories, Inc.

Client # 3650
Address: HSA Engineers & Scientists WPB
1486-A Skees Road
West Palm Beach, FL 33411
Attn: David Hightower

Page: 4 of 6
Date: 7/20/2004
Log # 11239-04

Sample Description: COC # 18188
Project # Lamb Island
Location: Okeechobee
Matrix: Water

Label: P3-D
Date Sampled: 7/16/2004
Date Received: 7/16/2004 3:35:00
Collected By: Client

Description	Results	Units	Method	Dilution Factor	Detection Limit	Extraction Date	Analysis Date	Analyst
Phosphate-Ortho								
Phosphate-Ortho	0.060	mg/L	/365.2	1	0.025	7/17/2004	7/17/2004	ESC

U = Below Laboratory Detection Limit

Soil results are reported in dry weight

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Respectfully Submitted,

for Edward Dale

Pam Shore
Quality Assurance Director

Jupiter
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West Palm Beach, FL 33411
Attn: David Hightower

Page: 5 of 6
Date: 7/20/2004
Log # 11239-05

Sample Description: COC # 18188
Project # Lamb Island
Location: Okeechobee
Matrix: Water

Label: P3-E
Date Sampled: 7/16/2004
Date Received: 7/16/2004 3:35:00
Collected By: Client

Description	Results	Units	Method	Dilution Factor	Detection Limit	Extraction Date	Analysis Date	Analyst
Phosphate-Ortho								
Phosphate-Ortho	0.068	mg/L	/365.2	1	0.025	7/17/2004	7/17/2004	ESC

U = Below Laboratory Detection Limit

Soil results are reported in dry weight

All Analysis were performed using EPA, ASTM, USGS or Standard Methods.
CompQAP #960152 EPA #FL01040 HRS #E86546
NELAC Certified

Respectfully Submitted,

for Edward L. Dalton
Pam Shore
Quality Assurance Director

Jupiter
Environmental Laboratories, Inc.

Client # 3650
Address: HSA Engineers & Scientists WPB
1486-A Skees Road
West Palm Beach, FL 33411
Attn: David Hightower

Page: 6 of 6
Date: 7/20/2004
Log # 11239-06

Label: P3-F
Date Sampled: 7/16/2004
Date Received: 7/16/2004 3:35:00
Collected By: Client

Sample Description: COC # 18188
Project # Lamb Island
Location: Okeechobee
Matrix: Water

Description	Results	Units	Method	Dilution Factor	Detection Limit	Extraction Date	Analysis Date	Analyst
Phosphate-Ortho								
Phosphate-Ortho	0.073	mg/L	/365.2	1	0.025	7/17/2004	7/17/2004	ESC

U = Below Laboratory Detection Limit

Soil results are reported in dry weight

All Analysis were performed using EPA, ASTM, USGS or Standard Methods.
CompQAP #960152 EPA #FL01040 HRS #E86546
NELAC Certified

Respectfully Submitted,

for Edward Dabre

Pam Shore
Quality Assurance Director

APPENDIX E

INTERNAL FIELD AUDIT FORM

FIELD AUDIT

Status And Temporal Variability Monitoring Networks
Florida Department of Environmental Protection
MS 3525
2600 Blair Stone Road
Tallahassee, Fl 32399-2400
Telephone (850) 245-8517

Sampling Agency: HSA Engineers and Scientists
Field Personnel: Ron Durham, HSA Engineers
Auditor(S): Tom Emenhiser, HSA Engineers
Audit Date: November 29, 2005
Project Name: Lamb Island Dairy Storm Water Phosphorus Remediation Project
Site: Lamb Island Dairy, all sampling sites
Audit Type: Water Quality Surface Water and Groundwater
Copies of Audit Report to: Ron Durham, Terry Horan, SFWMD Project Manager
Overall Sampling Performance

SUMMARY

In general, the sampling personnel collected the surface water samples and the groundwater samples in accordance with prescribed FDEP SOPs and overall good sampling procedures. Exceptions listed below, in the opinion of the auditor, would not result in inaccurate/unusable laboratory data. The following observations and comments are made on the sampling procedures that should be addressed by the sampling organization:

1. The field sampler did not bring a turbidity meter with him for analysis of turbidity on the monitoring well during stabilization. The field sampler acknowledged the oversight and indicated he was not aware of its requirement when only sampling for phosphorus and aluminum. Turbidity measurement for stabilization is required for all groundwater monitoring well sampling, per the FDEP, and the field sampler was aware of that at the end of the audit.

2. The field sampler is not checking the theoretical slope of the pH meter weekly as this is not a manufacturer's recommendation of the brand of pH meter used by the field sampler. He is, however, checking the pH and calibrating the unit with fresh pH 4,7, and 10 buffers daily when making pH measurements.

3. The field sampler was not checking the accuracy of the temperature probe on the multi meter against an independent thermometer on a monthly basis. The sampling organization has been advised of the requirement.

Documentation (FD1000)	Yes	No	NA
1. Used waterproof ink and corrected errors without obliteration	yes		
2. Described sampling location (Lat/Long, Map, Photos)	yes		
3. Recorded preservation information and verification if different from sampling manual	yes		
4. Labeled sample bottles properly (bar codes, date, time)	yes		
5. All sections of field sheet completed correctly, including Ground Water: purging equipment; purging procedure; well casing compositions; well diameter; water table depth; depth of well; volume of water in well; purge volume calculations; total volume of water purged; date; starting and ending times for purging; purging rate; flow meter readings; stabilization measurements; water level drawdown measurements; FLUWID, Microland use Surface Water: total depth; secchi depth, field measurements; weather conditions; equipment used Sediments: sample collection depth; areal location of sample; sample collection devices Biology: physical and chemical characterization information; stream or river habitat assessment information; lake habitat assessment information; biorecon information	yes		
6. Instrument calibration log: • Unique ID for meter • Standards concentration, date of preparation or expiration date • Date, time and results of each initial calibration and calibration verifications (link to sampling project) • Name of analyst performing verification • Corrective actions performed on instrument	yes		
7. Custody sheet completed properly (date, time, sites, number of samples, comments, labels)	yes		
8. Cleaning log: • Type and date of analyte free water • Time and date of lab cleaning • Time and date of field cleaning	N/A		
9. Lot numbers and dates of use recorded for all reagents, detergents, solvents, and chemicals	yes		
10. All instruments and sampling equipment identified with a unique code, and including: • Maintenance and repair procedures • Routine cleaning procedures • Filling solution replacement for probes • Parts replacements for probes • Date procedures performed on each unit • Names of personnel performing maintenance and repair • Descriptions of malfunctions and repair		NO	

***COMMENTS:**

Field Quality Control (FQ 1000)	Yes	No	NA
1. Blank collected in same manner as samples and represent normal sampling conditions. Circle one: a) Precleaned EB b) Field cleaned EB c) Field blank (no equipment)	yes		
2. Field reference samples were analyzed under field conditions and were acceptable	yes		

Field Testing and Calibration (FT 1000 - FT 1600)	Yes	No	NA
1. Sample measurements were chronologically bracketed between acceptable calibration verifications	yes		
2. Sample measurements were quantitatively bracketed between acceptable calibration verifications	yes		
3. Meter was rinsed with DI water between standards and allowed to stabilize before recording readings	yes		
4. pH was calibrated first with the 7 buffer, then a 4 or 10, depending on the expected sample range	yes		
5. Calibration verifications for pH were within ±0.2 su	yes		
6. Meter was checked weekly to ensure a $\geq$ 90% theoretical slope		NO	
7. Calibration verifications for conductance were within ± 5%	yes		
8. Calibration verifications for DO were within ± 0.3 mg/L DO when compared to the table of theoretical values for water saturated air	yes		
9. DO electrode was stored in a water saturated air environment when not in use	yes		
10. Initial calibration of turbidimeter was performed using primary standards and met acceptance criteria for NTU range		NO	
11. Sample cells were inspected for scratches, cleaned as necessary and placed correctly in turbidimeter	yes		
12. Sample cells were rinsed between calibrations and sample collections	yes		
13. Temperature was verified monthly at a minimum of two temperatures and met acceptance criteria of ±0.2 ℃		NO	
14. Sample measurements were not collected until meter readings stabilized	yes		

***COMMENTS:**

General Sampling Procedures (FS 1000, FS 2000), Miscellaneous	Yes	No	NA
1. Paperwork, supplies and equipment were inventoried before going into the field	yes		
2. Sampling manual was in the field vehicle	yes		
3. Sampling equipment and bottles were clean and appropriate	yes		
4. Analyte free water was less than 1 week old	yes		
5. Samples were collected in a logical order	yes		
6. Care was taken to avoid contamination of samples	yes		
7. Samplers wore gloves and changed as necessary	yes		
8. Samples were properly preserved within 15 minutes	Q		
9. pH was tested on preserved samples; paper was not inserted into bottle	yes		
10. Samples were properly filtered if necessary	yes		
11. Headspace was left in all sample bottles and whirlpaks			
12. Samples were packed properly • Bacteria whirlpaks packed together in bag • Acidified sample bottles packed separately • All samples placed together in large bag, protected from ice • Custody sheet completed, bagged and placed in cooler	N/A		
13. At least one sampler on site has attended Sampler Training Workshop	N/A		

Surface Water Sampling (FS 2100)	Yes	No	NA
1. Samples were collected from downstream to upstream and upwind from power sources	N/A		
2. Samples were collected on upstream side of bridge, body or boat without disturbing the sediments			
3. Water samples were collected prior to sediment samples (if any)	N/A		
4. Intermediate collections devices were well rinsed with sample water; rinse water was discarded away from sample site	N/A		
5. Whirlpaks were collected as grab samples by immersing the closed Whirlpak and opening it underwater; OR an open whirlpak was plunged opening downward below the surface and filled in a continuous sweeping arc; OR collected from an intermediate collection device without interruption of the flow	N/A		
6. Sample containers were submerged neck first, inverted into flow, slowly filled and returned to surface (if sample containers were used as collection device)	yes		
7. Field parameters were measured at appropriate depth(s)	yes		
8. Water depth was at least 10 cm	yes		
9. Water samples were collected at the appropriate depth and corresponded with field parameter measurement depth			
10. Sample was collected at correct location in waterbody	yes		
11. Depth was measured to nearest 0.1m	yes		
12. Secchi depth and stage height were determined if appropriate	yes		

***COMMENTS:**

Sediment Sampling (FS 4000)	Yes	No	NA
1. Lake was at least 1m deep at its deepest point	N/A		
2. Samples were collected in the proper location	N/A		
3. Surface water samples were collected prior to sediment samples	N/A		
4. A minimum of 3 grabs were collected	N/A		
5. Only the top 2-3cm of sediments were transferred to the sample jar	N/A		
6. Sample jar was filled ¾ full	N/A		

Groundwater Sampling (FS 2200)	Yes	No	NA
1. Any standing water was removed from well head	yes		
2. Water level was measured to nearest 0.01 ft without sounding the bottom	yes		
3. Well volume was correctly determined	yes		
4. Depth to water was measured at intervals during purging; drawdown was stabilized so pumping rate matched recharge rate	yes		
5. Pump or tubing was placed at top of water column	yes		
6. A closed flow cell was used to measure stabilization	yes		
7. At least one well volume was purged before beginning purge stabilization measurements and at least ¼ well volume was purged between measurements	yes		
8. Purging completion was measured as: • DO = 20%. If DO = 20%, reasons were justified and consecutive measurements were within the greater of ± 0.2 mg/L or 10% • Turbidity = 20 NTU. If turbidity = 20 NTU, reasons were justified and consecutive measurements were within the greater of ± 5NTU or 10% And at least three consecutive measurements of following parameters were within stated limits: • temperature ± 0.2° C • pH ± 0.2 su • specific conductance ± 5.0% of reading	Q		
9. If well failed to meet stabilization criteria after 5 well volumes, all instruments, equipment, tubing, etc. were tested and found functional before collecting sample	yes		
10. Low permeability well was purged at low flow rate. If well purged dry, well was allowed to recover then sample was collected.	yes		
11. Pump and tubing decontaminated between wells.			
12. A new filter was flushed with sample water before collecting filtered samples.	N/A		
13. For wells with in-place plumbing, purging and sampling was upstream of storage tanks where possible	N/A		
14. For wells with in-place plumbing, flow rate was reduced to less than 500mL/minute (1/8" stream) or 0.1 gal/min before collecting samples	N/A		

***COMMENTS:**