CHARACTERIZATION OF THREE STORMWATER PONDS

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

When it rains, stormwater runoff travels across the land and down streets, ditches, swales, and storm drains and eventually ends up in our lakes, rivers, and bays. The streets look cleaner because all of the oil, grease, trash and sediments are now accumulating in the runoff water. For this reason, runoff from rain events has been identified as a major pollution source to Florida's rivers, lakes and estuaries. One of the most common methods for treating stormwater pollution is to direct runoff to some type of constructed pond. Three stormwater ponds discharging directly into Tampa Bay formed the centerpiece of a monitoring project developed to inform the public about stormwater problems and to test methods to help remove stormwater pollution.

The three types of ponds are an effluent filtration system, a wet detention pond and a pond used for the final treatment of a low impact parking lot design. Although most of the low impact parking lot was destroyed to construct a cruise ship terminal, enough preliminary data had been collected to compare to the two ponds that were monitored in more detail. The techniques tested to try and improve the performance of the ponds included pre-treatment grate inlet skimmer boxes (drop box inserts) installed in the seven storm drain catch basins that discharged to the wet detention pond, a diversion wall to increase storm travel time for runoff through the wet detention pond, biocultures to improve the aesthetics of the ponds, additional plants to help take up nutrients and barley straw for algae control.

The project was divided into three divisions. 1) An Intensive study was conducted for two years that collected hydrology and flow weighted water quality samples during storm events for two ponds. 2) A study comparing five years of data characterized conditions in three types of stormwater systems and looked at trends. 3) Several improvement and maintenance practices were tested and the results monitored. The purpose was to compare the stormwater systems by monitoring storm events, collecting sediment samples, identifying macroinvertebrates and fish, and tracking field parameters (dissolved oxygen, pH, temperature and conductivity).

POND DESCRIPTIONS

The ponds represent three types of stormwater systems and are named to describe the type of runoff each receives. The Street pond is an effluent filtration system that treats runoff from a well-traveled urban thoroughfare and parking garages. This effluent filtration system uses an artificial side drain packed in aggregate to treat stormwater after runoff has passed through a sedimentation basin. The Building pond has been modified to act as a wet detention system and collects the runoff from the Aquarium roof, sidewalks, a delivery receiving dock and garden areas. The Parking Lot pond was the final treatment for a parking lot that used a low impact design.

RAINFALL

The two years of data for the intensive study showed considerable differences in rainfall amounts. During the first year of the study (ten months), the area experienced a drought and rainfall was considerably below normal (26 inches) compared to the long-term average (44 inches). During the ten months of construction activity, summer tropical storms made up for the below average rainfall at the site and was 39 inches compared to 37 inches for the historic record. During the ten months of data collected in the second year to compare with the first year, El Nino conditions increased rainfall at the site to above average levels (58 inches) compared to the long-term average (44 inches).

FLOW

The effluent filtration stormwater pond (Street pond) and the wet detention pond (Building pond) have similar responses to rainfall showing the filter system is still operational after seven years and is slowly releasing flow after storm events at about the same rate as the wet detention pond (Building pond). The Parking Lot pond only discharged once during the year it was monitored demonstrating that the low impact design was an excellent choice for reducing storm runoff and protecting the receiving waters.

WATER QUALITY

Flow weighted water quality samples were collected during storm events at the outflow of the two ponds during the intensive study. These concentrations were compared to concentrations measured in the under drain pipes and in rainfall to analyze concentrations at different locations in the system and to evaluate how well water quality met state of Florida Class III standards. Field parameters of pH, dissolved oxygen, temperature and conductivity were also compared to understand processes taking place in the ponds.

Nutrient concentrations are a concern since they cause the growth of noxious water weeds and can create odor problems. When data for year one (2001) are compared. Nitrate was measured at the highest concentrations in rainfall (median value of 0.2 mg/L) when compared to the outflow of the Building and Street ponds (0.05 and 0.02 mg/L respectively). Although ammonia was measured at high concentrations in rainfall (0.12 mg/l), the highest concentrations measured were in the under drain pipes (0.258 mg/L). Anaerobic conditions in the pipes partially explain these results. Dissolved oxygen levels also explain the higher ammonia concentrations measured in the surface discharge from the often duckweed covered Building Pond (0.13 mg/L) compared to the discharge water of the well-oxygenated Street Pond (0.02 mg/L).

Soluble phosphorus was also measured at higher concentrations in the under drain pipes. Ortho-phosphorus concentrations were over twice as high in the pipes compared to discharge water from the ponds (0.105 mg/L compared to 0.043 mg/L for the Building Pond and 0.127 mg/L compared to 0.042 mg/L for the Street Pond). Higher concentrations of inorganic nitrogen and phosphorus have also been reported from other studies of under drain systems.

Heavy metals measured at the outflow in both the ponds and in the under drain pipes were measured at low levels and were often below the laboratory detection limit. Suspended solids were also measured at low levels indicating that the stormwater systems are effective for removing these constituents. During the first year of data collected for the intensive study, the pond discharge waters were in non-compliance of standards only five times in the 180 samples collected and even lower concentrations in the under drain pipes never exceeded standards indicating the ponds are effectively treating stormwater. These good results for the surface water in the ponds were not seen in preliminary data collected at the site, which detected numerous exceedances of standards of as much as 50 percent for copper and 30 percent for lead. The high copper values were caused by algicide treatment.

Physical water quality parameters are relevant to understanding the processes that influence constituent cycling in natural waters. During this study, dissolved oxygen (DO), pH, temperature and conductivity were periodically measured with recording sensors, which took readings every hour for an extended peiod (usually about a week). The units were deployed about once a month when there was enough water in the ponds to take measurements. The most striking differences between ponds occurred for dissolved oxygen and conductivity. Conductivity was much higher in the Building Pond as a result of activities in the Aquarium and in the Parking Lot pond as a result of berm breeches causing contamination by water from Ybor channel. Dissolved oxygen was often measured near zero in the Building Pond, which was caused by a dense layer of floating macrophytes. The Street Pond, which is a productive eutrophic phytoplankton dominated system, exhibited widely fluctuating diurnal values of dissolved oxygen and pH. The State of Florida Class III water quality standards were sometimes exceeded for pH with values above 9.5.

SEDIMENT SAMPLES

Sediment samples were collected three times over the five years of monitoring at the site. A dramatic increase in constituent concentrations was measured in 2003 with especially high concentrations in the Building pond. Concentrations of potentially toxic pollutants were measured at much higher concentrations in the Building Pond compared to the Street Pond.

Particle sizes for the sediments in both ponds had the highest percentage (30 to 40%) of samples measured in an intermediate size range (0.125 to 0.250 mm) described as medium sand. The smallest particle size (less than 0.063 mm) was also well represented especially at the outfall of the Street Pond and at both stations in the Building Pond. Since small particle sizes also provide greater attachment sites for metal ions, this may help explain the higher metal concentrations measured in the surface sediments at this site and the low concentrations of metals measured in the water column.

Organic matter improves soil structure and provides conditions conducive to healthy soil microbes and solids settling. The Street Pond measured only low concentrations of organic matter (0.5 to 1%), although some increase was seen (2%) near the outfall. In contrast, the Building Pond measured higher concentrations (6 to 8%) probably a result of the considerable vegetation that continually died back and rained detritus in the pond. This was reduced to 4.5 percent after the maintenance provided by Hillsborough County Adopt-A-Pond program.

Total Kjeldahl nitrogen (TKN) is a combination of organic nitrogen and ammonia. The sediment sample concentrations in the Street pond were measured much lower than the Building pond. For the final year, TKN concentrations had increased in the sediments of the Street pond from less than 1600 mg/kg in 1997 to greater than 20,000 mg/kg in 2003 and in the Building pond to greater than 180,000 mg/kg. This demonstrates the large amount of nitrogen that can build up in the sediments in ponds with a high concentration of floating macrophytes. Concentrations were measured at much lower concentrations in the sediments 4 inches below the surface and although the Street pond had concentrations slightly less than the Building pond they were not much less.

Phosphorus concentrations followed much the same pattern as TKN with higher concentrations in the Building pond but phosphorus was not necessarily that much less in the deeper sediments indicating the possibility of migration into the deeper strata. Concentrations of phosphorus in the Street pond in 2003 were about 20,000 mg/kg compared to about 70,000 mg/kg in the Building pond.

Metals were also measured at higher concentrations in the Building Pond compared to the Street Pond. Both copper and zinc exceeded sediment guidelines and concentrations were in a range where they were probably toxic to biota in year 2000, but had been reduced to below toxic levels after the maintenance clean out of the pond.

Polycyclic aromatic hydrocarbons (PAHs) were a problem in both ponds: in the Street pond PAH detections increased from 17 percent of samples in 2000 to 63 percent in 2003; and in the Building pond from 28 percent to 75 percent. Of some concern is the fact that measurable levels of PAHs were detected in the Building pond and that acenaphthene, anthracene, phenanthrene and benzo(a)anthracene may exceed toxic levels.

Pesticides may be a problem in the sediments. Chlordane, DDE and DDD were detected in both ponds. Since these are serious contaminants, toxic to wildlife and bioaccumulate in organisms, they need more study. None of the pesticides were detected in the water column samples.

Biota. The macroinvertebrate and fish studies showed all the taxa reported were those highly tolerant of polluted conditions. In areas where sediments had measured possibly toxic levels of pollutants there were much lower abundance of species and individuals than in other areas. Indications also suggest that the aggressive fish *Gambusia affinis* may be further reducing species diversity.

POND IMPROVEMENTS

Skimmer Box Inserts collected 15 cubic feet per year of gross solids from the 5.67-acre drainage basin before it could travel by sediment transport into the pond. The skimmer box inserts also appeared to improve inflow water quality.

The diversion structure increased the travel time of the treatment volume and appeared to greatly reduce the concentration of constituents discharged from the Building pond for the eight storms that were measured compared to concentrations before it was installed.

Algicide treatment in the ponds greatly increased the toxic levels of copper in the sediments and in the water discharged from the pond. It also appeared to increase nitrate concentrations.

Biocultures may reduce organic nitrogen concentrations but did not improve the problem with floating nuisance vegetation.

Sediment removal as a pond maintenance technique reduced levels of copper in the sediments and reduced organic nitrogen and organic matter in the water column, but did not permanently improve the problems with floating vegetation.

CONCLUSIONS

Stormwater ponds greatly reduce pollution to our rivers, lakes and streams, but problems exist and toxic levels of metals and high levels of nutrients are still being discharged. Even under the best projections current rules allow 20 percent more pollutants to be added to our receiving waters each year.

One method to reduce these pollutant loads is to design with more opportunities in the drainage basin for infiltration by using some treatment train techniques. The Parking Lot pond is an example of how pollutant loads can be reduced using these methods. Stormwater was discharged from that basin only once during the year it was studied compared to the 20 to 40 times a year for traditional stormwater ponds. On the other hand, more study is needed to test infiltration effects. Higher soluble nitrogen and phosphorus were measured in flow that had passed through the under drain filters in the effluent filtration system than in the surface stormwater discharged.

Of some concern are the toxic levels of metals, pesticides and PAHs being sequestered in the sediments of stormwater systems with no plans for their disposal or the long-term effect on water quality and wildlife. Also ponds treated with algicides are probably increasing copper and nitrogen discharged to receiving waters.

INTRODUCTION

In a typical urban environment, where a variety of impervious surfaces now cover much of the land, the water that runs off during and after rainstorms is greatly increased and degraded. Instead of seeping into the soil, the rain flows rapidly off roads and roofs. In the process, it picks up oil, grease, heavy metals, trash, sediment, pesticides and fertilizers. Storm drains often channel this heavily polluted water directly to streams, rivers, lakes and bays, thus degrading our natural systems. This diffuse source of pollution is termed non-point source or stormwater runoff and is considered one of the major pollution problems for natural water bodies. Non-point sources include atmospheric deposition, surface runoff that immediately follows rainfall, low-flow longer-duration base flow, and the residual chemicals and sediments that release pollutants to the water column over a longer time period. Environmental directives to clean up this pollution source have resulted in rules for stormwater treatment. In the Tampa Bay area this responsibility has been delegated to the Southwest Florida Water Management District (District or SWFWMD).

Several stormwater ponds permitted by the District when the Florida Aquarium was built in downtown Tampa provided an opportunity to study various aspects of stormwater management and coordinate our results with the Aquarium educational program. Besides characterizing several types of stormwater systems, emphasis was placed on investigating some of the problems associated with pond maintenance, educating the public about runoff pollution and developing strategies to make stormwater systems an attractive landscape amenity. Another purpose of the project was to test methods to improve the quality of the storm discharge water and the final year of the monitoring program tested the results of some of these efforts.

This report presents the results of the stormwater monitoring effort at the Aquarium for over four years and also looked at some stormwater management alternatives. Data were collected characterizing three types of stormwater ponds from November 1996 until monitoring was terminated in November 2003. During that time period one of the ponds was obliterated to make space for a cruise ship terminal and changes were made to the remaining ponds for a downtown trolley installation.

The results of the study are divided into three major sections: 1) Two years of intensive storm event sampling using automatic equipment to collect flow and water quality data at the outflow of two stormwater systems, 2) Four years of water quality data, which included both grab and flow-weighted storm water samples, biological monitoring, and sediment analysis for three types of stormwater management systems, and 3) An analysis of some stormwater improvement techniques including skimmer box inserts installed in one drainage basin and a diversion weir to increase travel time in one of the ponds. Two companion reports are also available that provide detailed data on two of the stormwater management systems: a low impact parking lot (Rushton and Hastings 2001) and an effluent filtration system (Teague and Rushton 2005).

SITE DESCRIPTION

The site at the Florida Aquarium is located at 701 Channelside Drive, Tampa, Hillsborough County (Section 19, Township 29, Range 19). The stormwater systems treat storm runoff from a parking lot, an urban street, and Aquarium buildings. The ponds discharge to Ybor Channel which leads directly to Tampa Bay, an estuary of national significance, included in the National Estuary program, and identified as a water body in need of attention. The wet ponds in this study are quite different from each other and were named to designate the principal type of runoff each pond receives (Figures 1a - 1b and Table 1).

The Street Pond collects runoff from a well-traveled downtown thoroughfare and a large parking garage. The pond is designed to treat 10.4 acres of street and urban runoff. It is an effluent filtration system that uses artificial side drains packed in aggregate to treat stormwater. Filter systems direct low flows through this media to pipes, which in this case, discharge to the drop box at the outflow. High flows are still discharged over the outfall weir. A diagram of the side bank filter is shown in Figure 2. The shape of the filtration pond was altered during construction of the cruise ship terminal and an additional side bank filter was installed on the east side of the pond.

Flow-weighted composite samples were also collected at regular intervals in the under drain pipes to compare with the pond water. The under-drain pipes flow continuously, which is probably caused by intercepting the surrounding water table. The Street Pond has two pools, connected in the middle with an equalizer pipe. The first pool was designed to act as a sedimentation basin and the second pool is the filtration system with under-ground side bank filters located on the south and east sides of the pond. Maintenance of filter systems is an important component in keeping effluent filtration systems functional, but unfortunately this is rarely done. This pond is no exception and the draw down pipes are clogged with debris and the screening material is in disrepair. A whole pond study was conducted for this one pond to evaluate the water quality and quantity for all the flows into and out of the system. More complete results of this one pond were published in a separate report (Teague and Rushton 2005) but the outflow water quality is evaluated here to compare to the other ponds.

The Building Pond collects excess runoff from 5.67 acres of rooftop, sidewalks, garden areas, loading docks, driveways and a plant nursery. This pond is a failed effluent filtration system modified to function as a wet-detention pond. A bleed-down orifice creates a fluctuating pool designated in SWFWMD rules as the treatment volume, where runoff is stored after storm events and slowly released over a five-day period. During the second year of the intensive study, this pond has been the subject of several alterations to try to improve the water quality discharged from the pond. In July 2002, seven grate inlet skimmer box inserts were installed in the drainage basin to intercept gross solids before they reached the pond. Another problem with the pond was the short travel time once storm water entered the pond because the inflow pipes were located near the outfall weir. To try to correct this problem the treatment volume was re-routed so that it travels through the littoral zone.

Figure 1a. Site plan showing the three stormwater ponds and the layout of the whole basin stormwater system used for he Parking Lot Pond.

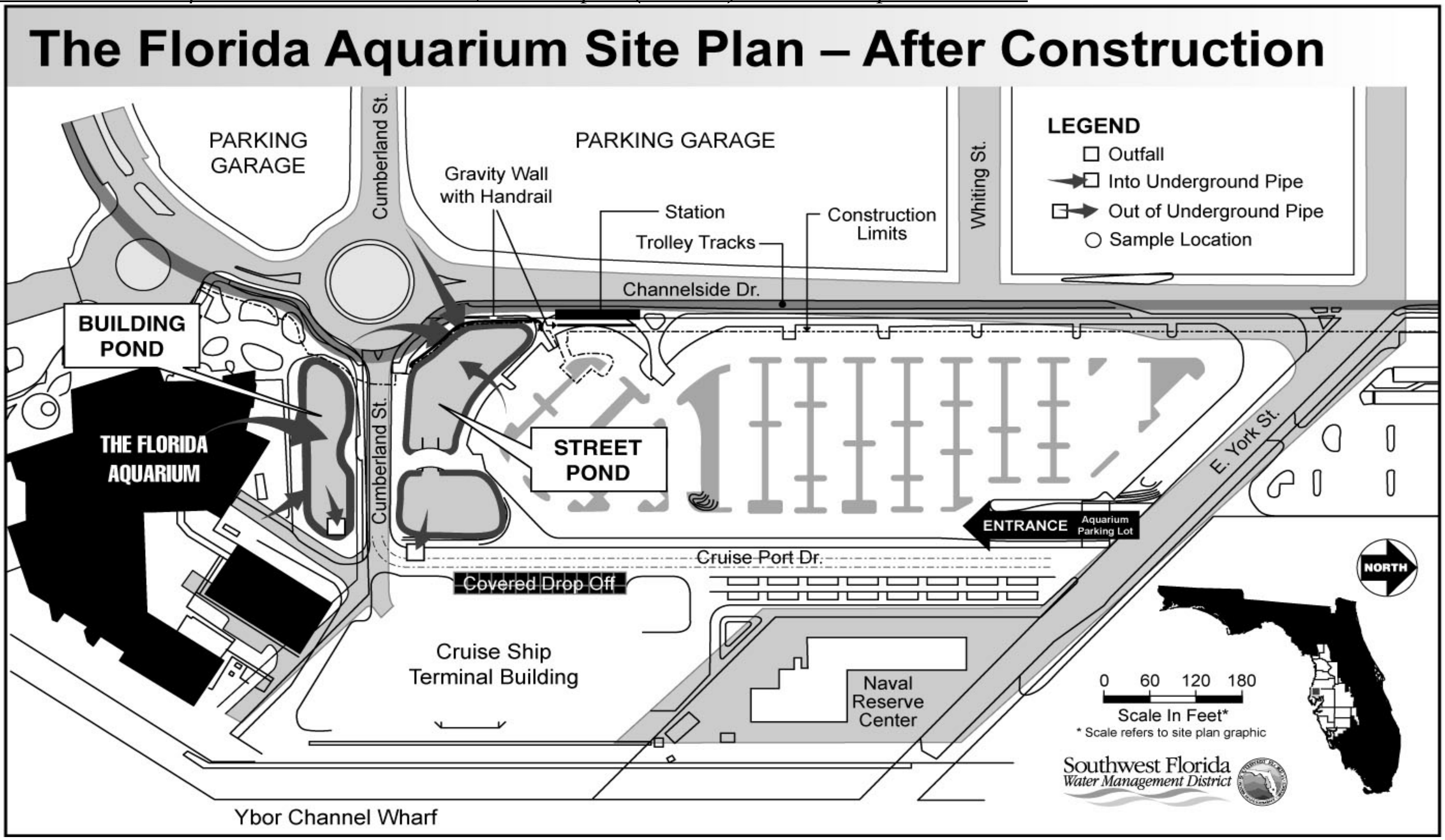

Figure 1b. Site plan showing the remaining two stormwater ponds, new cruise ship terminal, the trolley line and the layout of the basin after the construction activity.

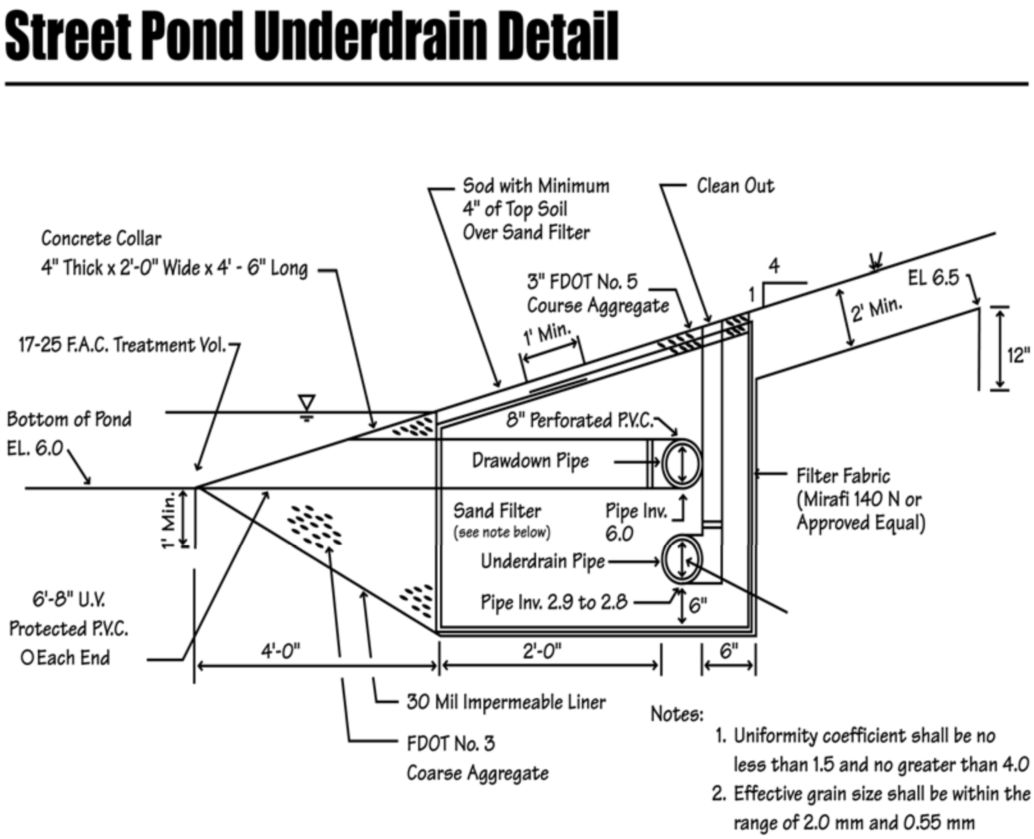

Figure 2. Cross section of side bank filter (effluent filtration) system used to treat stormwater in the Street Pond

The Parking Lot Pond was the final treatment for a low impact stormwater management design treating runoff from a 10.65-acre parking lot. Low impact designs incorporate swales, strands and recessed bioretention areas throughout the drainage basin, which allows for infiltration of stormwater, thereby reducing runoff and pollutants. During the time it was studied, the pond was essentially a stagnant pool because pre-treatment gardens and swales eliminated most of the runoff before it reached the pond. Since the pond rarely discharged, water quality into receiving waters was not an issue, but the appearance of the pond was a concern. Floating macrophytes and the submerged nuisance species*, hydrilla,* were problems. They were treated chemically during preliminary monitoring. This pond no longer exists since it was filled in to provide a site for a cruise ship terminal, but existing data is used to compare to the other two ponds in this report. A detailed report is available that analyzes different paving types as well as efficiency of the different elements in the parking lot stormwater treatment train (Rushton and Hastings 2001).

Thick algae mats and floating vegetation of several plant species, collectively referred to in this report as "duckweed", proved to be a recurring problem in all three ponds. Although a small portion of this floating vegetation gets washed out with rain events, much of it is held back by the aluminum skimmers installed to intercept surface water pollution such as oils and greases. Barley hay bales and biocultures were tried in an attempt to inhibit the floating macrophyte growth. Also littoral zone vegetation was planted in the Street Pond to try to remove excess nutrients. The result of these attempts and other alterations made to try to improve the aesthetics of the ponds are discussed in the report.

Table 1. Characteristics of the ponds and their drainage basins.

General Information	Building	Street	Pk Lot**
Type of Stormwater Treatment ➔	Wet-Detention	Effluent Filtration	Whole Basin
Most runoff originates from ➔	Building roof	City Street	Parking Lot
Drainage Basin Information			
Size (acres)	5.67	10.40	10.65
Percent Impervious	80	95	83
Pond Information			
Size (acres)	0.22	0.33	0.12
Min.Bottom Elevation (NGVD*)	3.38	1.00	3.00
Top of Bank Elevation (NGVD)	9.00	9.00	10.50
Max. Depth of Pond (ft)	4.07	6.00	4.45
Outfall Structure			
Top Weir Elevation (NGVD)	7.47	7.00	7.45
Invert Elevation (NGVD)	5.82	6.00***	5.95
Fluctuating Pool (ft)	1.80	1.00	1.50

*NGVD=National Geodetic Vertical Datum of 1929 (approximates elevation above mean sea level in feet)
**Parking Lot Pond was only monitored in the preliminary years of the study.
***Inflow pipes to side bank filter

METHODS

Three types of stormwater ponds were sampled to compare the sediments, biota, outflow water quality and hydrology. The Street Pond is an effluent filtration system with side bank filters, the Building Pond functions as a wet detention pond, and the third pond, the Parking Lot Pond, was the final treatment for a low impact stormwater management design. Although the third pond no longer exists, data collected in a preliminary study is used to compare to the other two ponds. The research is divided into three elements – The Intensive storm monitoring study, the pond characterization comparisons and the pond improvement techniques analysis.

INTENSIVE STORM MONITORING STUDY

An intensive monitoring study to compare the hydrology and outflow water quality of two types of storm water ponds was initiated in November of 2000. The construction of a cruise ship terminal interrupted the study from September 2001 through June 2003. A second year of data collection commenced in July 2002 through November 2003. When comparisons between years are made, the data are used for the same months (November through August) and the data set is labeled data-year-two.

Hydrology

Rainfall Measurements - The hydrology of the basin was characterized by recording rainfall at 15-minute intervals. Rain amount was calculated using a tipping bucket rain gauge connected to a Campbell Scientific CR10^{TM} data logger that stored the data and averaged the measurements at fifteen-minute intervals. Rainfall was characterized by calculating total rainfall, duration, inter-event dry period, and rainfall intensity using the following formulas.

Rainfall (cm, in)	rainfall amounts for each event >0..54 cm (0.23 in)
Inter-event dry period (hr)	time period since previous rain event (>6 hours separates storms).
Duration (hr)	period of active rainfall
Intensity (cm/hr, in/hr)	total event rainfall / duration
Max intensity (cm/hr, in/hr)	a 15-minute period during the storm with the highest average maximum intensity

Rainfall amounts less than 0.584 cm (0.23 in) were not included in the calculations because these small events produced little runoff.

Outflow Hydrology Measurements in both ponds were measured using CR500^{TM} data loggers connected to float and pulleys. The flow data for the weir structures at the outflows were estimated using the standard formula for a rectangular weir with end contractions and treating each side of the weir as a separate rectangular weir. Flow from the small bleed-down (bleeder) orifice in the Building pond was estimated using the standard pipe formula. The outflow structure in the Street Pond was rebuilt for the second year of the study and the dimensions and formulas were changed. More detailed information is in Appendix A.

Underdrain Hydrology Flows were measured at the Building and Street ponds for year one of the study using ISCO™ bubbler flow meters and Thel-Mar™ Volumetric weirs installed in the pipes (Appendix A). Since it was obvious that the side bank filter was totally clogged in the Building pond and that no flow, except groundwater, was discharged from the pond through the side bank filter, this equipment was moved to the Street Pond to sample the additional side bank filter installed at that site after the construction of the cruise ship terminal. Accurate measurements in the small eight-inch under drain pipes were difficult and often a best estimate had to be made.

Water Quality Sampling - The water quality in the storm discharge for the Building and Street ponds during the intensive study was monitored for almost one year (November 2000 through August 2001) by collecting flow-weighted samples after rain events. In addition, the under drain pipes in the street and Building ponds were instrumented to allow flow-weighted samples and these were collected on a regular basis since they had continuous flow. During the construction the outflow weir in the Street Pond was changed and an additional under drain side bank filter was added. This additional filter system in the Street pond was also monitored for year two and the water quality monitoring in the non-functional filter system in the Building Pond was discontinued.

Laboratory analyses were performed according to either Standard Methods (A.P.H.A. 1992) or Methods for Chemical Analysis of Water and Wastes (U.S.E.P.A. 1983). The Quality Assurance/Quality Control (QA/QC) procedures that were followed are published in the District's Comprehensive Quality Assurance Plan (CompQAP, SWFWMD 1997). When analyzing the water quality data, there were a large number of measurements below the laboratory detection limit (left censored data). When a value was not reported but listed as below the limit of detection (LOD) then one-half the detection limit was substituted for statistical analysis. After May 2003, new laboratory methods and detection limits were used. The description of both laboratory analyses along with their detection limits are listed in Tables 2a and 2b.

POND CHARACTERIZATION COMPARISONS

Field Parameters - Dissolved oxygen, temperature, pH, conductivity and sometimes oxidation reduction potential (redox) were measured with various Hydrolab™ units. Measurements were taken for one to two weeks at a time when there was enough water in the pond for the sensors to operate. For the outflow comparison study, the units were placed near the outfall structure in each pond to compare conditions in the pond.

Sediment Samples - Sediments were collected in eight locations in the ponds and separated into two depths (the first inch of the sediment surface and 4 to 5 inches below the surface) (Figure 3).

Table 2. Description of laboratory analyses for parameters measured in stormwater study. References refer to sections in Standard Methods (APHA 1992) or (US EPA 1983) where more detailed descriptions can be found. When values were below the laboratory detection limit, one-half the detection limit was substituted for statistical analysis. After May 2003 the methods and detection limits changed (Table 3)

Laboratory methods before May 2003.

Parameter	Method	Det. Limit	Reference.
Total Suspended Solids	Total filterable residue dried at 103-105^{o} C	0.05 mg/l	SM 2540
Total lead	Electrothermal atomic absorption spectrometry	0.001 mg/l	SM 3113 B
Total copper	Electrothermal atomic absorption spectrometry	0.001 mg/l	SM 3113 B
Total cadmium	Electrothermal atomic absorption spectrometry	0.0003 mg/l	SM 3113 B
Total zinc	Direct aspiration into air-acetylene flame	0.015 mg/l	SM 3111 B
Total iron	Direct aspiration into air-acetylene flame	0.025 mg/l	SM 3111 B
Ammonia-N	Automated phenate	0.1 mg/l	SM4500
Organic nitrogen	Semi Automatic Block Digestor	0.01 mg/l	EPA 351.2
Nitrate-nitrite-N	Cadmium reduction	0.01 mg/l	EPA 353.2
Total Phosphorus	Colorimetric automated block digester	0.01 mg/l	EPA 365.1
Ortho-phosphorus		0.01 mg/l	SM 4500-P
Calcium	Flame/furnace atomic absorption	0.04 mg/l	EPA 200.7
Magnesium	Flame/furnace atomic absorption	0.006 mg/l	EPA 200.7

Table 3. Description of laboratory analyses for parameters measured in stormwater

study. References refer to sections in Standard Methods (APHA 1992) or (US EPA 1983), where more detailed descriptions can be found. When values were below the laboratory detection limit, one-half the detection limit was substituted for statistical analysis.

Laboratory methods and detection limits after May 2003

Parameter	Method after May 2003	Det. Limit	Reference.
Total Suspended Solids	Total filterable residue dried at 103-105^{o} C	0.5 mg/l	SM 2540 D
Total and dissolved lead	ICP-OES	0.010 mg/l	EPA 200.7
Total & dissolved copper	ICP-OES	0.003 mg/l	EPA 200.7
Total cadmium	ICP-OES	0.001 mg/l	EPA 200.7
Total and dissolved zinc	ICP-OES	0.002 mg/l	EPA 200.7
Total and dissolved iron	ICP-OES	0.0125 mg/l	EPA 200.7
Ammonia-N	Automated phenate	0.005 mg/l	SM4500 NH3-H
Total nitrogen	Potassium persulfate auto clave	0.03 mg/l	EPA 353.2 SM4500 MC
Nitrate-nitrite-N	Cadmium reduction	0.0025 mg/l	EPA 353.2
Total Phosphorus	Ammonium persulfate auto clave	0.01 mg/l	EPA 365.1
Ortho-phosphorus		0.01 mg/l	SM 4500-P-F
Calcium	ICP-OES	0.25 mg/l	EPA 200.7
Magnesium	ICP-OES	0.25 mg/l	EPA 200.7

QAPP Appendix_AR_TABELS

Samples were taken near the inflow and outflow of each pond and the Street Pond was divided into both its parts with samples collected at the inflow and outflow before the equalizer pipes (pond 3) and again after entering the filtration pond (pond 4). Sampling equipment was prepared in advance and both the procedure for cleaning the equipment and collecting the samples followed the protocol listed in the District's Comprehensive Quality Assurance Plan (SWFWMD 1998). A hand driven two-inch acrylic corer was used to collect sample for nutrients, particle size analysis and metals. These were well mixed in a stainless steel basin using stainless steel implements. Four to six replicate cores were required to obtain an adequate sample for analysis. These were mixed using the four-corner method (SWFWMD 1998). Priority pollutant samples were collected with a stainless steel spoon and the sediments were taken for comparable depths and area as the other sediment samples. Samples were placed in EPA approved ICHEM glass jars supplied by the Department of Environmental Protection (FDEP) and analyzed in the FDEP laboratory in Tallahassee following EPA approved methods.

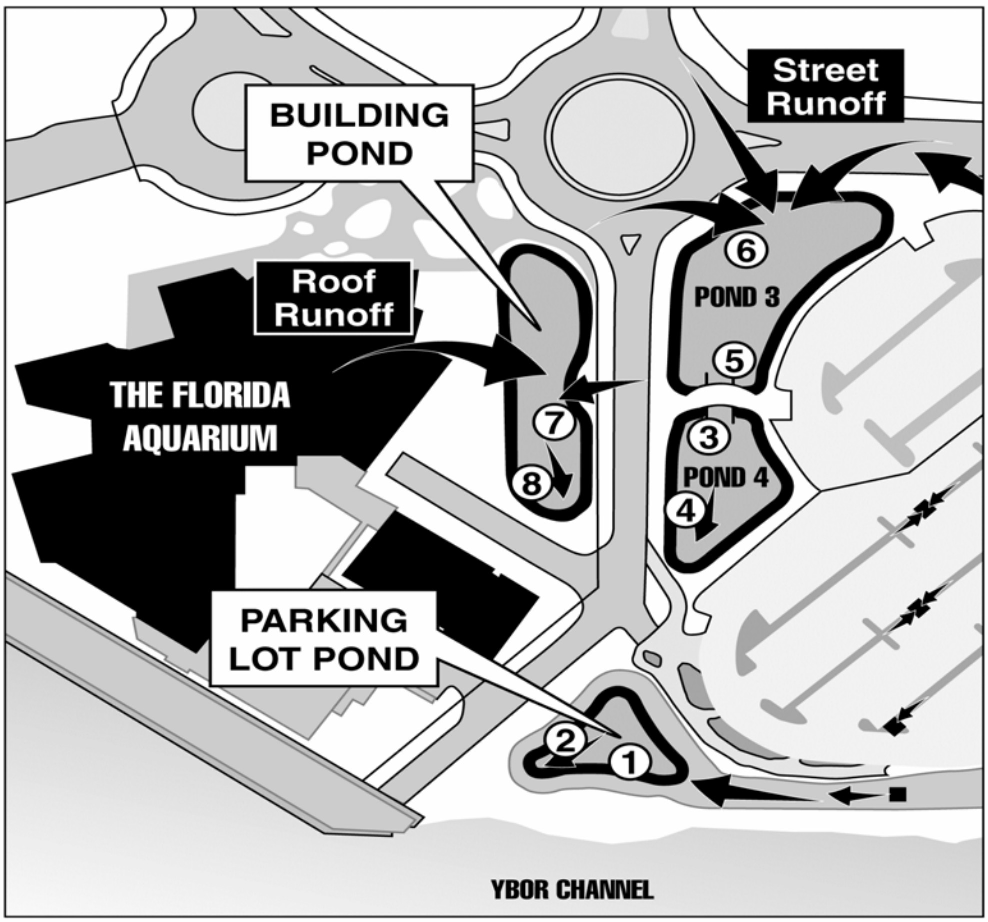

Figure 3. Location of sediment and macroinvertebrate sampling sites.

Table 4. Numerical sediment quality assessment guidelines for Florida Inland Waters (FDEP 2003)

CONSTITUENT	units	possible	probable
Classification* ➔		TEC	PEC
METALS			
Cadmium	mg/kg	1.0	5.0
Chromium	mg/kg	43	110
Copper	mg/kg	32	150
Lead	mg/kg	36	130
Nickel	mg/kg	23	49
Zinc	mg/kg	120	460
POLYCYCLIC AROMATIC HYDROCARBONS			
Acenaphthene	ug/kg	6.7	89
Anthracene	ug/kg	57	850
Phenanthrene	ug/kg	200	1200
Benz[a]anthracene	ug/kg	110	1100
Benzo(a)pyrene	ug/kg	150	1500
Chrysene	ug/kg	170	1300
Dibenz[a,h]anthracene	ug/kg	33	140
Fluoranthene	ug/kg	420	2200
Pyrene	ug/kg	200	1500
Total PAHs	ug/kg	1600	23000
PESTICIDES			
Chlordane	ug/kg	3.2	18
DDD	ug/kg	4.9	28
DDE	ug/kg	3.2	31
DDT	ug/kg	4.2	63
Diazinon	ug/kg	0.38	NG

*TEC=Threshold Effect Level PEC=Probable Effect Level NG=no guidelines
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Invertebrate Sampling – Benthic macroinvertebrates were collected on eight dates from July 3, 1997 through August 21, 1997 at eight sites where sediments were sampled. Samples were collected with a 6-inch by 6-inch Ekman dredge and sieved in the field using a #30(250 *u*m) standard testing sieve. The organisms retained were placed into 4-liter Nalgene bottles, preserved with 10 percent formalin, and stained with rose Bengal. In the laboratory, organisms were sorted win white enamel pans and idenfitied to genus and species using a variety of taxonomic keys (Ashe, 1983; Brinkhurst, 1986; Klemm, 1982; Milligan, 1997; Pennak, 1989; Thorp and Covich, 1991).

Macroinvertebrate assemblages were evaluated using tha Shannon-Weaver diversity Index and the equitability measurement. Diversity indices provide information on the effects of environmental stresses on biological communities, and values calculated for macroinvertebrate assemblages are often used to characterize water or sediment quality (USEPA 1973). The Sannon Weaver Diversity Index is based on information theory and takes into consideration the number of species (or taxa) present and the relative abundance of each species (or taxon). Species diversity can be calculated according to:

$$H = -\sum_{i=1}^{S} (p_i)(\log_2 p_i)$$

where H = the diversity index
s = the observed species
i = the species number
p_i = proportion of individuals of the total sample belonging to the *i*th species

The Shannon-Weaver Diversity Index has been used to determine diversity in polluted and unpolluted bodies of water. It has been estimated that unpolluted water typically has a diversity index between 3 and 4 and where in polluted water diversity measure is less than 2 in polluted water (Wilhm 1970).

The equitability measurement is used to describe the component of diversity which may be attributed to the "evenness" of the distribution of the total number of individuals among the species (or taxa) present. A measure of equitability, which is calculated as:

$$E' = H/H_M$$

where E' = equitability
H =the observed species diversity.
H_M =the maximum species diversity based on the number of species in the sample.

The equitability measurement is more sensitive to pollution than the Shannon-Weaver Diversity measurement (EPA 1973) and usually ranges from 0 to 1. The equitability measurement ranges from 0.6 to 0.8 in unpolluted streams and 0.0 to 0.3 in polluted streams (Odum, 1983).

The Wilcoxon Rank Sum test (Mann-Whitney U test) was used to evaluate significant differences in macroinvertebrate abundance among sites. The Wilcoxon Rank Sum test is a nonparametric test for comparing two independent groups (Helsel and Hirsch, 1995).

Water Quality Samples – In addition to the storm event samples collected in the intensive two-year study, storm event grab samples collected over a four-year period were also compared. Water quality samples have been collected at the Florida Aquarium during and after storm events since 1997, but the early samples were grab samples and the later samples were flow-weighted taken using automated equipment. Since the storm samples in this study only compare concentrations at the outflow of the pond it was theorized that by the time water was discharged, it would be well mixed and perhaps there would be no statistical difference between samples. To test this theory grab samples were compared to the results of composite samples for 21 rain event in the Building pond and for 13 storm events in the Street pond (Appendix A). Almost all samples measured significantly higher concentrations at the outflow with grab samples (Mann Whitney test, alpha=0.10). The exceptions were ammonia and total nitrogen, which showed no significant differences. The data for this test can be found in Appendix A-2 to A-5. Even though differences were noted, concentrations for the four years were compared to each other and to State Water Quality Standards.

Comparison to State Standards - Water quality concentrations were compared to State of Florida Water Quality Standards (Ch 62-302 FS) to determine percent exceedances (non-compliance) of standards. Data were compared to both Class II and Class III standards since both seemed appropriate for the site. Class II standards apply to levels considered safe for shellfish propagation or harvesting and since waters at the site discharge to an estuary it is desirable for water quality to meet these standards. Class III standards for marine waters are essentially the same as Class II marine waters for the parameters measured and are included with them in Table 5. In addition, water quality was compared with the Class III fresh water standards, which are the levels deemed detrimental for recreation and the propagation and maintenance of a healthy, well-balanced population of fish and wildlife. For metals, these standards are based on water hardness and a unique standard was calculated for each water sample. Standards for the parameters tested are listed in Table 3.

POND IMPROVEMENT TECHNIQUES

Drop Box Samples – The gross pollutants collected in the grate inlet skimmer box inserts at time of clean-out were analyzed by Columbia Laboratory for particle size using the dry sieve method. Representative aliquots of the material from the seven skimmer boxes were mixed together on a volume-weighted basis and two samples were extracted from the mixed material to send to the laboratory for analysis. Five different ranges of particle sizes were analyzed for selected metals, polycyclic hydrocarbons, organic matter, nitrogen and phosphorus. More detailed information about how samples were collected and combined can be found in Appendix A. Sample locations are in Figure 4.

Water quality samples were taken using a peristolic pump to determine the concentrations of constituents in storm water in the bottom of the drop boxes. A set of samples was taken 1) before the skimmer box inserts were installed, 2) during the period after they were installed and before the first clean out and 3) another set were taken between the first and second cleanout. These samples were analyzed by the Southwest Florida Water Management District laboratory and used the same procedures as the other water quality samples.

Table 5. A comparison of State Surface Water Quality Standards (February 1992 FAC Ch. 62-302). Standards are exceeded when pollutant concentrations do not meet the conditions given below. Units in ug/l unless Indicated.

Constituent	**Class II & III Standards - Marine**	**Class III Standards - Fresh**
Cadmium	> 9.3	$> e^{(0.7852[lnH]-3.49)}$
Copper	> 2.9	$> e^{(0.8545[lnH]-1.465)}$
Iron	>300	> 1000
Lead	>5.6	$> e^{(1.273[lnH]-4.705)}$; 50 max
Manganese	> 100	> 100 (mg/l) (Class II)
Zinc	> 86	$> e^{(0.8473[lnH]+0.7614)}$; $\geq$ 1000
Dissolved oxygen (DO)	5000; Normal daily and seasonal fluctuations above these levels shall be maintained (see rules).	5000; Normal daily and seasonal fluctuations above these levels shall be maintained (see rules).
pH	6.0 min. 8.0 max; ∀ 1.0 NB (standard units)	6.0 min 8.0 max; ∀ 1.0 NB (standard units)

lnH = natural logarithm of total hardness expressed as mg/l of $CaCO_3$. NB = Natural background.
If hardness is less than 25 mg/L then use 25 mg/L or greater than 400 mg/L then use 400 mg/L

Diversion Structure – The diversion structure was installed near the end of the monitoring period and difficulties with the outflow pipe becoming detached limited water quality monitoring to eight rain events. The concentrations were determined by the same laboratory methods as the other water quality samples and the timed- weighted samples collected were compared to the much larger number of flow-weighted samples collected during the previous two years.

Biocultures – Two types of proprietary microbial products were tested in the pond to try to reduce the amount of floating vegetation. To assess their effect water quality samples after the product was introduced were compared to samples taken before the treatment. Hydrolab measurements of dissolved oxygen, pH, temperature and conductivity were also measured.

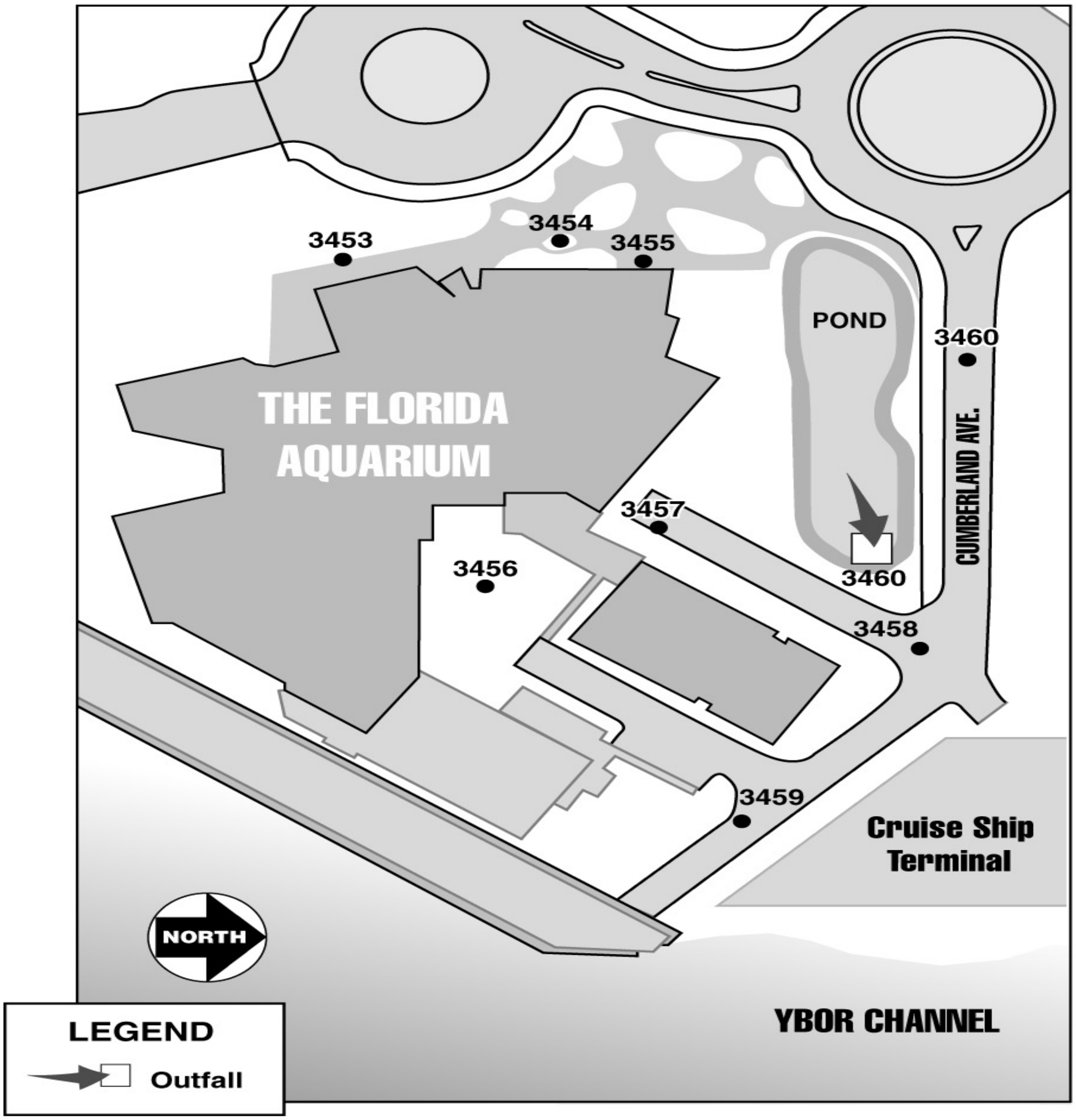


Figure 4. Location of drop boxes that drain into the pipe system that discharges into the Building pond. The skimmer box inserts were installed in these drop

boxes.

RESULTS AND DISCUSSION

This study was designed to compare three different types of stormwater wet ponds -- an effluent filtration system (Street pond), a wet detention pond (Building pond), and a low impact parking lot design (Parking Lot pond). The ponds were named for the major type of runoff they received. The report is divided into three sections: 1) The intensive study evaluates storm event sampling in the Building and Street ponds for two years using automatic monitoring equipment. The Parking Lot pond had been eliminated to build a cruise ship terminal. 2) The pond characterization study compares water quality, sediments, field parameters and the biota covering a four-year period for the three ponds. 3) The pond improvement study evaluated methods to enhance stormwater treatment and pond aesthetics.

INTENSIVE STORMWATER MONITORING STUDY

Although data were collected at the site between November 1996 and November 2003, only the 2001 and 2003 years represented an intensive monitoring effort. The two years of data in this section place special emphasis on comparing the hydrology and water quality at the outflow of two types of stormwater management systems. Once automatic equipment was installed, the complete hydrology measured in 15-minute increments was recorded and flow-weighted water quality samples could be collected. For storm events, the data are compared in two ways: 1) Year one and year two are divided by the construction period, and 2) Data-year-one and data-year-two are for comparable 10-month periods (November through August). In addition, rainfall characteristics and outflow data were analyzed for storm events.

Construction activities complicated some of the measurements and also interrupted data collection for an eight-month period. For year one, the outflow and the under drains in both the Street and Building ponds were compared, and for year two, the monitoring in the under drain in the failed filtration system of the Building pond was discontinued and monitoring was initiated in a new under drain installed in the Street pond. The control elevations of the outfall weirs, the bleed down pipe and the under-drain pipe are shown in Appendix C to compare with pond levels. The storms with water quality data are numbered for easy cross-reference with other data. Although some water quality samples have been collected in the ponds for over five years, only the water quality and flow data from November 2000 through August 2001 (year one) and July 2002 through November 2004 (year two) are presented in this section and water quality data for four years, which include both composite and grab samples, are compared later.

Hydrology Measurements

Continuous hydrology measurements were made of rainfall, pond elevations and water levels in the underdrain pipes to analyze rainfall characteristics, pond levels and flow amounts.

Amount of Rain - Florida normally has wet and dry seasons with sixty percent of all rainfall occurring during the four summer months between June and October. The different storm patterns occurring in summer and winter are the result of atmospheric currents from both the tropics and temperate latitudes caused by changes in the global wind belts. Seasonal wind changes bring the Tampa Bay region within the westerlies in winter and the northern margin of the tropical easterlies in summer. The summer rainy season is a result of this changeover. In June the upper flow over the Florida peninsula changes from northwesterly to southerly as a trough moves westward and becomes established in the Gulf of Mexico (Barry and Chorley 1976). This deep, moist southerly airflow provides appropriate conditions for convective storms. When this air passes over land, it is heated during the day, lifted aloft and as it rises, the water vapor within it condenses, clouds form and convectional storms bring rainfall. These conditions help make Tampa an area of intense thunderstorm activity. Also in summer, some easterly waves from the tropics may intensify and organize into circular motion resulting in tropical storms and hurricanes bringing several days of rain. In winter, fewer storms of longer duration occur as the westerlies push in frontal storm systems from the north. Since frontal storms rarely make it this far south in the spring and fall these are usually dry months, especially in the fall (October- November) and spring (April - May). El Nino years can change this typical pattern.

Rainfall at the site is compared to the long-term average for the region in Figure 5. During the first year of the study (ten months), the area was experiencing a drought and rainfall was considerably below normal (26 inches) compared to the long-term average (44 inches). During the ten months of construction activity summer tropical storms made up for the below average rainfall for the rest of the time period and rainfall at the site was 39 inches compared to 37 inches for the historic record. During the seventeen months of data collected during the second year, El Nino conditions increased rainfall at the site to above average levels (100 inches) compared to the long-term average (88 inches).

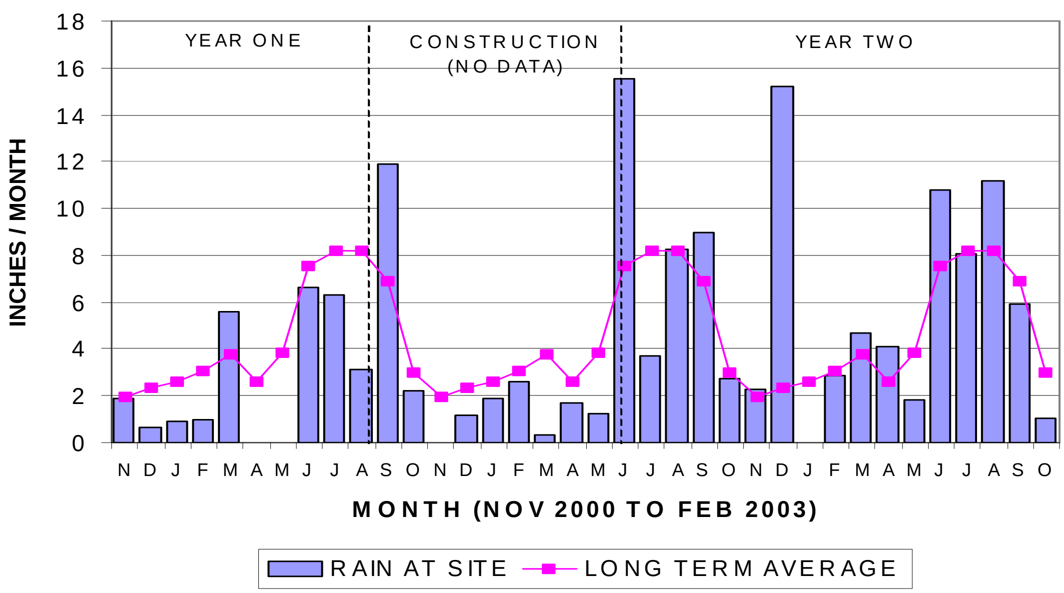


Figure 5. Amount of rain measured each month during the study compared to the

long-term rainfall average for the region.

Rainfall Characteristics - The intensity and duration of rain events are relevant to water quantity concerns by causing flooding and elevated peak discharges, especially in urban areas where much of the ground surface has been covered in concrete. The increase in impervious area also intensifies runoff problems by increasing pollutants and decreasing infiltration. Rainfall characteristics are summarized in Table 5 and all the data are recorded in Appendix B.

Table 5. A summary of rainfall characteristics measured for most rain events that produced flow (rain > 0.23 inches). All the data are in Appendix B.

SUMMARY STATISITCS	TOTAL RAIN (in.)	INTER-EVENT (hrs.)	DURA-TION (hrs.)	MAX. INT. (in./15 min.)	AVG. INT. (in./hr.)
YEAR ONE (NOVEMBER 2000 THROUGH AUGUST 2001) TOTAL RAIN=26.00 INCHES					
# Observations	31	31	31	31	31
Average	0.84	218.47	3.08	0.48	0.45
Median	0.60	97.50	2.50	0.40	0.21
Maximum	3.29	1525.50	11.75	1.40	2.40
Minimum	0.23	14.25	0.25	0.03	0.02
Std Deviation	0.67	315.76	2.95	0.38	0.61
Coefficient of Variation	0.80	1.45	0.96	0.79	1.35
CONSTRUCTION YEAR (SEPTEMBER 2001 THROUGH JUNE 2002) TOTAL RAIN=34.3 INCHES					
# Observations	27	26	26	26	26
Average	1.27	291.81	5.07	0.47	0.47
Median	1.01	198.63	2.63	0.39	0.31
Maximum	6.10	1053.25	36.75	1.28	1.71
Minimum	0.30	9.25	0.75	0.07	0.04
Std Deviation	1.13	294.99	7.20	0.34	0.45
Coefficient of Variation	0.89	1.01	1.42	0.73	0.96
YEAR TWO (JULY 2002 THROUGH OCTOBER 2003) TOTAL RAIN=99.68 INCHES					
# Observations	91	91	91	91	91
Average	0.91	125.82	5.03	0.30	0.34
Median	0.62	74.50	3.75	0.22	0.18
Maximum	4.64	1120.25	29.50	1.00	2.92
Minimum	0.22	6.25	0.25	0.04	0.04
Std Deviation	0.88	156.96	4.62	0.22	0.43
Coefficient of Variation	0.97	1.25	0.92	0.72	1.27
YEAR TWO (NOVEMBER 2002 THROUGH AUGUST 2003) TOTAL RAIN=57.97 INCHES					
# Observations	56	56	56	56	56
Average	1.04	127.37	5.68	0.31	0.36
Median	0.71	72.00	3.75	0.23	0.18
Maximum	4.64	1120.25	29.50	1.00	2.92
Minimum	0.22	8.50	0.25	0.05	0.04
Std Deviation	1.01	182.28	5.29	0.21	0.49
Coefficient of Variation	0.98	1.43	0.93	0.68	1.37

When comparing rainfall characteristics between year one and year two, differences were noted. As explained above, 2001 was a drought year compared to 2002 and 2003, which exhibited rainfall more typical of the long-term average. Drought conditions also affected the rainfall characteristics. The average storm in year two was 1.04 inches compared to 0.84 inches in year one, however, median concentrations were almost the same (0.62 vs 0.60 inches) indicating that a few large storms skewed the data for year two. The average number of hours between storms was almost twice as long for year one reflecting not only a greater percentage of winter months (dry season) in the record, but also the drought conditions. Other differences showed storm durations were greater in year two while storms were more intense in year one. When two comparable ten-month periods were evaluated almost twice as many storms were measured for data-year-two, which also had greater rain amounts (1.04 vs 0.84 inches), half the average inter-event dry period and longer storm durations with less rainfall intensity (Table 5).

Rainfall characteristics influence pollutant concentrations and removal efficiencies in several ways. Antecedent conditions (inter-event dry period) and rainfall intensity increase pollutant concentrations by providing time for accumulation on land surfaces as well as the rain energy to dislodge soil particles and other pollutants from the watershed. The size of the rain event also affects receiving waters. Small rain events account for 50 to 70 percent of all storms in our region, but produce only 10 to 20 percent of the runoff volume (Burton and Pitt 2002). The authors further explained that medium-sized events (from 0.5 inches to several inches in depth) contribute the majority of runoff volume and mass pollutant discharges. Therefore, the medium sized storms are likely responsible for most of the biological effects in the receiving waters (especially habitat destruction and sediment contamination). In addition, the few large storms (greater than several inches) also have a greater effect with the ability to flush out a stormwater system. This is especially true for discharging floating algae mats, phytoplankton and other organic matter from wet ponds into the receiving waters as well as depositing large amounts of pollution into the pond. Also wet and dry years affect input and output concentrations by changing subsurface flow and evapotranspiration. Some researchers have found that precipitation tends to contain contaminants at higher concentrations in short storms and when precipitation is infrequent (Mitsch and Gosselink 1993). This suggests that the washout effect, with rainfall purifying the air, is prevalent in short storms, while longer rainfall events dilute stormwater with better quality water.

Water Levels - The purpose of the data collection effort in this section was to compare two types of wet ponds used for stormwater treatment. The water levels at the outflow of the ponds for all the data are compared in Appendix C. The figures in Appendix C show the response of the ponds to specific amounts of rainfall and how pond levels relate to their weir configurations. For the Street pond (the effluent filtration system) the control elevation is the bottom of the draw down pipes (6.00 ft NGVD) and the overflow elevation is the top of the weir (6.99 for year 1 and 7.17 for year 2). A diagram of the underground filter system is in Figure 2. For the Building pond (a wet detention pond) the control elevation of the bleed down orifice is shown on the graphs as 5.83 and the over flow weir elevation is 7.49. More exact measurements for weir levels can be found in Appendix A. The figures in Appendix C were useful in making more precise measurements for elevations in relation to our measuring devices and they also provide a record of problems with the recording sensors.

Water levels are also useful for comparing the reaction of the two different types of ponds to storm events. A comparison of the water levels in the two ponds indicate similar responses to rainfall, although the smaller wet detention pond with a bleed down pipe (Building pond) fluctuates more widely than the effluent filtration system with under drains (Street pond) Figure 6. The pond levels in Figure 6 indicate that a level of 7.50 NGVD looks reasonable for the top of the overflow weir in the Building Pond and 7.17 is reasonable for the over flow weir in the Street Pond. The control elevation for the under drain system in the Street pond is 6.00 NGVD, but it appears that flow into the under drains slows considerably at 6.5 NGVD. In general the bleed down structure in the Building pond discharges water at a slightly more rapid rate than the under drain pipes in the Street pond. The levels indicate that the under drain system in the Street pond is still operational after seven years, even though it has received no maintenance, although it may have been cleaned out during cruise ship terminal construction and the installation of an additional underdrain system on the north side of the pond.

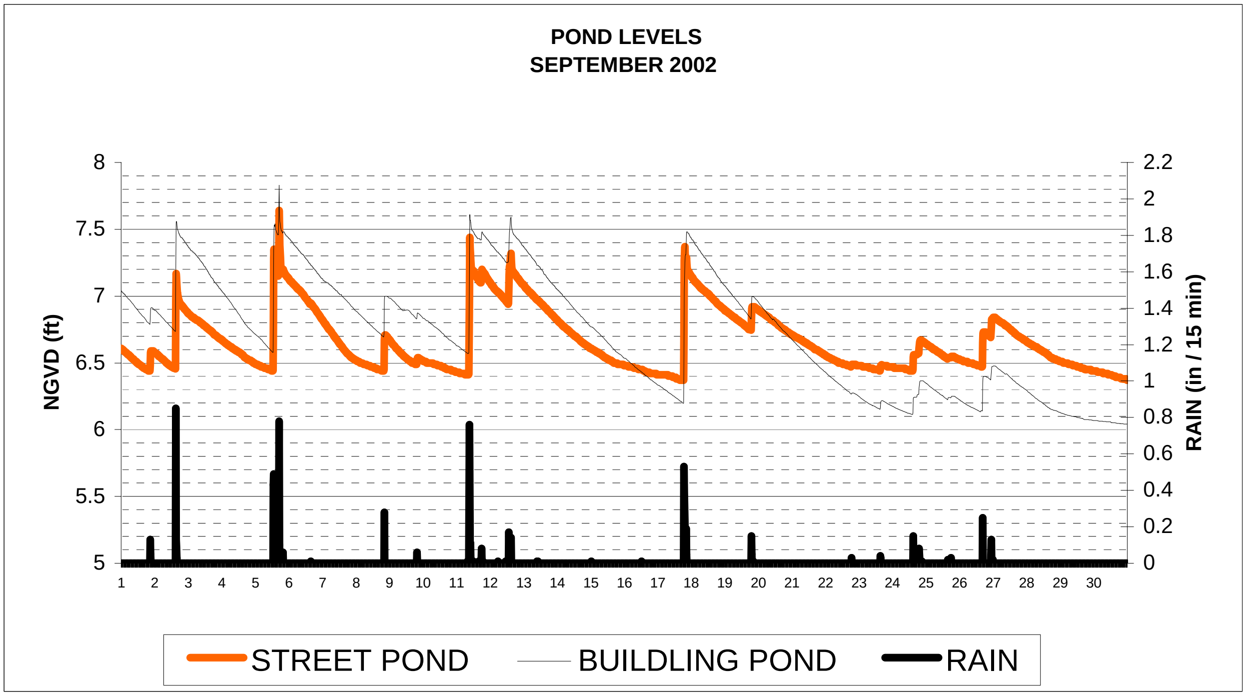


Figure 6. Comparison of pond levels in response to rainfall after the cruise ship terminal construction.

Since the outfall structure was changed and an additional under drain had been installed for the water levels described above. The same water level analysis was applied to data collected before the cruise terminal construction (Figure 7). The Building pond was not altered by the cruise ship terminal construction, but the Street pond outfall structure was rebuilt. The shape of the filtration pond and the outfall weir were altered to accommodate an access road, while an additional under drain system was installed on the north side of the outfall weir structure (see Figure 1b). Before construction the over flow weir for the Street pond was at 7.04 NGVD and this level looks reasonable from the behavior of the water level in the pond. The decline in water levels through the under drain pipes show water discharge out of the pond but the flow decreases at about 6.3 NGVD even though the bottom of the under drain pipes are at 6.00 NGVD. The water level sensor in the Street pond is located at 5.4 NGVD and the bottom of the pond level where the water level is measured is at 5.8 NGVD explaining the flat line for the lower water level readings and the steep decline after water in the stilling well went below the bottom of the pond on June 16th. Once again, the water levels indicate the under drain pipes are functioning. As in the previous analysis, the Building pond shows slightly wider variations than the Street pond. The control elevation for the bleed down orifice for the Building pond is located at 5.8 NGVD, which is also indicated by the change in water levels. All the water level information for each month of the project is shown in

Appendix C with the top of weir elevations and the draw down or bleed down elevations indicated on the figures.

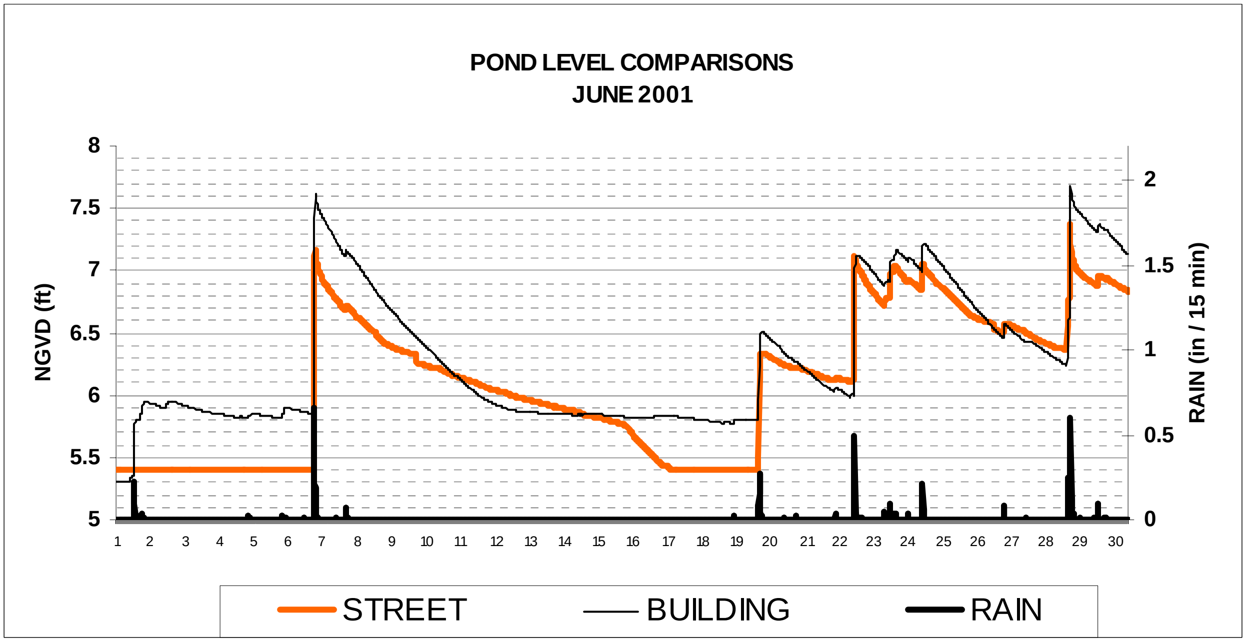


Figure 5. Comparison of pond levels to rainfall before the cruise ship terminal construction.

Pond Designs – Hydrology is important in designing effective stormwater ponds. The ponds must take care of a reasonable amount of runoff and pollution without costing too much or causing flooding upstream. To meet these goals, calculations are made to treat the runoff from a percentage of all storm events given a minimum inter-event dry period. If all the runoff water from 90 percent of the storm events can be treated in the pond, it is assumed the pollutant mass loads associated with 90 percent of the storm events will be removed (Wanielista and Yousef 1993). The runoff from all storm events with one inch or less of rainfall are specified to be treated in Florida (Livingston 1989). For the Street pond, it is estimated that 49 percent of inflow during year one and 32 percent of inflow during year two were discharged over the outflow weir and bypassed the under drain filter system. No comparable calculations could be made for the Building pond since no inflow data were available, but an analysis of the number of times the ponds discharged over the weir during storm events indicate that most of the storm water would have been slowly released through the bleed down orifice. Out of the 66 storms over 0.10-inch depth measured in data-year-one, 20 storms (30%) discharged some water over the weir in the Street pond, while the Building pond only discharged 7 storms (11%) over the weir. Considerably more rainfall occurred during data-year-two and another under drain was added to the Street pond. Out of the 80 storms over 0.10-inch depth measured during that year, 28 (35%) discharged over the outfall weir in the Street pond and 24 (30%), in the Building pond. For data-year-one, only 7 storms were greater than one inch, while in data-year-two, 18 storms measured rainfall greater than one inch. It should also be noted that for small drainage areas less than 100 acres, only the first one-half inch of runoff has to be treated in effluent filtration systems, but one inch of runoff still has to be treated in wet-detention pond. Although reducing runoff volume is important in protecting receiving waters, the pollution in runoff is also of concern.

Water Quality Measurements

Constituent chemical concentrations in rainfall and in storm water discharge over outfall weirs were analyzed to determine effects on receiving waters.

Overflow Weir Storm Water - A comparison of water quality concentrations measured in rainfall and at the outflow of the ponds demonstrates differences between the two ponds and between years (Figure 8 and Appendix D). This section compares water quality discharged from the two ponds over the bypass outfall structures. The discharge through the under drain systems are discussed in a later section and more complete information about the entire effluent filtration system is available in a companion report (Teague and Rushton 2005).

Nitrogen – The various forms of nitrogen exhibit a complex cycle where different chemical states are continually involved in transformations and other processes. A simplified explanation might describe the cycle as an organic carbon source providing the energy for use by organisms to transform nitrogen by ammonification, nitrification, denitrification, fixation and assimilation. Natural systems have developed over time to balance the cycle, but anthropogenic nitrogen concentrations discharged by modern technology have increased nutrients in storm runoff far beyond the levels that natural systems have adapted to. These nitrogen sources include agriculture, automobiles, power plants, urban yards and many industries. Nitrogen compounds are of great concern in stormwater ponds because of their role in eutrophication and their effect on the oxygen content of receiving waters. On the other hand, nitrogen is an essential nutrient for plant growth, which in turn is utilized by wild life. Striking the correct nutrient balance before water is discharged from stormwater ponds is the goal of management, but achieving these reduced nitrogen levels often results in rampant plant growth in stormwater ponds, which is objectionable to some people.

Concentrations of nitrogen are a reflection of pond conditions (Figure 8). Ammonium nitrogen is the preferred form for plant growth, and it is formed by the decomposition of dead plant material, which under anaerobic conditions, is microbially converted to nitrates (Kadlec and Knight 1996). Low levels are considered 0.05 to 0.10 mg/l and plant growth increases as more ammonium is added. These low concentrations were measured in the discharge water in the Street pond, but higher levels than these were measured in the Building pond and in rainfall.

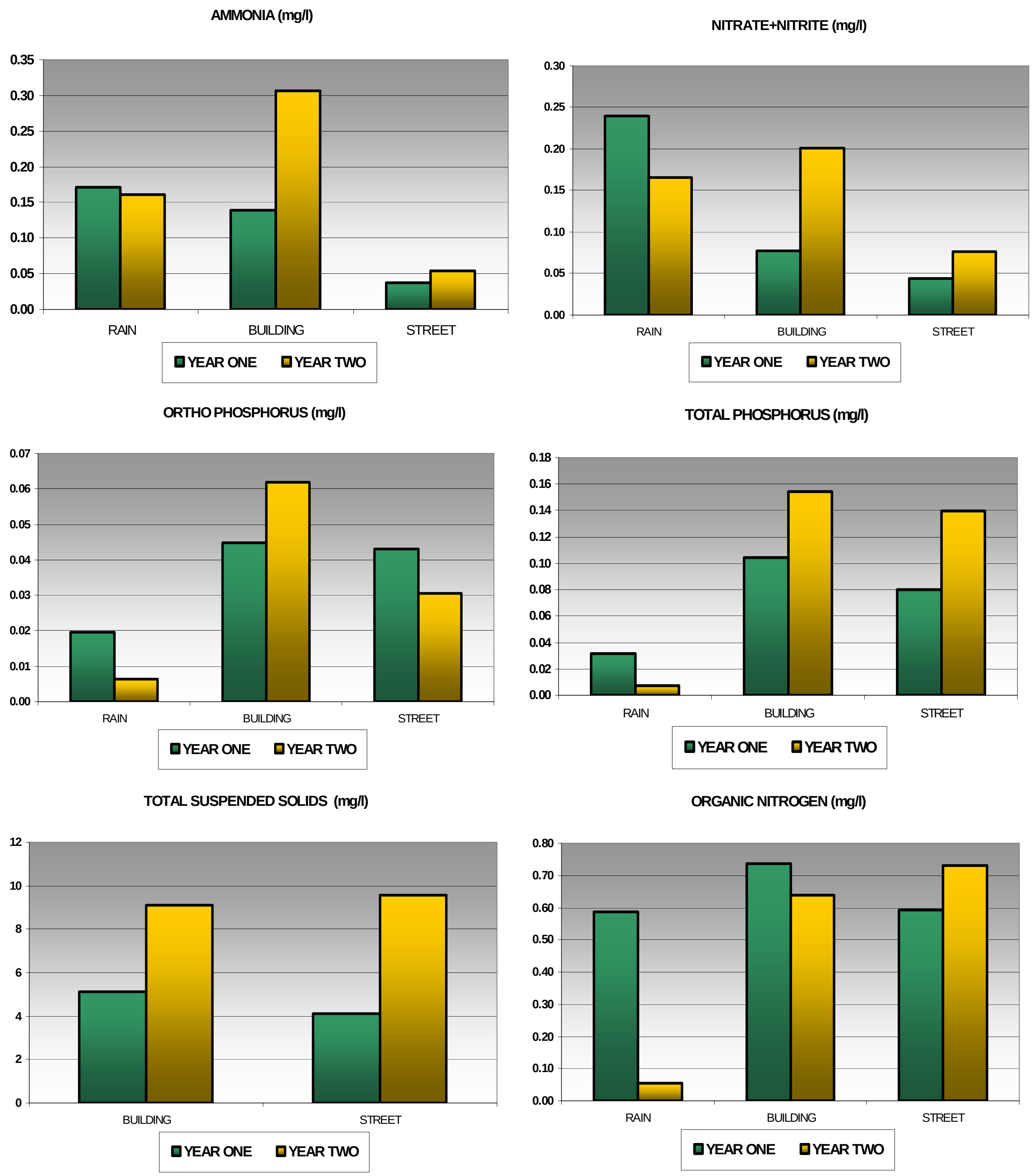


Figure 8. Nutrients measured in rainfall and discharge water over the outflow weir. It includes averaged data from November to August for both year one and year two.

Nitrate is usually measured at low levels of about 0.10 mg/l in natural wetlands since conditions of the necessary carbon source and anoxic conditions favor denitrification (Kadlec and Knight 1996). Nitrate was measured higher than this level in rainfall and during the second year of the study in the Building pond, but concentrations measured in the discharge water at the overflow weir were well below 0.10 mg/l for both years in the Street pond. Organic nitrogen is formed in wetlands as a product of biomass decomposition, which degrades to ammonium nitrogen (Kadlec and Knight 1996). In natural wetlands, the result is a low concentration of organic nitrogen concentration of approximately 1 to 2 mg/l. Organic nitrogen was measured at much lower levels than that in the Florida Aquarium ponds.

Phosphorus – The introduction of even trace amounts of phosphorus into receiving waters can have a profound effect on the structure of aquatic systems. Although phosphorus is a required nutrient for plant growth, even small increases can upset the balance of aquatic systems. In inland waters, it is often a limiting factor and small concentration increases can cause a shift in the trophic state of receiving waters. Unlike nitrogen, rainfall is not a significant source for phosphorus, but phosphorus is introduced into the pond environment by soil erosion, construction activities, fertilizers, cleaning products, and vegetation cycling. Pathways for the removal of phosphorus in the water column are sedimentation and the sorption of phosphorus to soil particles. Unlike nitrogen, which has a gaseous phase, phosphorus is bound up in the sedimentary cycle and is released back into the water column by low dissolved oxygen as part of the redox cycle. Although phosphorus is not directly altered by changes in redox as are nitrogen, iron, manganese, and sulfur, it is indirectly released from soils and sediments by its association with these elements, especially iron. In fact, the buffer capacity of the sediment, which determines how much phosphate can be adsorbed or desorbed is determined by the concentration of iron oxides, which in turn are dependent on oxygen. In highly productive (eutrophic) systems such as storm water ponds, phosphorus can be sorbed during the day when dissolved oxygen is high only to be released by sediment organisms at night in response to anoxic conditions (Hamelink *et al*. 1994). Even in oxygen rich sediments, once soil attachment sites are occupied, they are no longer available for phosphate removal. Also, if phosphorus is bound up in the plankton, it may subsequently decompose to release soluble phosphorus.

Phosphorus was measured at relatively low concentrations at the outfall of both stormwater ponds at the Florida Aquarium (Figure 8). Most pristine natural wetlands have total phosphorus concentrations less than 0.1 mg/l, although some oligotrophic wetlands such as the Florida Everglades are adapted to much lower levels (0.01 mg/l) (Kadlec and Knight 1996). The total phosphorus concentrations for the first year in both ponds were measured either near or below 0.1 mg/l, but these concentrations had increased to greater than 0.14 mg/l in the second year. Rainfall TP can range from 0.01 to 0.05 mg/l depending on land use with average values more commonly 0.02 to 0.04 mg/l (Kadlec and Knight 1996). These levels are consistent with the concentrations measured in rainfall at the Florida Aquarium.

Total Suspended Solids (TSS) – The term suspended solids is descriptive of the organic and inorganic particulate matter which is of a size and type that allows the particles to stay suspended in water. Suspended sediments decrease light penetration and photosysthesis, clog gills and filtering systems of aquatic organisms, reduce prey capture, reduce spawning, reduce survival of sensitive species, and carry adsorbed pollutants (Burton and Pitt 2002). Most suspended particles measured in stormwater are less than 45 um in size (Stahre and Urbonas 1990). TSS is of importance in understanding stormwater pollution since it is believed that most pollutants appear to have a strong affinity to suspended solids, but there are exceptions especially for dissolved and soluble constituents (Stahre and Urbonas 1990).

The total suspended solids in the Aquarium ponds were measured at reasonably low levels (4 to 10 mg/l) (Figure 8). High TSS concentrations are more easily reduced than low concentrations, and a lower limit of 10 to 20 mg/l has been estimated as the boundary when no further sedimentation occurs (Stahre and Urbonas 1990). Low concentrations of suspended solids (average values less than 5 mg/l for year one and less than 10 mg/l for year two) measured at the outflow of these two ponds are consistent with other research results which have shown that stormwater ponds are effective for removing suspended solids.

General Trends - Some general trends in nutrient concentrations measured for storm events in the Aquarium ponds were shown in Figure 8. These include: 1) average constituent concentrations measured higher in the Building pond than in the Street pond, 2) higher average concentrations of nutrient and suspended solid during the second year in both ponds, 3) higher concentrations of ammonia and nitrate are usually measured in rainfall than at the outflow of the ponds, and 4) concentrations in rainfall were measured much lower during the second year. Some explanations for these results are discussed below.

The higher concentrations measured in the Building pond resulted from the fact that the three inflow pipes discharged near the outflow weir and pollution did not have an opportunity to travel through the littoral zone at the far end of the pond. In fact, stormwater was discharged almost as soon as it entered the pond for the higher flows. A diversion wall to direct flow into the littoral zone was installed near the end of the monitoring period, and these results will be discussed in a later section. Another reason for elevated nutrient levels in the Building pond was the different type of drainage basins. The Building pond received runoff from a plant nursery, garden areas and a delivery loading dock, all of which contribute nutrients. In addition, the loading dock has a sump pump, which discharges directly into the pond during high water levels. This water has everything from garbage, cleaning supplies, fish food, and much more. Although street runoff contains high levels of oils, greases, metals and sediments, the only nutrients it receives are from rainfall, which resulted in lower nutrient concentrations entering the Street pond. The sources of these solids are primarily from dry deposition, roadways, construction, and erosion.

The higher concentrations measured during the second year of the study indicate the more intensive use of the land during year two. Year one represented pollution from construction activity, but year two included more traffic, more people and additional activities with the opening of the cruise ship terminal and better access to the Aquarium. Also year one was a drought year and the ponds experienced longer inter-event dry periods (on average 218 hours compared to 127 hours in year two (See Table 5). The longer average time water stays in ponds before being flushed out with another storm event, the more time pond processes have to reduce pollutant concentrations.

Not all constituents increased in the ponds during the second year. The lower organic nitrogen measured in the Building pond was the result of the Hillsborough County Adopt-A-Pond program cleaning out the cattails and bottom sediments indicating an improvement in pond performance from maintenance practices. One explanation for the reduction of ortho phosphorus in the Street pond during year two may have been the re-contouring of the filtration basin and the exposure of deeper soils with available attachment sites to remove soluble phosphorus.

Rainfall has been identified as a source of inorganic nitrogen by many researchers. For example, about 25 percent of the nitrogen that enters Tampa Bay comes into the bay directly from rainfall on the bay (TBEP 2000). A general trend of reduced concentrations of constituents in rainfall for data-year-two may have been the difference between drought and rainy conditions. Some researchers have found that precipitation tends to contain contaminants at higher concentrations in short storms and when precipitation is infrequent (Mitsch and Gosselink 1993). This describes the differences between data-year-one with an average of 218 days between storm events and averaging 3 hours compared to data-year-two with 127 days between events and averaging 5 hours. More frequent storms clear the air and since more pollution occurs in rainfall during the first part of a storm, longer storms produce more rainwater uncontaminated by air pollution. Another explanation may have been the location of the rain collector, which was located in the construction storage yard that generated a lot of dust in year one and in a vegetated low traffic area in year two.

Metals – The metal concentrations in the storm water discharged over the outflow weirs of the ponds exhibit many of the same patterns as the nutrients and suspended solids and for the same reasons (Figure 9). Metals are a concern in urban runoff with loadings 10 to 100 times greater than the concentration of sanitary sewage (USEPA 1983). Heavy metal sources are largely associated with the operation of motor vehicles, atmospheric fallout and road surface material.

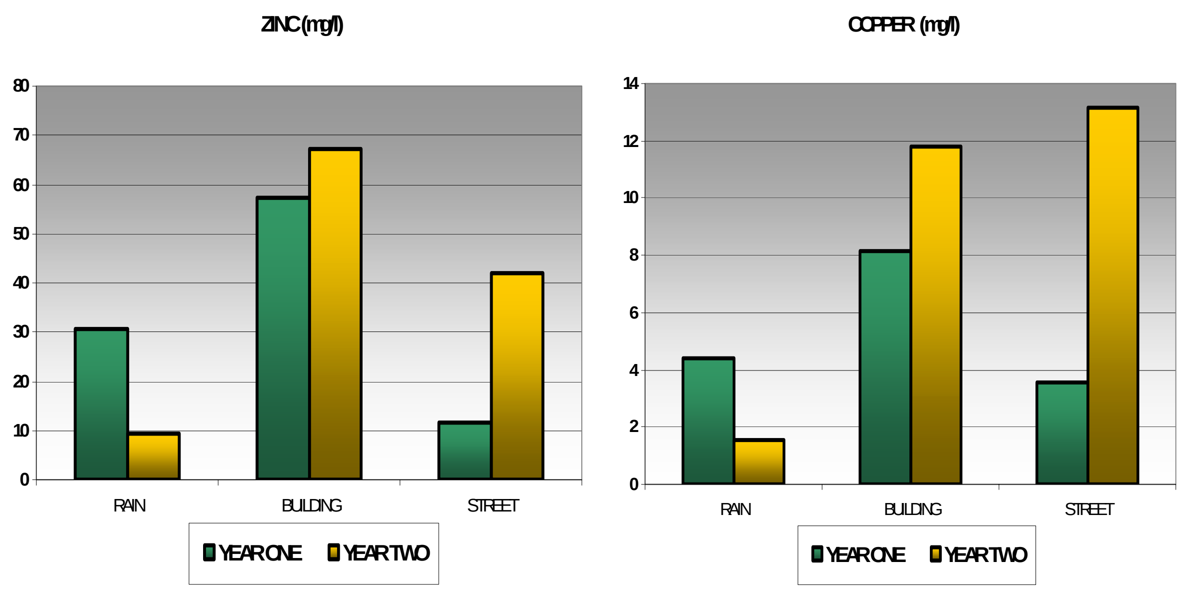


Figure 9. Metals measured in rainfall and storm water discharged over the outflow weir. It includes data from November to August for data-year-one and data-year-two. Cadmium and lead were also analyzed but over half the samples were below the laboratory detection limit.

Metals at the Florida Aquarium ponds were frequently measured below the laboratory detection limit, except for copper and zinc, which were measured at higher concentrations (Figure 9 and Appendix D). These are the same metals that The National Urban Runoff Program (USEPA 1983) showed were the most abundant and detected most frequently in stormwater. Zinc was measured at the highest concentrations in the Building Pond. Zinc is often used in roofing material and many researchers (Pitt 2000 and others) have found higher zinc levels in roof runoff, which helps explain the increased concentrations of zinc in the Building Pond. In addition, the Florida Aquarium site is located adjacent to the city incinerator and a marine dry dock and had significantly higher loads of metals measured in atmospheric deposition than other sites in the Tampa Bay region (Dixon *et.al.*1998). Metal concentrations were also compared to state water quality standards and some exceedances were found. These will be discussed in a later section when four years of water quality data at the site are compared.

Under Drain Samples - The under drain system of both ponds flowed continuously, therefore, samples do not necessarily represent storm flow, but they do represent discharge water. The under drain flow from the Street pond increases in response to storm events and indicates the system is working as designed. It was recognized early on that the under drain pipes from the Building pond were clogged and for that reason the outfall structure was modified to include a bleed down orifice to slowly release the storm water that was oriiginally designed to go through the under drains (see site description for more information). The level data for the Building pond substantiate the premise that the under drains are clogged and that the small amount of discharge represents ground water and/or infiltration from the pond (see Figures 6 and 7). Flow from this source is a small steady stream that does not respond to rain events. Dissolved nutrient concentrations from both systems are similar.

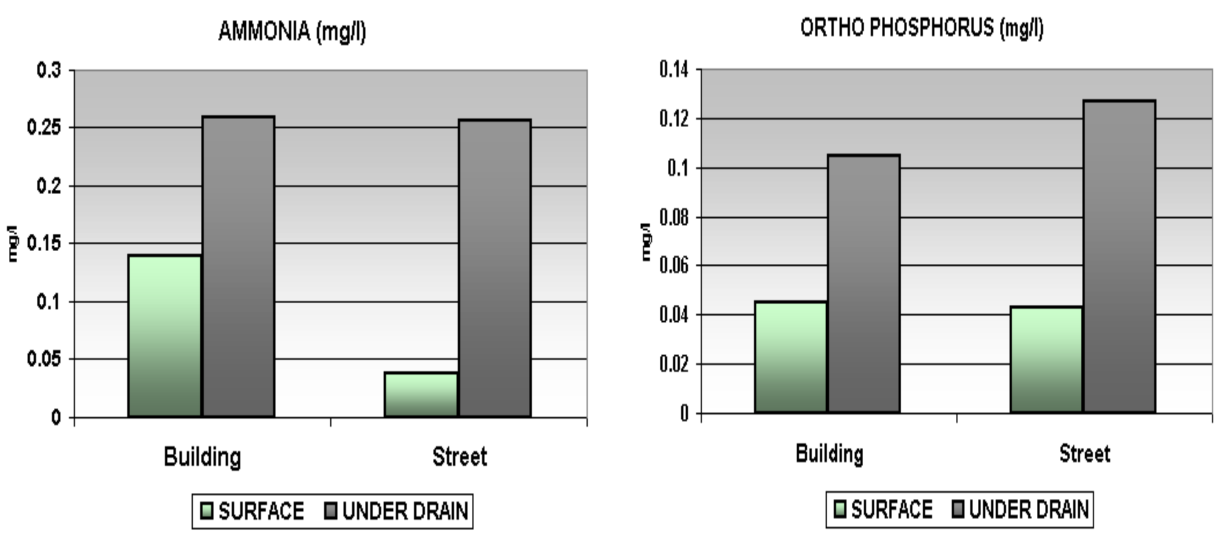


Figure 10. Comparison of ammonia and phosphorus concentrations in the ponds and in the under drain pipes for year one of the study.

Samples were collected from the under drains of both pipes during the first year of the study and the results provide some insight into the effect of ground water infiltration (Figure 10 and Appendix E). The under drains in the Street pond collect infiltration from ground water as well as direct flow from ground water through the system. It is believed that most of the water discharged from the Building pond under drains is from ground water that has been transported through the filter. The water flowing from the Street pond when the pond level was below the drawdown pipes probably represents groundwater and no storm flow. The surface water represents storm flows and the under drain water quality measures the averaged values for continuous flow (Figure 10). Much higher concentrations of ammonia and ortho- phosphorus are measured discharging through the filters than measured in storm water.

One explanation for this discrepancy was found when a complete water budget was constructed for the Street pond and an analysis of constituent concentrations was evaluated dependent on the level of the pond. The water budget for the Street pond during storm events estimated that 20 percent of flow was discharged over the outfall weir, 77 percent exited through the under drains and 3 percent was lost by evapotranspiration. It was also estimated that about 9 percent more water left the pond than was measured entering at the inflow. An analysis of the data for the Street pond, which divided the under drain discharge into storm flow and flow discharged when the water level in the pond was below the level of the draw down pipe substantiates some of the differences measured in the two under drain systems. The concentrations of ammonia and ortho-phospphorus are much higher when the level of the pond was measured below the level of the draw down pipes (Figure 11). A more complete analysis of the water budget and concentrations measured in the Street pond is available in a companion report (Teague and Rushton 2005).

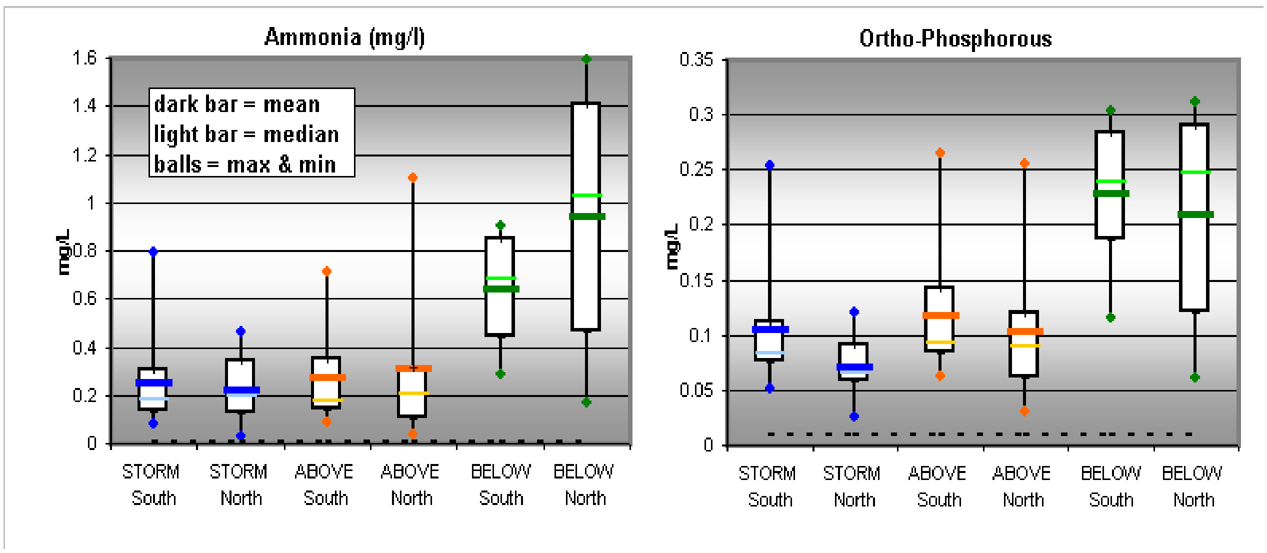


Figure 11. Box plots of under drain flow for ammonia and ortho-phosphorous during different pond levels. Key: storm event—STORM (blue), above the bottom of the under drain pipe (ABOVE (orange), and below the bottom of the under drain pipe—BELOW (green) (adapted from Teague and Rushton 2005).

Other studies have also measured higher levels of dissolved nitrogen and phosphorus in the under drain pipes of effluent filtration systems. For example, in the Lake Tohopekaliga Demonstration Project, Cullum and Dierberg (1990) measured concentrations of ammonia, nitrate, and soluble reactive phosphorus higher in the under drain outflows than in water within the pond. Harper and Herr (1993) also observed that concentrations of both ammonia and nitrate increased substantially during migration through the filter media at the DeBary detention with filtrations site. They also found increases of over 200% for outflow concentrations of ortho phosphorus through the filter media. Trapped organic particles of N and P on the filter media were listed as probable causes. It is this filterable form of pollutant that has a greater potential for affecting aquifers and is also the most difficult to control using conventional stormwater methods that rely on sedimentation principles (Pitt 1996).

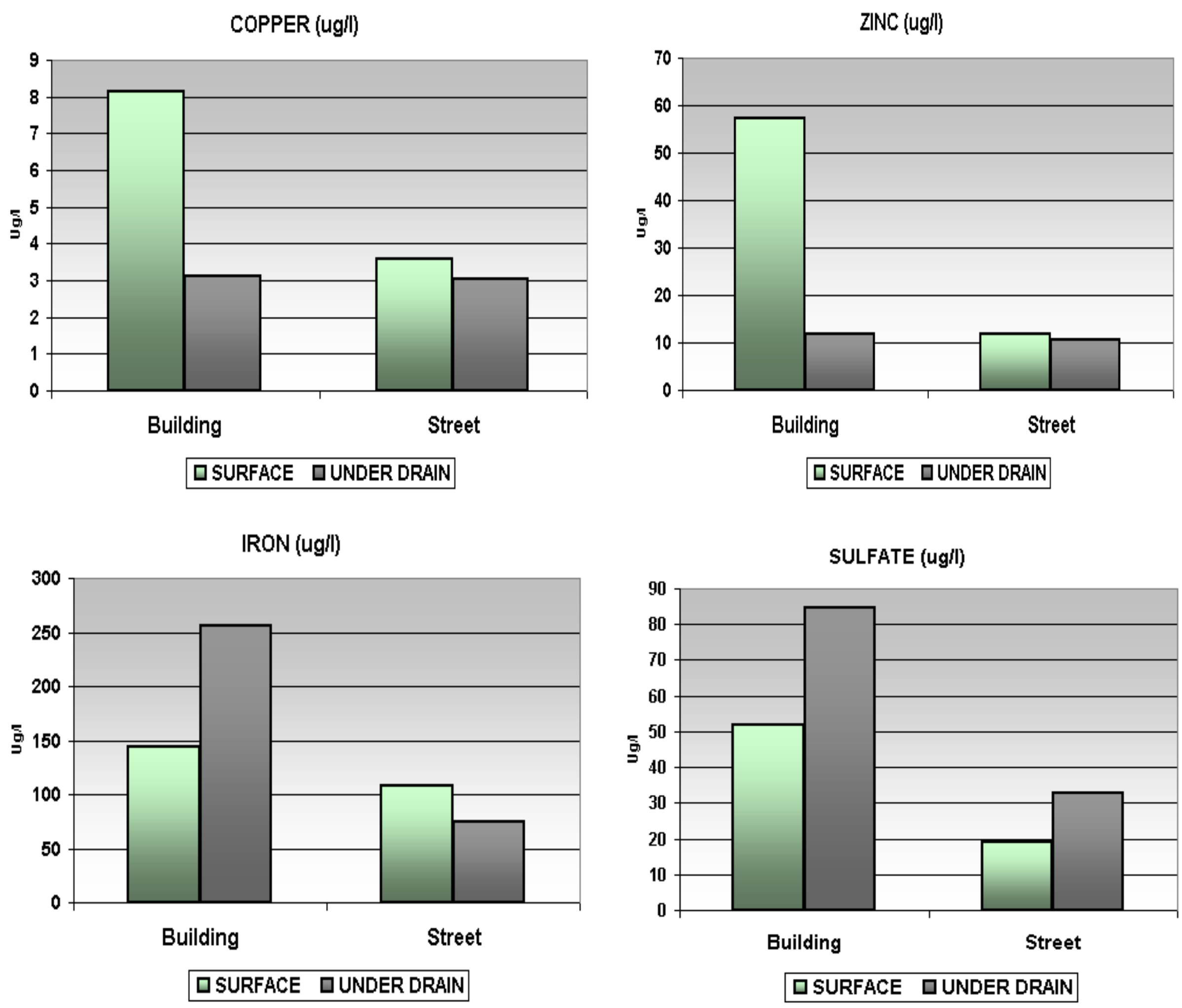


Figure 12. Comparison of copper, zinc, iron and sulfate concentrations measured in storm water compared to the discharge water of the under drain pipes.

Some of the pollutants that rely on sedimentation were usually discharged at concentrations near or below the laboratory quantification limit in the under drains and for the Street pond at the overflow weir as well. This was also true of copper, lead, zinc and total suspended solids measured in this study. Examples of copper and lead are shown in Figure 12. Some constituents, such as iron and sulfur, are often measured at higher concentrations in ground water than surface water and these were found in higher concentrations in the under drain pipes in the Building pond (Figure 12).

This analysis indicated that more study is needed to determine the effect of infiltration devices including those that are being proposed for low impact development swales and rain gardens. It may be that these devices will be increasing nutrients to the receiving waters. A more complete analysis than the one available from the data collected at this site needs to be conducted to determine the true nutrient reduction available. A study should also be conducted testing different filtration media. One question to be answered should be, are there more dissolved nutrients in ground water or is the filter media actually increasing these pollutants as suggested in some studies.

POND CHARACTERIZATION COMPARISONS

Data were collected at the site over a seven-year time period and included three types of stormwater treatment systems. Although not all of the flow and water quality data were collected using the more rigorous methods afforded by better monitoring equipment after November 2000, the results do provide insight into processes taking place. The three types of ponds are an effluent filtration system, a wet detention pond and a pond used for the final treatment of a low impact parking lot design. Although the parking lot pond was destroyed to construct the cruise ship terminal, there is enough preliminary data to make a comparison of that pond with the two monitored in more detail later. Data covering the interval from November 1996 to November 2003 are compared for field parameters, sediment, macroinvertebrates, fish and water quality.

Field Parameters

Physical water quality parameters are relevant to understanding the processes that influence constituent cycling in natural waters. During this study, dissolved oxygen (DO), pH, temperature, conductivity and occasionally redox potential were periodically measured with recording sensors. Several examples where the ponds can be compared to each other are shown in Appendix G. The contrast between ponds helps explain some of the constituent concentrations. An example for measurements taken during 1996 (Figure 13) demonstrates the differences between the three ponds. During the period of measurement, the Parking Lot pond was completely covered with algae, The Building pond was partially covered with floating duckweed, and the Street pond was mostly open with some floating algae. These conditions affected the fluctuations and concentrations of dissolved oxygen and pH. Although processes such as diffusion from the air, decomposition of organic matter, and calcium chemistry affect diurnal cycles, photosynthesis is the major driving force. Rainfall events also affect the fluctuations of field parameter.

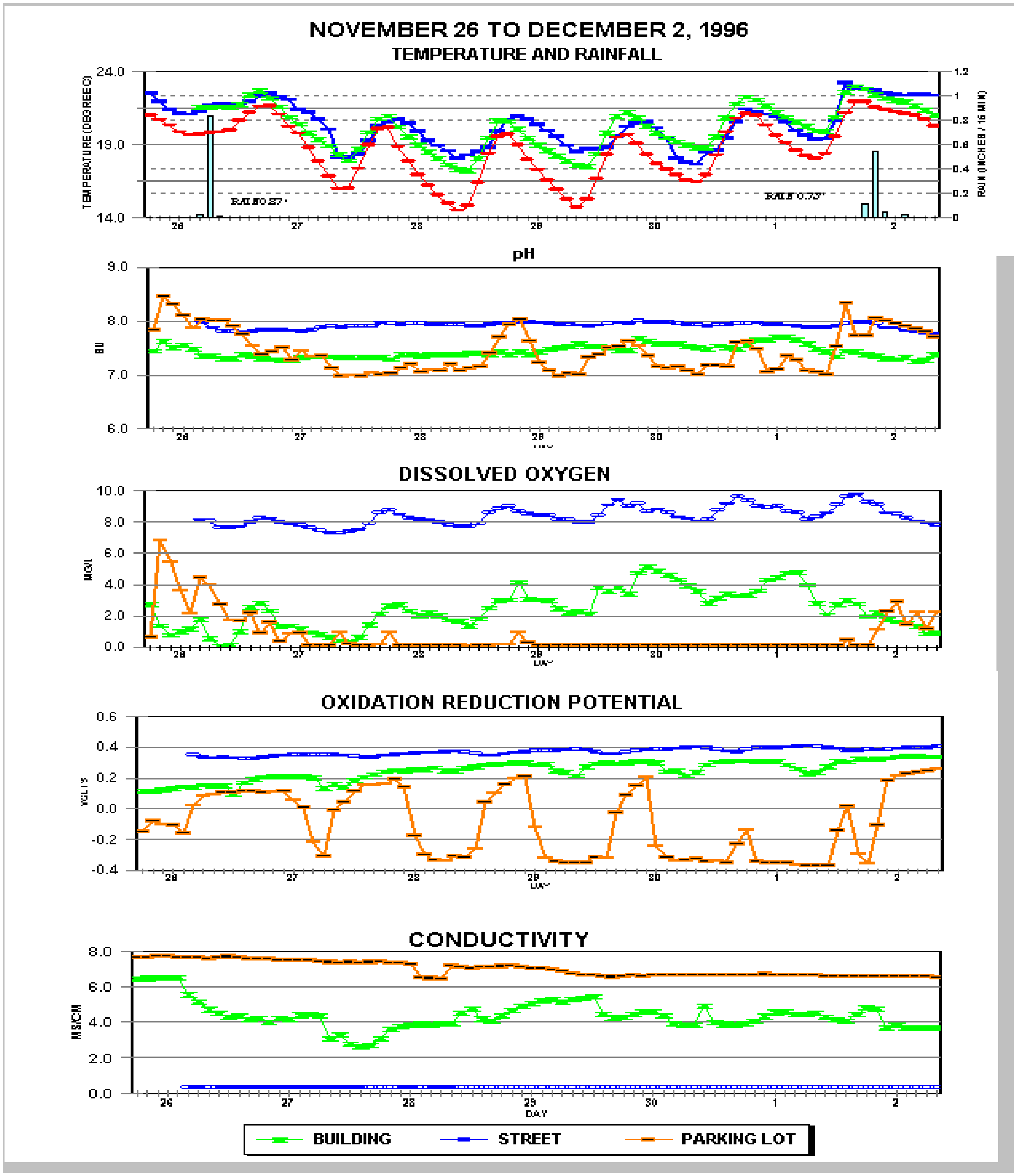


Figure 13. Hydrolab readings taken at one-hour intervals near the outfall of the three ponds.

Daily Fluctuations - Oxygen is the byproduct of photosynthesis, where green plants convert sunlight into chemical energy and give off oxygen during the day while both plants and animals consume oxygen through respiration at night. In aquatic environments, this is seen as the daytime increase and the nighttime disappearance of dissolved oxygen. In winter these fluctuations are dampened because of reduced sunlight and the dormant state of plants. Other conditions that suppress dirurnal fluctuations are floating vegetation or algae mats. These are the conditions shown in Figure 13 where the Parking Lot pond is covered with floating algae mats and winter conditions have dampened the fluctuations in the other two ponds.

Dissolved Oxygen - In productive (eutrophic) lakes and ponds in summer the cycle for dissolved oxygen and pH is quite pronounced indicating an abundance of biological activity is taking place and this is the pattern most often seen for the Street pond and sometimes when floating mats of vegetation are not present in the other two ponds (Appendix G). Since the process of photosynthesis requires sunlight for algal photosynthesis, it is suppressed in ponds with dense covers of floating vegetation. Anoxic conditions release phosphorous and metals from the sediments and aerobic organisms are more efficient transformers of pollutants, therefore, the State of Florida water quality standards set the minimum level for any 24-hour period at 5.0 mg/L with 4.0 mg/L as the absolute minimum. These low oxygen levels may have been one reason why higher concentrations of pollutants were discharged from the Building pond than from the Street pond.

pH of the Street pond exhibits the same diurnal cycle as oxygen because pH is also driven by photosynthesis. Photosynthesis during the day utilizes carbon dioxide and produces oxygen, thereby shifting the carbonate-bicarbonate-carbon dioxide equilibria to a higher pH. The cycle is reversed at night when respiration uses oxygen and gives off carbon dioxide. Diurnal pH fluctuations are not evident in systems covered in floating vegetation, which explains the much more moderated level in the Building pond. The pH is important because many treatment bacteria are not able to exist outside of certain ranges. This explains one reason the State of Florida has set a range between 6.5 SU to 8.5 SU for its water quality standard for pH unless natural conditions such as peat bogs exist. Denitrifiers operate best in the range $6.5 < pH < 7.5$, and nitrifiers prefer $pH = 7.2$ (Kadlec and Knight 1996). In addition to controlling various biological processes, pH is also a determinant of several important chemical reactions affecting aluminum, iron, phosphate and ammonium. The Aquarium ponds usually meet state standards for pH, except during the summer when afternoon pH sometimes goes above 9.5 SU.

Rainfall Effects – Storms altered the pattern for all the field parameters measured. For the Street pond, which had wide diurnal fluctuations, storms depressed readings, but the Building pond exhibited a different pattern and often showed increases in pH and dissolved oxygen (Appendix G). The increase in dissolved oxygen and pH in the Building pond can be explained because rain carries DO and promotes mixing. It also reduces the amount of floating vegetation as some of this is swept over the outfall weir or sinks to the bottom of the pond. The sag curve for pH seen in the Street pond after rain events is partially caused by dilution from rainfall, which has much lower pH than the pond water. Also oxygen depletion after rain events in the Street pond may be caused by an influx of organic nutrients, which increases bacterial respiration rates, thus exerting a biochemical oxygen demand and reducing oxygen concentrations (Burton and Pitt 2002).

Conductivity (specific conductance) is a measure of the total concentrations of ionized material in a water body. Conductivity is measured at much higher concentrations in the Building Pond and the Parking Lot pond than in the Street pond. This is caused by discharges from the Aquarium into the Building pond between storm events. Whenever a problem occurs in one of the fish tanks, the only place to discharge the water is into this pond. Saline sources also come from cleaning filters, discharging water from a sump and other activities associated with keeping the main attraction in working order. The elevated conductivity in the Parking Lot pond came from breaches in the berm between the inflow swale and Ybor channel causing brackish water to flow into the pond. For the Street pond, the larger rain events dilute the water in the pond with fresh water and a drop in conductivity is noted. In general, conductivity increases between storm events as pond water evaporates and ions become more concentrated. The Street pond consistently exhibits low conductivity and no trend is obvious at this scale.

Oxidation Reduction Potential (REDOX) - Redox is a measure of the oxidation potential in the water or sediments. Redox measurements in natural waters show little change as long as the water contains some oxygen, enabling redox potential to remain fairly high and positive (0.3 to 0.5 volts). Although not much data were collected for redox, the data that were collected indicate both the Building pond and Parking Lot pond fell below this level (Appendix G). When redox falls below 0.22 the metabolic demand of organisms use oxygen from other ions as the terminal electron acceptor in a predicatable pattern (nitrate, manganese, iron, sulfate, and carbon dioxide) which leads to metal enrichment in the water column by complexing and adsorption to the acid molecule. Processes such as temperature, organic matter and pH also influence the rate of the redox reaction.

Summary - Field parameters measured with recording sensors for a week at a time show some changes over time. The Street pond initially did not exhibit any of the wide fluctuations in parameters that indicate a eutrophic pond, but this changes over time. The Building pond changes from one with the wide fluctuations of a productive system to one with dissolved oxygen and pH suppressed by anoxic conditions caused by the thick vegetation cover. The Parking Lot pond was stagnant and the few times it was measured exhibited low redox and oxygen levels or else widely fluctuating levels (Figure 13 and Appendix G).

Sediment Samples

Sediment cores were collected in September 1997, November 2000, and December 2003. Usually samples were collected at two depths: 1) the surface soils represented by the 1 to 2 inch surface layer and 2) the deeper strata represented by the 4 to 5 inch layer below the sediment surface. Particle size and priority pollutants represent the top five inches of sediments. All the data collected for the sediment sampling effort as well as ambient water quality samples taken at the same time can be found in Appendix H. The Parking Lot pond no longer existed for the December 2003 sampling event and different parameters were sometimes measured in 1997, therefore, most of the sediment analysis includes only the Building and the Street ponds. It should be remembered that personnel from the Hillsborough County Adopt-A-Pond program removed cattails and the surface soils from the Building pond between the 2000 and 2003 sampling events.

Particle Size Analysis - Soil particles are composed of widely varying sizes and shapes, which influence their sedimentation rate. The size of sediment particles also affects the removal of pollutants in stormwater runoff by sedimentation. Usually the smaller the particle size, the greater the attachment of metal ions to the soil particle and the longer it takes for it to settle out of suspension in the water column. For all ponds, the highest percentage (25 to 40%) of the sediment sample was measured in an intermediate size range (0.125 to 0.25 mm) described as medium sand (Figure 14). The smallest particle size (less than 0.063 mm) was also well represented especially in the Building and Parking Lot ponds and since small particle sizes also provide greater attachment sites for metal ions, this may help explain the higher metal concentrations measured in the surface sediments in the Building Pond as will be discussed later.

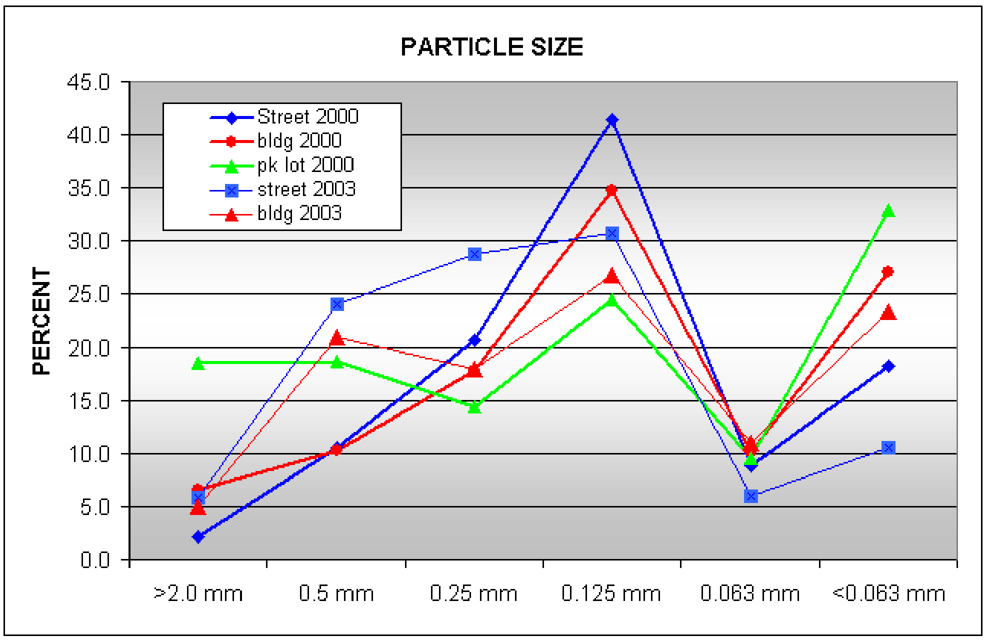


Figure 14. Particle size measured in the sediments for two different years.

Percent Organic Matter - Organic matter improves soil structure and provides conditions favored by soil microbes. These microbes are important for transformation and degradation processes that remove pollutants. Also the behavior of metals in aquatic ecosystems is connected to the role of organic matter in processes such as sorption and/or the chelation/complexation of metals. Once metals are bound with organic and inorganic compounds they can settle rapidly and become incorporated in the sediments removing them from the water column and possible transport out of the system.

The Street Pond measured only low concentrations of organic matter (1 to 2%). In contrast, the Building Pond measured higher concentrations (5 to 8%), probably a result of the considerable floating vegetation that covered the pond and periodically died and sank to the bottom. Since organic matter is effective for attracting metal ions before sinking to the bottom and becoming part of the sediments, this may provide another process to explain the higher sediment metal concentrations found in the Building Pond. Organic matter was not measured in 1997 and the lower concentration measured in the Building pond in 2003 was probably the result of Adopt-A-Pond removing sediments during their maintenance clean out (Figure 15).

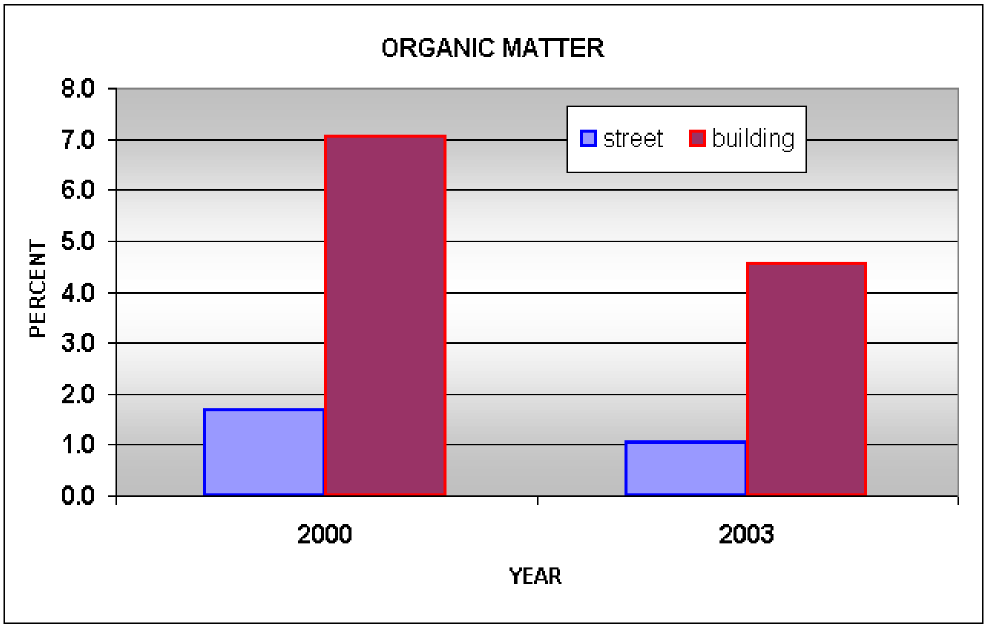


Figure 15. Percent organic matter measured in the sediments for two different years

Nutrients – Nutrients in the sediments were measured as Kjeldahl nitrogen and total phosphorus. The nutrients dramatically increased in the sediments from 2000 to 2003 (Figure 16) and both nitrogen and phosphorus exhibit the same patterns of increased concentrations in 2003. This may reflect the construction activity, more people and traffic at the site, the passage of time, or the increase in vegetation in the ponds. Two different strata were sampled to determine if surface contaminants were being transported deeper into the soil profile.

Total Kjeldahl nitrogen (TKN) includes both organic nitrogen and ammonia. As expected the upper inch of sediments had higher concentrations of TKN than the sediments four inches below the surface, but concentrations for both depths exhibit the same pattern with higher concentration in 2003. The much higher concentrations of TKN in sediment may represent floating vegetation that has died and sunk to the bottom to become incorporated in the sediments. The higher concentrations in the Building pond probably reflects the much more constant problem of floating vegetation, and the lower levels of dissolved oxygen that might oxidize the mats or facilitate nitrification. It should be noted that the concentrations measured at this site for TKN are orders of magnitude higher than have been measured at any of our other study sites. Some examples for surface sediment include: an agricultural site, where TKN ranged from 140 to 5,700 mg/kg (Rushton 2002), a wet detention pond where concentrations ranged from 91 to 2,100 mg/kg (Rushton et al. 1997), and a natural wetland used for stormwater treatment with TKN concentrations that ranged from 2,219 to 19,802 mg/l (Carr and Rushton 1995). Sediments for other sites used for stormwater treatment in Florida were also evaluated in a previous study and the highest concentration listed was 13,000 mg/l for an older pond in Largo (Carr and Rushton 1995). These ranges from the literature are typical at the Aquarium ponds for 1997 and 2000, but not 2003. The Building pond concentrations were greater by a factor of five (120,000 to 195,000 mg/kg) than concentrations measured at other sites. Although concentrations in 2003 in the Street pond were only slightly higher (20,000 to 30,000 mg/kg) than the range measured in the vegetated wetland.

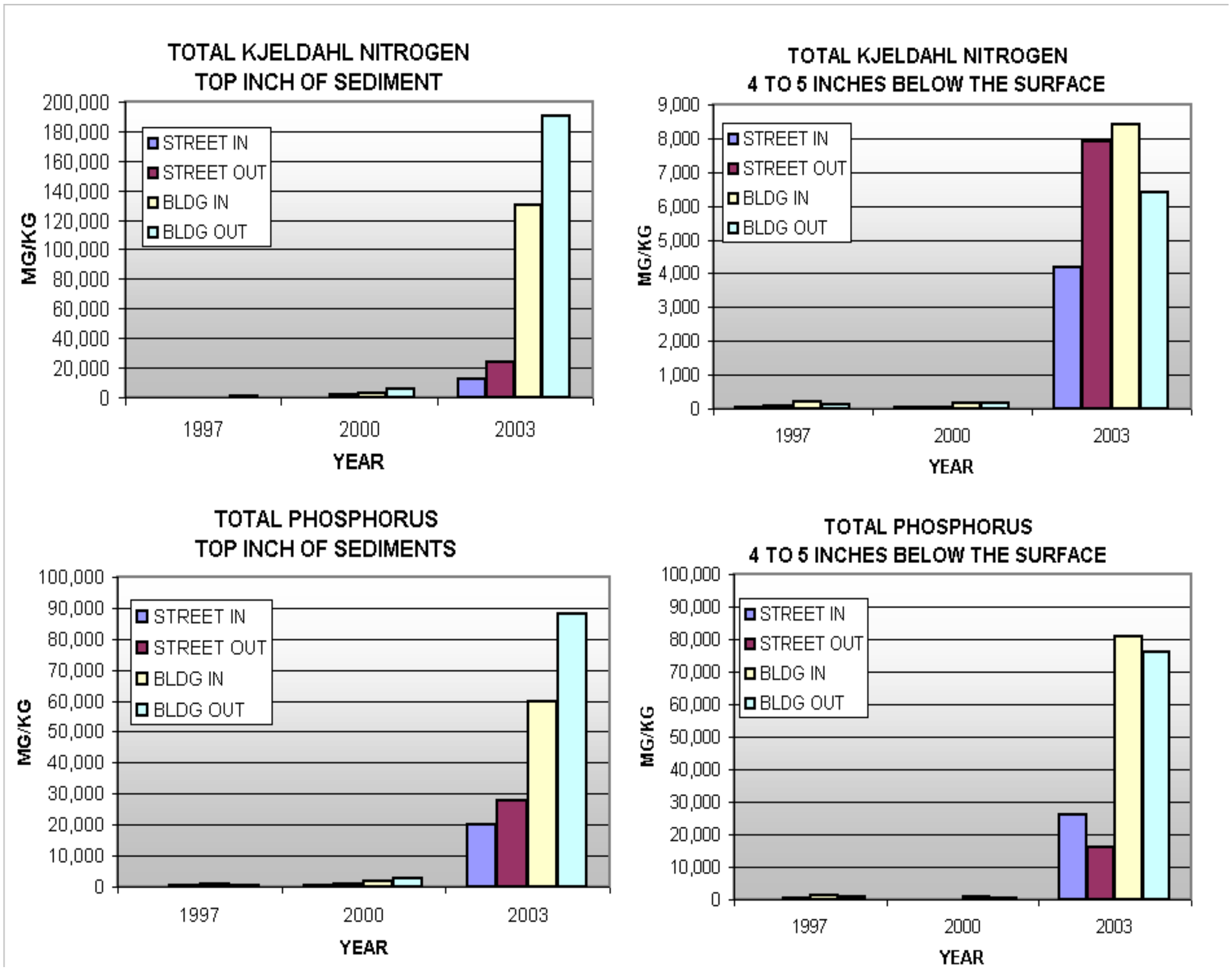


Figure 16. Changes in nutrient concentrations in the sediments measured during three different years and for two different depths. Note different scale for TKN.

Total Phosphorus – Phosphorus also shows a sharp increase in the sediments in 2003 (Figure 16) and these concentrations were also much higher than measured in other studies, although, for samples collected in 1997 and 2000 the range was comparable to other studies. Unlike TKN, the concentrations in the deeper sediments were about the same or slightly higher than in the surface sediments. This may indicate that phosphorus is being transported to the deeper strata. Water quality samples for total phosphorus taken during storm events were measured at reasonable levels (0.08 to 0.14 mg/l), so sedimentation must have been an important pathway for its removal (see Figure 8). Concentrations for storms did increase by about 0.07 mg/l from year one to year two indicating that the sediments may lose some of their ability to adsorb more phosphorus over time. More studies need to follow the change in stormwater ponds over a long period of time.

Metals – The sediments were tested for nine metals, but only a few were measured in concentrations that might cause problems to biota in the ponds (Appendix H). Two of these were Copper and zinc, where concentrations in the surface sediments were much higher in 2000 than in any other year and demonstrated a large increase from concentrations in 1997, especially in the Building pond.

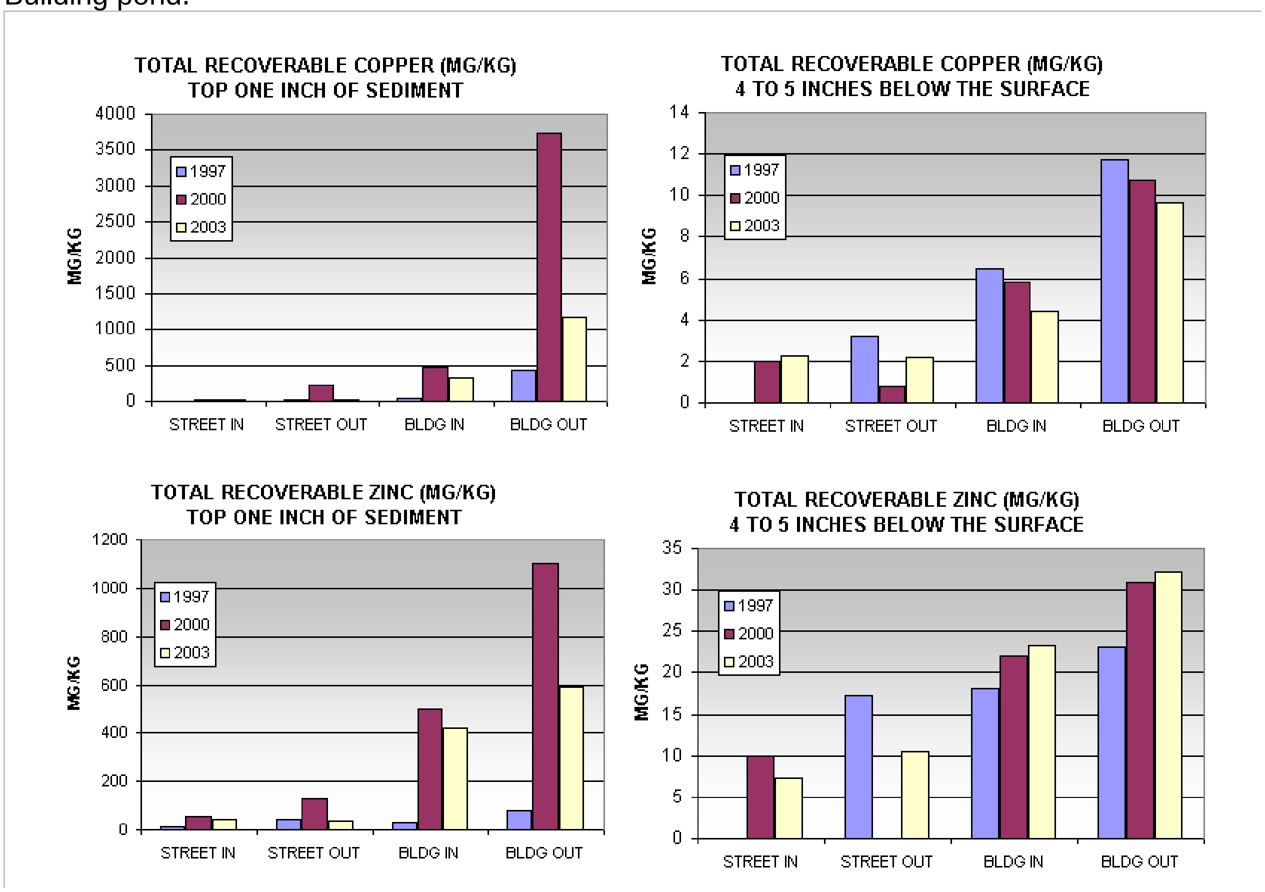


Figure 17. Concentrations of copper and zinc measured in the sediments for three different years and two different strata (Note different scales).

Although concentrations were less in 2003 they were still not reduced to the 1997 levels. Concentrations in the deeper strata were much less than surface sediments and many were below the laboratory detection limit in the Street pond. When concentrations are compared to standards considered a problem for aquatic organisms, the Street pond rarely had concentrations high enough to cause toxicity problems, but the Building pond frequently exceeded the level where organisms could be affected. In fact, copper, lead and zinc exceeded levels where concentrations are probably toxic (see Table 3). The reduction of copper and zinc in the Building pond in 2003 is the result of the removal of surface sediments by the Adopt-A-Pond maintenance activity. However, both copper and zinc still exceeded the concentrations where the surface sediments were probably toxic to organisms (150 mg/kg for copper and 460 mg/kg for zinc).

Organic Pollutants - Polycyclic Aromatic Hydrocarbons,s (PAHs) are a product of modern technology, and the increasing dependence of today's society on products derived from organic chemicals has led to widespread hydrocarbon pollution in stormwater runoff. Some of the many pathways available for PAHs to enter the environment are air pollution, exhausts from vehicles, and from asphalt paving material (ATSDR 2001). PAHs do not easily dissolve in water and those present in air as vapors and stuck to the surfaces of small solid particles settle to the bottoms of rivers or lakes. Breakdown in soil and water generally takes weeks to months and is caused primarily by the actions of microorganisms (ATSDR 2001). This emphasizes the importance of keeping conditions in pond sediments suitable for a healthy assortment of biota.

Sediment samples were tested for more than 100 organic pollutants but only those listed in Table 6 were detected at the site. It is difficult to evaluate PAH concentrations since many of the guideline concentrations listed in Table 4 are below the laboratory detection limit. In order to evaluate trends, the percentage of times the PAH was detected in each pond are recorded in Table 6. The data showed that there were no PAHs detected in the Street Pond except at the inflow in 2000 and it was estimated that only 17 percent of the samples tested detected PAHs. By 2003 this ratio had changed dramatically and 63 percent of the samples analyzed detected PAHs and they were detected at all four stations in the surface sediments. Some of these were above the detection limit and indicated a possible toxicity problem. The Building pond also detected more PAHs in 2003 than in 2000, but of some interest is the fact that a significant amount of the detections were in the deeper soils. For those constituents above the laboratory detection limit with listed toxic levels for fresh water (see Table 3), many were above the possibly toxic levels while acenaphthene, anthracene, and phenanthrene exceeded the probably toxic level in the deeper sediment at the outflow of the Building pond.

Pesticides - Pesticides measured in the sediments identified chlordane, diazinon, chlorphyifos ethyl and DDT derivatives with concentrations above the laboratory quantification limit. Of these, chlordane was measured above the probably toxic level and DDE was detected in possibly toxic range (See Table 3). The other pesticides with concentrations that could be quantified did not have toxic levels listed. Most of the pesticides were only measured in the surface sediments and more were detected in the Building pond than the Street pond. There appeared to be no trend to indicate that pesticides were increasing in the sediments over time. Diazinon is one of the most often detected pesticides measured in stormwater studies (Waller et al. 1994) and it was found at both the inflow and outflow of the Building Pond. Diazinon is a popular broad-spectrum pesticide and is used extensively in residential settings. It is also extremely toxic to aquatic organisms. Chlordane is another frequently measured pesticide in stormwater studies and was detected in both ponds near the inflow of the ponds. The persistent pesticide, DDD or DDE, was also measured in both ponds. DDE was measured above the possibly adverse affect level of 2.2 *u*g/Kg with a range of 6.1 to 11 ug/kg in both ponds. Since all of these pollutants are serious contaminants, toxic to wildlife and bioaccumulate in organisms, they need more study.

Table 6. Polycyclic Aromatic Hydrocarbons and Pesticides measure in the sediments in the Street and Building ponds in 2000 and again in 2003. The surface soils and a strata 4 to 5 inches below the surface were analyzed. (See appendix H for all of the data).

	STREET SURFACE SEDIMENTS 2000 N=4	BLDG. SURFACE SEDIMENTS 2000 N=2	STREET SURFACE SEDIMENTS 2003 N=4	BLDG. SURFACE SEDIMENTS 2003 N=2	STREET DEEPER SEDIMENTS 2000 N=3	BLDG. DEEPER SEDIMENTS 2000 N=2	STREET DEEPER SEDIMENTS 2003 N=3	BLDG. DEEPER SEDIMENTS 2003 N=2
SEMI-VOLATILE ORGANICS								
Acenaphthene	0%	0%	0%	0%	0%	50%	0%	50%
Anthracene	0%	0%	25%	50%	0%	50%	0%	50%
Benzo(a)anthracene	25%	50%	100%	100%	0%	50%	33%	100%
Benzo(a)pyrene	25%	50%	100%	100%	0%	50%	33%	100%
Benzo(b)fluoranthene	25%	50%	100%	50%	0%	100%	66%	100%
Benzo(k)fluoranthene	25%	0%	75%	100%	0%	50%	0%	100%
Benzo(g,h,i)perylene	25%	0%	100%	100%	0%	50%	0%	100%
Bis(2-ethylhexyl)phthalate	0%	50%	50%	100%	0%	0%	0%	0%
Butyl benzyl phthalate	0%	0%	0%	100%	0%	0%	0%	0%
Chrysene	25%	50%	100%	100%	0%	100%	33%	100%
Di-n-octyl phthalate	25%	0%	0%	0%	0%	0%	0%	0%
Dibenzo(a,h)anthracene	0%	0%	0%	0%	0%	0%	0%	50%
Fluoranthene	25%	50%	75%	100%	0%	100%	33%	50%
Indeno(1,2,3-cd)pyrene	25%	50%	100%	100%	0%	0%	0%	100%
Phenanthrene	25%	50%	75%	100%	0%	0%	33%	100%
Pyrene	25%	50%	100%	100%	25%	50%	66%	100%
AVERAGE	17%	28%	63%	75%	2%	41%	19%	69%
PESTICIDES								
Bromacil	0%	100%	0%	50%	0%	0%	0%	0%
Chlorpyrifos Ethyl	0%	50%	0%	50%	0%	0%	0%	0%
Diazinon	0%	100%	50%	0%	33%	0%	0%	0%
Beta-BHC	0%	50%	0%	0%	0%	0%	0%	0%
Chlordane	50%	50%	75%	100%	33%	0%	33%	0%
DDD-p.p'	0%	100%	25%	100%	0%	0%	0%	0%
DDE-p,p'	25%	100%	50%	100%	0%	0%	0%	0%
Endosulfan Sulfate	0%	0%	0%	0%	33%	0%	0%	0%
Endrin Aldehyde	0%	0%	0%	0%	0%	0%	0%	0%
Methoxychlor	0%	0%	0%	0%	0%	0%	0%	0%
AVERAGE	8%	55%	20%	40%	10%	0%	3%	0%

Fish Survey

A survey of the fish and other biota in the water column was conducted for two different years. Clear Plexiglas fish traps were set out in the ponds for a 2 to 3 hour period near the beginning of the study period in 1997 and again in 2003 to determine changes. Seven sampling events spanning a two month time period were conducted for each year, but unfortunately they did not cover the same months. In 1997 the survey was conducted in the summer and in 2003, the traps were set out in the fall. Still the results demonstrate some of the changes that had taken place over time, especially for the fish (Tables 7 and 8). In 1997 tadpoles were the dominant species for one sampling event, but no species were captured on some dates and only a few (1 to 4) on other dates. No fish were found in the Street Pond and their numbers were reduced to zero in the Building pond after the first two sampling days. The elimination of the fish was the result of malathion spraying for citrus canker problems, which caused a fish kill in the Building pond. An unidentified gold fish was also present in the Building pond during 1997, but was not collected in 2003. *Gambusia* was not collected in 1997 but was a dominant fish species by 2003 in both ponds and water fleas were much more prevalent as well. 2003 also exhibited a much more even number of individuals on each sampling day, but the assemblage was dominated by three species, *Gambusia,* sail fin mollies and water fleas.

Table 7. Fauna measured in water column of the ponds during the summer of 1997

Building Pond:								
				DATE				
Species:	**06/20/1997**	**06/27/1997**	**07/07/1997**	**07/11/1997**	**07/17/1997**	**07/31/1997**	**08/21/1997**	**Totals**
Gambusia	0	0	0	0	0	0	0	**0**
Sail Fin Mollie	143	0	0	0	0	0	0	**143**
Water Flea	0	0	0	0	0	0	0	**0**
Tadpole	0	0	15	0	0	0	0	**15**
Back Swimmer	0	0	0	0	0	0	0	**0**
Goldfish	19	9	0	0	4	0	2	**34**
Dragonfly Larva	0	0	0	0	0	0	0	**0**
Water Beetle	0	0	0	0	0	0	0	**0**
Leech	0	0	0	0	0	0	0	**0**
Totals:	**162**	**9**	**15**	**0**	**4**	**0**	**2**	**192**
Street Pond:								
				DATE				
Species:	**06/20/1997**	**06/27/1997**	**07/07/1997**	**07/11/1997**	**07/17/1997**	**07/31/1997**	**08/21/1997**	**Totals**
Gambusia	0	0	0	0	0	0	0	**0**
Sail Fin Mollie	0	0	0	0	0	0	0	**0**
Water Flea	0	1	0	0	0	0	0	**1**
Tadpole	350	63	0	0	3	0	0	**416**
Back Swimmer	0	0	1	0	1	4	0	**6**
Goldfish	0	0	0	0	0	0	0	**0**
Dragonfly Larva	0	0	0	0	0	0	1	**1**
Water Beetle	0	0	0	0	0	0	0	**0**
Leech	0	0	0	0	0	0	0	**0**
Totals:	**350**	**64**	**1**	**0**	**4**	**4**	**1**	**424**

Table 8. Fauna measured in the water column of the ponds during the summer of 2003.

Building Pond:								
				DATE				
Species:	**10/20/2003**	**10/27/2003**	**11/03/2003**	**11/10/2003**	**11/17/2003**	**11/24/2003**	**12/01/2003**	**Totals**
Gambusia	25	19	30	20	9	16	38	**157**
Sail Fin Mollie	43	38	0	30	12	8	11	**142**
Water Flea	0	40	0	0	0	0	0	**40**
Tadpole	0	0	0	0	0	0	0	**0**
Back Swimmer	0	0	0	0	0	0	0	**0**
Goldfish	0	0	0	0	0	0	0	**0**
Dragonfly Larva	0	0	0	0	0	0	0	**0**
Water Beetle	0	0	0	0	0	0	0	**0**
Leech	0	1	0	0	0	0	0	**1**
Totals:	**68**	**98**	**30**	**50**	**21**	**24**	**49**	**340**

Street Pond:								
				DATE				
Species:	**10/20/2003**	**10/27/2003**	**11/03/2003**	**11/10/2003**	**11/17/2003**	**11/24/2003**	**12/01/2003**	**Totals**
Gambusia	0	9	0	4	5	0	3	**21**
Sail Fin Mollie	52	58	12	16	18	35	7	**198**
Water Flea	0	40	0	30	20	20	0	**110**
Tadpole	0	0	0	0	0	0	0	**0**
Back Swimmer	0	0	0	0	0	0	0	**0**
Goldfish	0	0	0	0	0	0	0	**0**
Dragonfly Larva	0	0	0	0	0	0	0	**0**
Water Beetle	0	0	0	1	0	0	0	**1**
Leech	0	0	0	0	0	0	0	**0**
Totals:	**52**	**107**	**12**	**51**	**43**	**55**	**10**	**330**

An additional sampling event was conducted on July 31, 2002 that divided the collected species into two size classes, compared different areas in the ponds and recorded the vegetation present. The same two dominant species that were present in 2003 were also collected in 2002 (Table 9).

Table 9. Number of fish caught in four traps on July 31, 2002.

Species		**Building Pond**	**Building Pond**	**Street Pond**	**Street Pond**
		Inflow	**Outflow**	**Inflow**	**Outflow**
Sail fin Mollie > 1.5"				4	4
Sail fin Mollie < 1.5"		7	6	11	21
Gambusia > 1"		10	3		
Gambusia < 1"		7	11		
Total		**24**	**20**	**15**	**25**

The low species diversity of fish in the ponds may be caused by the aggressive nature of *Gambusia affinis*. It is interesting to note that sailfin mollies (*Poecilia latipinna*) and an unidentified gold fish were quite prevalent in the Building pond until the aerial spraying with malathion to kill the insect causing citrus canker in 1997. This resulted in a massive fish kill in the Building pond (the only pond with fish in 1997) and few fish were found in the collection after June during 1997. Also there were no Gambusia present in 1997. By 2003 both *Gambusia* and sailfin mollies were present in both ponds, but more sailfins and fewer *Gambusia* were measured in the Street pond compared to the Building pond. Also in the one sampling event in 2002, there was no Gambusia in the Street Pond, but a good assemblage of Sail fin Mollies, while the Building pond had only small mollies and fewer individuals. The ichthyological community has viewed the introduction of *Gambusia* into non-native habitats with alarm, because of real and potential damage to these ecosystems (Rupp 2004). The first complaint is that *Gambusia* species are not really that effective in mosquito control and better control has been achieved with native species (Courtenay and Meffe 1989). They further explain that *Gambusia* are far too aggressive and predatory to be indiscriminately spread throughout the world without recognition of dangers to native biota and an international ban on their use as a control agent is biologically appropriate and warranted. Bottom sediments contaminated with metals and PAHs may also have caused the low species colonization. More studies need to be conducted to determine a satisfactory fish population for stormwater ponds that can control mosquitoes and still maintain diversity.

Macroinvertebrate Study1

The assessment of macroinvertebrate abundance and diversity is useful for determining the ecological integrity of water bodies (Rosenberg and Resh, 1993). The large number of macroinvertebrate species present in any given region, their general sedentary nature, and their high reproductive rates make them excellent indicators of environmental conditions. As essential components of many aquatic food webs, their abundance is also closely tied to a system of productivity and consumer diversity.

Thousands of stormwater ponds are being built to treat stormwater runoff. These impoundments are often characterized by poor water quality, high sediment loading, and high concentrations of pollutants. The effects of these and other environmental factors in natural aquatic systems suggest that stormwater ponds provide poor macroinvertebrate habitat, yet few studies of stormwater macroinvertebrates have been conducted. Free and Mulamootil (1983) demonstrated that only a few tolerant species persist in stormwater systems. In contrast, Rushton *et al* (1997) found that a relatively new impoundment harbored a diverse collection of benthic invertebrates, including some species reported intolerant of pollution. However, the assemblage found in the newly constructed pond may not have been representative, because water quality in the pond was much better than that found in older systems.

Poor water quality in stormwater ponds can be the result of several environmental and chemical factors. Low dissolved oxygen levels and high concentrations of organic contaminants and toxic metals can impact benthic macroinvertebrate abundance (Rosenberg and Resh, 1993). Numerous

1 Matt Dooris conducted the macroinvertebrate study when he was an intern at SWFWMD. This section was written by him and edited by Dr. Doug Leeper of SWFWD who has had experience with macroinvertebrates.

studies have shown that environmental factors, such as water hardness, salinity, and alkalinity can influence metal toxicity (e.g. Chadwick *et al*., 1986; Clements *et al*., 1988; LaPoint *et al*., 1984; Moore and Ramamoorthy, 1984; Winner *et al*., 1975; Winner and Gauss, 1986). Stormwater ponds are generally not considered to be viable freshwater systems. Nevertheless, their frequency in the landscape, and the biotic assemblages found in some ponds (Rushton *et al*. 1977) suggest that they may serve as important aquatic habitat in an increasingly urbanized landscape.

The macroinvertebrate assemblages of the three stormwater ponds at the Florida Aquarium are discussed in this section along with environmental factors influencing their diversity and abundance (Appendix I).

Parking Lot Pond- The Parking Lot pond is a highly eutrophic water body with relatively high levels of nutrients and organic materials in the bottom sediment and water column. Extensive growth of hydrilla and emergent vegetation in the littoral zone cause wide fluctuations in dissolved oxygen and pH due to changes in photosynthetic rates throughout the day (see previous section).

The Parking Lot pond contained the highest macroinvertebrate diversity of all ponds. A total of 2000 individuals from 8 macroinvertebrate taxa were collected (Figure 18 and Appendix I). Species diversity and equitability, based on samples across all dates, were 1.77 and 0.59, respectively. Macroinvertebrate abundance at site 1 (1663 individuals) was significantly greater (Wilcoxon Rank Sum Test, $p<0.001$) than at site 2 (337 individuals), and diversity index values were also greater (1.68 at site 1 versus 1.35 at site 2).

Much higher concentrations of copper, lead, zinc, and DDE in the sediments of site 2 may have contributed to the low macroinvertebrate diversity (See Appendix H-1). Clements (1988) demonstrated predictable changes in a stream macroinvertebrate community structure based on laboratory bioassay data and in site concentrations of heavy metals. He also provided evidence that certain species of oligochaetes (*Limnodrilus hoffmeisteri* and *Tubifex tubifex*) are more tolerant of heavy metal contamination than many other macroinvertebrate taxa. High concentrations of aluminum in site 2 sediments may have moderated the toxicity of metal contaminants. Aluminum forms complexes with OH^-, F^-, and SO_4^{2-} (Roberson and Hem, 1967), which can combine with phosphorus, suspended solids, and heavy metals. The stable compounds formed remain inactive and are deposited in the sediment. The rate of complex formation is dependent upon many factors including pH, temperature, concentrations of complexing ligands, ionic strength, and the concentration of aluminum. Basic conditions (pH>8) increases the solubility of aluminum making it more accessible for biogeochemical transformations (Harper, 1990). The pH in the pond often exceeded 9 standard units.

The gastropod, *Planorbella duryi*, and the tubificid, *Limnodrilus hoffmeisteri*, dominated the macroinvertebrate assemblage in the Parking Lot pond, each species accounting for over 40% of the individuals collected. Both species were much more abundant at site 1 than at site 2, the abundance of *Limnodrilus hoffmeisteri* differing by nearly an order of magnitude between the sites. Less abundant taxa, including the gastropods, *Physella hendersoni hendersoni* and *Physella heterostropha heterostropha*, and the amphipod, *Hyallela azteca*, were also more abundant at site 1.

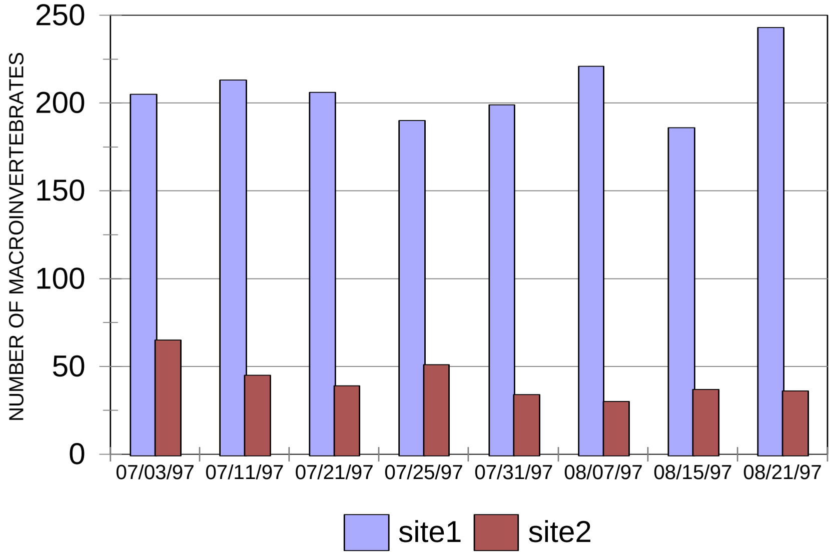
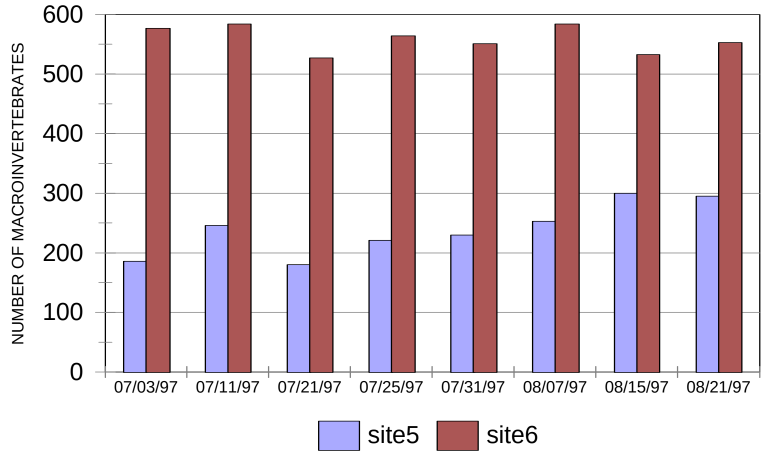


Figure 18. Comparison of macroinvertebrates measured at site 1 compared to site 2 in the Parking Lot pond. (See Figure 3 for site location).

The dominance of *Limnodrilus hoffmeisteri* may be explained by its tolerance for polluted conditions. Tubificids are generally not restricted by sediment particle size or composition and are often found in habitats high in organic material and low in dissolved oxygen. Dissolved oxygen is a primary factor that determines whether or not a macroinvertebrate species will survive in a given area (Davis, 1975). Low dissolved oxygen concentrations make it difficult for aerobic organisms to satisfy their oxygen requirements, and certain species of benthic macroinvertebrates can withstand lower dissolved oxygen concentrations than other species

Street Pond - The Street pond contained little or no emergent vegetation and dissolved oxygen concentrations remained fairly stable. Macroinvertebrate abundance was greatest in the Street pond. A total of 6384 individuals from 5 taxa were collected from Pond 3 (sites 5 and 6), and 4735 individuals from 5 taxa were collected from Pond 4 (sites 3 and 4)(Figure 19, Appendix I-3 and I-4). Species diversity and equitability values from Pond 3 were 0.593 and 0.256, respectively and those at Pond 4 were 0.36 and 0.15. Comparisons among sites within sub-ponds indicated that macroinvertebrates were significantly less abundant at site 5 than at site 6 (Figure 17), although diversity and equitability values were similar. Pond 3 exhibited a higher diversity index than Pond 4 and contained 15 % more individuals.

Limnodrilus hoffmeisteri numerically dominated the macroinvertebrate assemblages of both Street pond sub-basins. The gastropod, *Physella h. heterostropha* was moderately abundant in both sub-basins, and the tubificid, *Tubifex templetoni*, was present at site 6 but not in site 5 in Pond 3. Dominance of the macroinvertebrate assemblage by *Limnodrilus hoffmeisteri* and the moderate abundance of *Physella h. heterostropha* and *Tubifex templetoni* indicate organic enrichment of the Street pond sediments.



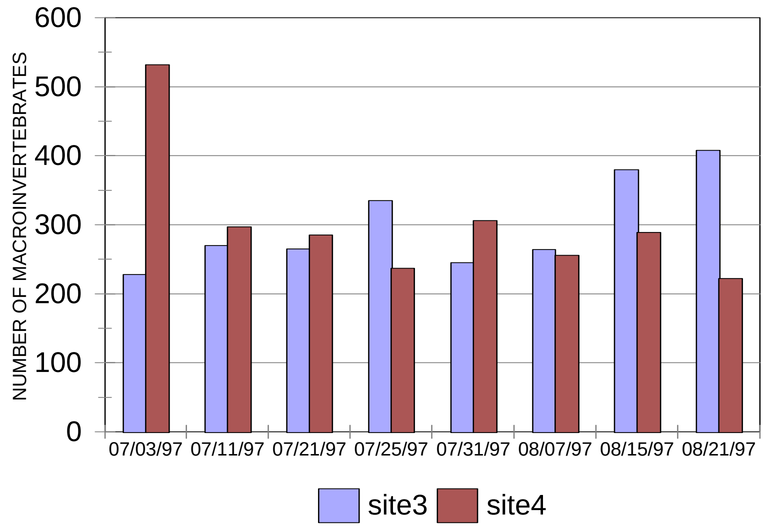


Figure 19. Comparison of macroinvertebrates measured at different locations in the Street pond. (See Figure 3 for site location).

Building Pond - The Building pond was characterized by large mats of floating algae that sank to the pond bottom following periodic algicide treatments. These treatments proved to be detrimental to the macroinvertebrate community. One reason for low diversity may have been dissolved oxygen usually measured below 5 mg/l. Also some concentrations for copper and zinc exceeded the probably toxic levels for macroinvertebrates in the Building Pond (see Appendix H-1).

Macroinvertebrate abundance and taxa richness was lowest in the Building pond (Appendix I-2). Only 464 individuals from 2 taxa were collected. Species diversity and equitability values were low; 0.08 and 0.05, respectively, and did not differ much between sites in the pond (inflow of site 7 and outflow of site 8). Abundances were also similar among sites (Figure 20).

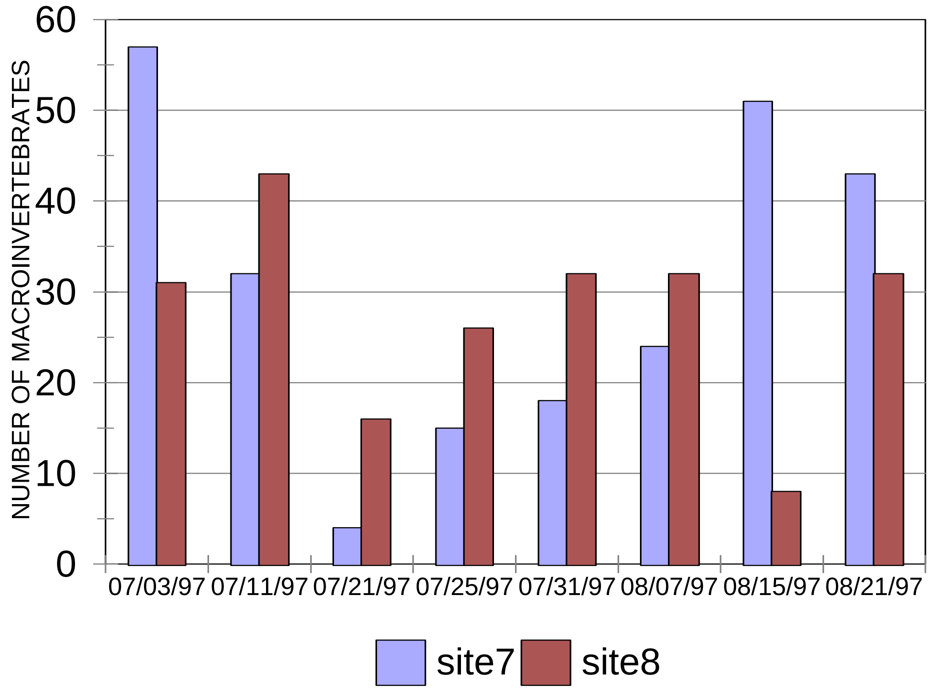


Figure 20. Macroinvertebrate abundance measured in the Building pond at the Florida Aquarium during the summer of 1997 (See Figure 3 for site locations).

Physella h. heterostropha dominated all taxa (99.1%) with only a few members of *Planorbella duryi* scattered throughout the pond. No tubificid worms were collected in the Building pond, possibly because of the high concentrations of algae in surface waters and on the bottom sediment (Milligan, 1997). The presence of *Physella h. heterostropha* in the Building pond is notable considering that the genus *Physella* is reportedly rare in areas of densely matted vegetation (Pennak, 1989). High concentrations of metal toxicants and an equitability measurement of 0.05 indicate that the Building pond is a poor habitat for benthic macroinvertebrates.

Conclusion - All ponds contained taxa reported to be highly tolerant of polluted conditions. The Building and the Parking Lot ponds often experienced dissolved oxygen levels below 5 mg/l (see Appendix G) and also had the lowest number of species. High concentrations of metal contaminants were also observed in some areas of the ponds, which lowered the number of individuals present. All ponds contained species diversity values (E') in the range indicating polluted conditions and the pollution tolerant species of *Physella h. heterostropha*, *Planorbella duryi*, and *Limnodrilus hoffmeisteri* dominated all taxa.

Results from this study provide a snapshot of the summer macroinvertebrate assemblages in three stormwater ponds in a highly urbanized area of central Florida. A survey of a large number of ponds from a broader range of settings during different seasons will be required to adequately characterize stormwater pond macroinvertebrate assemblages of the region.

Water Quality Comparisons

Water quality was discussed in some detail in a previous section when the composite storm sample results were presented. This section is meant to be a brief summary comparing the results for four years of data collection. The first two years, 1997 and 1998 represent grab samples taken within a day after rain events, while for the 2001 and 2002 sampling years flow-weighted composite samples over the entire hydrograph were analyzed. Since the pond should be well mixed by the time water is discharged at the outflow, we thought both types of samples might be comparable (see the Method Section and Appendix A for statistical analysis of grab vs composite samples). Although grab samples taken after rain events were shown to be significantly higher than flow weighted samples for some constituents, an inspection of the data indicates that with a large data set, errors may average out. With this caveat, the storm water quality data are summarized in Figures 21 and 22. Be aware that once the Parking Lot pond was eliminated to build the cruise ship terminal that pond could no longer be studied, but two years of data were available.

Nutrient concentrations measured a few difference between ponds (Figure 21). For one, the concentration of ammonia and nitrate exhibit a sharp increase in 2003 in the Building pond. Several factors may have caused this result. The runoff from the plant nursery discharges to this drainage basin and this could represent fertilizer runoff. Also slow release fertilizer pellets were observed in one of the drop boxes in a garden area in 2003 indicating landscaping practices may have contributed extra nutrients. In addition, 2003 had much more rainfall and the sump at the loading dock was frequently pumped directly into the pond near the outfall. The necessity to pump this water into the pond increased after the construction of the cruise ship terminal in 2001. Even though the cruise ship terminal is not part of the drainage basin, it was noted that irrigation water and tests from a pump station were discharged into one of the drop boxes draining to the Building pond. Increased ammonia concentrations could also be the result of anoxic conditions in the Building pond, which increased after 2000 (see Appendix G).

Another difference between ponds was the elevated levels of organic nitrogen and phosphorus in the Parking Lot pond, especially in 1997. High concentrations of phosphorus were also measured in the sediments in 1997 and these may be leaching out because of low dissolved oxygen levels in the pond. Except for these few higher values, most nutrients were measured at about average concentrations when compared to other stormwater ponds and they fluctuated within a narrow range between years. Although the Parking Lot pond had higher concentrations of organic nitrogen and phosphorus, this pond rarely discharged and pollution loads to the receiving waters was not an issue.

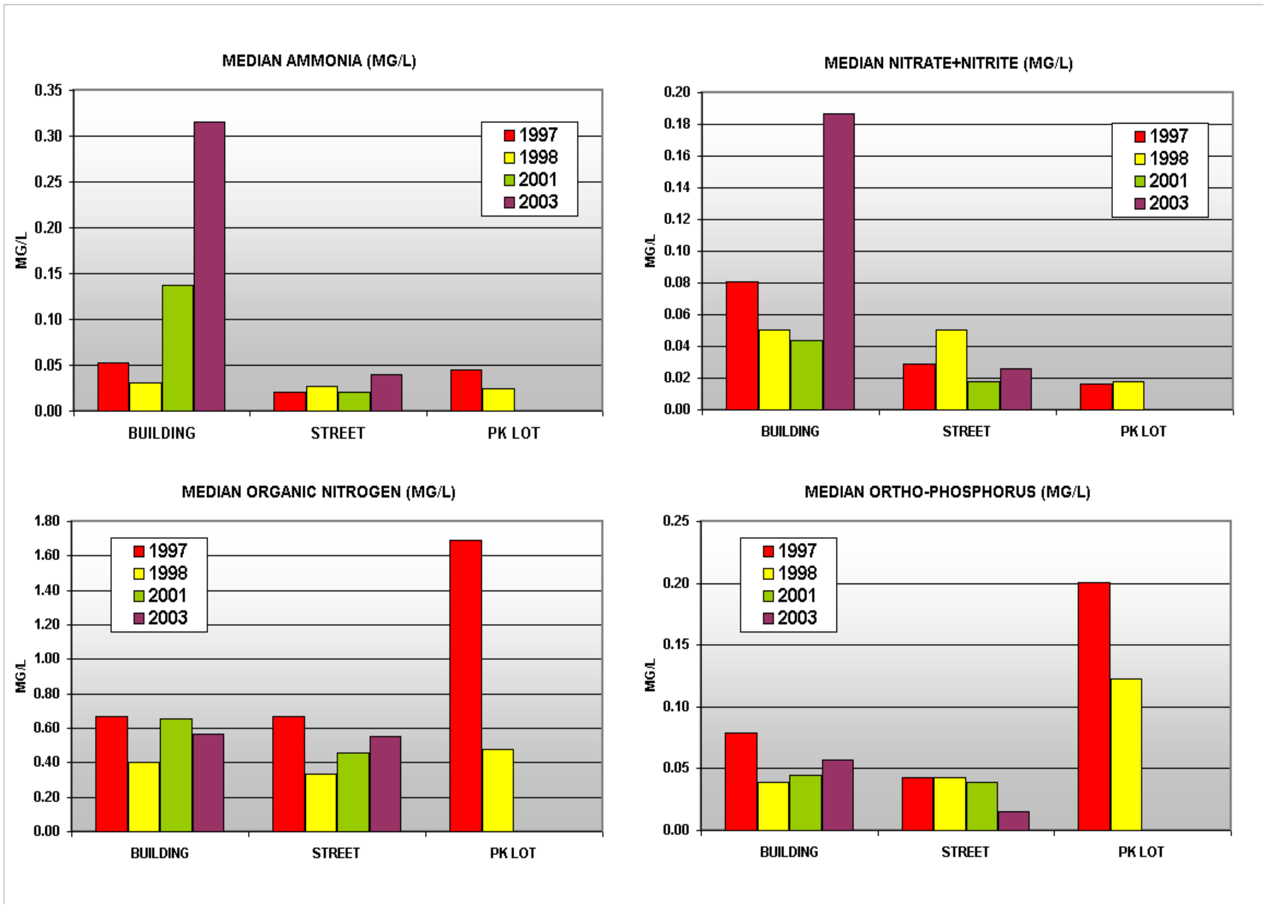


Figure 21. Concentrations of nutrients measured at the outfall of stormwater pond for storm events during four years of data collection at the Florida Aquarium.

Metal concentrations were usually measured below the laboratory detection limit and were not a serious problem, but there were a few exceptions (Figure 22). Both the Building and Parking Lot pond were treated with an algicide containing copper during 1997 and elevated copper was measured in the water column during those years. As an aside, after the cessation of algicide applications, the vegetation problems continued to plague the ponds, but instead of floating algae mats, *hydrilla*, duckweed and other vegetation persisted as nature tried to restore a balance and take up the excess nutrients transported to the pond in storm water.

Iron below 1000 ug/l is not considered toxic to organisms and the levels in the ponds were well below this concentration with average values between 100 and 300 ug/l. Zinc was usually measured below the detection limit in the Street and Parking lot ponds, and the elevated levels in the Building pond may be the result of roof runoff. Total suspended solids were measured at about the lowest levels that can be achieved by settling and indicate the system is well able to reduce suspended particulate matter. There is a weak indication that metal concentrations may be increasing since they were measured at higher levels in 2003.

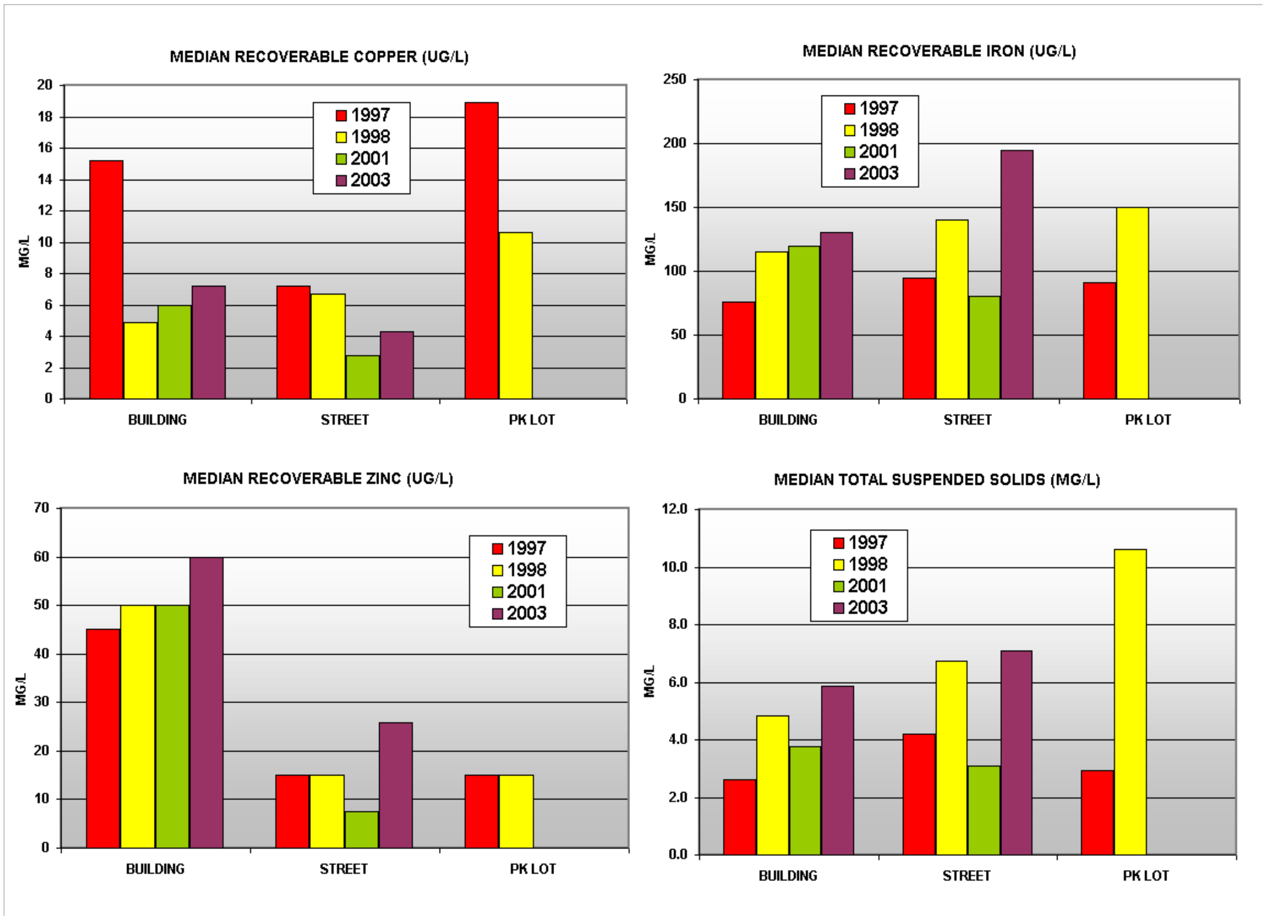


Figure 22. Concentrations of metals and TSS measured at the outfall of stormwater pond for storm events during four years of data collection at the Florida Aquarium.

Comparison to State Standards

Metal concentrations were compared to State Water Quality Class III Standards to determine if the levels discharging from the site were detrimental to the biota. State standards for metals in fresh water systems are based on formulas that calculate a unique standard for each individual sample using the natural logarithm of water hardness (see Table 5). The concentration of each sample is listed with its unique standard in Appendix E and summary data are reported in Figure 23 and Appendix E-7. Although water hardness is not a pollutant of concern in stormwater, soft water makes pollutants more toxic to wild life therefore, the toxicity of metals for fresh water Class III standards is related to water hardness. A summary of results showing the percentage of samples that failed to meet standards for each pond for each year indicates more problems in the early years (Figure 23).

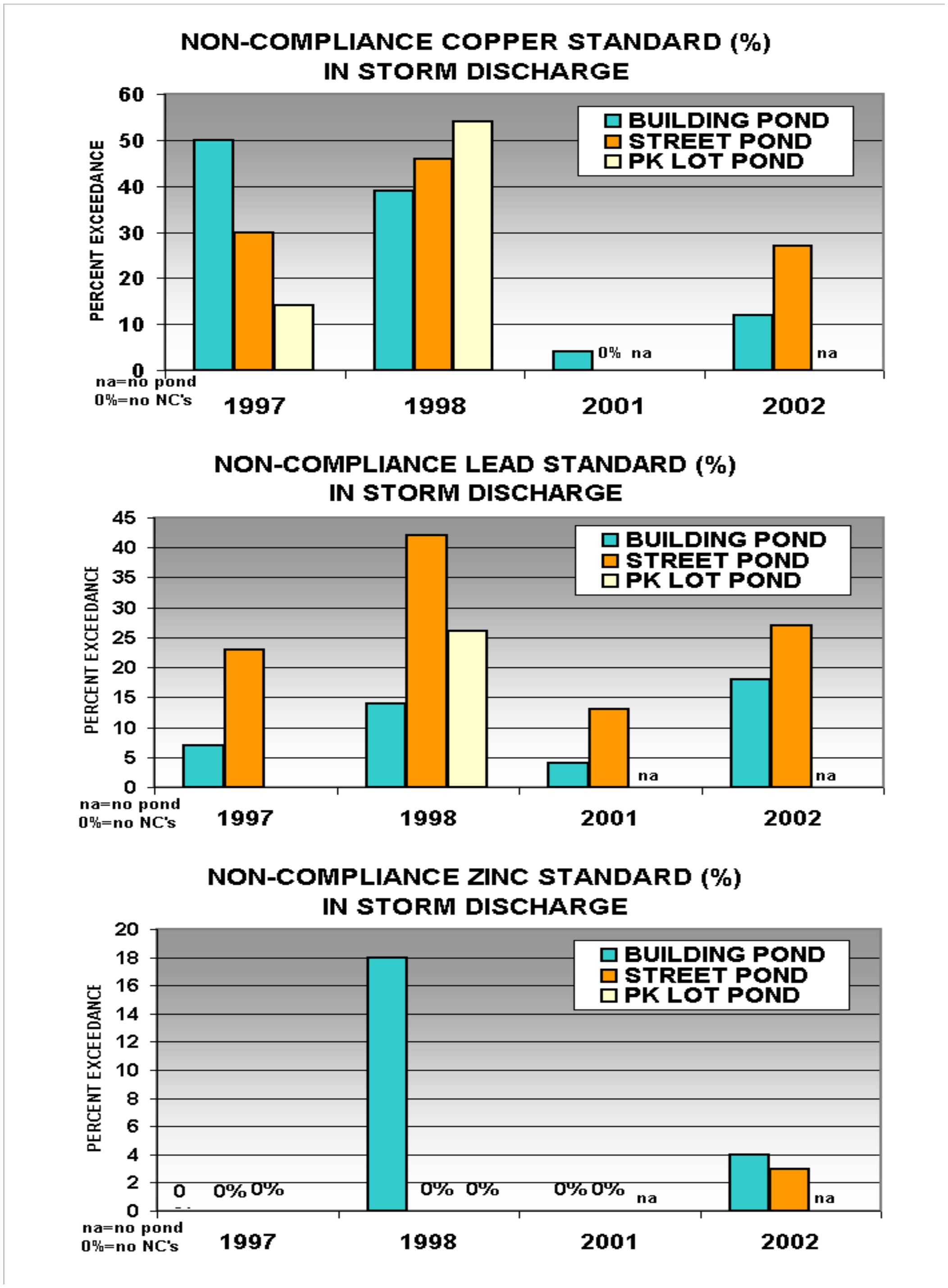


Figure 23. Percent non-compliance of State water quality standards measured for each year in the Florida Aquarium ponds.

Hardness and its associated constituents were measured at higher concentrations in the Building Pond because of higher levels discharged into the pond to solve serious problems in the Aquarium fish tanks, to rinse filter equipment, to flush out the loading dock sump and other discharges. High hardness levels were measured in the Parking Lot pond because of occasional backflow from Ybor Channel and several breaks in the berm allowing inflow into the pond from the brackish channel

Lead. Although average concentrations for lead were about the same in each pond, standards were exceeded more often in the Street pond because of soft water. Our greatest problem with analyzing the lead data occurred because the laboratory detection limit during this study (2 ug/l) is about the same as the value for the standard. The median standard calculated for the Street pond was about 2.1 and the median concentration was about 1.7 ug/l for most years. The harder water in the other two ponds raised the median standard concentrations to values over 7 ug/l. The same argument applies to the other two metals analyzed.

Copper. Significantly higher exceedences were measured for copper in 1997 and 1998 because of algicide applications to control floating algae mats and other nuisance vegetation. The applications ceased after 1998 and standards were met much more often.

Zinc. The standards for zinc were usually met and, except for the Building pond in 1998, concentrations were never high enough to be a concern.

Samples were also compared to the Marine Standards since the site discharges to salt water. All of the standards were met except for copper where none of the samples were in compliance and all were above the level considered toxic (2.9 mg/kg).

Summary – Pond maintenance practices when an algicide was used to control floating algae mats caused ponds to be in non-compliance of state water quality standards by 40 to 50 percent. Higher zinc concentrations were measured in the Building pond, probably as a result of roofing material, but most samples met standards. More non-compliance of standards for lead was measured in the Street pond, a result of softer water and street runoff. The failure of water quality to meet state standards may explain the low macroinvertebrate species diversity and the colonization of only species tolerant of polluted conditions. Concentrations of metals were reduced by a considerable amount when compared to the inflow of the Street pond (Teague and Rushton 2005) and as measured in the water quality in the drop boxes in the Building pond drainage basin as will be discussed next.

POND IMPROVEMENTS

One of the purposes of the study was to test different techniques to improve the function of the ponds. Since the poorest water quality was discharged from the Building pond, most of our effort focused on this one pond. The two major improvements included: 1) pre-treatment grate inlet skimmer boxes (drop box inserts) installed in the seven storm drain catch basins that discharge into the Building pond, and 2) a diversion structure constructed to route the treatment volume in the Building pond so that it travels through a shallow vegetated area (littoral zone) that was bypassed in the original design.

Skimmer Box Inserts

Grate inlet skimmer inserts capture gross pollutants such as leaves, sediments and trash and hold them in a skimmer tray above the water level in the catch basin instead of letting the solids travel by sediment transport into the wet detention pond. Skimmer boxes require maintenance and should be cleaned out about every three to six months when installed in urban locations. A schematic of the grate inlet skimmer box is shown in Figure 24.

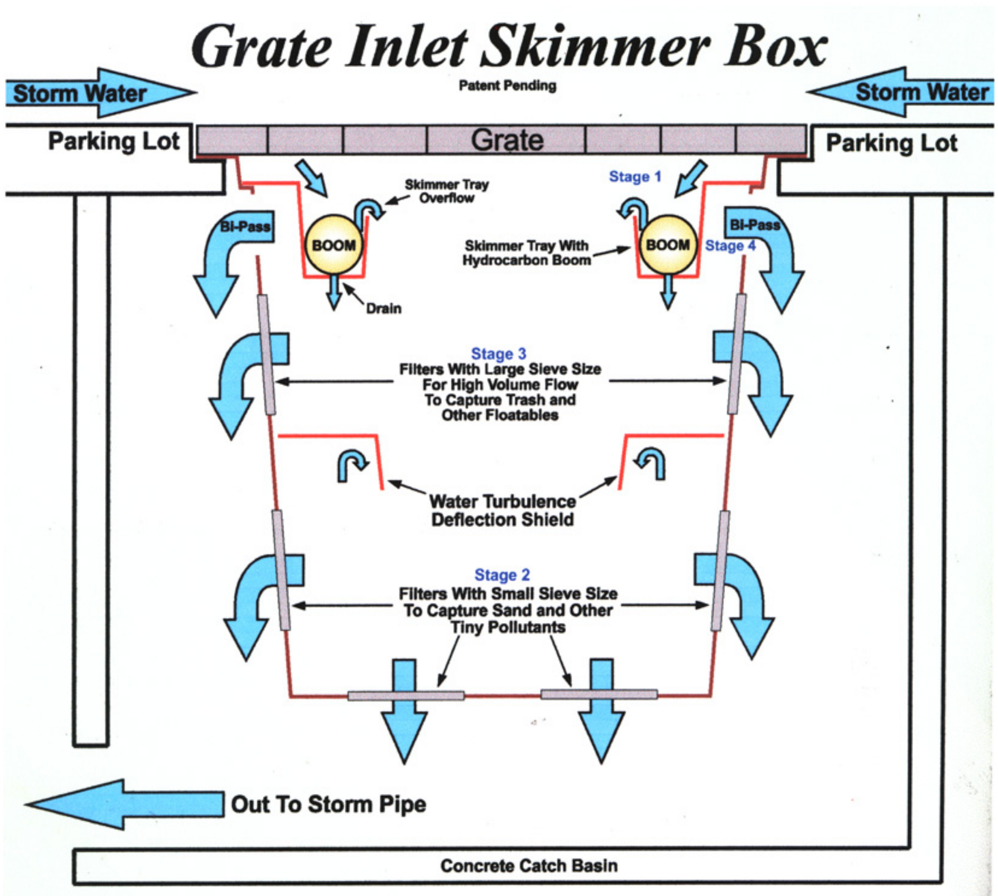


Figure 24. Diagram of drop box insert (Source: Suntree Technologies, Inc.)

Water Quality Samples were taken in the bottom of the drop boxes before the skimmer boxes were installed, in the period between installation and the first cleanout, and between the first and second cleanout period to note any differences in water quality before and after the installation (Figure 25a, 25b and Appendix K). In almost all cases the average concentrations were much higher before the skimmer boxes were installed.

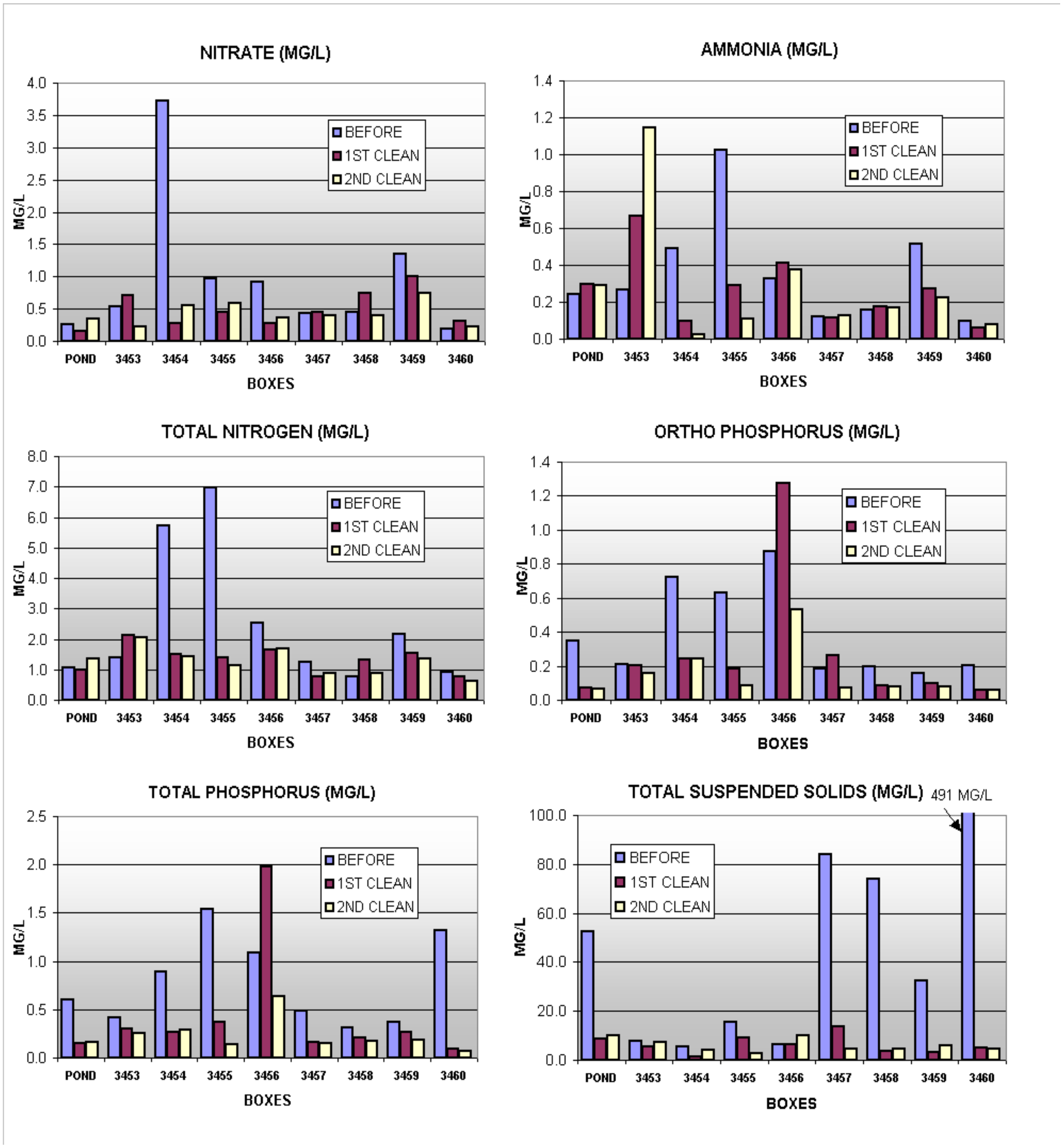


Figure 25a. Comparison of average water quality concentrations in the bottom of the drop boxes before and after installation for nutrients and TSS. POND=sample taken at pond outfall (see Figure 4 for location of drop boxes)

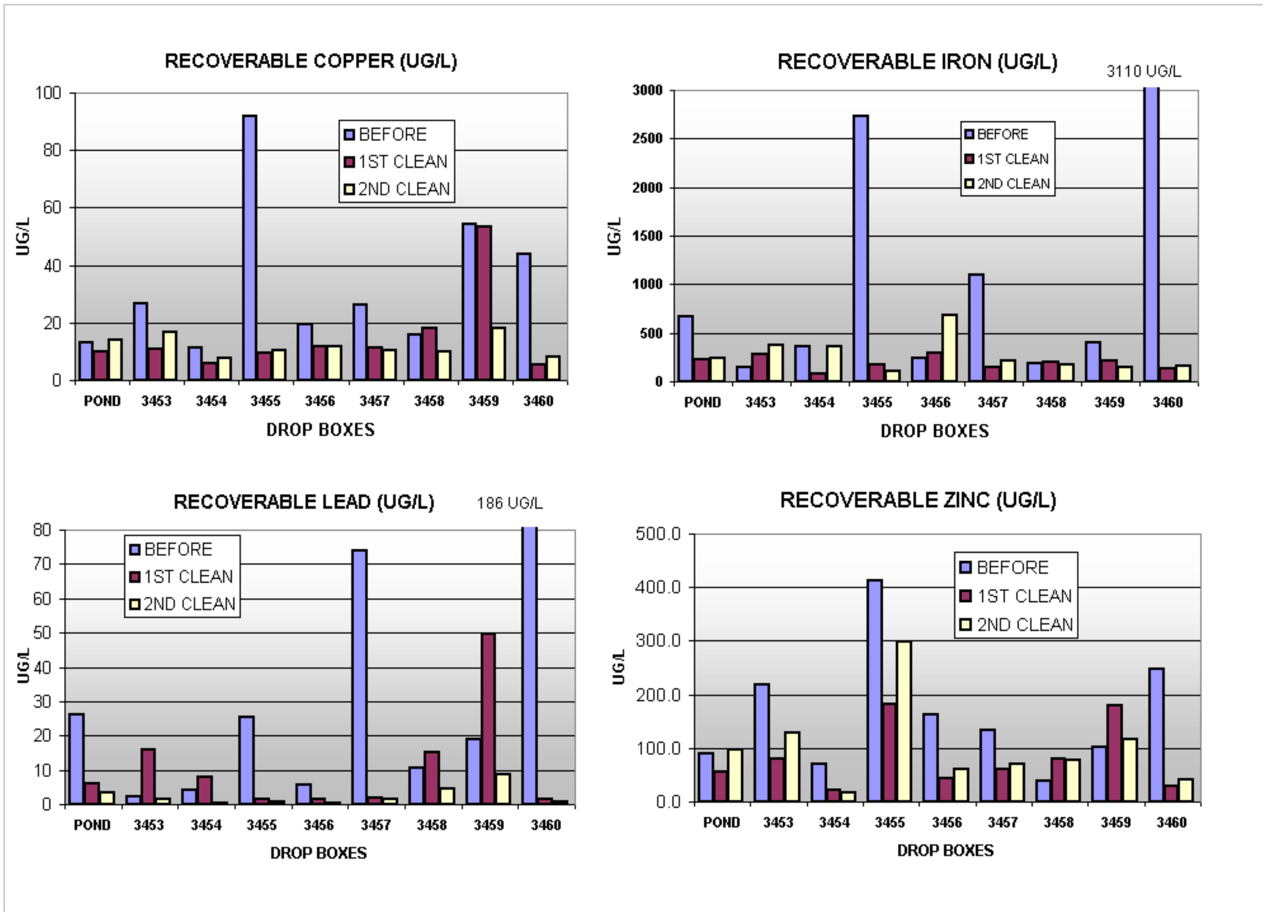


Figure 25b. Comparison of water quality in the bottom of the drop boxes before and after installation for metals (see Figure 4 for site locations).

Some of the higher values (especially TSS) were undoubtedly caused by construction activity, but even the drop boxes not affected by the construction (3453 through 3456) had higher average values before the installation of the drop boxes (see Figure 4 for location of the skimmer box inserts). Higher phosphorus was measured in boxes draining the garden areas (3454-3456), higher nitrogen from the garden areas (3454-3456) and plant nursery (3459), higher metals, especially lead from drop boxes in streets (3458 and 3460), the loading dock (3457) and often from a maintenance area inside the aquarium (3455). Other confounding factors were the wide range of water quality concentrations measured in the drop boxes both before and after the installation and the small number of samples analyzed. Another problem was unmeasured flow into the pipe system, which was not the result of surface runoff through the boxes, but came from places unknown. In all cases, the pond seemed to reduce concentrations before discharge to receiving waters (pond discharge is designated as pond in the figures). High concentration spikes are often measured and a more careful study needs to be conducted to determine how much pollution reduction in the flow stream is possible using drop box inserts. One thing is certain – the skimmer boxes were effective in collecting a large amount of gross solids.

Gross solids samples – The drop boxes were cleaned out three times from the time they were installed in December 2002 until the termination of the study in February 2004. For the first two clean outs, the solids collected were quantified by volume and two duplicate samples were sent to Columbia Laboratory for analysis by particle size. One of the sampling days is shown in Figure 26. Although it appears water quality improved after the drop boxes were installed, the only thing that was actually quantified is that 15-cubic feet per year of potentially polluting gross solids was intercepted by the drop boxes before it could be flushed into the pond (Figure 27).

Figure 26. Cleaning out the skimmer box inserts. a) Crane being moved into place to remove the grate. b) Uncovering the mess that is inside. c) Pushing all the material into the basket and mixing it well in preparation to taking samples to send to the lab. d) Installing cleaned out basket and new boom to make ready to replace the grate (photo credits: Suntree Technologies, Inc).

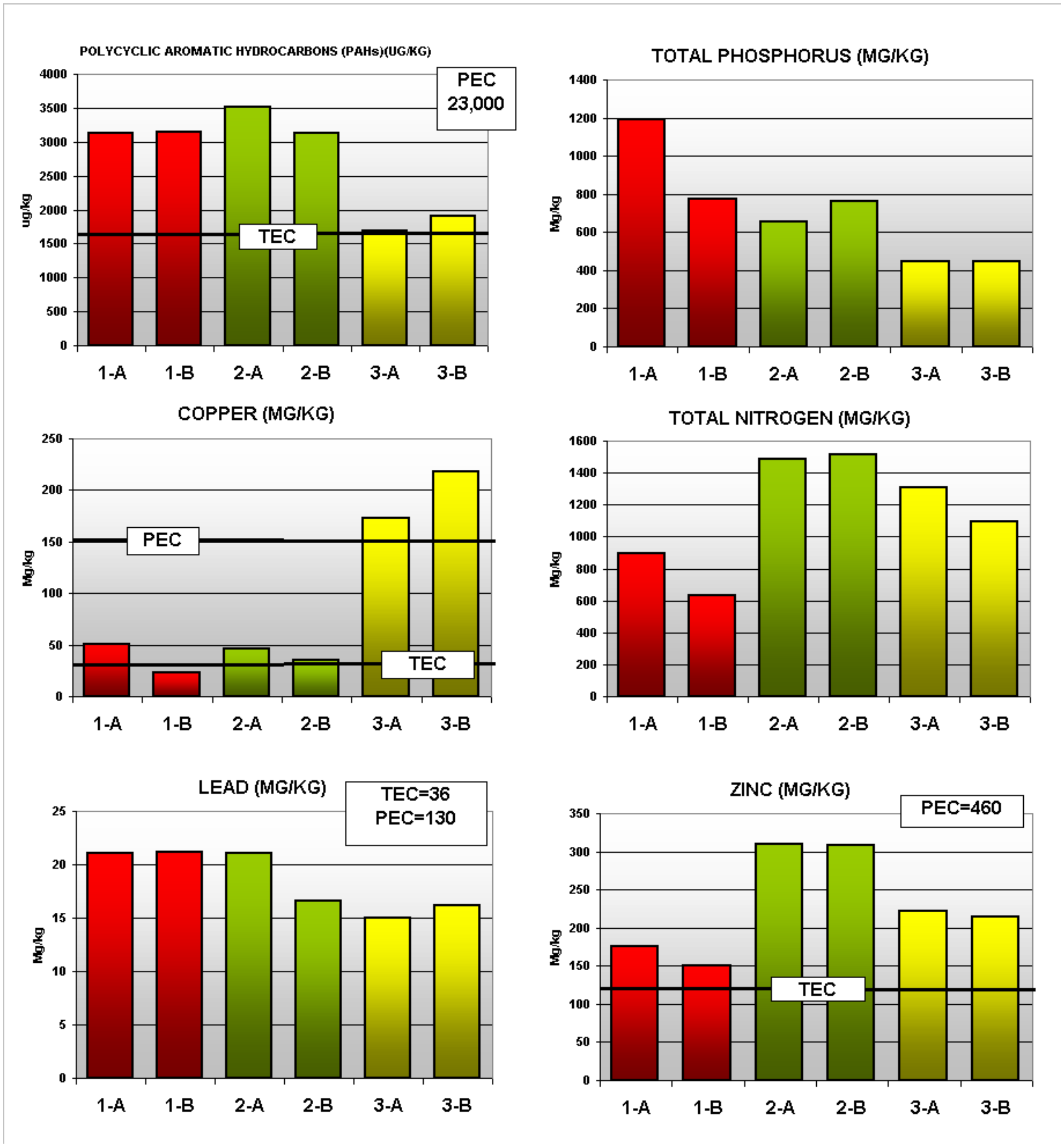


Figure 27. Concentrations measured in gross solids collected by the drop boxes for three cleanout periods. A and B are duplicate samples. TEC=Threshold Effect Level, PEC=Probable Effect Level (See Table 4).

The material collected by the skimmer box inserts were compared to sediment samples collected in the Building pond. Samples had concentrations higher than were measured in the surface sediments of the pond in 1997, but not as high as measured in later years (see Figure 16 and Appendix H). The concentrations in the drop boxes were also higher than measured in the deeper sediments (4 to 5 inch depth) for all years. The same pattern was seen for the metals of concern. Phosphorus was measured at much lower concentrations in the drop boxes than measured for both soil strata in the sediments of the pond. Samples were also compared to concentrations considered detrimental to the pond biota and although concentrations were often measured above the threshold effect level (TEC) where a damaging effect might be seen, only copper during 2003 reached concentrations that were above the probable effect level (PEC) where they would be toxic.

Conclusions – Drop box inserts are effective for collecting coarse solids from the stormwater flow stream. The skimmer box inserts removed about 15 cubic feet of material per year from this 5.67-acre drainage basin. Although the smallest particle size had the highest concentrations of pollutants, the larger particle sizes contributed a greater mass of pollutants. Of some concern is that sieving samples into separate particle size ranges is changing the concentration of pollutants measured in samples. More detailed information from the study is presented in Appendix J.

Diversion structure

Since all three of the pipes that delivered stormwater to the pond were located near the discharge weir, a diversion structure was installed to flush the treatment volume through the littoral zone. This flow had previously gone through the bleed down orifice in the outfall weir structure. Figure 28 is a picture of the diversion structure and Figure 29 shows the site plan with the location of the structure and the new planting.

Figure 28. Diversion structure being installed (left) and once it has been completed (right). Note thick covering of duckweed.

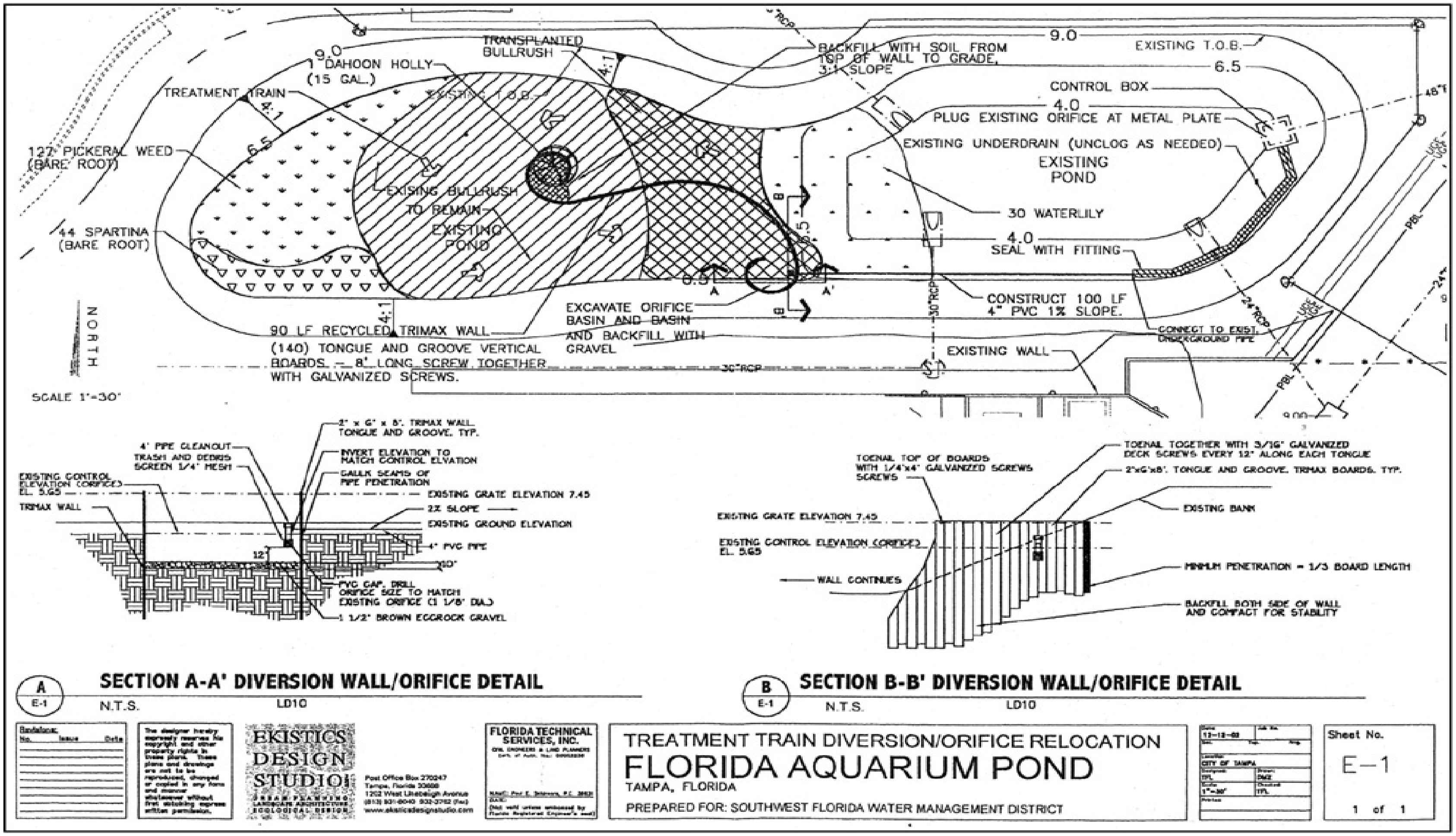


Figure 29. The site plan shows the alterations to the Building pond with the diversion structure and new plantings. Also note the three inflow pipes close to the control box (outflow weir).

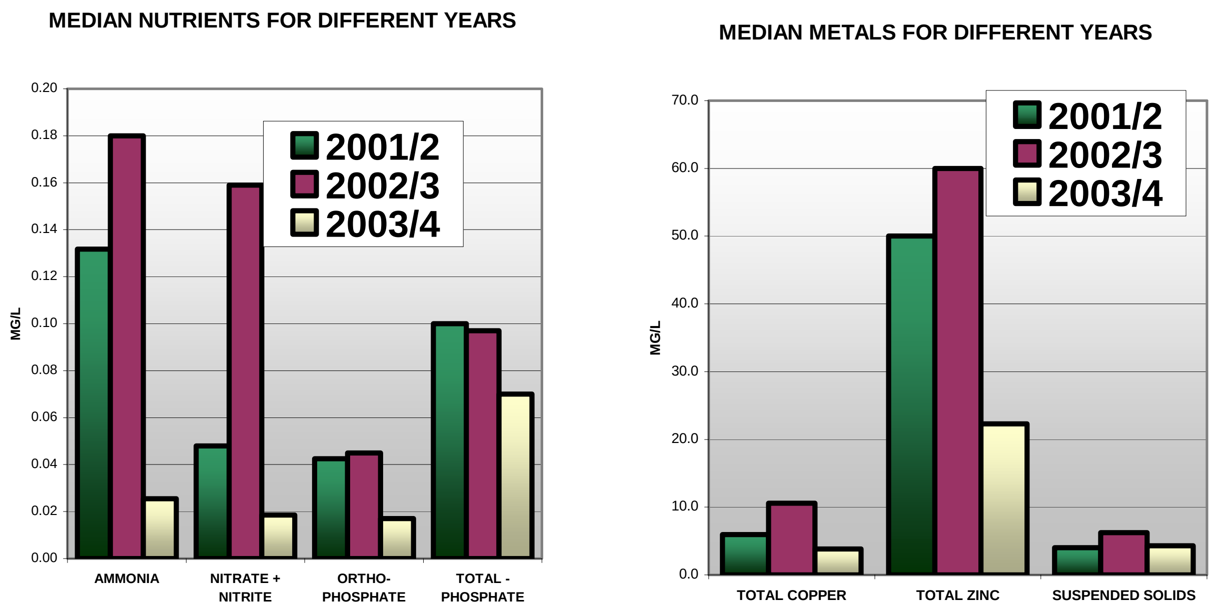


Figure 30. Water quality concentrations are compared to samples taken before the diversion structure was installed (2001/2 and 2002/3) and after it was installed (2003/4).

When the water quality samples collected after the diversion structure was installed are compared to samples before the installation, it appears that there is a considerable improvement in water quality. Unfortunately the structure was put in near the end of the project and only eight storm samples could be collected. These are compared to the much larger data sets for data-year-one and data-year-two. The indications are that the extended travel time through the littoral zone is greatly improving water quality, but a more careful study needs to be done to conclusively document these results.

MAINTENANCE PRACTICES

Maintenance practices were evaluated and these included: algicide treatment, removing surface sediments and cattails in the Building pond, planting a littoral zone in the Street pond, adding barley bales to encourage beneficial organisms for pollutant reduction and using patented biocultures designed to remove excess nutrients and pond scum. None of the studies was rigorous enough to provide conclusive results, but some of the results indicate methods that may warrant further study.

Algicide Treatment - The Building pond was plagued with floating algae mats when these ponds were first sampled in November 1996. It was noticed that a man came around about once a month and added copper sulfate to the pond. It was also noted that the chemicals eliminated the floating mats, but that the surface waters were quickly re-colonized with more mats. What appeared to happen was that the chemical dose killed the existing algae, causing the dead and decaying material to sink to the bottom of the pond and decompose, releasing nutrients back into the water column thus supplying the nutrients for more algae growth, more chemicals and more cycling. Although our research effort was designed to test pond discharge water for storm events and was not designed to test for chemical treatment, the data suggested a boom and bust cycle caused by algicide treatment (Figure 31).

Nitrate and to some extent organic nitrogen appear to spike in response to increase copper concentrations. It should be noted that nitrogen also spikes in response to large rain event, especially after a long dry period. There were no more spikes in copper after the treatment stopped and all the nitrogen spikes appear to be related to rain events.

Besides eliminating a toxic source of copper, the cessation of treatment may have had other benefits. It has also been documented that long-term algicide treatment may be counter productive. Other studies have found that copper application was successful in suppressing algal growth but that after long term applications it is no longer effective (Duvall et al. 2001). These researchers theorized that the algal species became acclimatized or selected for copper resistant species. Their study also found increased algal production with increased nutrients when chemical treatment was continued. Another result occurs with chemical treatment over many years, a toxic layer can form on the bottom of the pond and eventually kill the pond by making it sterile and unable to support macroinvertebrates or fish. This probably accounts for the low invertebrate species diversity when that was measured in 1997 (see Figure 20). Other detrimental effects that were noted included the Parking Lot pond turning pea green like thick soup.

Algicide treatment also explains the high copper concentrations measured in the sediments of the Building pond during the year 2000 sediment sampling event (see Figure 17). Copper concentrations were significantly reduced in 2003 after the surface sediments had been removed during maintenance by Adopt-A-Pond. Another change that occurred after the cessation of copper treatments, was a change in the type of vegetation. Instead of floating algae mats, a thick mat of duckweed and associated species covered the Building pond and *hyrilla* choked the Parking Lot pond. Some proprietary products that use bacteria and enzymes are currently on the market to control vegetation by competing for the nutrients, these were tried to determine if this could help with the vegetation problems.

Biocultures – Microbial products or Biocultures are proprietary blends of highly specialized microorganisms, which are reported to reduce nutrients and odors and to accelerate the breakdown of sludge and organic wastes in water bodies. The treatments add enzymes and bacteria to ponds in order to stimulate or augment existing populations of bacteria, which then consume organic debris and dissolved nutrients. Since copper-based chemicals had already been shown as ineffective in controlling plant growth while at the same time they increased toxicity in the Aquarium ponds, a bioculture was thought to be a possible alternative solution. Biocultures were reported to reduced nutrients in the water column, and were introduced in an effort to reduced rampant weedy plant growth. Biocultures from two different vendors were tested at two different times, to see if these products would improve conditions in the Aquarium ponds.

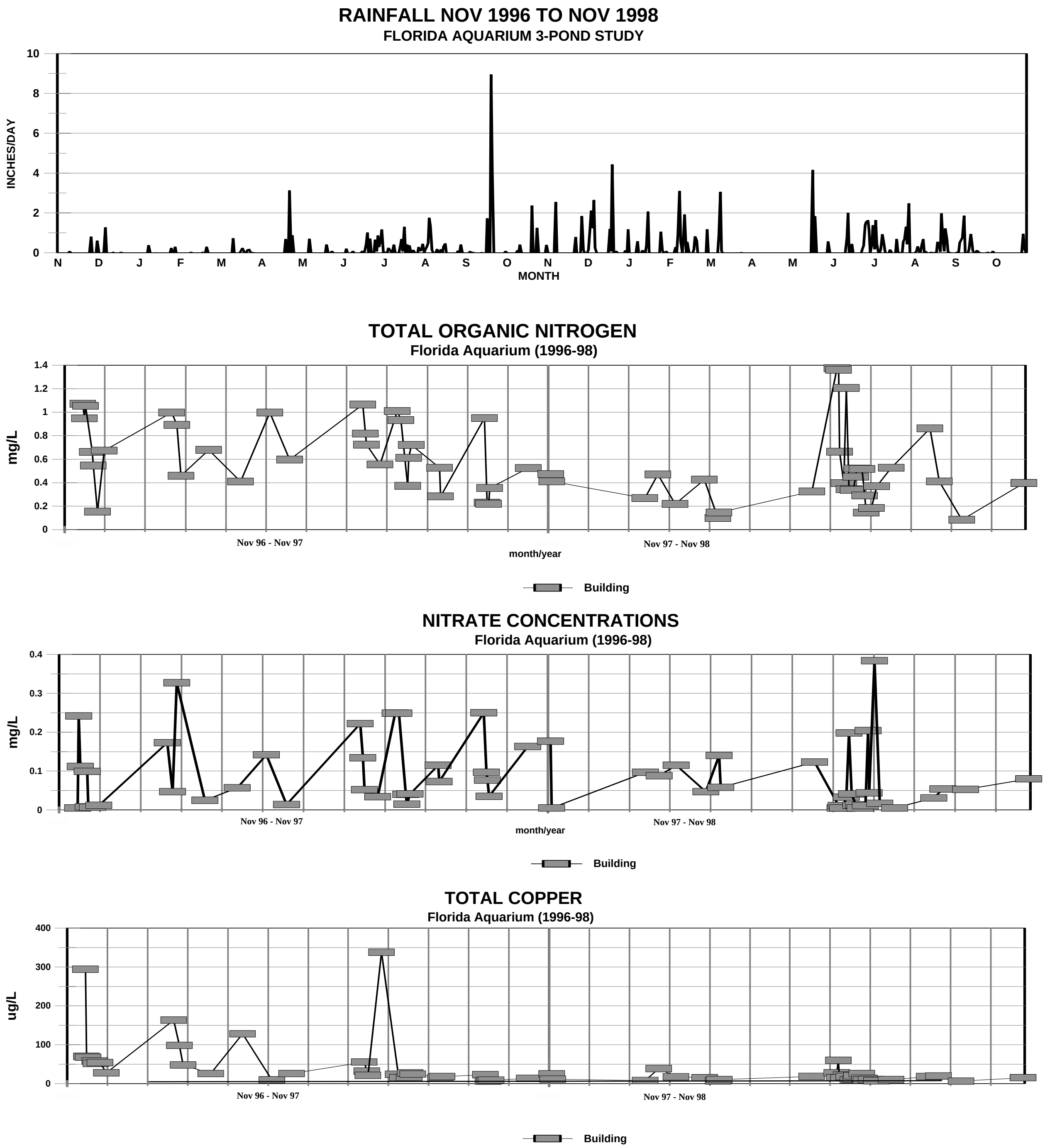


Figure 31. Changes in copper, organic nitrogen and nitrate when copper applications were stopped about September of 1997

"Living Soils"- This trial took place in June of 1998 and was introduced by a company called Living Soils, Inc. The product was reported to be composed of nature's compounds and to extract ammonia, nitrites, nitrates, phosphates and toxic chemicals from the water. Microbes are used to scarify the water of nutrients and to digest organic material, such as dead algae and leaves. The reactants were reported to be an ultra violet compound, which bonds sulfuric acid (from Violet 49) and sodium carbonate (from Blue 9) to produce a molecule, which is activated in the presence of 200-nanometer of light. The products are hydrogen sulfide that evaporates, ammonium sulfide that precipitates and falls to the bottom, while excess oxygen and carbon dioxide are released into the water column. The reaction is supposed to raise oxygen levels substantially throughout the water body after treatment. The treatment is a two-stage process where a product called SU 200 is added to remove nutrients and about five days later microbial organic digesters identified as AQ2 are introduced (Figure 32 and Appenidx L). Since the treatment is not especially effective for reducing macrophytes, as much duckweed as possible was skimmed from the surface of the Building pond before the ponds were treated with SU200 on June 18, 1998. On June 25, 1998, the AQ2, a microbial digester was added to the ponds. Unfortunately two large rain events occurred between the two treatments that confound the results. Also this was the beginning of the rainy season and only one rain event (0.56 inches) had occurred in June, although several large rain events were recorded in May.

After the trial began, both ponds exhibited a large reduction in organic nitrogen and in the Parking Lot pond a reduction in phosphorus and copper. Most of the other changes in the Building pond can be explained by rainfall, but it should be noted that concentrations were already low because the floating duckweed does a pretty effective job of reducing nutrient concentrations in the water column. The Parking Lot pond measured higher concentrations, and the different flora types and flow regimes may explain the different results. The Building pond is a flashy system and rainfall rapidly flows through the pond and is discharged; and probably the introduced compounds were discharged as well. The Parking Lot pond was dominated by phytoplankton in the water column and in addition it was stagnant because it hardly ever discharged water out of the pond. This experiment may show that floating plants also reduce inorganic nutrients as well as microbial additions and that ponds dominated by phytoplankton and floating algae with high water column nutrient levels could benefit from bioculture treatment. Field parameters were also measured and no changes were noted for either treatment. The pattern of widely fluctuating levels typical of highly productive ponds persisted (Appendix K). If the ponds had been anoxic with low dissolved oxygen levels the results might have been different and higher DO measured. The bad news was that the ponds still looked a mess one month after treatment. The Building Pond was covered 100 percent with duckweed and the Parking Lot Pond had shifted from a system dominated by phytoplankton to one dominated by hydrilla.

"Healthy Pond" - A bioculture labeled "Healthy Ponds" was introduced into the Street pond in August of 2003. It is reported to be a biological treatment, which uses special bacteria to reduce the amount of nutrients and organic matter in a pond. When the bacteria are added to the water, they produce enzymes that break down complex organic matter into simple nutrients, and then they consume these excess nutrients. Since it may take several weeks for the bacteria to break down the organic matter and excess nutrients, a special dispensing system was used to continuously release bacteria over a period of about 30 days (Figure 33).

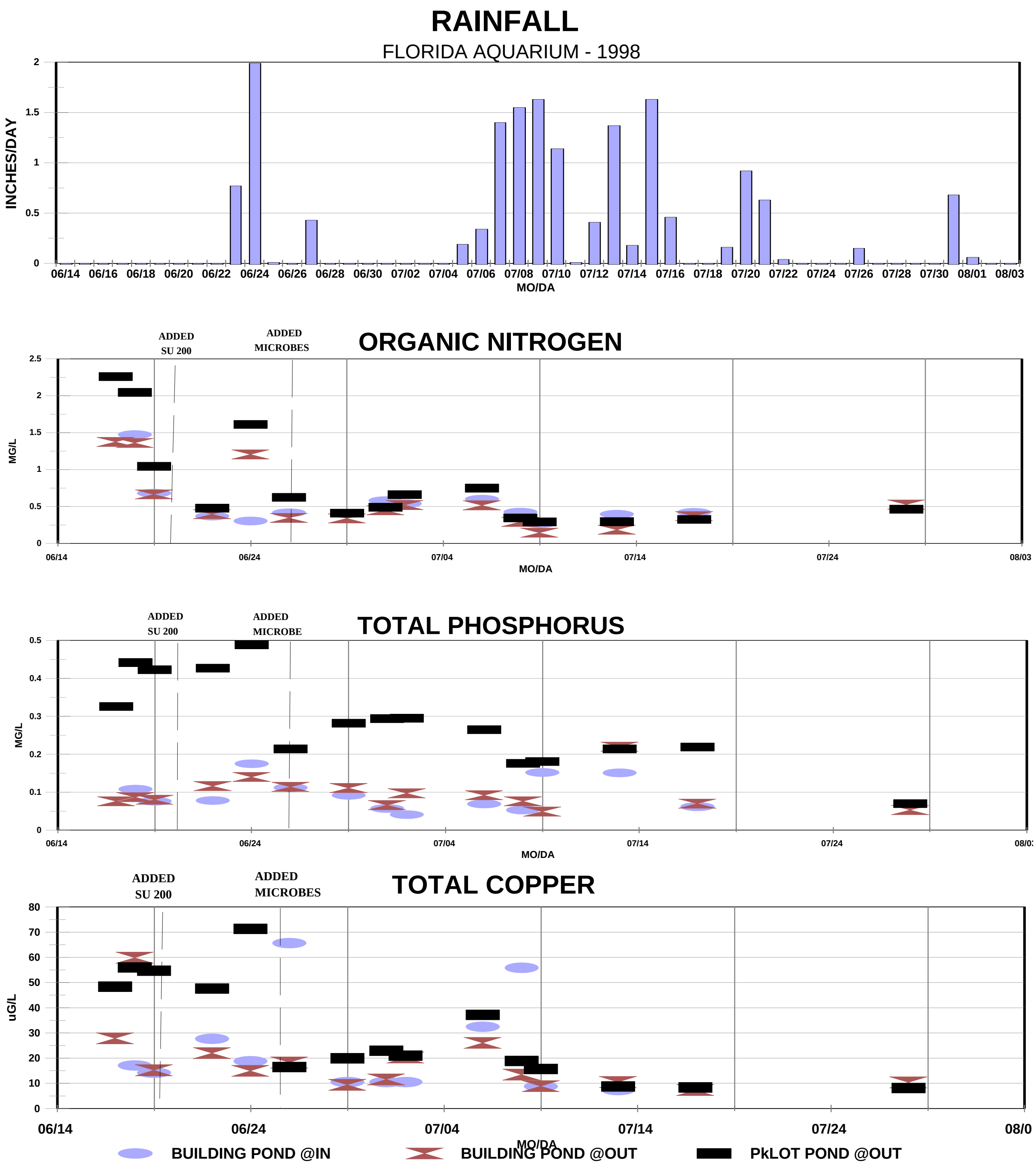


Figure 32. Comparison of constituents measured after "Living Soil" treatment

The dispensing containers were deployed on August 14th. To determine any differences in water quality, samples were analyzed about every two weeks starting four months before the addition and for four months after the addition to determine any changes in water quality. Grab samples were collected at three locations in the pond – near the inflow at station 6, at the outfall of the sedimentation basin at station 5 and at the outfall of the pond station 4 (See Figure 3). The constituents tested were nitrogen, phosphorus, suspended solids and chlorophyll. There were no discernable differences in suspended solids and organic nitrogen after the introduction of the bacteria until October when large increases were measured. Total phosphorus and ammonia may have increased after the introduction of bacteria, especially at the inflow station 6. Nitrate may have decreased. It was not determined if this increase was caused by the addition of the bacteria (see Appendix M). After September 2003, there were large increases in the concentrations, especially TSS and chlorophyll. According to the field journal, it was reported that about that time the duckweed looked stagnant and there was a fish kill. There is no explanation for these observations. Another dose of "Healthy Pond" culture was added on November 6, 2002 by the vendor and exceptionally large concentrations of TSS and chlorophyll were measured in the pond after this addition, but not at the inflow of the pond (Figure 34).

Figure 33. Bioculture in dispenser container

There was no change in the aesthetics of the pond after the "Healthy Pond" introduction, which was still covered in duckweed. Since the treatment method is recommended for ponds much more highly polluted than the Street pond, results may have been much different in other applications. For example, suspended solids in the Street pond were less than 10 mg/l until the increase in October and organic nitrogen was less than 0.7 mg/l. Nitrate+nitrite was measured near the laboratory detection limit of 0.01 mg/l and phosphorus was about 0.04 mg/l except near the inflow of the pond, where water was continually being replaced. Chlorophyll a may have increased with the bacteria application.

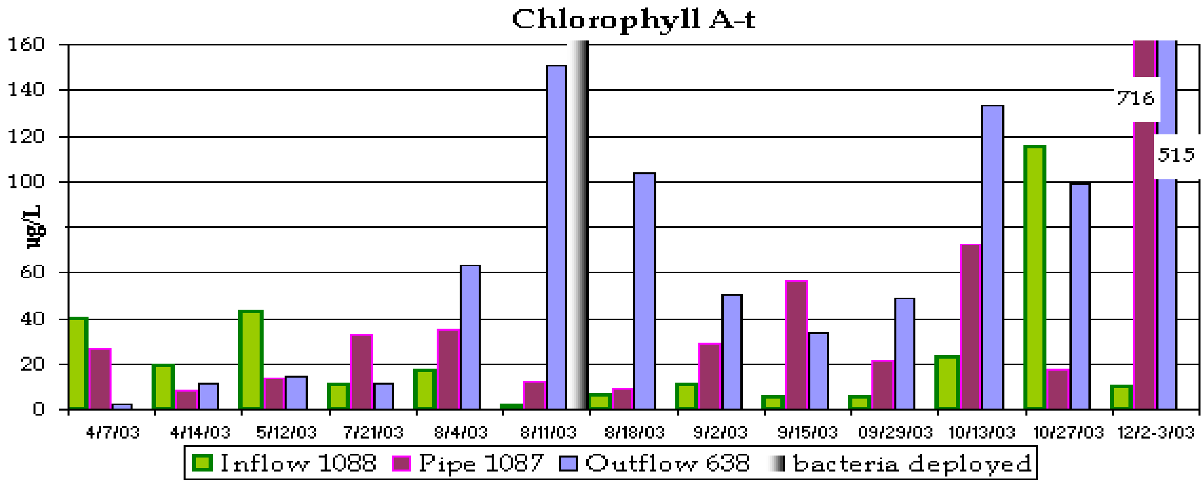


Figure 34. Chlorophyll a concentrations measured before and after the introduction of "Healthy Pond" cultures into the Street pond at three locations (green=inflow, purple=mid-pond, blue=outflow). The first addition was made on August 14, 2002 and a second dose was added to the pond on November 6, 2002 (see Appendix K for all of the data).

These two tests indicate that biocultures are not especially effective in moderately polluted stormwater ponds, where nutrients in the water column are already being taken up by macrophytes and water is being continually flushed through the pond with every rain event These are the same results reported for a microcosm study in ponds where the researchers reported that filamentous algae and aquatic vascular plants were not significantly affected by any of the microbial products tested compared to a control group (Duvall et al. 2001). They further concluded that in their study there were no indications that microbial products reduce chlorophyll concentrations or control algal growth. Biocultures may be effective in grossly polluted situations where floating algae mats have reduced dissolved oxygen and created septic conditions, but they did not improve the nuisance floating macrophytes in the Aquarium ponds.

Barley Straw. Barley straw is reported to control algal growth and some barley bales were added to the ponds in 2001to test their effect on the floating vegetation mats. The actual mechanism of control is not completely understood, but the conditions for it to be effective are well established. The straw needs to decompose in water while oxygen is available. Apparently, chemicals released by the decomposing barley kills or inhibits the growth of algae (Foster 2001). The specific chemical(s) has not been identified (oxidized polyphenolics and hydrogen peroxide are two decomposition products that have been suggested) (Lembi 2001). Barley straw does not kill already exisiting algae, but is suppose to prevent new growth of algae. In Florida, a small-scale study found that barley straw does inhibit algae growth, but that the amount of straw needed for a pond was not practical in Florida (Langland 2001). Barley straw made no difference in floating macrophyte populations at the Aquarium ponds and apparently no difference in constituent concentrations (compare 2001 with 2002 in Figure 21).

Pond Maintenance – As stormwater ponds age, the accumulated dead vegetation and the gross solids that have been washed into the pond sink to the bottom where they are available for re-suspension and for releasing pollutants back into the water column. One method suggested to maintain pond integrity is to clean out the bottom sediments about every 10 to 20 years. The Hillsborough County Adopt-A-Pond program has set up a program where they help Home Owner's Associations clean out and maintain their ponds. They also helped us clean out the Building pond at the Florida Aquarium. It improved the aesthetics of the pond by removing cattails and helped the performance of the pond by removing contaminated bottom sediments. The improvement is difficult to quantify because of the tendency for constituents to increase over time, but the reduced organic nitrogen measured in the water column in spite of increased concentrations of all other constituents is probably one manifestation of removing the organics (see Figure 8). The large reduction in copper and zinc measured in the sediments in the Building pond in 2003 is another (see Figure 17). The reduction in the Street pond was attributed to the recontouring of that pond during the cruise ship terminal construction. The percent organic matter measured in the sediments in 2003 compared to 2000 is another example.

Figure 34. Cleaning out bottom sediments and cattails in the Building pond during maintenance by Adopt-A-Pond.

SUMMARY OF RESULTS

INTENSIVE STORMWATER MONITORING STUDY

Two stormwater ponds were compared to each other for storm events for two years using automatic monitoring equipment. The same ten-month period each year was used for the comparisons.

- Comparable data show data-year-one was a drought year with significantly less rainfall (26 inches) when compared to data-year-two (58 inches) and the long-term average (44 inches) (Figure 5 and Table 5).

- The two pond levels show similar responses to rainfall, although the smaller Building pond exhibits slightly wider fluctuations (Figures 5 and 6). The levels indicate the filters in the effluent filtration stormwater wet pond (Street pond) are still operational and are slowly releasing flow after storm events at about the same rate as the bleed down orifice in the wet detention pond (Building pond), indicating they are still working as designed.

- Higher concentrations of pollutants were usually measured in the Building pond compared to the Street pond for both years (Figures 8 and 9).

- Lower concentrations of constituents were measured in rainfall during the second year compared to year one, which is attributed to the increased rainfall amount in year 2 or the location of the rainfall collector in year 1 (Figures 8 and 9).

- More ammonia and nitrate are usually measured in the rainfall than measured in the discharge water from the ponds indicating, these nutrients need to be cleaned up at the source by reducing air pollution (Figure 8) and that ponds are effective in reducing their concentration.

- The samples collected from the under drains had concentrations over twice as high for ammonia and ortho-phosphorus than measured in the pond discharge water and this concentration in the under drains is measured even higher between storm events (Figures 10 and 11).

POND CHARACTERIZATION COMPARISONS

Data have been collected at the site over a seven-year time period comparing three types of stormwater treatment systems.

- Field parameters of temperature, pH, dissolved oxygen, and conductivity reflect the conditions of the pond at time of measurement, which shifts from highly productive with wide fluctuations to anoxic conditions with suppressed values caused by floating vegetation covering the pond (Figure 13 and Appendix G).

- Field conditions are affected by rainfall and photosynthesis (Figure 13).

- A dramatic increase in sediment nutrient concentrations was measured in 2003 with values much higher than have been measured in other stormwater studies (Figure 16).

- Metals in the surface sediments in the Building pond exceeded the probably toxic levels of 150 mg/l for copper and 460 mg/l for zinc (Figure 17).

- Both the Building and Street ponds show a large increase in polycyclic aromatic hydrocarbons measured in the sediments from 2000 to 2003 and many were above the possibly toxic level and some above the probably toxic level (Table 6 and Appendix H).

- Pesticides were measured in the sediments. Chlordane was above the probably toxic level and DDE was detected in the possibly toxic range (Appendix H).

- Fish and other aquatic biota showed a great increase from 1997 to 2003 especially for *Gambusia* and water fleas. A reduction in some fish species may be attributed to the aggressive nature of *Gambusia*, which is viewed as an undesirable species by many ichthyologist unless it is native to the region (Tables 7, 8 and 9).

- In a macroinvertebrate study conducted in 1997, all the taxa reported were those highly tolerant of polluted conditions. Low abundance of even these species was reported in locations where possibly toxic concentrations of pollutants had been measured in the sediments (Figures 18, 19 and 20 for inverts; and Table 17 and Appendix H for sediments).

- The concentrations measured at the outflow for four years show fairly even concentrations except for a few instances (Figure 21 and 22). Increases in inorganic nitrogen in the Building pond was traced to some fertilizer practices, the high values in copper in 1997 were attributed to algicide applications, high concentrations in the Parking Lot pond resulted from contamination by Ybor channel inflows and the higher values for zinc in the Building pond could have come from roof runoff.

- Most water quality concentrations for metals were near the laboratory limit of detection or in the case of TSS values were less than can be removed by sedimentation indicating the ponds are doing a good job of reducing most pollutants (Figure 22).

- Exceptions were copper in the early years where 30 to 50 percent of samples failed to meet the copper standard probably caused by algicide applications; and lead in the Street pond where 12 to 40 percent of samples failed to meet standards (Figure 23).

POND IMPROVEMENTS

One of the purposes of the study was to test different techniques to improve the function of the ponds. Since the poorest water quality was discharged from the Building pond, most of our efforts focused on this one pond.

- Skimmer box inserts reduced concentrations of pollutants by a large amount for water quality samples collected before they were installed and samples collected after installation (Figure 25a and 25b).

- The skimmer box inserts removed 15 cubic feet of gross solids contaminated with potentially toxic pollution from the drainage basin (5.67 acres) before it could contaminate the pond sediments during the first year after installation (Figure 27 and Appendix J).

- A diversion structure installed to increase the travel time of the treatment volume in the Building pond decreased concentrations in the discharge water by a considerable amount (Figure 30).

MAINTENANCE PRACTICES

Various treatments were tested to determine if they would improve the aesthetics of the ponds.

- Algicide treatment for eliminating floating algae mats was being used in 1997. Data suggest that this was increasing both copper and nitrogen in the pond discharge water (Figure 31); and also increasing copper in the sediments to toxic levels (Figure 17).

- Biocultures indicate that they may reduce organic nitrogen and phosphorus, but did not improve the aesthetics of the pond (Figure 32).

- Barley straw made no difference in the water quality of the pond or the aesthetics.

- Scraping out the bottom sediments of the pond and removing nuisance vegetation removed toxic levels of copper and reduced organic nitrogen and organic matter, but did not permanently improve the problems with floating vegetation.

SEE EXECUTIVE SUMMARY FOR CONCLUSIONS

REFERENCES

Agency for Toxic Substances and Disease Registry (ATSDR). 2001. Polycyclic Aromatic Hydrocarbons (PAHs). http://www.atsdr.cdc.gov/ToxProfiles/phs8806.html.

American Public Health Association, American Water Works Association, and Water Pollution Control Federation (APHA). 1985. Standard Methods for the Examination of Water and Wastewater, 17th Edition. American Public Health Association, Washington, DC.

Ashe, P.1983. A Catalogue of Chironomid genera and Subgenera of the World Including synonyms (Diptera:Chironomidae). Ent. Scand.Suppl. 17:1-68.

Barry, R. G. and R. J. Chorley. 1978. Atmosphere, Weather and Climate, Third Edition. Methuen & C Ltd.

Boyd, C. E. 1995. Bottom Soils, Sediment, and Pond Aquaculture. Chapman & Hall, New York, NY.

Burton, G. A., Jr. and R. E. Pitt. Stormwater Effects Handbook:Atoolbox for Watershed Managers, Scientists, and Engineers. Lewis Publishers. CRC Press. New York.

Brinkhurst, R.O.1986. Guide to the Freshwater Aquatic Microdrile Oligochaetes of North America. Canadian Journal of fisheries and Aquatic Sciences. 84:259.

Carr, D. W. and B. T. Rushton. 1995. Integrating a Native Herbaceous Wetland into Stormwater Management. Southwest Florida Water Management District, 2379 Broad Street, Brooksville, FL 34604.

Chadwick, J.W., S.P.Canton, and R.L.Dent. 1986. Recovery of Benthic Invertebrate Communities in Silver Bow Creek, Montana, Following Improved Metal Mine Wastewater Treatment. Water Air Soil Pollution. 28:427-438.

Clements, W.H..,D.S.Cheery, and J.Cairns, Jr. 1988. Heavy Metals on Insect Communities in Streams. Canadian Journal of Fisheries and Aquatic Sciences 45:2017-2025.

Courtenay, W. R. Jr. and G. K. Meffe. 1989. Small fishes in strange places: AQ review of introduced poeciliids. In: G.K. Meffe and F. F. Snelson, Jr., (eds). Ecology and Evolution of Livebearing Fishes. Englewood Cliffs, NJ:Prentice Hall, pp 301-331.

Cullum, M. G. and Dierberg, F. E. 1990. Evaluation of a Dry Detention with Filtration Stormwater Management System Which Receives Runoff from a Mixed Urban Land Use. South Florida Water Management District, West Palm Beach, Fl.

Davis, J.C. 1975. Minimal Dissolved Oxygen Requirements of Aquatic Life with Emphasis on Canadian Species: A Review. Journal of Fish Res Bd Can 32:2295-2332

Dixon, L.K., M.G.Geyl, and S. Murray. 1998. Interpretation of Bulk Atmospheric Deposition and Stormwater Quality Data in the Tampa Bay Region. Mote Marine Laboratory Technical Report No. 602. Tampa Bay Estuary Program, Mail Station I-1/NEP, St.

Petresburg, FL 33701.

Duvall, R.J., L.W.J. Anderson, and C.R.Goldman. 2001. Pond Enclosure Evaluations of Microbial Products and Chemical Algicides Used in Lake Management. J. Aquatic Plant Management 39:99-106.

Florida Department of Environmental Protection (FDEP) 2003 Development and evaluation of Numerical Sediment Quality assessment Guidelines for Florida Inland Waters.Technical Report http://www.dep.state.fl.us/water/monitoring/docs/seds/SQAGs_for_Florida_Inland_Waters_01_03.PDF

Florida Department of Environmental Protection (FDEP). 1992. Standard Operating Procedures for laboratory Operations and Sample Collection. Tallahassee, Florida. FDEP-QA-001/92, Quality Assurance Section, Tallahassee, Florida.

Foster, Johnny. Barley Straw for Natural Algae Control. http://www.fosterlake.com/barleystraw.html

Free, B.M. and G.G.Mulamoottil. 1983. The Limnology of Lake Wabukayne, a Stormwater Impoundment. Water resources Bulletin. 19:821-827.

Harper,H.H. 1990. Long-Term Performance Evaluation of the Alum Stormwater Treatment System at Lake Ella, Florida. FDER Project WM339. Environmental Research & Design, Inc. Orlando, Florida.

Harper, H.H. and J.L.Herr. 1993. Treatment Efficiencies of Detention with Filtration Systems. Final Report for SJRWMD Contract No. 90B103. Environmental research & Design, Inc. Orlando, FL.

Hammelink, J. L., P. F. Landrum, H. L. Bergman, W. H. Benson. 1994. Bioavailability: Physical, Chemical, and Biological Interactions. Lewis Publishers. Boca Raton.
http://www.fishbase.org/Summary/Species Summary.cfm
http://www.nanfa.org/articles/Acmosquito.htm

Helsel, D.R. and R.M.Hirsch. 1995. Statistical Methods in Water resources. Elsevier Science Publishers B.V.Amsterdam, The Netherlands.

Kadlec, R. H. and R. L. Knight. 1996. Treatment Wetlands. Lewis Publishers, CRC Press, New York

Kehoe, M. J. 1993. Water Quality Survey of Twenty-Four Stormwater Wet-Detention Ponds. Southwest Florida Water Management District, 2379 Broad Street, Brockville, FL 34609.

King, S. 1996. Managing the Blooming Algae. The IPM Practitioner. July:1-11.

Klemm, D.J. 1982. Leeches (Annelida:Hirudinea) of North America. EPA-600/3-82-025. US EPA, Washington DC.

Krebs, C.J. 1978. Ecology: The Experimental analysis of distribution and abundance, 2nd edition, Harper and Row, Publishers, New York, 678 pp.

Langeland, K.A. Barley Straw. Center for Aquatic Plants, Gainesville, FL 32606.

LaPoint, T.W., W.M.McLancan and M.K.Morris. 1984. Relationships Among Observed Metal Concentrations, Criteria, and Benthic Structural Community Responses in 15 Streams. J. Water Pollution control Fed. 56:1030-1038.

Lembi, C. A. 2001. Barley straw for Algae Control. Botany and Plant Pathology, Purdue University http://www.agcom.purdue.edu/AgCom/Pubs

Livingston, Eric. 1989. State Perspectives on Water Quality Criteria. In Design of Urban Runoff Quality Controls. Roesner, L.A., Roesner, Urbonas, B. and Sonnen M. G. (eds) ASCE 345 E. 47th St. New York, NY 10017-2398.

Long, E. R., D. D. MacDonald, S. L. Smith, F. D. Calder 1995. Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments. Environmental Management 19:81-97

Long, E. R., D.A. Wolfe, R.S. Carr, K.J. Scott, G. B. Thursby, H. L. Windom, R. Lee, F. D. Calder, G. M. Sloane, and T. Seal. 1994. Magnitude and Extent of Sediment Toxicity in Tampa Bay, Florida. NOAA, Technical Memorandum NOS ORCA 78, 1305 East-West Highway, Silver Spring, MD 20910.

Marble, A. D. 1992. A Guide to Wetland Functional Design. Lewis Publishers, Boca Raton, FL

Milligan,M.R. 1997. Identification Manual for the Aquatic Oligochaeta of Florida Southwest Florida Water Management District, Tampa, FL

Mitsch, W.J. and J.G. Gosselink. 1993. Wetlands. Van Nostrand Reinhold, New York, NY>

Moore,J.W. and S.Ramamoorthy. 1984. Heavy Metals in Natural Waters: Applied Monitoring and Impact Assessment. Springer-Verlag, New Yourk, NY.

Mueller, D.K., Hamilton, P.A., Helsel, D.R., Hitt, J.K., and Ruddy, B.C. 1995. Nutrients in Ground Water and Surface Water of the United States: An Analysis of Data Through 1992. Water-Resources Investigations Report 95-4031. U.S. Geological Survey, Denver, CO

Murray, J. W. 1987. Mechanisms Controlling the Distribution of Trace Elements in Oceans and Lakes. *In* Sources and Fates of Aquatic Pollutants, R.A. Hites and S. J. Eisenreich (eds). Advances in Chemistry Series 216, American Chemical Society, Washington, DC

O'Connor, P. O., K. D. Kostas, J. L. Hyland, J. F. Hyland, J. F. Paul, and J. K. Summers. 1998. Comparisons of Sediment Toxicity with Predictions Based on Chemical Guidelines.

Odum, H.T. 1983. Systems Ecology:An Introduction. John Wiley & Sons, Inc. New York, NY

Page, L. M. and B. M. Burr. 1991. Gambusia affinis mosquito fish. Environmental Toxicology and Chemistry, 17(3):468-471.

Pennak, R.W. 1989. Fresh-Water Invertebrates of the United States, 3rdED, John wiley &Sons, Inc., New York,NY

Pitt, R. 2000. Source Characterization. In Innovative Urban Wet-Weather Flow Management Systems, R. Field, J.P. Heaney and R.Pitt (eds). Technomic Publishing Co., Inc. http://www.epa.gov/ednnrmmrl/book/epa-600

Roberson, J.P. and J.D.Hem. 1967. Solubility of Aluminum in the Presence of Hydroxide, Floride and Sulfate. U.S.Geologic Survey Water-Supply, Tampa, Florida.

Rosenberg, D. M. and V.H.Ressh. 1993. Freshwater Biomonitoring and Benthic Macroinvertebrates. Chapman and Hall, Inc. < New York, NY.

Rupp, H. R. 2004 Adverse Assessments of Gambusia affinis.

Rushton, B. T. 2002. Treatment of Stormwater Runoff from an Agricultural Basin by a Wet-Detention Pond in Ruskin, Florida. Southwest Florida Water Management District, 2379 Broad Street, Brooksville, FL 34604.

Rushton, B. T. C.Miller, C. Hull and J. Cunningham. 1997. Three Design Alternatives for Stormwater Detention Ponds. Southwest Florida Water Management District, 2379 Broad Street, Brooksville, FL 34604.

Rushton, B.T. and R. Hastings. 2001. Florida Aquarium Parking Lot: A Treatment Train Approach to Stormwater Management., Southwest Florida Water Management District, 2379 Broad Street, Brooksville, FL 34604.

Southwest Florida Water Management District (SWFWMD) 1998. Water Management Monthly, Volume VIII, Issue IX, February 1998.

Stahre, P. and B. Urbonas. 1990. Stormwater Detention. Prentice Hall, Englewood Cliffs, NJ 07632.

Steel, R. G. D. and J. H. Torrie. 1960. Principles and Procedures of Statistics. McGraw-Hill Book Company, Inc. New York, NY.

Stumm, W. and J. J. Morgan. 1981. Aquatic Chemistry: An Introduction Emphasizing Chemical Equilibria in Natural Waters. John Wiley & Sons, New York, NY.

Tampa Bay Estuary Program. 2000. Estimates of Total Nitrogen, Total Phosphorus, Total Suspended Solids, and Biochemical Oxygen Demand Loadings to Tampa Bay, Florida. 100 8th Avenue SE, St. Petersburg, Florida 33701. Prepared by Janicki Environmental, Inc.

Teague, Kara, and B. T. Rushton. 2005. Stormwater Runoff Treatment by a Filtration

System and Wet Pond in Tampa, Florida. Final Report. Southwest Florida Water Management District, 2379 Broad Street, Brooksville, FL 34604.

Thorp, J.H. and A.P. Covich. 1991. Ecology and Classification of North American freshwater Invertebrates. Academic Press, Inc. San Diego, CA.

United States Environmental Protection Agency (USEPA). 1973. Biological Field and Laboratory Methods for Measuring the Quality of surface Waters and Effluents, Report 670/4-73-001. U.S.EPA, Washington, D.C.

United State Environmental Protection Agency (USEPA). 1986. Quality Criteria for Water 1986. Washington, D.C., U. S. Environmental Protection Agency Report 440/586001, Office of Water Resources, Washington, DC.

United States Environmental Protection Agency. 1983. National Urban Runoff Program, Vol I, NTIS PB84-185552, U.S.EPA, Washington, D.C.

Urbonas, B. R. 1999. Design of Sand Filter for Stormwater Quality Enhancement. Water Environment Research 71(1):102-112.

Wanielista, M. P. and Y. A. Yousef. 1993. Stormwater Management. John Wiley & sons, Inc. New York.

Wilhm, J.L. 1979. Range of Diversity Index in Benthic Macroinvertebrate Populations. Journal of the Water Pollution Control Federation, 42:R221-R224.

Winner, R.W., J.S.VanDyke, N.Caris, and M.P.Farrel. 1975. Response of the Macroinvertebrate Fauna to a Copper Gradient in an Experimentally-Polluted Stream. Journal of Applied Limnology. 19:2121-2127.

Winner, R.W.and J.D.Gauss. 1986. Relationship Between Chronic toxicity and Bioaccumulation of Copper, Cadmium, and Zinc as affected by Water Hardness and Humic Acid. Journal of Aquatic Toxicology. 8:149-161.

Yousef, Y. A., T. Hvitved-Jacobsen, M. P. Wanielista, R. D. Tolbert. 1986. Nutrient Transformation in Retention/Detention Ponds Receiving Highway Runoff. Journal Water Pollution Control Federation 58(8):838-843.

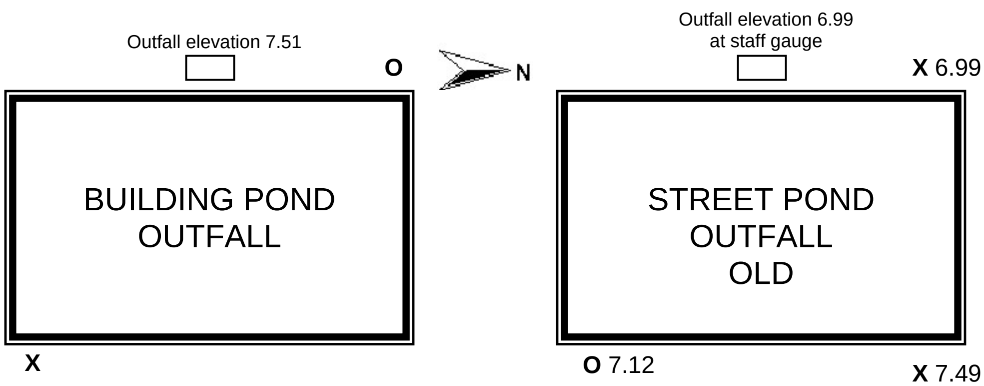
APPENDIX A

Quality Assurance Information

Weir Diagrams and Formulas
Comparison of Grab and Composite Samples
Water Quality Test

Original data: Excel: Demo/Grabs and Word: Demo/ Flow Calculation Setup

FLOW CALCULATION SET UP FOR BUILDING POND AND STREET POND AT THE FLORIDA AQUARIUM



X = LOCATION WHERE WATER FLOWS OVER WEIR FIRST
O = LOCATION WHERE WATER FLOWS OVER WEIR LAST

Standard formula for rectangular weir with end contractions:

Q=K*(L-(0.2 * H))*(H^1.5)

Q = flow in cubic feet per second (cfs)
K = constant of 3.33
L = length of weir
H = head (depth of water over weir)

BUILDING POND ELEVATION vs. FLOW:

There is a 1.0-inch (0.08 ft) difference in elevation between the southeast corner where the water flows first and the northwest corner where the water flows last. Flow calculations begin at pond level (at pond level 7.51, head is 0.0). For pond levels 7.51 ft. thru 7.56 ft. (head 0.0 ft. thru 0.04 ft.), flow calculations should be done utilizing only one long side of the outfall box (H=head):

3.33 * (8.50 – (0.2 * H)) * (H^1.5)) + 2 * (3.33 * (3.67 – (0.2 * H)) * (H^1.5))

YEAR ONE STREET POND ELEVATION vs. FLOW:

There is a 1.5-inch (0.13 ft.) difference in elevation between the northwest corner where the water flows first and the southeast corner where the water flows last. Flow calculations begin at 6.99 NGVD. At pond level 7.04, head is 0.0. Between pond levels 6.99 and 7.06, flow calculations should be done utilizing only one long side of the outfall box

3.33* (8.50 – (0.2 * H))*(H^1.5)

Between pond levels above 7.06 thru 7.49 (head 0.07 ft. thru 0.50 ft.), flow calculations should be done utilizing all four sides of the outfall box:

2 * (3.33 * (8.50 – (0.2 * H)) * (H^1.5) + 2 * (3.33 * (3.04 – (0.2 * H)) * (H^1.5))

YEAR TWO STREET POND ELEVATION vs. FLOW:

Flow calculations begin at 7.17 NGVD. At pond level 7.17, head is 0.0. Between pond levels 7.17

and 7.06, flow calculations should be done utilizing only one long side of the outfall box

3.33* (9.90 – (0.2 * H))*(H^1.5)

Between pond levels above 7.06 thru 7.49, flow calculations should be done utilizing all four sides of the outfall box:

(3.33 * (9.90 – (0.2 * H)) * (H^1.5) + 2 * (3.33 * (4.41 – (0.2 * H)) * (H^1.5))

TESTING TO DETERMINE IF REFRIGERATOR TUBING IS BEING CHANGED OFTEN ENOUGH (THREE-MONTH INTERVAL)

Equipment blank samples taken for quality assurance for the Florida Aquarium demonstration project shows that when refrigerator tubing is changed on a regular basis (3 month interval) there is little contamination from the equipment. New bottles were purchased, but not acid washed, and the data also show that some of these sample bottles were slightly contaminated.

		March 30, 2001					May 4, 2001			May 25, 2001			
		DI Blank	STA 1085		STA 640	STA 1088	DI Blank	STA 1083		DI Blank	RNF 466	STA 640	STA 638
			old	new	old	old		old	new		new	new	new
CONSTITUENT	UNITS		bottle	bottle	bottle	bottle		bottle	bottle		bottle	bottle	bottle
AMMONIA	mg/L	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
NITRITE	mg/L	0.0025	0.0025	0.0025	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
NITRATE	mg/L	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.015	0.005
TOTAL-N	mg/L	0.11	0.10	0.12	0.15	0.14	0	0	0	0	0	0	0
ORTHO-P	mg/L	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
TOTAL-P	mg/L	0.005	0.005	0.005	0.011	0.014	0.005	0.005	0.005	0.005	0.005	0.005	0.005
CADMIUM	ug/L	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
COPPER	ug/L	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
IRON	ug/L	12.5	12.5	12.5	12.5	60	12.5	12.5	12.5	12.5	12.5	12.5	12.5
LEAD	ug/L	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
MANGANES	ug/L	0.5	0.5	5.8	0.5	1.4	0.5	2.6	0.5	0.5	0.5	0.5	0.5
ZINC	ug/L	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
CHLORIDE	mg/L	0.2	0.72	0.99	0.72	0.2	0.2	0.8	0.2	0.74	0.77	0.69	1.18
POTASSIUM	mg/L	0.018	0.018	0.05	0.02	0.12	0.02	0.02	0.02	0.04	0.04	0.05	0.018
SODIUM	mg/L	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
SULFATE	mg/L	0.06	0.06	0.06	0.06	0.23	0.06	0.35	0.06	0.49	0.49	0.49	0.06
CALCIUM	mg/L	0.63	0.8	0.33	0.42	0	0	0	0	0.04	0.12	0.08	0.04
MAGNESIUM	mg/L	0	0	0	0	0	0	0.02	0	0	0	0	0
HARDNESS	mg/L	1.57	2.00	0.82	1.05	0.00	0.00	0.08	0.00	0.10	0.30	0.20	0.10

Table A-2. Testing tubing and bottles with DI water for quality assurance.

DATE	AMMONIA					NITRATE + NITRITE					TOTAL NITROGEN					ORTHO- PHOSPHATE					TOTAL - PHOSPHATE				
	mg/L					mg/L					mg/L					mg/L					mg/L				
	0.012					0.01					0.1					0.01					0.01				
	Street					Street					Street					Street					Street				
	Bld 640	inflow 1088	udrain 3904	udrain 1085	DI Blank	Bld 640	inflow 1088	udrain 3904	udrain 1085	DI Blank	Bld 640	inflow 1088	udrain 3904	udrain 1085	DI Blank	Bld 640	inflow 1088	udrain 3904	udrain 1085	DI Blank	Bld 640	inflow 1088	udrain 3904	udrain 1085	DI Blank
07/02/01					0.005					0.005					0.220					0.005					0.005
Tubing																									
Old Bottle				0.005					0.005					0.14					0.005					0.005	
Clean Bottle				0.021					0.005					0.5					0.005					0.005	
10/09/02					0.029					0.019					0.190					0.005					0.012
Tubing			0.017	0.006				0.012	0.019				0.180	0.12				0.005	0.005				0.034	0.019	
Old Bottle			0.023					0.013					0.05					0.005					0.016		
Clean Bottle			0.012					0.015					0.05					0.005					0.011		
02/26/2003 *bad di water*					0.006					0.005					0.050					0.140					0.005
Tubing			0.006	0.006				0.116	0.111				0.160	0.140				0.016	0.014				0.005	0.012	
Old Bottle																									
Clean Bottle																									
Clean Tubing				0.006					0.109					0.173					0.016					0.005	
07/07/03					0.006					0.005					0.050					0.005					0.005
Tubing	0.006		0.006	0.006		0.013		0.005	0.005		0.050		0.050	0.050		0.005		0.005	0.005		0.005		0.005	0.005	
07/23/03					0.006					0.005					0.17					0.005					0.005
Tubing		0.006					0.005					0.050					0.005					0.005			
07/30/03					0.009					0.003					0.050					0.050					0.050
Old Bottle				0.003					0.003					0.005					0.005					0.012	
Clean Bottle				0.003					0.005					0.005					0.005					0.005	
10/20/03																									
Tubing																									
10/20/03					0.008					0.005					0.005					0.005					0.005
***Tubing	0.01	0.006		0.006		0.004	0.007		0.001		0.251	0.024		0.03		0.015	0.005		0.005		0.036	0.005		0.005	

Table A-3. Testing tubing and bottles with DI water for quality assurance.

DATE	TOTAL CADMIUM					TOTAL COPPER					TOTAL IRON					TOTAL LEAD					TOTAL ZINC					HARDNESS				
	ug/L					ug/L					ug/L					ug/L					ug/L					mg/L as CaCO3				
	0.2					2.3					30.0					0.4					12.0					20.0				
	Street					Street					Street					Street					Street					Street				
	Bld 640	inflow 1088	udrain 3904	udrain 1085	DI Blank	Bld 640	inflow 1088	udrain 3904	udrain 1085	DI Blank	Bld 640	inflow 1088	udrain 3904	udrain 1085	DI Blank	Bld 640	inflow 1088	udrain 3904	udrain 1085	DI Blank	Bld 640	inflow 1088	udrain 3904	udrain 1085	DI Blank	Bld 640	inflow 1088	udrain 3904	udrain 1085	DI Blank
07/02/01					0.150					1.0					12.5					0.750					7.5					0.7
Tubing																														
Old Bottle				0.15					1.0					12.5					0.75					7.5					0.7	
Clean Bottle				0.15					11.9					12.5					0.75					7.5					0.7	
10/09/02					0.360					4.5					15.0					0.200					6.0					1.1
Tubing			0.100	0.100				1.2	1.2				15.0	15.0				0.200	0.200				6.0	6.0				1.4	1.4	
Old Bottle			0.100					1.2					15.0					0.200					6.0					1.4		
Clean Bottle			0.100					1.2					15.0					0.4					6.0					1.4		
02/26/03					0.500					20.5					6.3					5.000					23.2					103.5
Tubing			0.500	0.500				17.6	19.0				6.3	6.3				5.000	5.000				28.9	20.7				102.4	102.8	
Old Bottle																														
Clean Bottle																														
Tubing				5.000					18.4					6.3					5.000					24.6					104.5	
07/07/03					0.500					1.5					21.8					5.000					2.5					0.8
Tubing	0.500		0.500	0.500		1.5		1.5	1.5		157.0		48.8	100.0		5.000		5.000	5.000		15.8		4.3	4.5		8.0		2.5	5.1	
07/23/03					0.500					1.5					6.3					5.000					3.3					0.8
Tubing		0.500					1.5					37.4					5.000					8.2					3.6			
07/30/03					0.500					1.5					6.3					5.000					2.3					0.8
Old Bottle				0.500					1.5					47.3					5.000					2.6					4.6	
Clean Bottle				0.500					1.5					6.3					5.000					2.8					0.8	
10/20/03																														
10/20/03					0.5					1.5					6.3					5					1.0					0.0
Tubing	0.5	0.5		0.500		1.5	1.5		1.5		113.0	6.3		6.3		5	5		5.000		8.1	1.0		1.0		0.0	0.0	0.0	0.0	

APPENDIX A Quality Assurance Information

Appendix A-2. Comparison of concentrations at the pond outfalls for composite vs grab samples.

DATE	TOTAL CADMIUM				TOTAL COPPER				TOTAL IRON				TOTAL LEAD				MANGANESE				TOTAL ZINC				HARDNESS			
	ug/L				ug/L				ug/L				ug/L				ug/L				ug/L				mg/L as CaCO3			
	0.3				2.0				25.0				1.5				1.0				15.0				20.0			
	Building		Street		Building		Street		Building		Street		Building		Street		Building		Street		Building		Street		Building		Street	
	comp	grab	comp	grab	comp	grab	comp	grab	comp	grab	comp	grab	comp	grab	comp	grab	comp	grab	comp	grab	comp	grab	comp	grab	comp	grab	comp	grab
03/29/01			*0.15*	*0.15*			3.4	4.4			156	160			1.60	1.600			6.4	6.4			25.0	30.0			57.3	53.8
03/30/01			*0.15*	*0.15*			3.1	4.4			130	90			1.90	1.70			5.7	3.5			20.0	20.0			42.4	36.7
04/02/01	*0.15*	*0.15*			7.0	4.6			90	80			1.50	*0.75*			12.1	13.6			60.0	40.0			114.2	157.8		
06/07/01	0.30	0.40			18.8	11.3			180	70			2.50	1.80			30.1	28.7			110.0	90.0			220.4	1.0		
06/11/01	0.15	*0.15*			8.8	12.0			30	110			*0.75*	*0.75*			14.4	43.9			80.0	80.0			173.5	240.1		
06/23/01	*0.15*	0.30	*0.15*	*0.15*	12.0	12.9	4.4	3.6	120	130	80	90	3.30	2.10	*0.75*	*0.75*	36.7	25.6	10.7	9.4	70.0	70.0	*7.5*	20.0	237.0	202.5	78.3	80.0
06/25/01	*0.15*	*0.15*			7.7	9.1			90	140			*0.75*	1.60			23.8	31.2			50.0	40.0			197.9	231.4		
06/29/01	*0.15*	*0.15*	*0.15*	*0.15*	5.7	5.6	3.4	*1.0*	90	120	330	280	1.60	*0.75*	3.40	3.00	11.6	26.3	8.9	6.6	40.0	30.0	*7.5*	*7.5*	137.8	145.8	56.8	53.6
07/03/01	*0.15*	*0.15*			4.6	9.0			90	130			*0.75*	*0.75*			11.0	17.1			30.0	30.0			113.2	117.3		
07/06/01	*0.15*	*0.15*			4.7	5.4			100	150			*0.75*	*0.75*			8.2	24.7			20.0	20.0			128.1	160.9		
07/11/01	*0.15*	0.30	*0.15*	*0.15*	6.6	7.4	2.5	5.2	110	250	100	90	1.60	2.10	*0.75*	*0.75*	12.4	20.6	9.5	10.2	40.0	50.0	*7.5*	*7.5*	138.2	137.9	83.2	86.4
07/13/01	*0.15*	*0.15*	*0.15*	*0.15*	4.3	10.1	*1.0*	*1.0*	100	310	70	80	*0.75*	3.50	*0.75*	*0.75*	7.6	17.0	6.9	7.4	50.0	40.0	*7.5*	*7.5*	111.7	119.0	72.6	72.4
07/16/01	*0.15*	*0.15*			4.5	3.0			60	160			*0.75*	*0.75*			7.3	21.3			30.0	30.0			112.2	147.5		
07/18/01	*0.15*	*0.15*	*0.15*	*0.15*	5.7	7.3	2.8	2.2	180	240	60	40	1.70	3.20	*0.75*	*0.75*	11.2	22.3	4.5	6.0	30.0	40.0	*7.50*	*7.5*	148.1	162.1	56.8	59.8
07/20/01	*0.15*	*0.15*			3.7	4.1			110	150			*0.75*	*0.75*			10.0	18.0			20.0	30.0			302.1	148.4		
07/22/01	*0.15*	*0.15*	*0.15*	*0.15*	3.9	4.7	*1.0*	*1.0*	260	260	60	70	2.30	2.70	*0.75*	*0.75*	12.0	20.4	17.1	10.2	20.0	40.0	20.0	*7.5*	142.6	128.8	73.8	65.9
07/24/01	*0.15*	*0.15*			5.9	6.0			330	370			2.20	2.80			9.6	20.8			50.0	60.0			130.5	133.7		
07/27/01	*0.15*	*0.15*			4.0	6.1			140	160			*0.75*	*0.75*			9.0	21.8			40.0	40.0			133.7	151.0		
07/28/01	*0.15*	*0.15*			4.1	6.2			180	250			*0.75*	2.20			14.7	26.3			30.0	50.0			153.6	178.8		
08/01/01	*0.15*	*0.15*	*0.15*	*0.15*	5.5	6.7	4.1	2.5	120	160	60	60	*0.75*	*0.75*	*0.75*	0.75	11.3	20.9	17.0	8.8	40.0	50.0	20.0	20.0	164.3	154.0	76.5	82.5
08/03/01	*0.15*	*0.15*	*0.15*	*0.15*	6.0	6.9	2.0	*1.0*	150	320	60	80	*0.75*	2.20	*0.75*	*0.75*	12.6	22.3	4.9	17.3	50.0	60.0	*7.5*	*7.5*	156.4	163.6	156.4	94.8
08/06/01			*0.15*	*0.15*			*1.0*	*1.0*			60	70			*0.75*	*0.75*			4.5	5.4			*7.5*	*7.5*			76.5	80.7
08/08/01	*0.15*	*0.15*	*0.15*	*0.15*	6.6	7.3	2.7	*1.0*	230	310	240	110	3.40	4.50	2.20	*0.75*	15.3	24.4	9.1	21.2	60.0	70.0	*7.5*	*7.5*	155.4	156.1	155.4	70.0
08/10/01	*0.15*	*0.15*	*0.15*	*0.15*	5.0	7.5	2.2	2.6	110	120	50	150	1.70	1.80	*0.75*	*0.75*	8.1	21.1	8.8	11.8	50.0	50.0	*7.5*	20.0	155.4	164.1	155.4	75.8
Count	21	21	13	13	21	21	13	13	21	21	13	13	21	21	13	13	21	21	13	13	21	21	13	13	21	21	13	13
Mean	0.157	0.176	0.150	0.150	6.433	7.295	2.585	2.377	136.667	190.000	112.000	105.385	1.431	1.774	1.219	1.062	13.762	23.252	8.769	9.554	46.190	48.095	11.731	13.077	158.391	152.461	87.791	70.188
Median	0.150	0.150	0.150	0.150	5.700	6.900	2.700	2.200	110.000	160.000	70.000	90.000	0.750	1.800	0.750	0.750	11.600	21.800	8.800	8.800	40.000	40.000	7.500	7.500	148.052	153.993	76.507	72.440
Max.	0.300	0.400	0.150	0.150	18.800	12.900	4.400	5.200	330.000	370.000	330.000	280.000	3.400	4.500	3.400	3.000	36.700	43.900	17.100	21.200	110.000	90.000	25.000	30.000	302.118	240.075	156.393	94.807
Min.	0.150	0.150	0.150	0.150	3.700	3.000	1.000	1.000	30.000	70.000	50.000	40.000	0.750	0.750	0.750	0.750	7.300	13.600	4.500	3.500	20.000	20.000	7.500	7.500	111.705	1.046	42.440	36.718
Std. Dev.	0.033	0.068	0.000	0.000	3.434	2.623	1.128	1.558	70.166	86.891	84.884	62.131	0.871	1.104	0.832	0.672	7.511	6.259	4.198	4.932	21.789	18.061	6.723	7.783	47.089	46.936	40.366	15.965
C.V. *	0.203	0.378	0.000	0.000	0.521	0.351	0.419	0.630	0.501	0.446	0.728	0.566	0.594	0.608	0.656	0.609	0.533	0.263	0.460	0.496	0.460	0.366	0.551	0.572	0.290	0.300	0.442	0.219

*C.V. = Coefficient of Variation (Standard Deviation/Mean)

Appendix A-2. Comparison of concentrations at the pond outfalls for composite vs grab samples.

OUTFLOW - MAJOR IONS

DATE	CALCIUM				CHLORIDE				POTASSIUM				SODIUM				SULFATE				MAGNESIUM			
	(mg/l)				mg/L				mg/L				mg/L				mg/L				mg/L			
					0.4				0.04				0.06											
	Building		Street		Building		Street		Building		Street		Building		Street		Building		Street		Building		Street	
	comp	grab	comp	grab	comp	grab	comp	grab	comp	grab	comp	grab	comp	grab	comp	grab	comp	grab	comp	grab	comp	grab	comp	grab
03/29/01			18.2	18.600			13.7	13.9			4.98	5.01			12.60	12.70			19.8	20.0			1.75	1.79
03/30/01			15.1	13.600			9.1	4.4			4.08	2.90			8.44	4.25			14.0	8.8			1.15	0.67
04/02/01	24.3	32.7			191.0	274.0			5.67	7.31			108.00	155.00			41.3	55.5			13.00	18.50		
06/07/01	33.0	29.4			508.0	339.0			13.60	9.92			289.00	191.00			84.5	60.1			33.50	23.00		
06/11/01	30.4	47.0			359.0	460.0			10.50	14.90			208.00	267.00			70.0	85.2			23.70	29.80		
06/23/01	38.5	32.3	28.5	29.4	526.0	453.0	12.9	11.0	13.90	12.10	4.98	4.59	298.00	257.00	11.50	9.82	88.5	75.4	20.6	18.1	34.20	29.60	1.74	1.60
06/25/01	32.6	37.9			434.0	507.0			12.00	13.70			243.00	285.00			71.2	81.3			28.30	33.20		
06/29/01	23.7	24.9	20.9	20.0	290.0	305.0	6.2	4.6	8.48	9.17	3.77	3.06	165.00	173.00	5.50	3.88	51.1	51.2	10.9	8.3	19.10	20.30	1.11	0.88
07/03/01	23.9	25.2			189.0	190.0			5.98	6.24			109.00	110.00			40.7	38.7			13.00	13.20		
07/06/01	28.2	35.9			206.0	251.0			6.40	7.94			119.00	146.00			40.3	43.0			14.00	17.30		
07/11/01	29.3	29.5	30.3	31.7	233.0	234.0	8.8	9.0	7.13	7.18	4.68	4.39	135.00	135.00	8.99	9.08	43.1	40.3	13.2	13.2	15.80	15.60	1.82	1.77
07/13/01	26.1	29.7	26.7	26.7	167.0	158.0	6.8	6.6	5.54	5.28	3.82	3.79	96.50	93.20	7.08	6.93	35.8	30.0	10.9	10.6	11.30	10.90	1.44	1.40
07/16/01	27.6	34.9			154.0	219.0			5.16	6.83			88.90	127.00			29.1	35.5			10.50	14.80		
07/18/01	33.4	36.3	20.8	21.8	220.0	261.0	5.8	6.3	6.60	7.21	3.79	3.89	130.00	145.00	5.81	6.24	39.5	44.9	9.1	9.6	15.70	17.50	1.18	1.29
07/20/01	35.4	33.3			231.0	235.0			6.68	6.78			132.00	132.00			43.4	44.5			51.90	16.00		
07/22/01	34.0	0.2	27.1	24.1	204.0	180.0	8.5	7.8	5.94	5.54	4.11	3.86	116.00	101.00	7.65	7.44	34.1	28.2	10.8	10.4	14.00	12.20	1.48	1.38
07/24/01	35.6	37.5			146.0	133.0			4.84	4.67			82.70	77.80			27.0	26.7			10.10	9.88		
07/27/01	36.9	40.8			140.0	172.0			4.53	5.37			83.00	101.00			29.8	33.7			10.10	12.10		
07/28/01	41.9	43.2			169.0	255.0			4.86	7.17			97.90	144.00			33.4	43.8			11.90	17.40		
08/01/01	40.4	37.7	40.1	30.3	223.0	212.0	51.8	11.3	6.67	6.52	6.07	4.59	128.00	122.00	32.30	10.30	38.4	35.2	20.5	13.6	15.40	14.70	4.85	1.67
08/03/01	37.4	38.6	31.0	35.0	224.0	246.0	11.7	11.5	6.86	7.20	4.66	4.82	125.00	135.00	10.80	10.60	40.3	42.4	15.5	15.8	15.30	16.50	1.82	1.80
08/06/01			28.1	29.8			10.1	9.3			4.32	4.23			9.30	9.06			15.7	15.5			1.54	1.53
08/08/01	35.2	34.9	25.0	25.9	241.0	248.0	8.2	7.3	6.53	6.81	4.19	4.02	137.00	141.00	8.18	7.04	44.1	43.4	16.2	15.1	16.40	16.90	1.44	1.30
08/10/01	38.8	40.1	27.4	28.5	211.0	232.0	6.4	6.5	6.24	6.75	3.84	4.17	121.00	133.00	6.26	6.14	42.4	46.5	14.3	14.3	14.20	15.70	1.14	1.12
Count	21	21	13	13	21	21	13	13	21	21	13	13	21	21	13	13	21	21	13	13	21	21	13	13
Mean	32.695	33.426	26.092	25.800	250.762	264.952	12.318	8.418	7.339	7.838	4.407	4.102	143.429	151.000	10.339	7.960	46.095	46.929	14.734	13.326	18.638	17.861	1.728	1.400
Median	33.400	34.900	27.100	26.700	220.000	246.000	8.840	7.840	6.530	7.170	4.190	4.170	125.000	135.000	8.440	7.440	40.700	43.400	14.300	13.600	15.300	16.500	1.480	1.400
Max.	41.900	47.000	40.100	35.000	526.000	507.000	51.800	13.900	13.900	14.900	6.070	5.010	298.000	285.000	32.300	12.700	88.500	85.200	20.600	20.000	51.900	33.200	4.850	1.800
Min.	23.700	0.150	15.100	13.600	140.000	133.000	5.830	4.440	4.530	4.670	3.770	2.900	82.700	77.800	5.500	3.880	27.000	26.700	9.140	8.260	10.100	9.880	1.110	0.670
Std. Dev.	5.543	9.418	6.391	5.986	112.129	99.574	12.127	2.885	2.780	2.712	0.662	0.623	63.053	56.104	6.943	2.577	17.444	16.419	3.832	3.638	10.415	6.259	0.974	0.352
C.V. *	0.165	0.275	0.235	0.223	0.436	0.367	0.946	0.329	0.370	0.338	0.144	0.146	0.429	0.363	0.645	0.311	0.369	0.341	0.250	0.262	0.545	0.342	0.542	0.241

*C.V. = Coefficient of Variation (Standard Deviation/Mean)

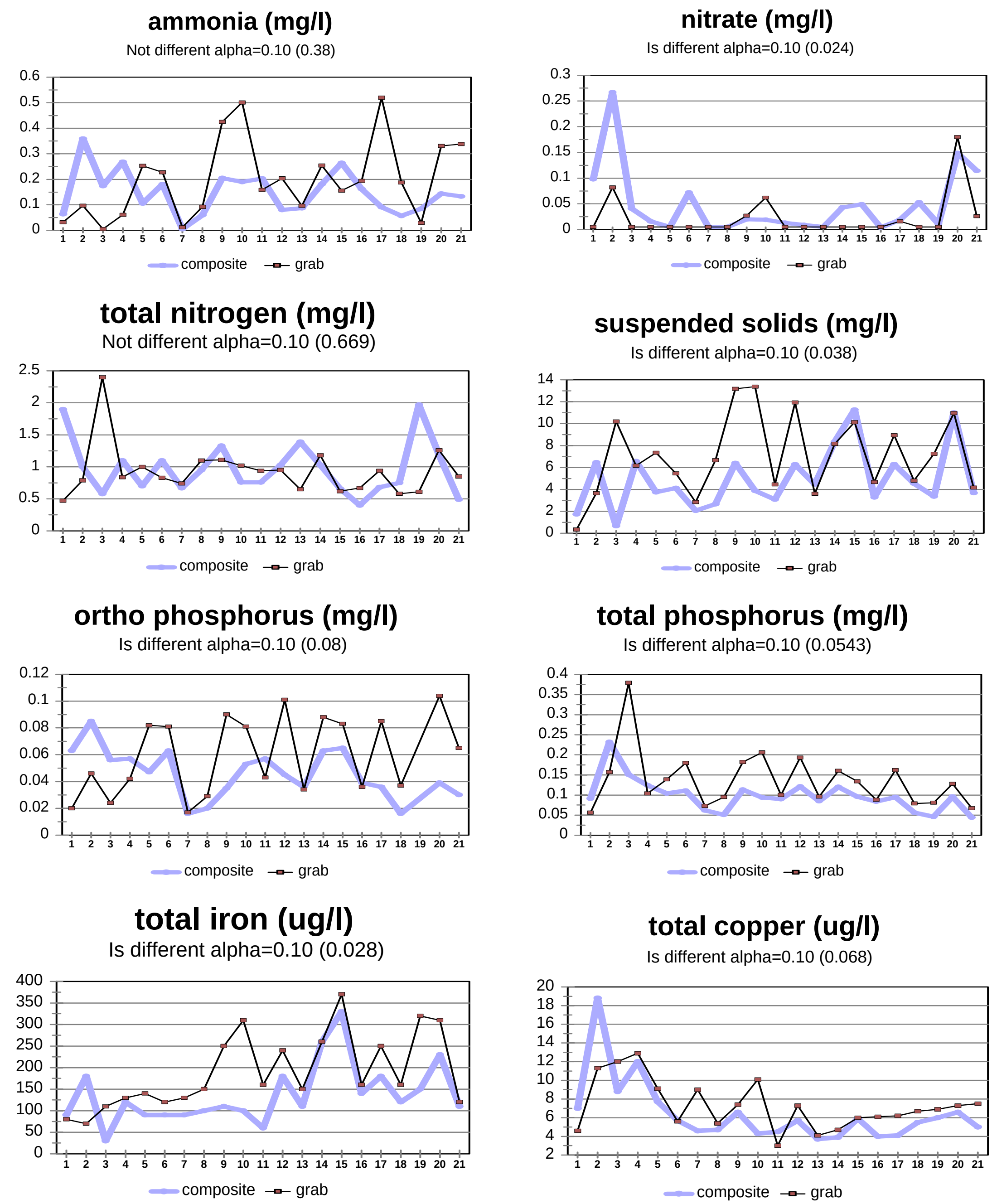


Figure A-2. Composite samples taken at the outflow of the Building Pond compared to grab samples taken when the samples were retrieved. Differences were tested with Mann-Whitney statistical test. Differences are noted at the alpha=0.10 level and the actual significance level is given in parentheses. The x-axis represents the individual storm events and y-axis represents concentrations. Except for nitrates, the grab samples usually measured higher concentrations than the composite samples. Storms 1 and 2 were exceptions to this conclusion.

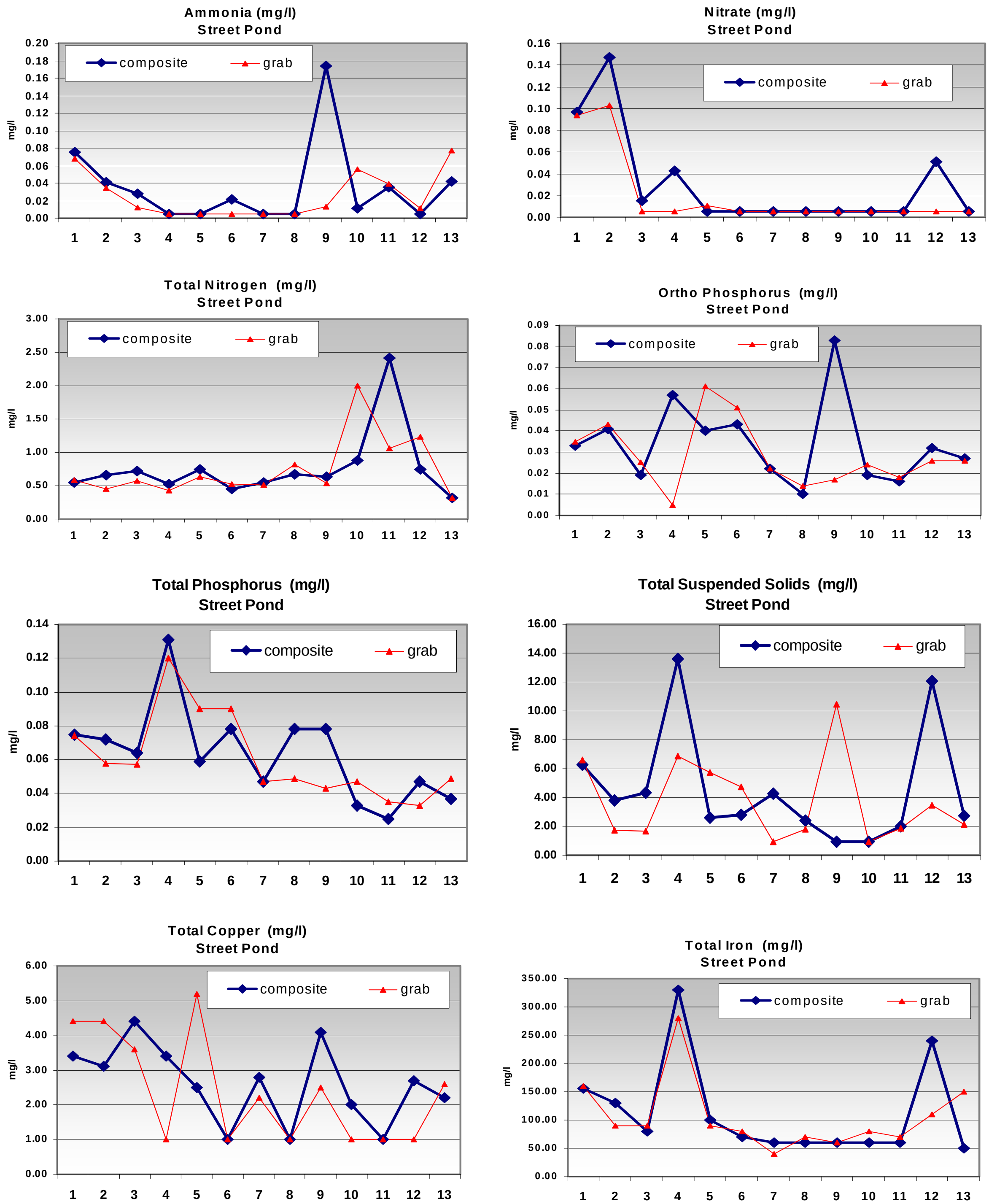


Figure A-3. Composite samples taken at the outflow of the Street Pond compared to grab samples taken when the samples were retrieved.

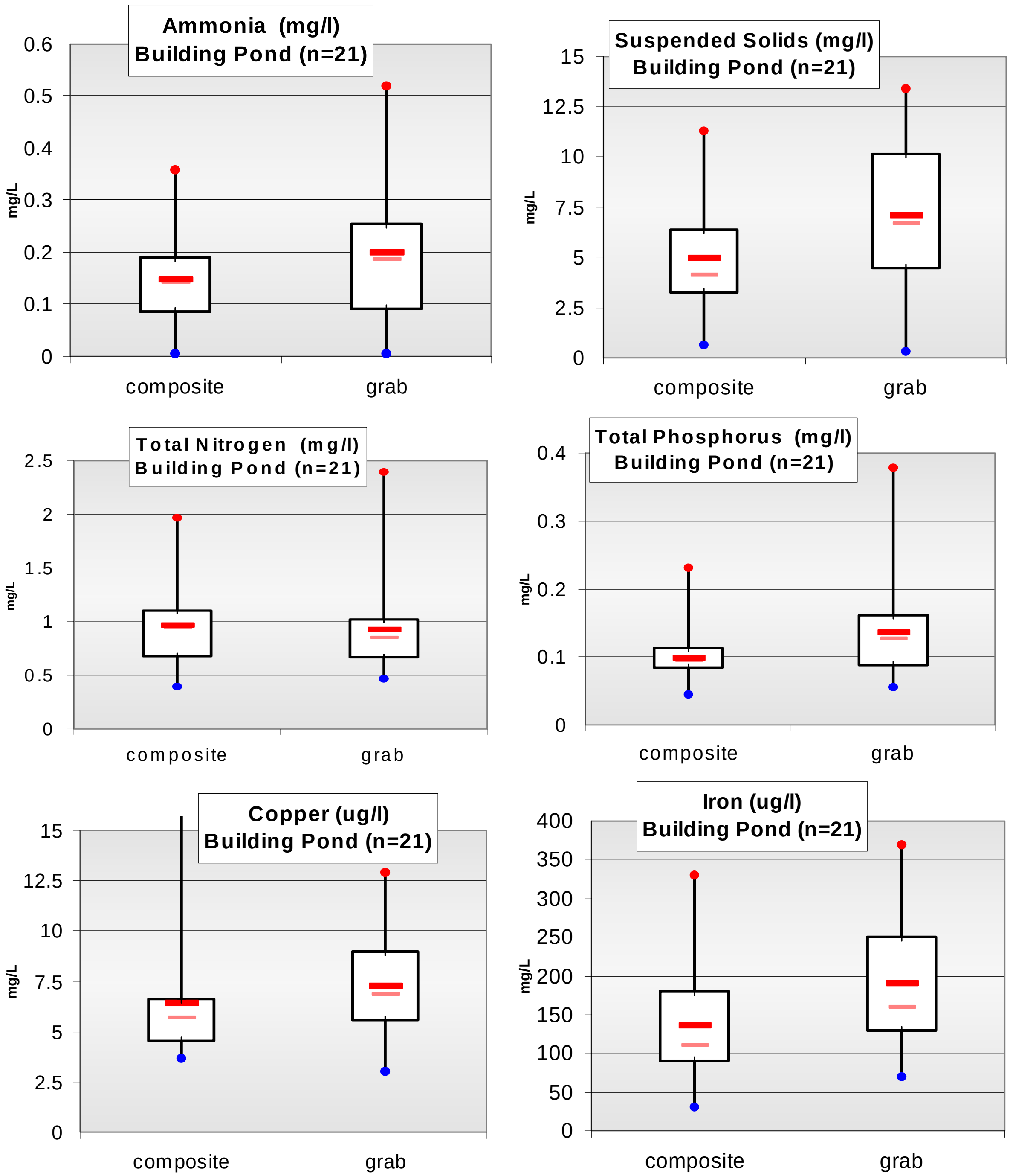


Figure A-4. Box plots at the outflow of the Building Pond comparing grab samples taken when the composite samples were retrieved to determine differences.

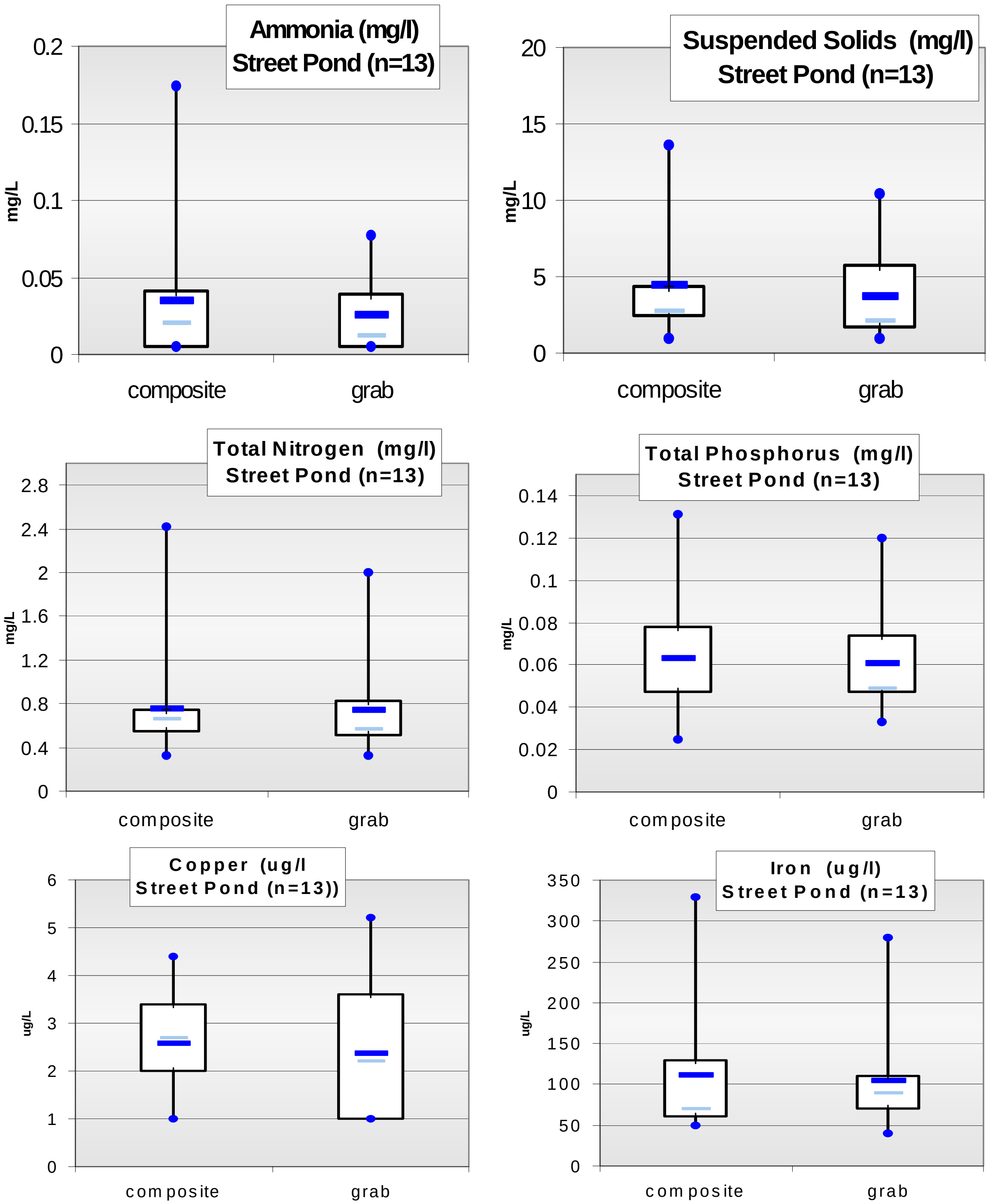


Figure A-5. Box plots at the outflow of the Street Pond comparing grab samples taken when the composite samples were retrieved to determine differences.

More duplicate samples as well as samples taken before and after the sampler tubing was changed are reported in a companion report (Teague and Rushton 2005)

12/06/96 COMPARISON

COMPONENT	INITIAL SAMPLE	DUPLICATE SAMPLE	DIFF	MEAN
NUTRIENTS (MG/L)				
Ammonia	0.026	0.032	-0.006	0.029
Nitrate	0.029	0.024	0.005	0.0265
Nitrogen, Total	0.055	0.056	-0.001	0.0555
TKN	0.01	0.01	0	0.01
Organic Carbon, Total	8.25	6.52	1.73	7.385
Phosphorous, Ortho	0.043	0.02	0.023	0.0315
Phosphorous, Total	0.067	0.058	0.009	0.0625
METALS (ug/l)				
Cadmium	0.2	0	0.2	0.1
Copper	5.9	5.2	0.7	5.55
Iron	46	59	-13	52.5
Lead	1.2	1.7	-0.5	1.45
Manganese	4.2	4.4	-0.2	4.3
Zinc	26	21	5	23.5
IONS mg/l)				
Hardness	103	102	1	102.5
Calcium	37	37	0	37
Chloride	9.5	8.6	0.9	9.05
Potassium	4.4	4.5	-.01	4.45
Sodium	12	12	0	12
Sulfate	28	29	-1	28.5
Magnesium	2.6	2.3	0.3	2.45

Appendix A-3

SEDIMENT SAMPLING PREPARATION PROCEDURE

AHEAD OF TIME

Have meeting with all the people involved in the sediment sampling and assign jobs

Get the FedEx or UPS account # from Gwen to send sediment samples to the Lab on collection day.

Get name of lab, address, telephone number, and contact person of the laboratory doing our sediment analyses from SWFWMD (Mark Rials).

Order bottles from the laboratory for BNA, pesticides, TKN, total phosphorus, sediment size analysis, and any other analyses that are going to be done. Also check that chain of custody sheets will arrive with bottles.

Find out from the Mail Room what time is the latest we can have the coolers there to be shipped *PRIORITY OVERNIGHT*- this will determine how we ship the coolers - if I remember correctly UPS is later than FedEx - get at least **9** *PRIORITY OVERNIGHT* shipping labels and plastic covers for whichever carrier we will be using (they are in the cabinet over the typewriter by Josie)

Make copies (both sides) of chain of custody sheets - you need enough to log each type of sample on a separate line (each site will take up 4 lines) - *be sure to have extras*

Get chain of custody forms and new stickers from lab

Get stickers for bottles

Plastic gloves and a box of paper towels and 6 lab pads - for cleaning sediment sampling equipment in the field

Make sure we have enough markers, pens, and pencils and a pad of paper

Make sample sets for each of the 7 sites and 2 sets for duplicates.

1 - DEP Sediment analysis jar (1 qt)
1 - DEP Sediment size jar (8 oz ?)
2 - DEP Pesticide bottles (lg. Amber glass)
2? - DEP BNA bottles (lg. Amber glass)
? - DEP jars for sediment samples
5 - district WQ sample bottles (standard set)

Put 2 sets of bottles in each cooler - if you can't get 2 complete sets in a cooler, pack sediment and WQ separately

Have 2 empty coolers for ice (extra coolers in the environmental storage room if there are not enough in lab storage room)

Have 3 empty coolers to sort full bottles

Get a drink cooler (rm. B or storage rm.)

Reserve a hydrolab - on Quincy's calendar

Get sediment corer (there should also be 2 scoops for mixing in the corer box) and at least 8 feet of extensions (I think these are 5-6 ft extensions, so about 2 will be needed. Make certain you have the bolt to attach it to the corer). Corer is in room B in 2 wood carrying cases and extensions are in environmental storage room out back (or Keith's storage room)

Get 2 stainless steel mixing pans & 4" hand shovel in room B

Get 2 glass mixing pans and small hand shovel in stormwater cabinet

Make sure you have the two pipe wrenches that are usually in the truck.

Take a 12" ruler to measure depth of sample.

Get 2 squirt bottles full of Ethanol -

Bottles should be in room B someplace -

Fill in Lab - be sure you know where they keep the Ethanol in the lab - we will probably need to refill the bottles

Taking the sediment core:

Put corer together and insert stainless steel or plastic tube (some Vaseline may make disassembling the corer easier)

Select spot to sample and don't muck up the bottom too much because you will have to take several cores if you are taking two depths (top 1" and 4 to 5 ")

Send someone ahead with the hydrolab to take readings and WQ samples at the sites selected for the sediment samples.

Scrape away a little off the top of soil where you intend to take the sample.

Position corer and measure how deep it will have to go into the ground to take five inches of sample.

Gently twist and rock corer into the sediments. Only twist in direction to make fitting tighter.

When the corer is deep enough, hold down suction on top of corer and gently rock to remove from sediments.

As soon as free from sediments turn sideways in case the core wants to slide out.

When retrieved lift suction and carefully pour water out of the top end of the corer.

Remove tube and take plunger to push the sample out and into a stainless steel or glass tray.

Have three pans waiting.

For entire core

For the top inch of sediment (remove vegetation or sticks, etc)

For four to five inch depth (throw away the part not used in the middle)

Repeat until there is enough sample for analysis

Mix the separate layers separately in their pans.

Mix thoroughly using four-corner method or any other (this usually results in a soupy mixture.

Put into appropriate bottles

Rinse equipment with DI water

Record time and other notes into field journal.

Repeat procedure at next site until all are sampled

Take a duplicate sample for each 10 sites sampled.

The procedure is simpler if only taking sample of top four inches of sediments, but tasks are essentially the same.

Wash all sediment sampling equipment: dredge, corer, scoops, pans, and shovels (all parts of corer except extensions)

Wash Liquinox and rinse well
Rinse thoroughly with Ethanol
Drain on lab pads
Wrap corer and parts in lab pads - return to cases
Put Ekman dredge in a clean plastic bag and return to case
Put lab pad between the pans so they don't stick - put them in a clean plastic bag - they can go in one of the extra "sorting" coolers for transporting.

DAY AHEAD OF TIME - (there may be additions to this list)

1. ***REMEMBER TO CANCEL YOUR TRUCK TODAY IF YOU DON'T NEED IT*** !
2. Calibrate and charge hydrolab and put your name on it on a full sheet of paper so no one else takes it
3. Fill several DI bottles (the ones with the hoses work best)
4. Load supplies
5. Confirm reservation for truck

SAMPLING DAY(S) P.M. - (there may be additions to this list)

6. Pack and ship DEP samples
7. Fill out chain of custody forms and double check
8. Turn in District WQ samples
9. Refill supplies as needed

D:\Demo\sediments\Procedure.doc

APPENDIX B

Rainfall Characteristics for All Rain Events >0.23
Intensive Study 200-2003

Appendix B. Rainfall characteristics for most of the larger rain events (> 0.23 in).

START DATE	END DATE	YEAR	DAY Julian	START TIME	END TIME	TOTAL RAIN (in.)	INTER-EVENT (hrs.)	DURA-TION (hrs.)	MAX. INT. (in./15 min.)	AVG. INT. (in./hr.)
YEAR ONE										
11/25/00	11/25/00	2000	330	2015	2115	1.50	168.00	1.00	0.20	0.20
11/26/00	11/26/00	2000	331	915	1245	0.36	24.50	3.50	0.05	0.02
12/17/00	12/17/00	2000	353	245	300	0.43	530.00	0.50	0.43	0.11
12/28/00	12/28/00	2000	363	830	1045	0.23	763.75	2.25	0.05	0.03
01/08/01	01/08/01	2001	8	1145	1415	0.94	241.00	2.50	0.15	0.06
02/01/01	02/01/01	2001	32	430	930	0.57	563.00	5.00	0.20	0.03
02/03/01	02/03/01	2001	34	1315	1715	0.39	51.75	4.00	0.03	0.02
03/04/01	03/04/01	2001	63	915	1430	1.59	688.00	5.25	0.19	0.07
03/19/01	03/19/01	2001	78	1145	1500	0.89	357.25	3.25	0.11	0.05
03/29/01	03/29/01	2001	88	1045	2230	3.29	237.75	11.75	1.16	0.07
06/01/01	06/01/01	2001	152	1300	1330	0.32	1525.50	0.50	0.32	0.64
06/06/01	06/06/01	2001	157	1745	2015	1.97	124.25	2.50	1.40	0.79
06/19/01	06/19/01	2001	170	1645	1915	0.64	308.50	2.50	0.52	0.26
06/22/01	06/22/01	2001	173	1045	1315	1.00	77.50	2.50	0.91	0.40
06/23/01	06/23/01	2001	174	830	1630	0.52	19.25	8.00	0.20	0.07
06/28/01	06/28/01	2001	179	1545	2030	2.15	121.25	4.75	1.40	0.45
07/01/01	07/01/01	2001	182	15	300	0.46	51.75	2.75	0.41	0.17
07/07/01	07/07/01	2001	188	1430	1500	0.31	155.50	0.50	0.31	0.62
07/10/01	07/10/01	2001	191	1030	1045	0.60	67.50	0.25	0.60	2.40
07/11/01	07/11/01	2001	192	630	1145	0.82	19.75	5.25	0.60	0.16
07/13/01	07/13/01	2001	194	1100	1300	0.64	47.25	2.00	0.61	0.32
07/17/01	07/17/01	2001	198	1430	1615	0.42	97.50	1.75	0.40	0.24
07/21/01	07/21/01	2001	202	1345	1500	0.98	97.75	1.25	0.94	0.78
07/23/01	07/23/01	2001	204	900	1430	1.18	42.00	5.50	0.72	0.21
07/27/01	07/27/01	2001	208	1515	1600	0.48	96.75	0.75	0.48	0.64
07/31/01	07/31/01	2001	212	1915	2130	0.40	99.25	2.25	0.21	0.18
08/02/01	08/02/01	2001	214	1100	2215	0.98	37.50	11.25	0.28	0.09
08/05/01	08/05/01	2001	217	2215	2230	0.46	72.00	0.25	0.46	1.84
08/07/01	08/07/01	2001	219	1645	1715	1.05	42.25	0.50	1.05	2.10
08/08/01	08/08/01	2001	220	2330	2400	0.29	30.25	0.50	0.29	0.58
08/09/01	08/09/01	2001	221	1315	1415	0.31	14.25	1.00	0.30	0.31
CONSTRUCTION YEAR										
09/03/01	09/03/01	2001	246	15	130	1.01	585.75	1.25	1.00	0.81
09/06/01	09/06/01	2001	249	1845	2115	0.83	17.25	2.50	0.68	0.33
09/08/01	09/08/01	2001	251	1745	1830	1.28	44.50	0.75	1.28	1.71
09/13/01	09/14/01	2001	257	1630	1415	6.10	118.00	21.75		0.28
09/14/01	09/15/01	2001	258	2330	630	1.46	9.25	7.00	0.43	0.21
09/22/01	09/22/01	2001	265	2030	2130	1.23	182.00	1.00	1.22	1.23
10/21/01	10/21/01	2001	294	1715	1930	1.32	691.75	2.25	0.49	0.59
10/24/01	10/25/01	2001	298	2245	315	0.87	75.25	4.50	0.26	0.19
12/08/01	12/08/01	2001	342	30	245	0.73	1053.25	2.25	0.22	0.32
12/18/01	12/18/01	2001	352	415	500	0.43	241.50	0.75	0.28	0.57
01/02/02	01/02/02	2002	2	1200	1445	0.83	367.00	2.75	0.41	0.30
01/14/02	01/15/02	2002	15	1045	15	1.05	284.00	13.50	0.11	0.08

APPENDIX B Rainfall Characteristics

START DATE	END DATE	YEAR	DAY Julian	START TIME	END TIME	TOTAL RAIN (in.)	INTER-EVENT (hrs.)	DURA-TION (hrs.)	MAX. INT. (in./15 min.)	AVG. INT. (in./hr.)
02/07/02	02/07/02	2002	38	945	1500	1.07	561.50	5.25	0.27	0.20
02/22/02	02/23/02	2002	54	800	2045	1.54	473.00	36.75	0.07	0.04
03/03/02	03/03/02	2002	62	2000	2115	0.31	215.25	1.25	0.11	0.25
04/03/02	04/03/02	2002	93	1230	2045	1.38	735.25	8.25	0.44	0.17
04/15/02	04/15/02	2002	105	1630	1815	0.30	283.75	1.75	0.11	0.17
05/16/02	05/16/02	2002	136	1830	1930	0.32	744.25	2.00	0.27	0.16
05/18/02	05/19/02	2002	139	2345	1000	0.91	52.25	10.25	0.21	0.09
06/12/02	06/12/02	2002	163	1715	1815	0.84	583.25	1.00	0.36	0.84
06/15/02	06/15/02	2002	166	700	1045	0.60	60.75	3.75	0.32	0.16
06/17/02	06/17/02	2002	168	1515	2115	0.81	52.50	6.00	0.13	0.14
06/18/02	06/18/02	2002	169	645	1130	2.67	9.50	4.75	0.56	0.56
06/24/02	06/24/02	2002	175	1600	2300	3.26	148.50	7.00	0.87	0.47
06/25/02	06/25/02	2002	176	1430	1900	1.64	175.50	4.50	0.69	0.36
06/27/02	06/27/02	2002	178	1730	1915	0.84	46.50	1.75	0.51	0.48
06/28/02	06/28/02	2002	179	1630	2145	2.72	21.25	5.25	0.97	0.52
06/29/02	06/29/02	2002	180	1845	1930	1.21	21.00	0.75	0.74	1.61
YEAR TWO										
07/01/02	07/01/02	2002	182	1500	2030	0.91	43.50	5.50	0.36	0.17
07/09/02	07/09/02	2002	190	1215	1545	0.33	183.75	3.50	0.12	0.09
07/12/02	07/12/02	2002	193	945	1215	0.39	66.00	2.50	0.12	0.16
07/13/02	07/13/02	2002	194	700	1515	0.64	18.75	8.25	0.17	0.08
07/25/02	07/25/02	2002	206	1700	1815	0.39	289.75	1.25	0.31	0.31
07/29/02	07/29/02	2002	210	1745	1845	0.27	95.50	1.00	0.11	0.27
08/02/02	08/02/02	2002	214	900	1015	0.29	86.25	1.25	0.17	0.23
08/02/02	08/02/02	2002	214	2230	2330	0.27	6.25	1.00	0.11	0.27
08/07/02	08/07/02	2002	219	1200	1630	1.48	132.50	4.50	0.16	0.33
08/09/02	08/09/02	2002	221	2100	2200	0.33	52.50	1.00	0.16	0.33
08/14/02	08/15/02	2002	226	1700	200	2.93	139.00	9.00	0.89	0.33
08/17/02	08/17/02	2002	229	1715	2015	0.74	187.25	3.00	0.39	0.25
08/27/02	08/27/02	2002	239	645	945	0.47	226.50	3.00	0.07	0.16
08/30/02	08/30/02	2002	242	1430	1930	1.17	76.75	5.00	0.53	0.23
09/02/02	09/02/02	2002	245	1515	1600	1.10	67.75	0.75	0.85	1.47
09/05/02	09/05/02	2002	248	1300	2000	2.51	69.00	7.00	0.78	0.36
09/08/02	09/08/02	2002	251	2015	2030	0.29	72.25	0.50	0.28	0.58
09/11/02	09/11/02	2002	254	845	1815	1.53	60.25	9.50	0.76	0.16
09/12/02	09/12/02	2002	255	1330	1500	0.71	19.25	1.50	0.17	0.47
09/17/02	09/17/02	2002	260	1900	2045	1.39	124.00	1.75	0.53	0.79
09/24/02	09/24/02	2002	267	1500	1930	0.31	162.25	4.50	0.15	0.07
09/26/02	09/26/02	2002	269	1645	2245	0.39	45.25	6.00	0.25	0.07
10/12/02	10/12/02	2002	285	1715	2245	0.92	378.50	5.50	0.54	0.17
10/15/02	10/15/02	2002	288	1345	1730	0.53	63.00	3.75	0.23	0.14
10/23/02	10/23/02	2002	296	1845	1900	0.27	193.25	0.50	0.22	0.54
10/30/02	10/30/02	2002	303	1245	1330	0.51	161.75	0.75	0.33	0.68
11/12/02	11/13/02	2002	317	1845	500	0.88	317.25	10.25	0.33	0.09
11/16/02	11/16/02	2002	320	945	1630	0.70	76.45	6.75	0.13	0.10
11/17/02	11/17/02	2002	321	230	845	0.56	10.00	7.25	0.06	0.08

APPENDIX B Rainfall Characteristics

START DATE	END DATE	YEAR	DAY Julian	START TIME	END TIME	TOTAL RAIN (in.)	INTER-EVENT (hrs.)	DURA-TION (hrs.)	MAX. INT. (in./15 min.)	AVG. INT. (in./hr.)
12/05/02	12/06/02	2002	340	2130	600	1.04	444.75	8.50	0.46	0.12
12/09/02	12/10/02	2002	344	330	900	3.68	69.50	29.50	0.19	0.12
12/12/02	12/13/02	2002	347	1500	915	4.64	54.00	18.25	0.42	0.25
12/20/02	12/20/02	2002	354	600	800	0.54	164.75	2.00	0.26	0.27
12/24/02	12/25/02	2002	359	1915	200	1.30	114.00	8.75	0.18	0.15
12/31/02	12/31/02	2002	365	1800	2400	3.87	142.75	6.00	0.64	0.65
02/16/03	02/16/03	2003	047	16:15	22:30	0.70	1120.25	6.25	0.19	0.11
02/22/03	02/22/03	2003	053	16:45	19:15	0.57	138.25	2.50	0.15	0.23
02/28/03	02/28/03	2003	059	11:45	23:45	1.00	136.50	12.00	0.58	0.08
03/16/03	03/17/03	2003	075	23:30	1:00	0.69	383.75	1.50	0.19	0.46
03/21/03	03/21/03	2003	080	10:00	13:45	1.64	105.00	3.75	0.28	0.44
03/23/03	03/23/03	2003	082	5:45	20:45	1.45	41.00	14.00	0.19	0.10
03/27/03	03/27/03	2003	086	13:00	18:45	0.34	88.25	5.75	0.16	0.06
04/09/03	04/09/03	2003	099	1:45	4:15	0.25	295.00	2.50	0.06	0.10
04/09/03	04/09/03	2003	099	16:15	16:45	0.37	12.00	0.50	0.21	0.74
04/25/03	04/26/03	2003	115	19:00	4:00	3.40	386.25	9.00	0.76	0.38
05/18/03	05/18/03	2003	138	20:30	21:15	0.35	544.50	0.75	0.18	0.47
05/19/03	05/19/03	2003	139	15:15	23:00	0.32	18.00	7.75	0.15	0.04
05/22/03	05/22/03	2003	142	19:45	22:30	0.77	68.75	2.75	0.17	0.28
06/05/03	06/05/03	2003	156	5:45	7:45	0.36	318.25	2.00	0.08	0.18
06/08/03	06/08/03	2003	159	10:15	12:15	0.26	74.50	2.00	0.09	0.13
06/09/03	06/09/03	2003	160	10:00	13:45	0.74	21.75	3.75	0.38	0.20
06/11/03	06/11/03	2003	162	16:00	17:15	1.65	50.25	1.25	0.66	1.32
06/16/03	06/16/03	2003	167	16:30	21:30	0.92	119.25	5.00	0.26	0.18
06/17/03	06/17/03	2003	168	20:30	21:15	0.29	23.00	0.75	0.19	0.39
06/18/03	06/18/03	2003	169	11:15	19:45	1.52	14.00	8.50	0.26	0.18
06/19/03	06/19/03	2003	170	6:00	16:30	1.50	10.25	10.50	0.81	0.15
06/20/03	06/20/03	2003	171	7:30	21:45	1.40	15.00	14.25	0.39	0.10
06/21/03	06/21/03	2003	172	6:30	14:15	0.48	8.75	7.75	0.15	0.06
06/22/03	06/22/03	2003	173	8:30	15:45	1.25	18.25	7.25	0.18	0.17
07/03/03	07/03/03	2003	184	5:15	12:15	0.36	253.50	7.00	0.24	0.05
07/04/03	07/04/03	2003	185	18:00	19:00	0.44	29.75	1.00	0.39	0.44
07/08/03	07/08/03	2003	189	16:30	18:30	0.93	93.50	2.00	0.30	0.47
07/09/03	07/09/03	2003	190	16:45	17:00	0.73	22.25	0.25	0.49	2.92
07/11/03	07/11/03	2003	192	1:15	1:30	0.25	32.25	0.25	0.22	1.00
07/11/03	07/11/03	2003	192	14:30	15:15	0.71	13.00	0.75	0.41	0.95
07/12/03	07/12/03	2003	193	18:15	22:00	0.59	243.00	3.75	0.23	0.16
07/13/03	07/13/03	2003	194	16:00	19:00	1.86	18.00	3.00	0.45	0.62
07/16/03	07/16/03	2003	197	14:30	17:30	0.31	67.50	3.00	0.20	0.10
07/18/03	07/18/03	2003	199	19:00	20:15	0.81	50.75	1.25	0.49	0.65
07/22/03	07/22/03	2003	203	12:30	15:00	0.22	88.25	2.50	0.13	0.09
07/27/03	07/27/03	2003	208	14:30	14:45	0.47	119.50	0.25	0.37	1.88
08/02/03	08/02/03	2003	214	16:00	20:15	3.90	145.25	4.25	1.00	0.92
08/07/03	08/07/03	2003	219	10:45	20:45	0.46	110.50	10.00	0.29	0.05
08/08/03	08/08/03	2003	220	8:30	21:45	0.48	25.00	13.25	0.22	0.04
08/09/03	08/09/03	2003	221	9:00	16:00	1.24	11.25	7.00	0.34	0.18

APPENDIX B Rainfall Characteristics

START DATE	END DATE	YEAR	DAY Julian	START TIME	END TIME	TOTAL RAIN (in.)	INTER-EVENT (hrs.)	DURA-TION (hrs.)	MAX. INT. (in./15 min.)	AVG. INT. (in./hr.)
08/10/03	08/10/03	2003	222	0:30	10:45	0.84	8.50	10.25	0.19	0.08
08/16/03	08/16/03	2003	228	18:00	20:00	0.28	151.25	2.00	0.12	0.14
08/20/03	08/20/03	2003	232	15:30	21:00	0.62	91.50	5.50	0.21	0.11
08/21/03	08/21/03	2003	233	15:15	19:00	1.54	18.25	3.75	0.79	0.41
08/25/03	08/25/03	2003	237	15:30	19:15	0.28	92.50	3.75	0.05	0.07
08/26/03	08/26/03	2003	238	18:00	19:15	0.26	22.75	1.25	0.20	0.21
08/27/03	08/27/03	2003	239	16:00	19:00	0.96	20.75	3.00	0.62	0.32
09/02/03	09/02/03	2003	245	16:15	22:15	0.52	141.25	6.00	0.32	0.09
09/03/03	09/03/03	2003	246	15:45	20:15	0.27	17.50	4.50	0.21	0.06
09/05/03	09/05/03	2003	248	4:00	16:45	0.83	31.75	12.75	0.13	0.07
09/06/03	09/06/03	2003	249	3:15	5:15	0.33	10.50	2.00	0.17	0.17
09/19/03	09/19/03	2003	262	18:00	22:45	2.31	324.75	4.75	0.80	0.49
09/25/03	09/25/03	2003	268	13:15	23:45	0.79	134.50	10.50	0.06	0.08
09/28/03	09/28/03	2003	271	14:30	18:15	0.26	62.75	3.75	0.08	0.07
09/29/03	09/29/03	2003	272	4:30	10:00	0.24	10.25	5.50	0.04	0.04
10/14/03	10/14/03	2003	287	8:15	8:30	0.25	358.25	0.25	0.25	1.00
10/28/03	10/28/03	2003	301	16:15	23:15	0.61	343.75	7.00	0.13	0.09

SUMMARY STATISITCS	TOTAL RAIN (in.)	INTER-EVENT (hrs.)	DURA-TION (hrs.)	MAX. INT. (in./15 min.)	AVG. INT. (in./hr.)
YEAR ONE (NOVEMBER 2000 THROUGH AUGUST 2001)					
# Observations	31	31	31	31	31
Average	0.84	218.47	3.08	0.48	0.45
Median	0.60	97.50	2.50	0.40	0.21
Maximum	3.29	1525.50	11.75	1.40	2.40
Minimum	0.23	14.25	0.25	0.03	0.02
Std Deviation	0.67	315.76	2.95	0.38	0.61
Coefficient of Variation	0.79	1.45	0.96	0.79	1.35
CONSTRUCTION YEAR (SEPTEMBER 2001 THROUGH JUNE 2002)					
# Observations	28	28	28	27	26
Average	1.34	280.48	5.73	0.48	0.47
Median	1.03	178.75	3.25	0.41	0.31
Maximum	6.10	1053.25	36.75	1.28	1.71
Minimum	0.30	9.25	0.75	0.07	0.04
Std Deviation	1.17	286.91	7.62	0.34	0.45
Coefficient of Variation	0.87	1.02	1.33	0.71	0.96
YEAR TWO (JULY 2002 THROUGH OCTOBER 2003)					
# Observations	92	92	92	92	92
Average	0.93	125.97	5.08	0.31	0.34
Median	0.63	75.48	3.75	0.22	0.18
Maximum	4.64	1120.25	29.50	1.00	2.92
Minimum	0.22	6.25	0.25	0.04	0.04
Std Deviation	0.90	156.10	4.62	0.22	0.43
Coefficient of Variation	0.97	1.24	0.91	0.73	1.27

APPENDIX B Rainfall Characteristics

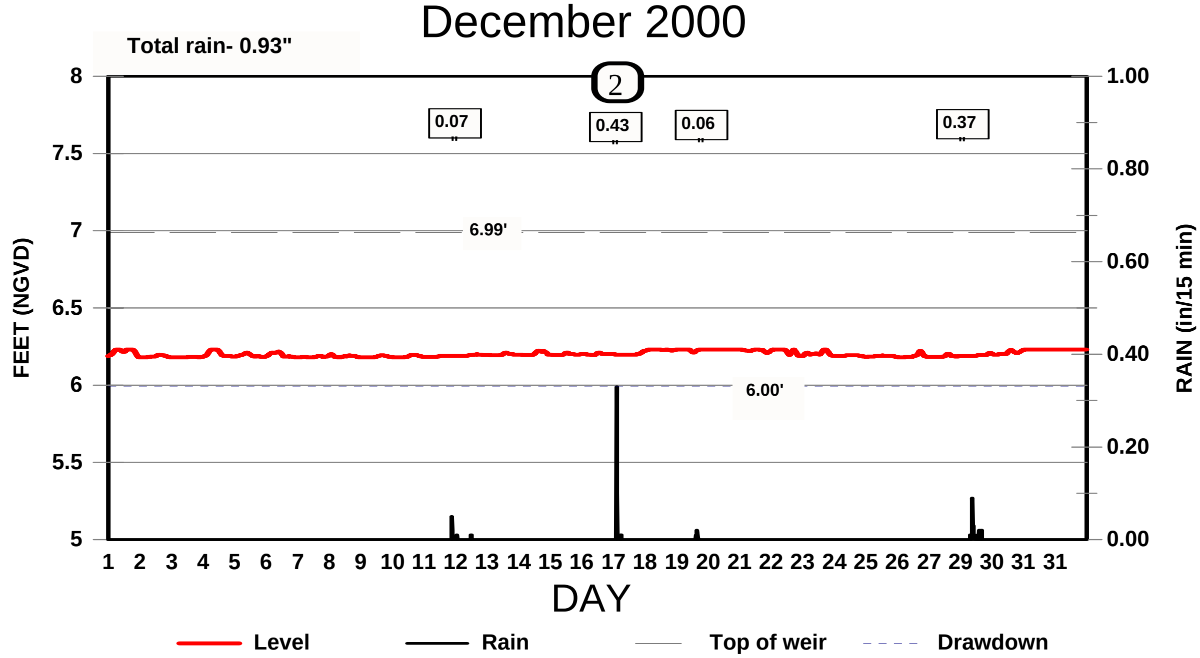
APPENDIX C

Water Level Plotted with Rainfall
Intensive Study 2000-2003

APPENDIX C Water Level Plotted with Rainfall

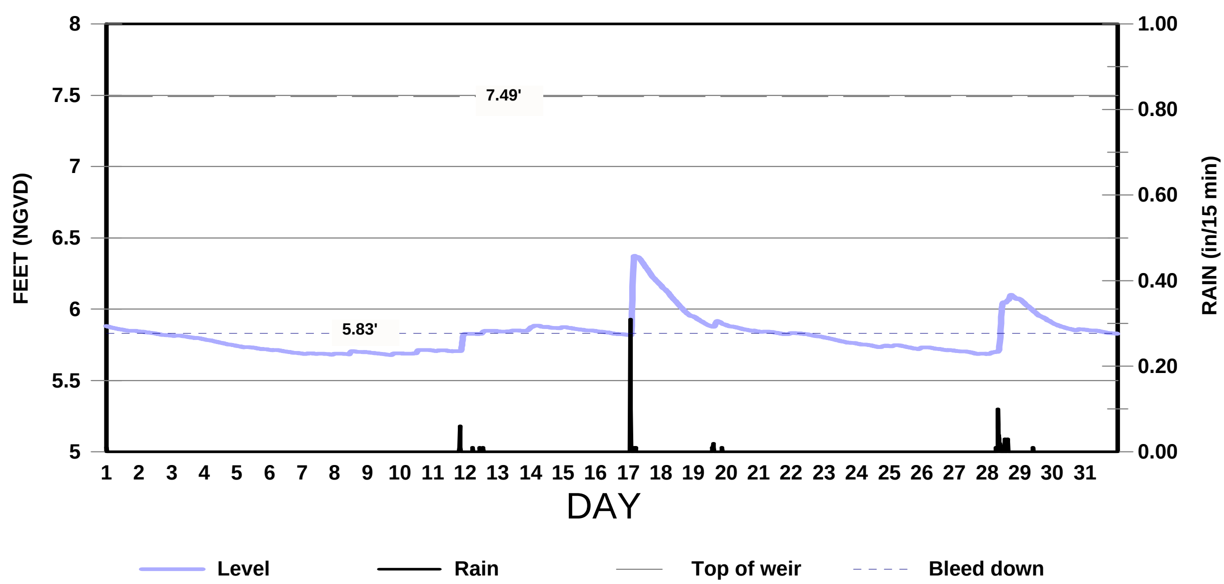
Street Pond Outflow

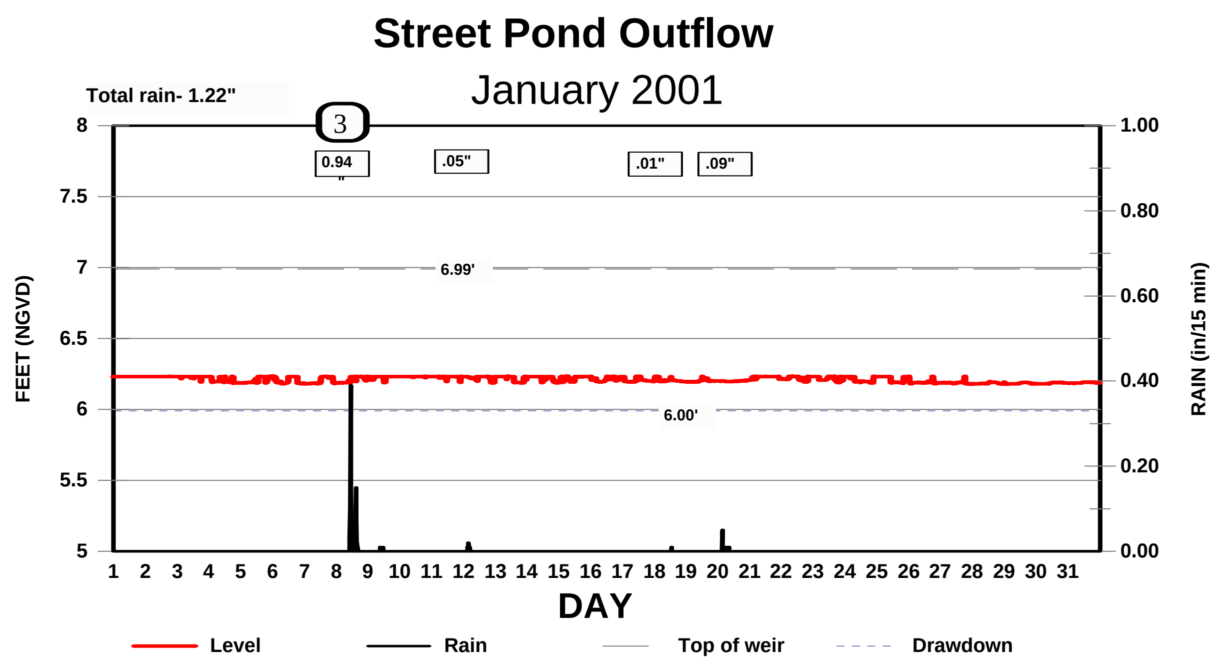
December 2000

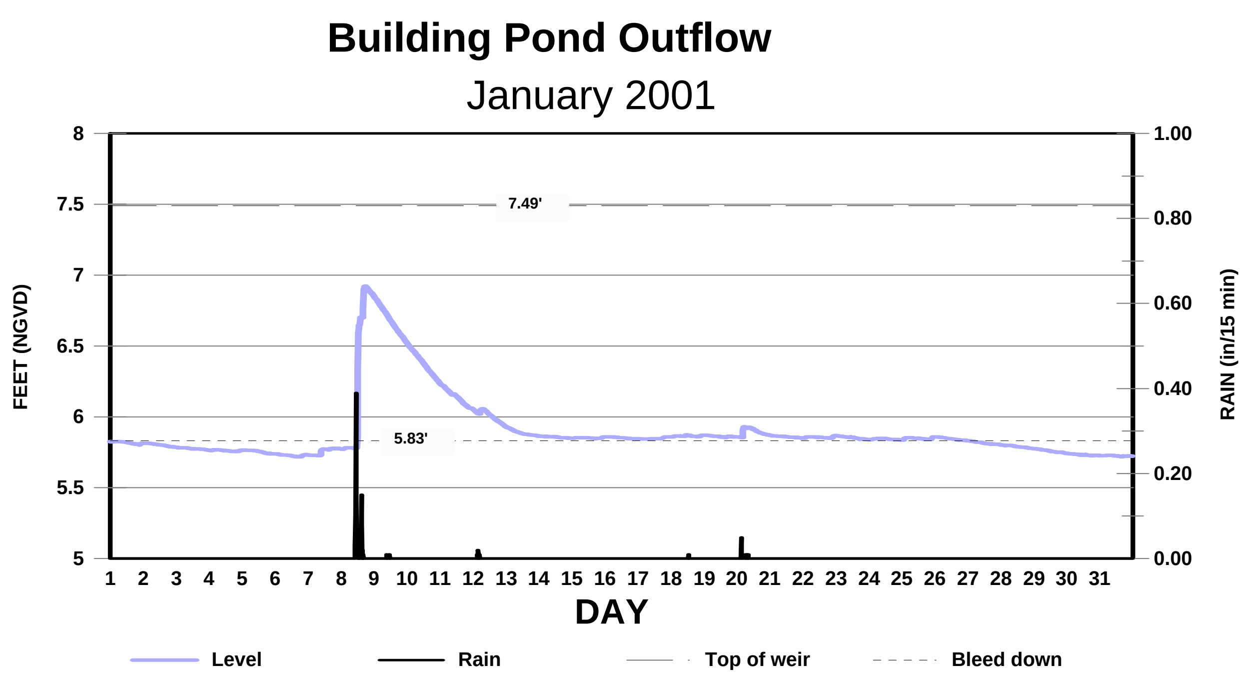


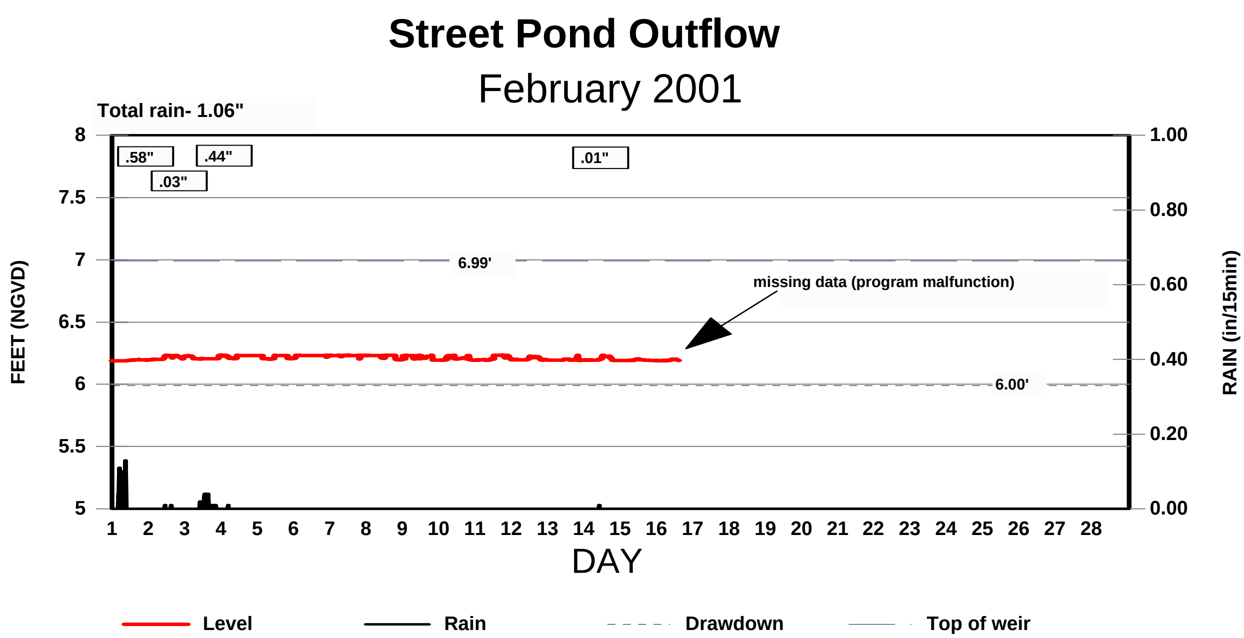
Building Pond Outflow

December 2000

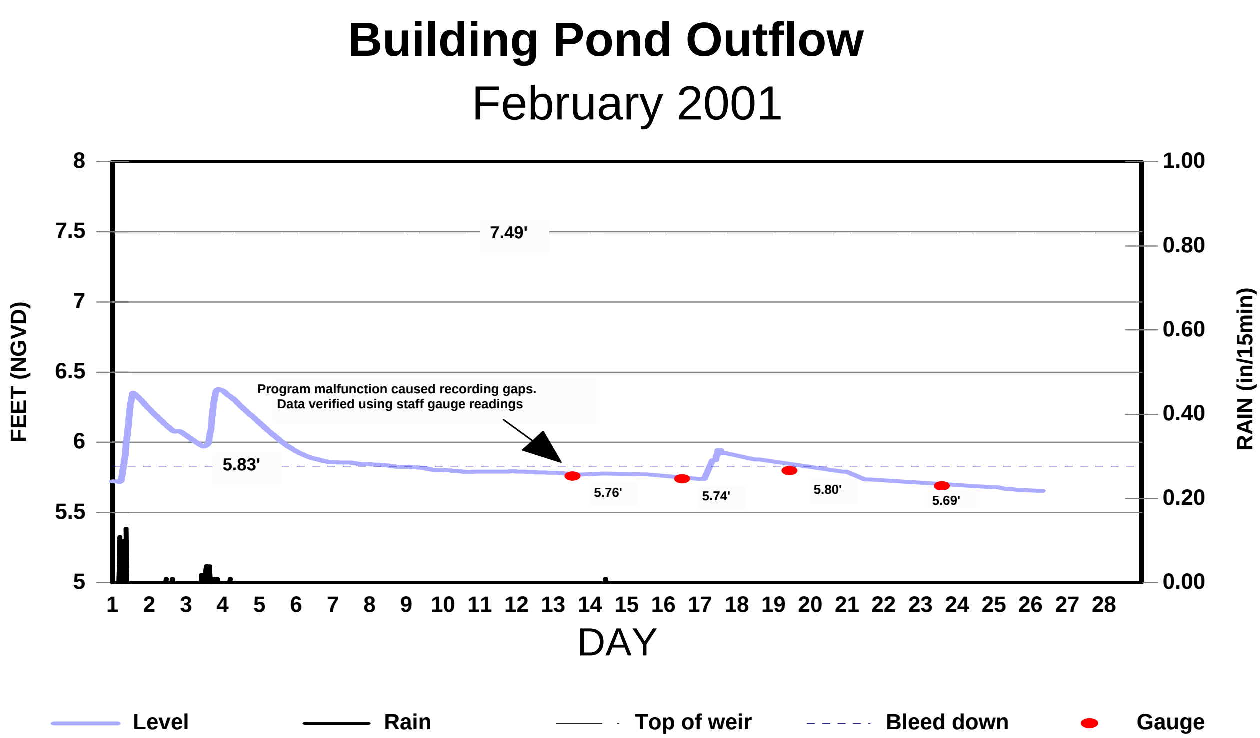



Street Pond Outflow
January 2001
Total rain- 1.22"
3
0.94"
.05"
.01"
.09"
6.99'
6.00'
FEET (NGVD)
RAIN (in/15 min)
DAY
Level
Rain
Top of weir
Drawdown

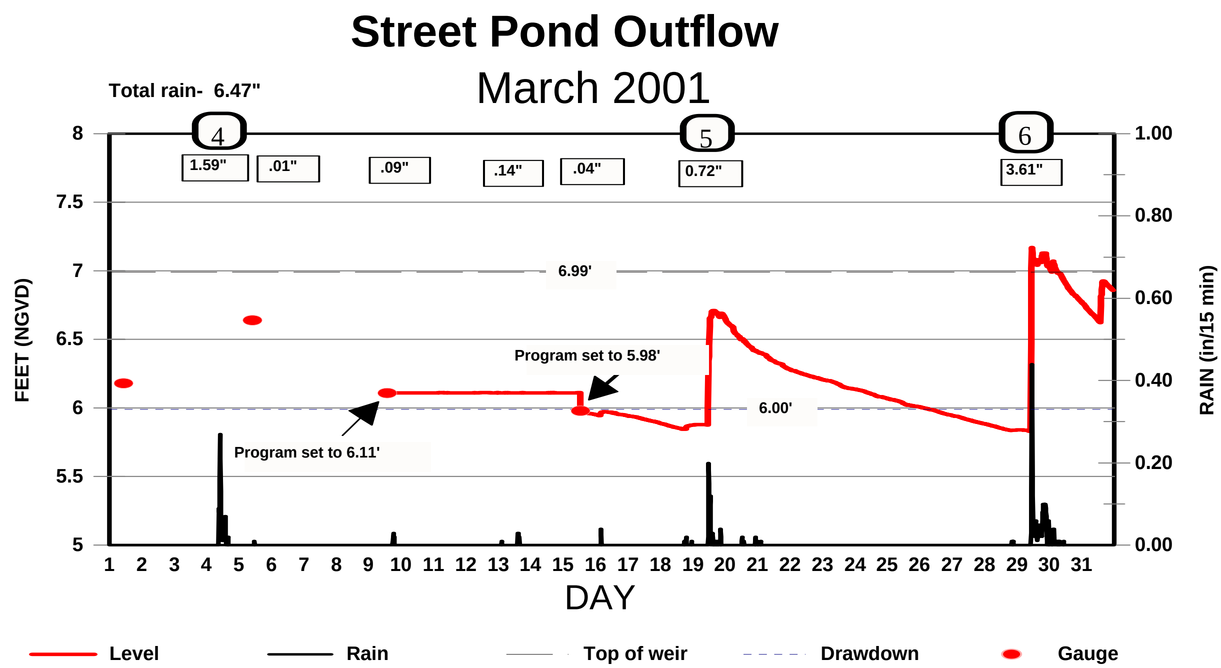

Building Pond Outflow
January 2001
7.49'
5.83'
FEET (NGVD)
RAIN (in/15 min)
DAY
Level
Rain
Top of weir
Bleed down



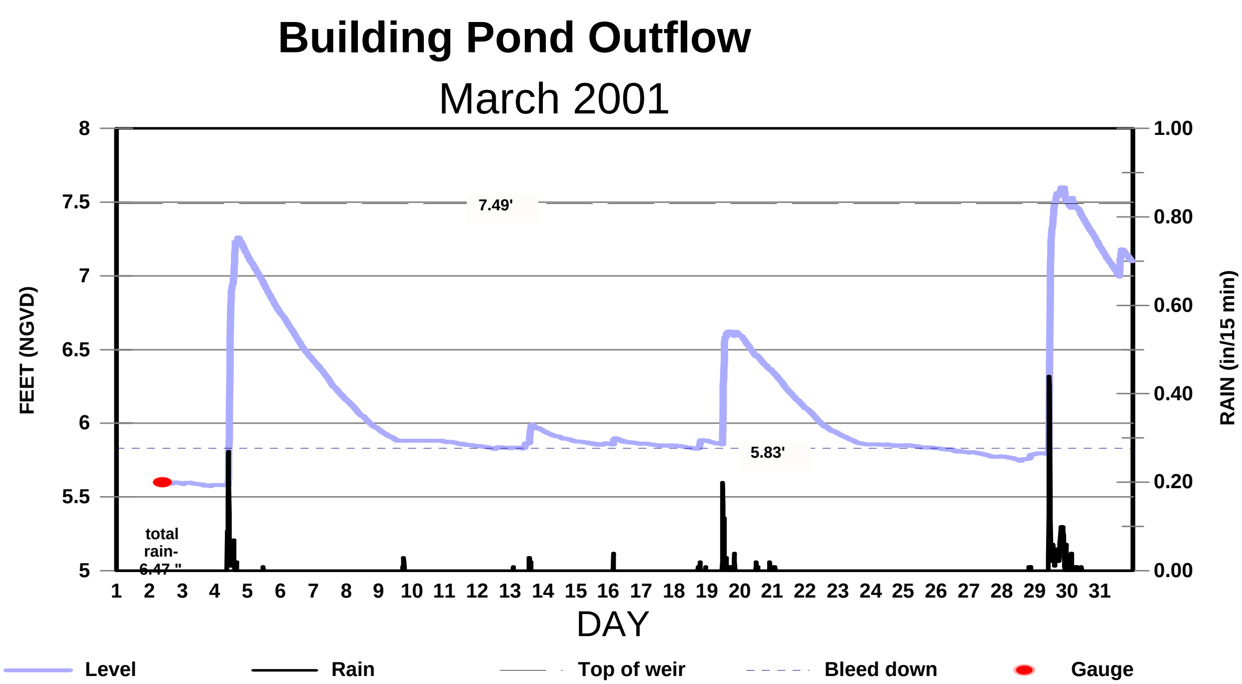
Street Pond Outflow
February 2001
Total rain- 1.06"
.58"
.03"
.44"
.01"
6.99'
missing data (program malfunction)
6.00'
FEET (NGVD)
RAIN (in/15min)
8
7.5
7
6.5
6
5.5
5
1.00
0.80
0.60
0.40
0.20
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
DAY
Level
Rain
Drawdown
Top of weir



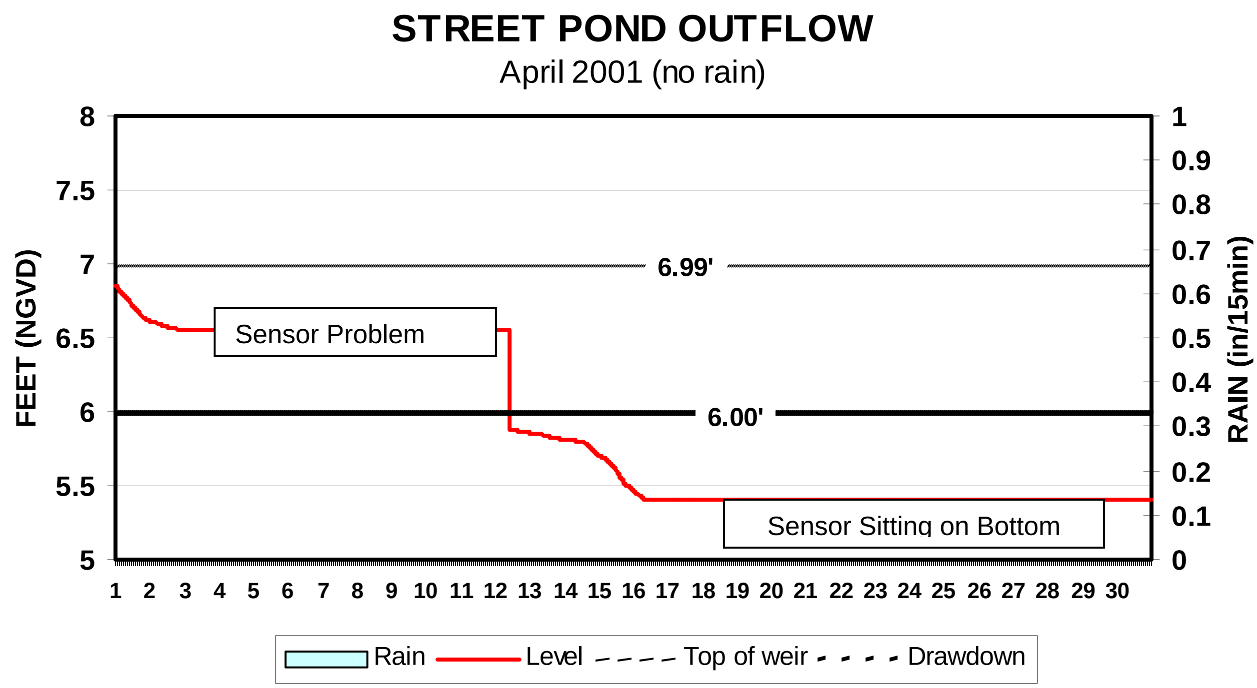
Building Pond Outflow
February 2001
7.49'
Program malfunction caused recording gaps.
Data verified using staff gauge readings
5.83'
5.76'
5.74'
5.80'
5.69'
FEET (NGVD)
RAIN (in/15min)
8
7.5
7
6.5
6
5.5
5
1.00
0.80
0.60
0.40
0.20
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
DAY
Level
Rain
Top of weir
Bleed down
Gauge

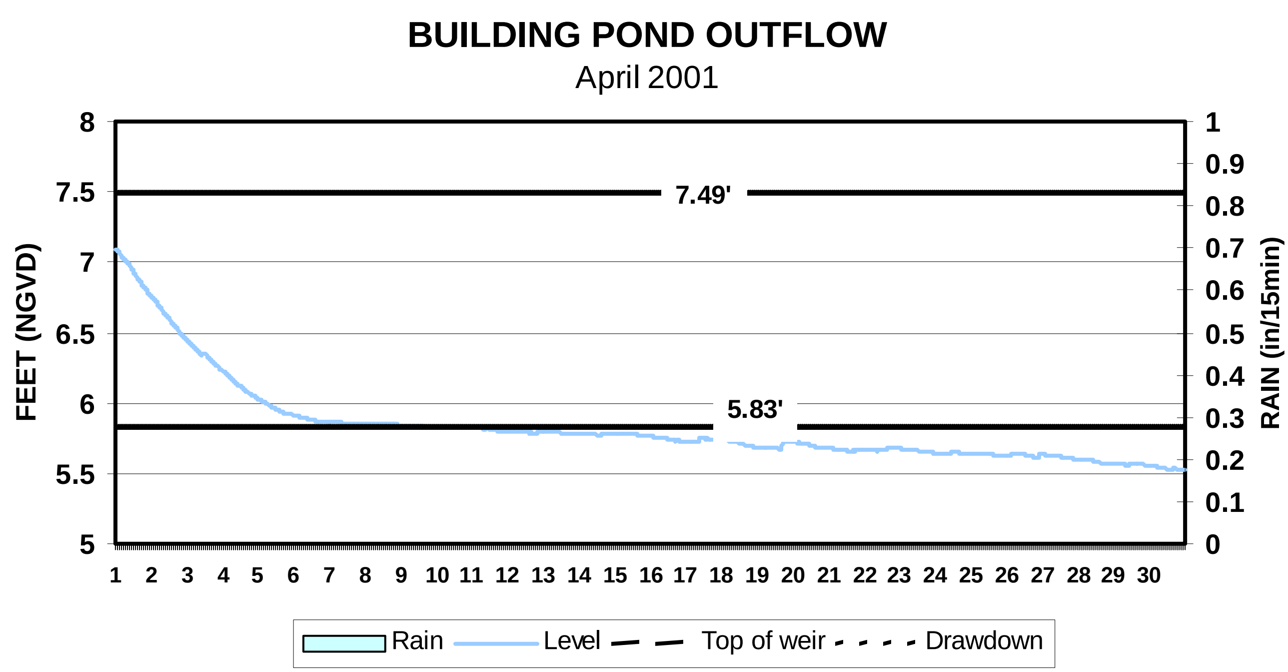


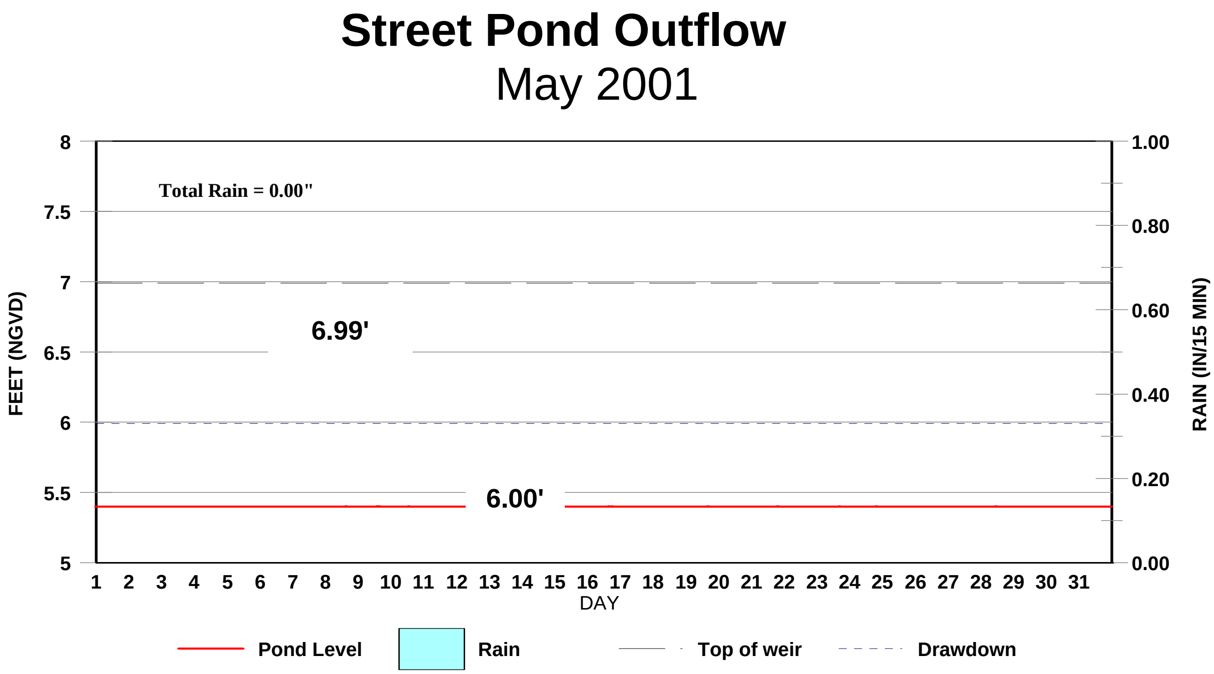
Street Pond Outflow
March 2001
Total rain- 6.47"
4
5
6
1.59"
.01"
.09"
.14"
.04"
0.72"
3.61"
6.99'
Program set to 5.98'
6.00'
Program set to 6.11'
FEET (NGVD)
RAIN (in/15 min)
DAY
Level
Rain
Top of weir
Drawdown
Gauge

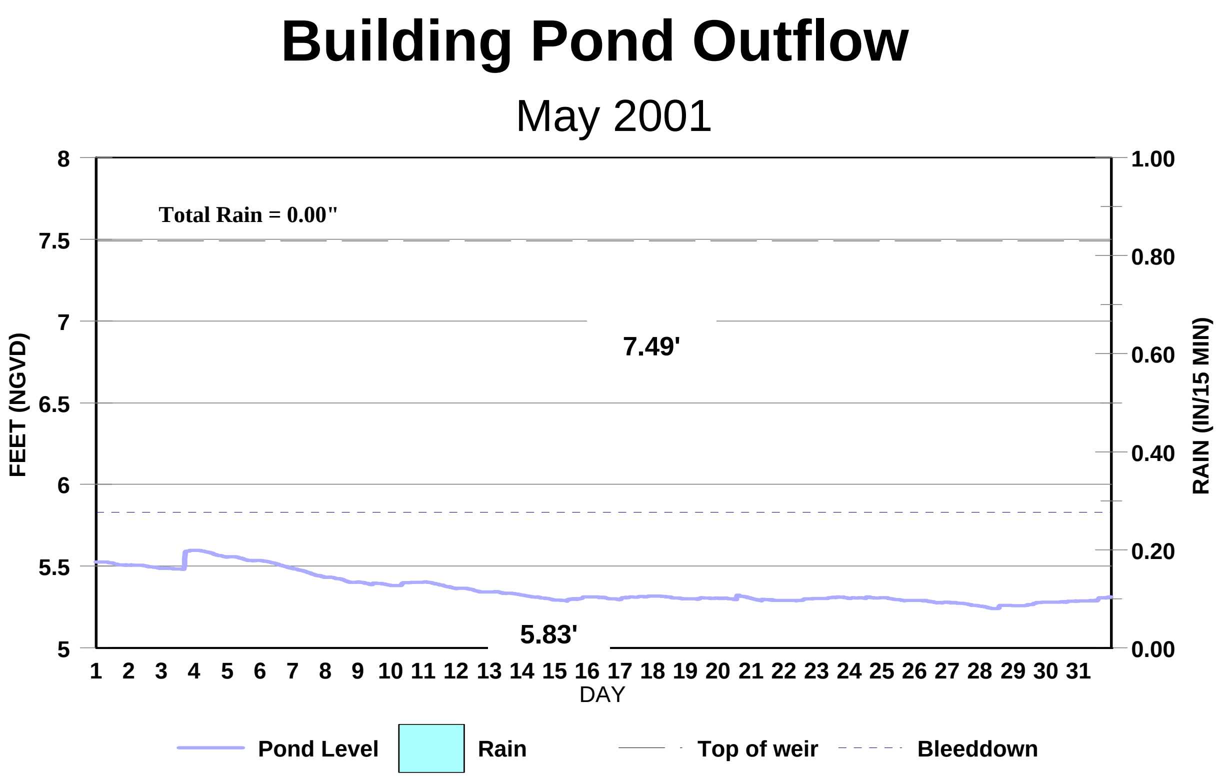


Building Pond Outflow
March 2001
7.49'
5.83'
total rain- 6.47"
FEET (NGVD)
RAIN (in/15 min)
DAY
Level
Rain
Top of weir
Bleed down
Gauge


STREET POND OUTFLOW
April 2001 (no rain)
FEET (NGVD)
8
7.5
7
6.5
6
5.5
5
RAIN (in/15min)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
6.99'
6.00'
Sensor Problem
Sensor Sitting on Bottom
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Rain
Level
Top of weir
Drawdown

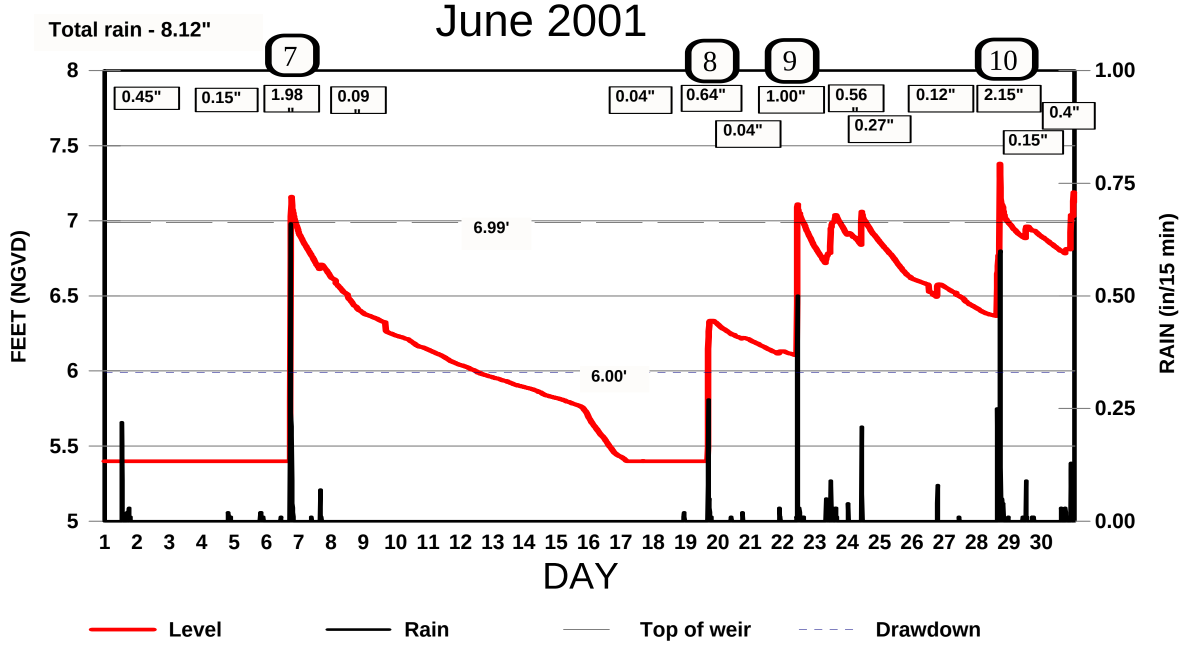

BUILDING POND OUTFLOW
April 2001
FEET (NGVD)
8
7.5
7
6.5
6
5.5
5
RAIN (in/15min)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
7.49'
5.83'
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Rain
Level
Top of weir
Drawdown


Street Pond Outflow
May 2001
Total Rain = 0.00"
6.99'
6.00'
FEET (NGVD)
RAIN (IN/15 MIN)
DAY
Pond Level
Rain
Top of weir
Drawdown


Building Pond Outflow
May 2001
Total Rain = 0.00"
7.49'
5.83'
FEET (NGVD)
RAIN (IN/15 MIN)
DAY
Pond Level
Rain
Top of weir
Bleeddown

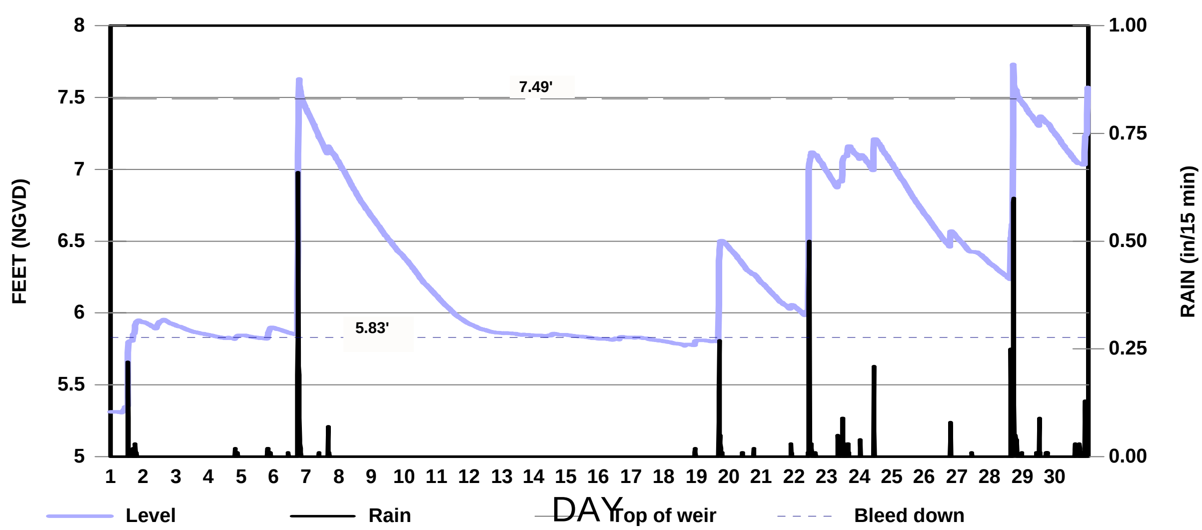
Street Pond Outflow

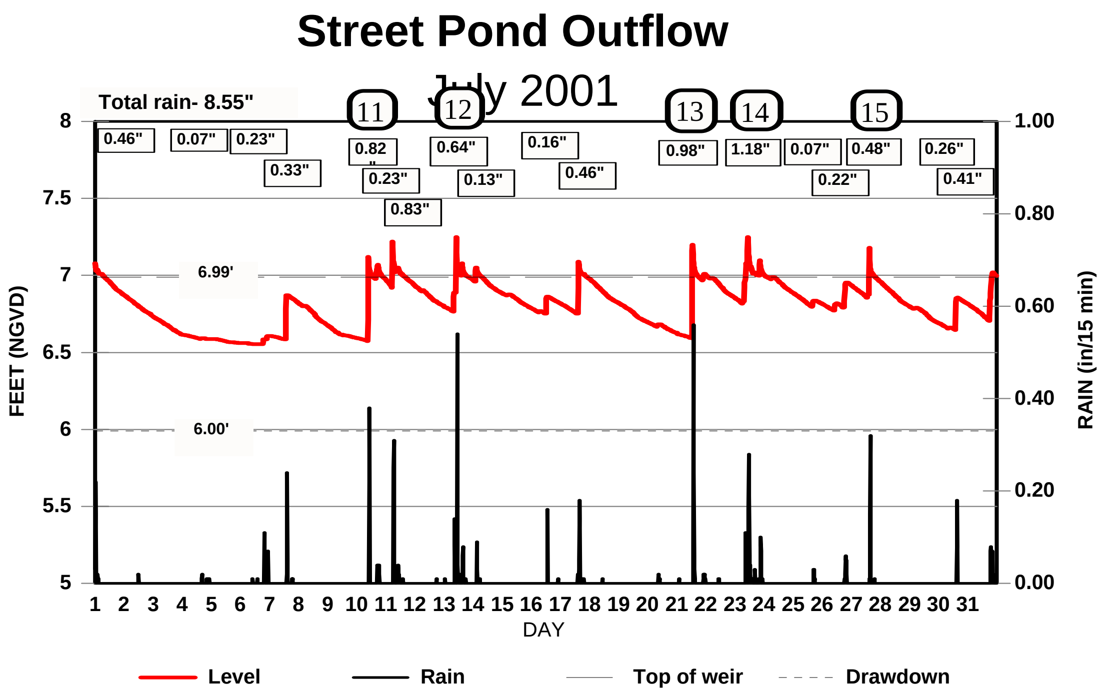
June 2001

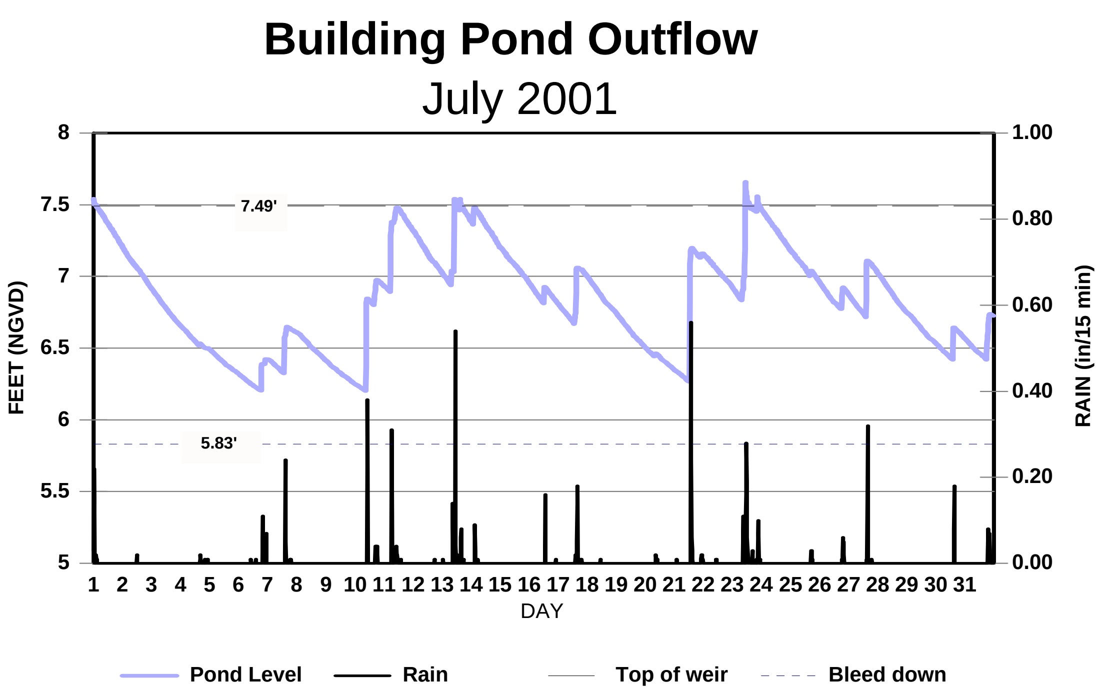


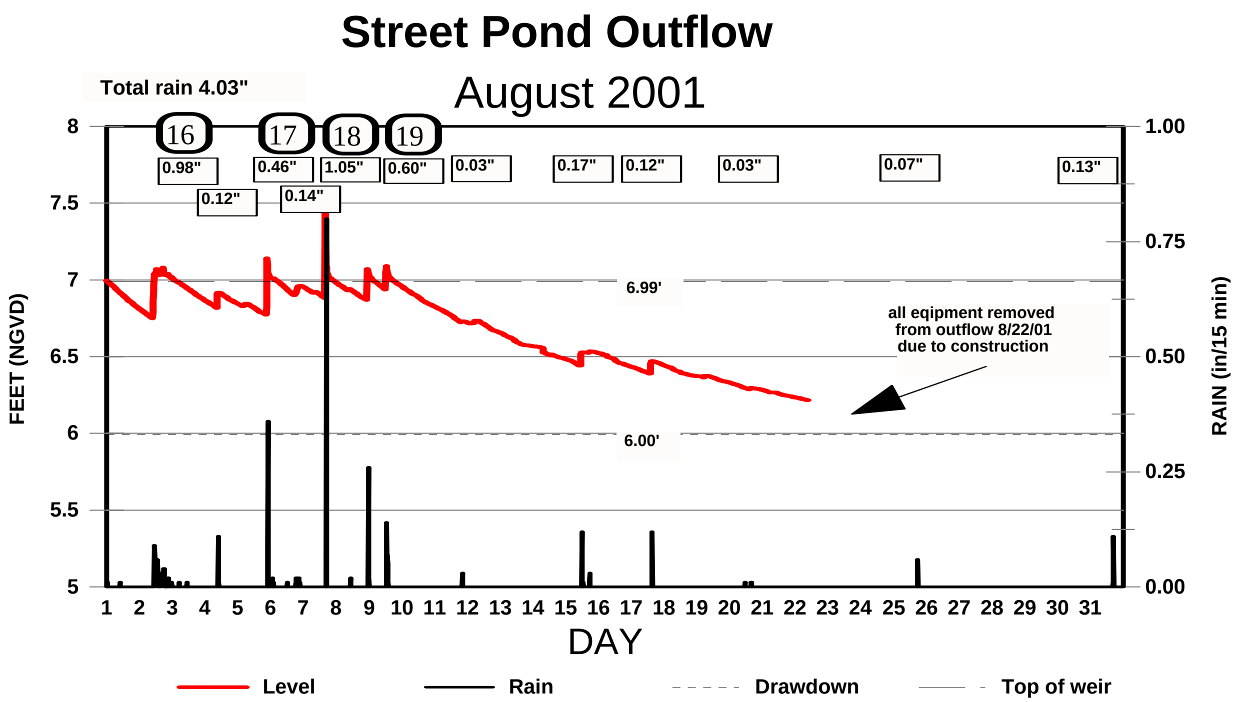
Building Pond Outflow

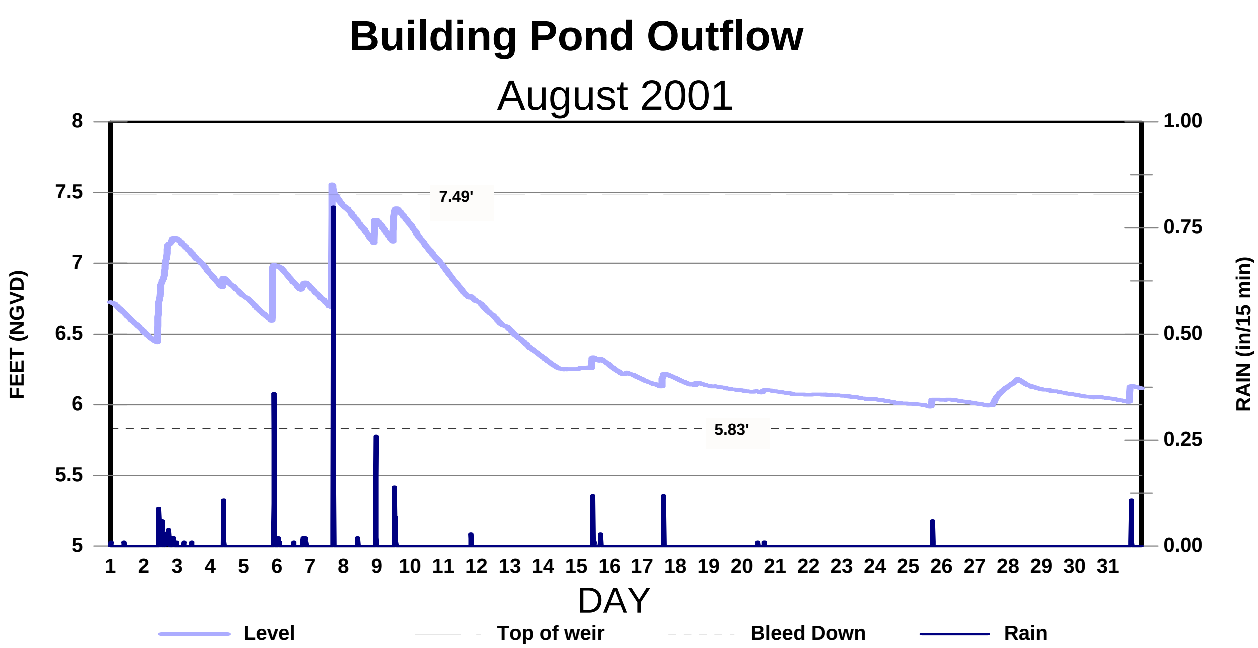
June 2001




Street Pond Outflow
July 2001
Total rain- 8.55"
11
12
13
14
15
0.46"
0.07"
0.23"
0.33"
0.82
0.23"
0.83"
0.64"
0.13"
0.16"
0.46"
0.98"
1.18"
0.07"
0.22"
0.48"
0.26"
0.41"
6.99'
6.00'
FEET (NGVD)
RAIN (in/15 min)
DAY
Level
Rain
Top of weir
Drawdown


Building Pond Outflow
July 2001
7.49'
5.83'
FEET (NGVD)
RAIN (in/15 min)
DAY
Pond Level
Rain
Top of weir
Bleed down

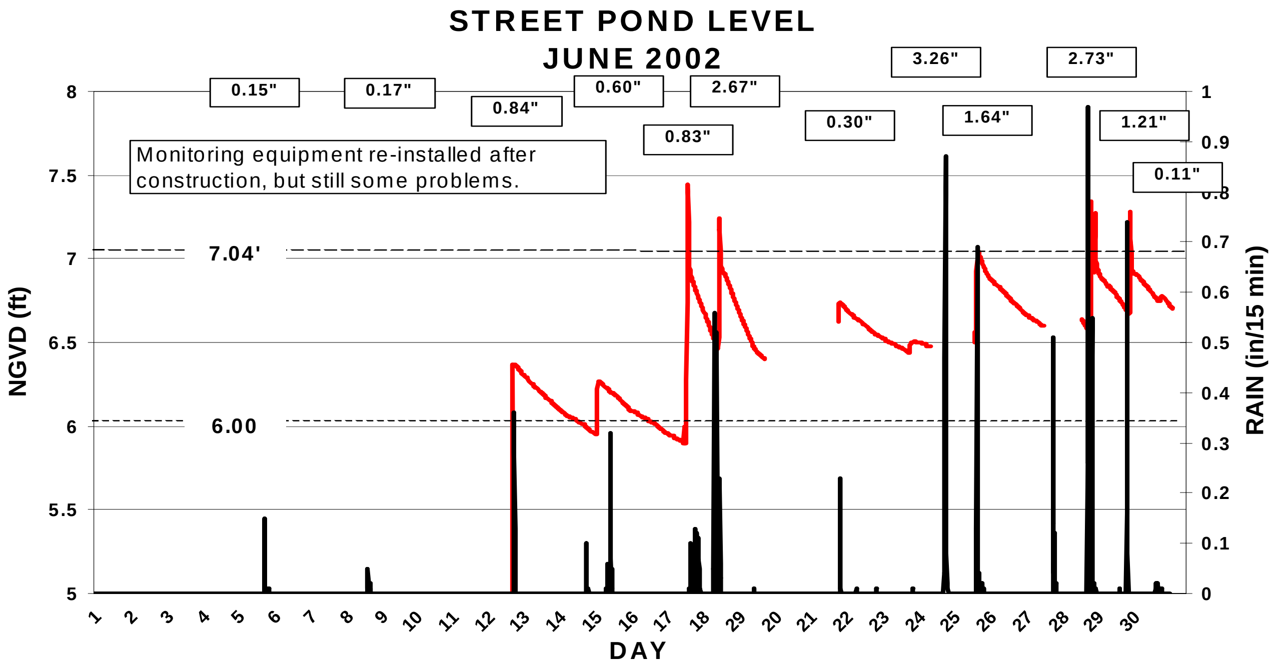

Street Pond Outflow
August 2001
Total rain 4.03"
16
17
18
19
0.98"
0.12"
0.46"
0.14"
1.05"
0.60"
0.03"
0.17"
0.12"
0.03"
0.07"
0.13"
6.99'
6.00'
all eqipment removed
from outflow 8/22/01
due to construction
FEET (NGVD)
RAIN (in/15 min)
DAY
Level
Rain
Drawdown
Top of weir

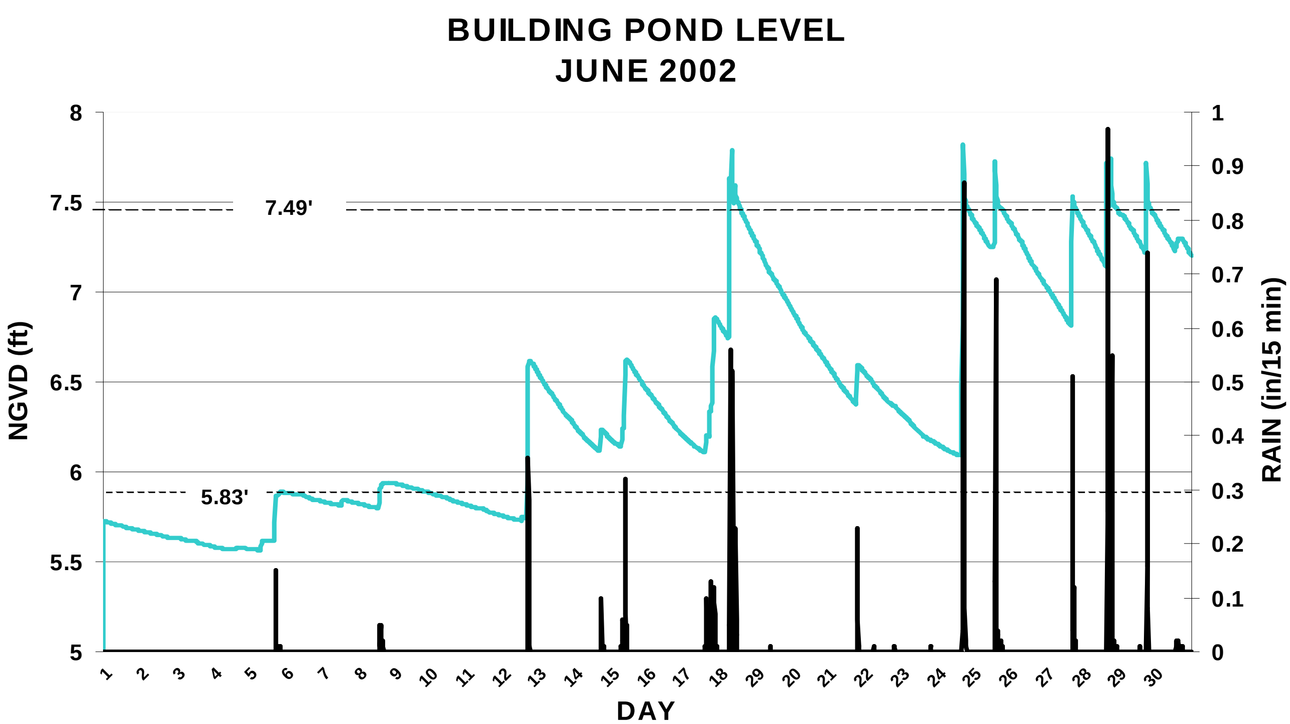

Building Pond Outflow
August 2001
7.49'
5.83'
FEET (NGVD)
RAIN (in/15 min)
DAY
Level
Top of weir
Bleed Down
Rain

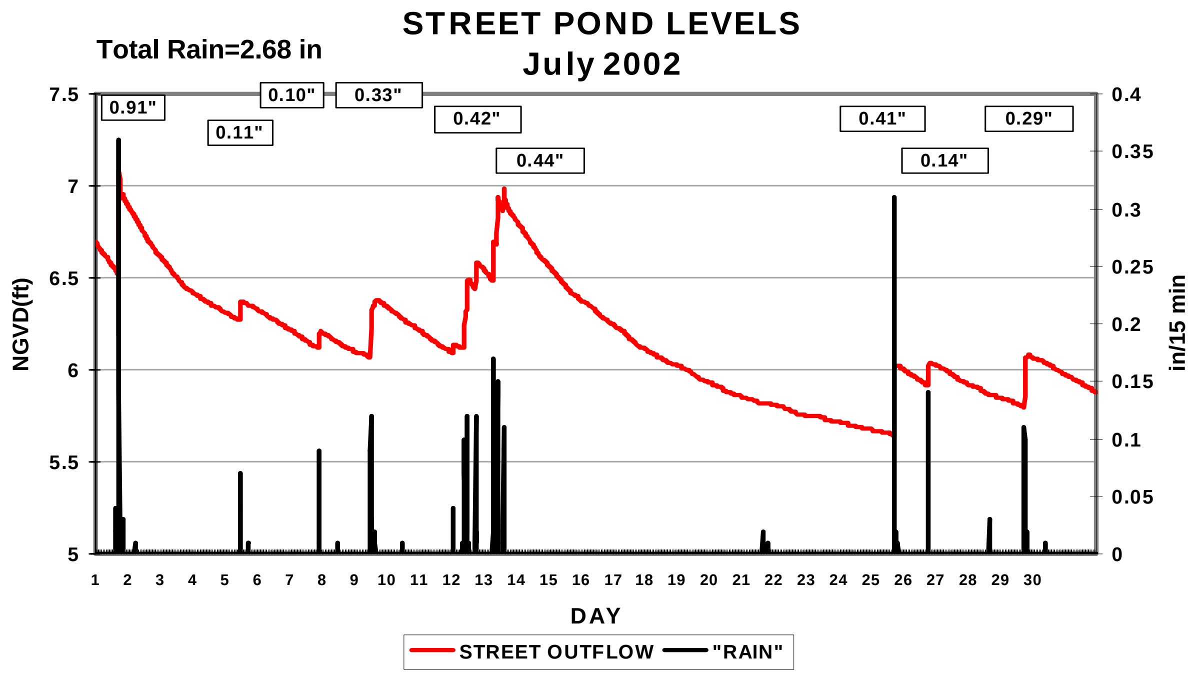
APPENDIX C Water Level Plotted with Rainfall

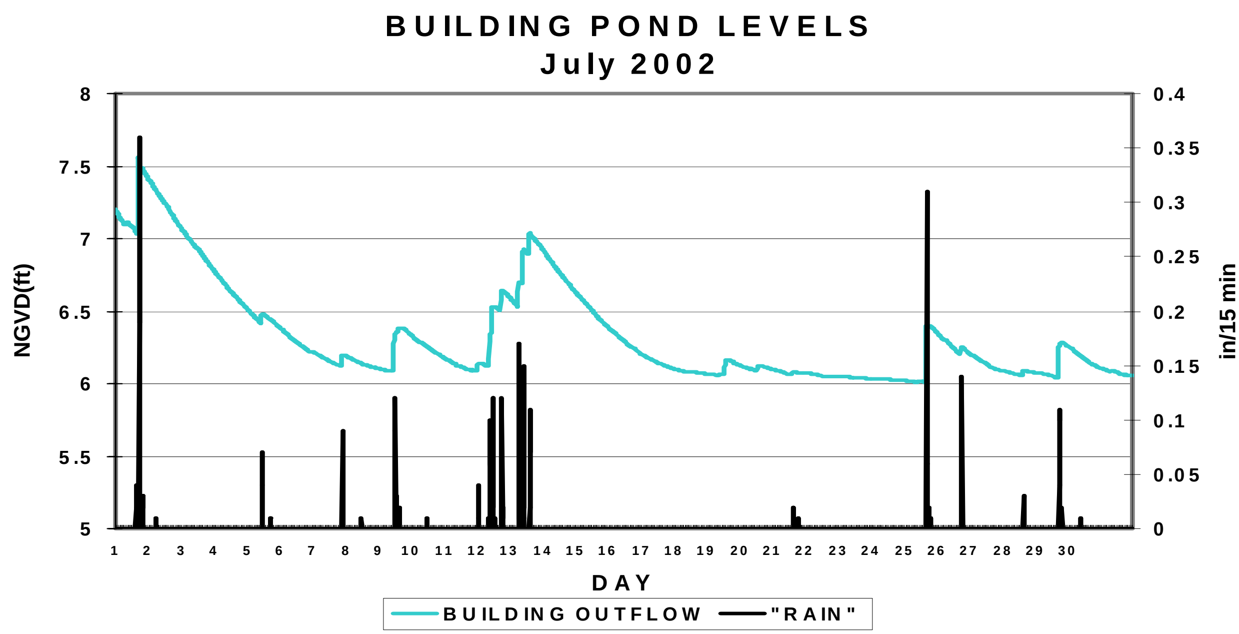
APPENDIX B

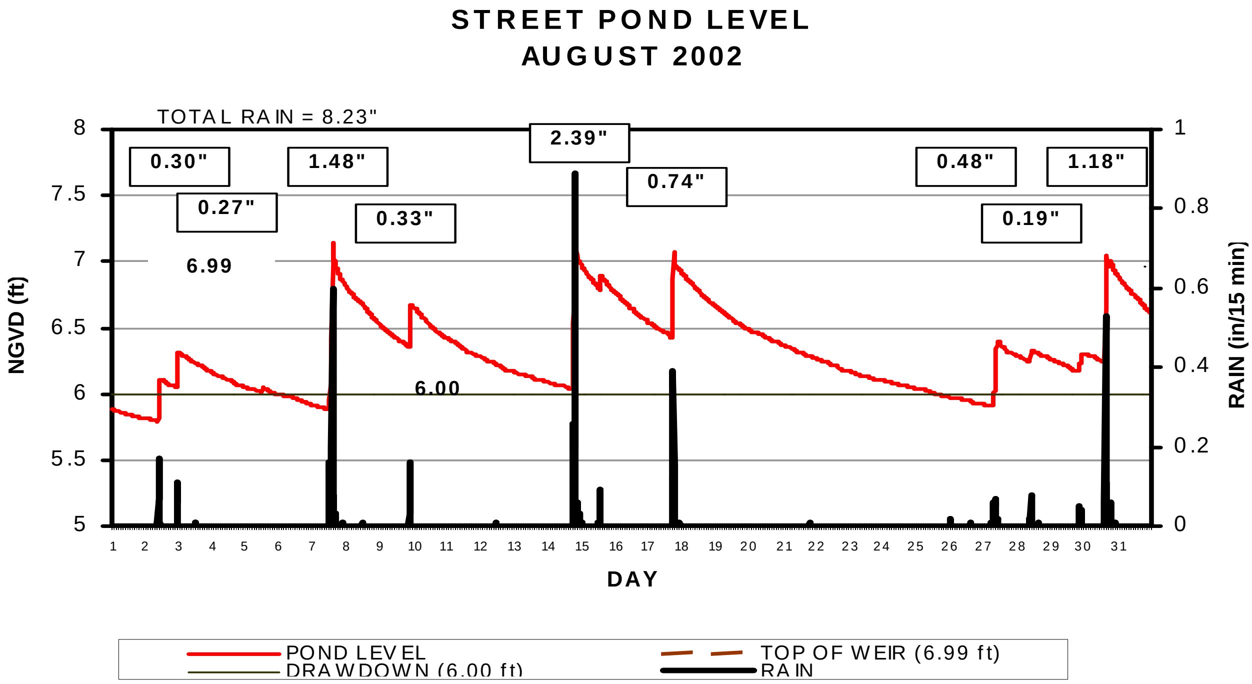
YEAR TWO

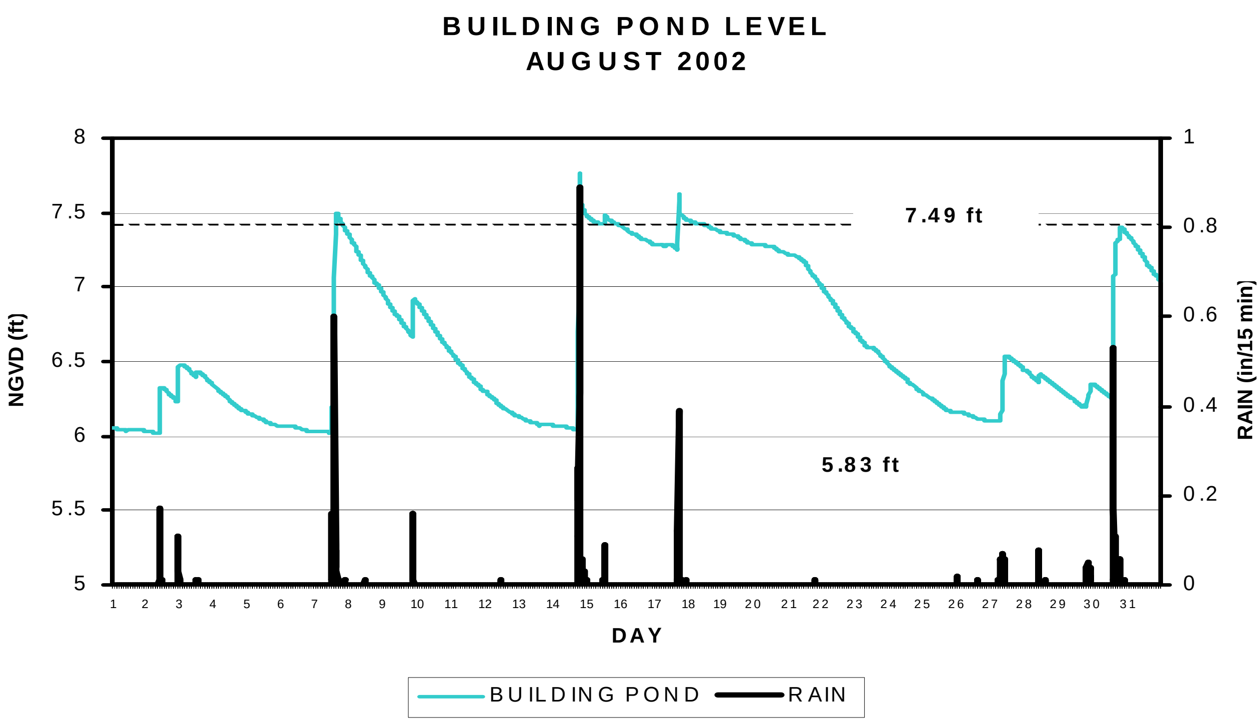

STREET POND LEVEL
JUNE 2002
Monitoring equipment re-installed after construction, but still some problems.
0.15"
0.17"
0.84"
0.60"
0.83"
2.67"
0.30"
3.26"
1.64"
2.73"
1.21"
0.11"
7.04'
6.00
NGVD (ft)
RAIN (in/15 min)
DAY

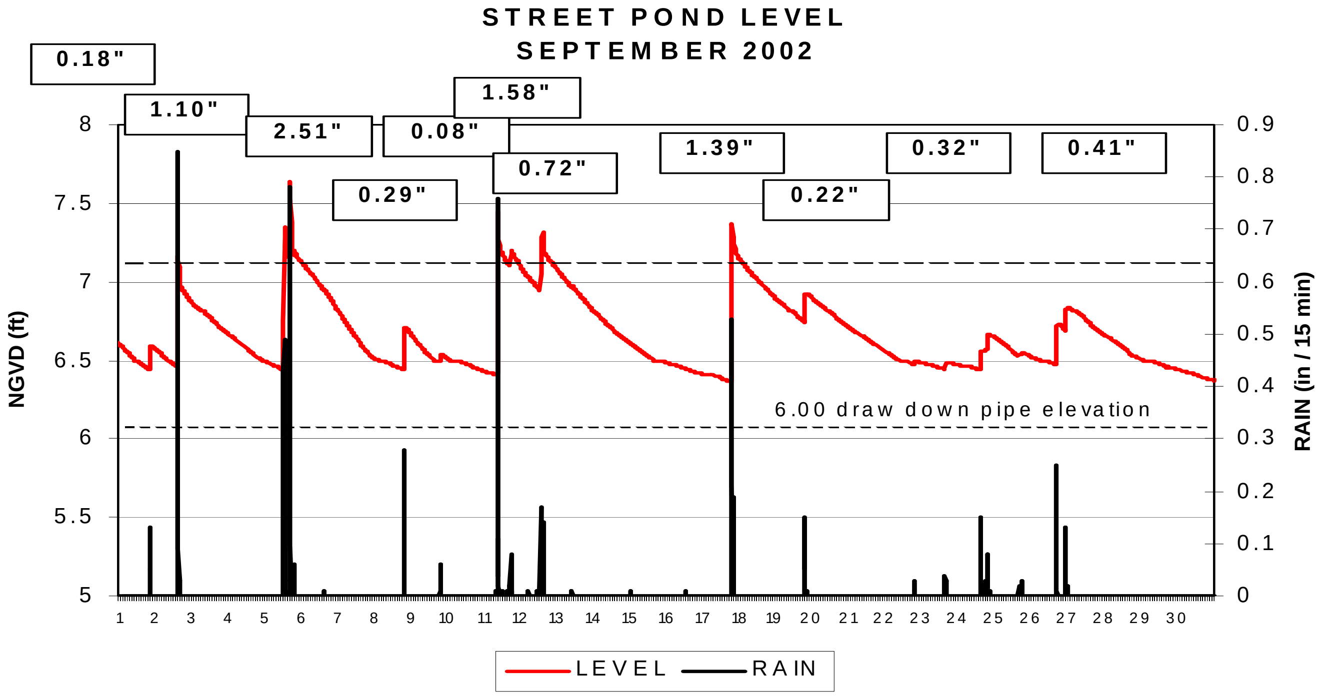

BUILDING POND LEVEL
JUNE 2002
7.49'
5.83'
NGVD (ft)
RAIN (in/15 min)
DAY

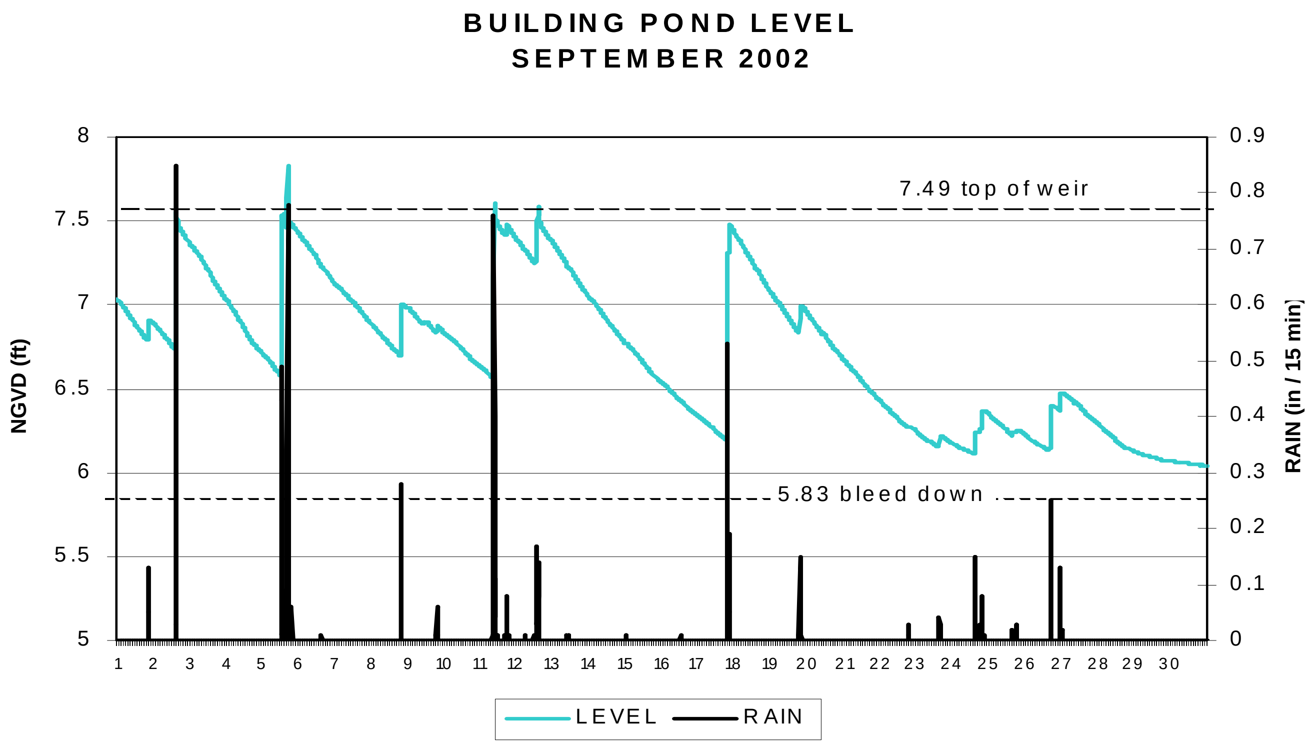

STREET POND LEVELS
July 2002
Total Rain=2.68 in
0.91"
0.11"
0.10"
0.33"
0.42"
0.44"
0.41"
0.14"
0.29"
NGVD(ft)
in/15 min
DAY
STREET OUTFLOW
"RAIN"

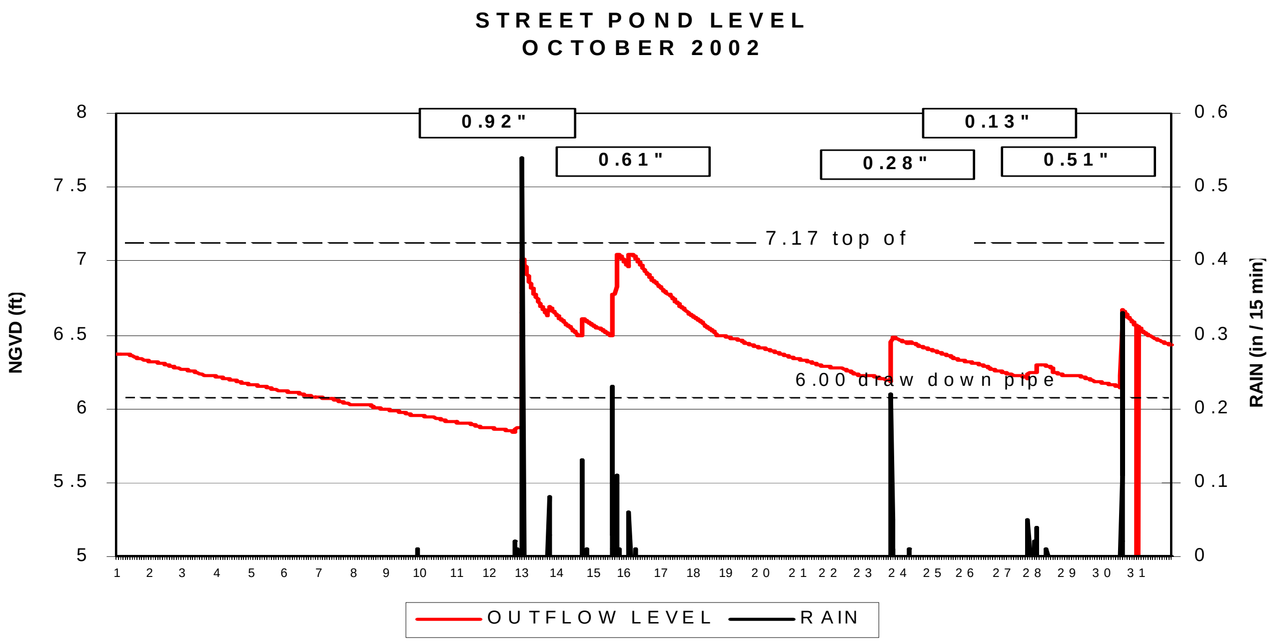

BUILDING POND LEVELS
July 2002
NGVD(ft)
in/15 min
DAY
BUILDING OUTFLOW
"RAIN"

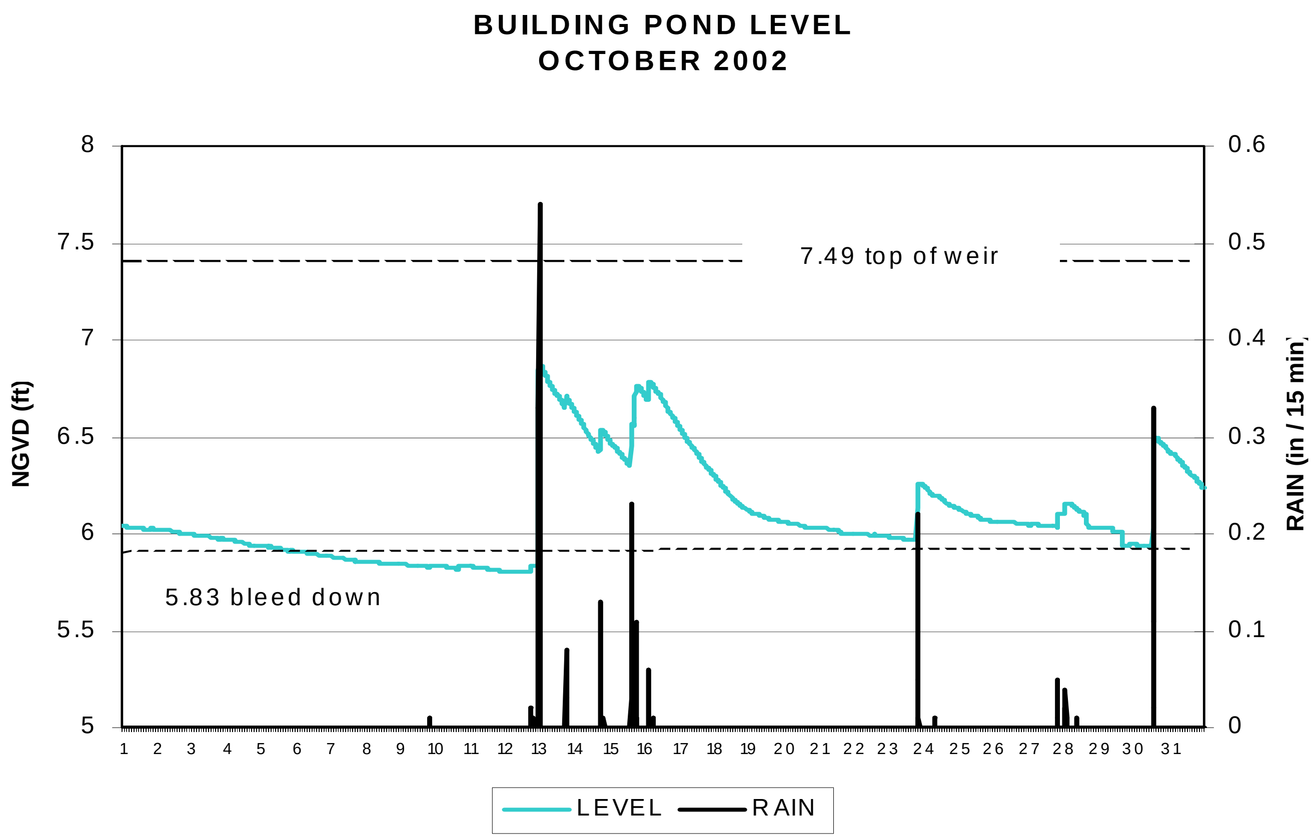

STREET POND LEVEL
AUGUST 2002
TOTAL RAIN = 8.23"
0.30"
0.27"
1.48"
0.33"
2.39"
0.74"
0.48"
0.19"
1.18"
6.99
6.00
NGVD (ft)
RAIN (in/15 min)
DAY
POND LEVEL
DRAWDOWN (6.00 ft)
TOP OF WEIR (6.99 ft)
RAIN

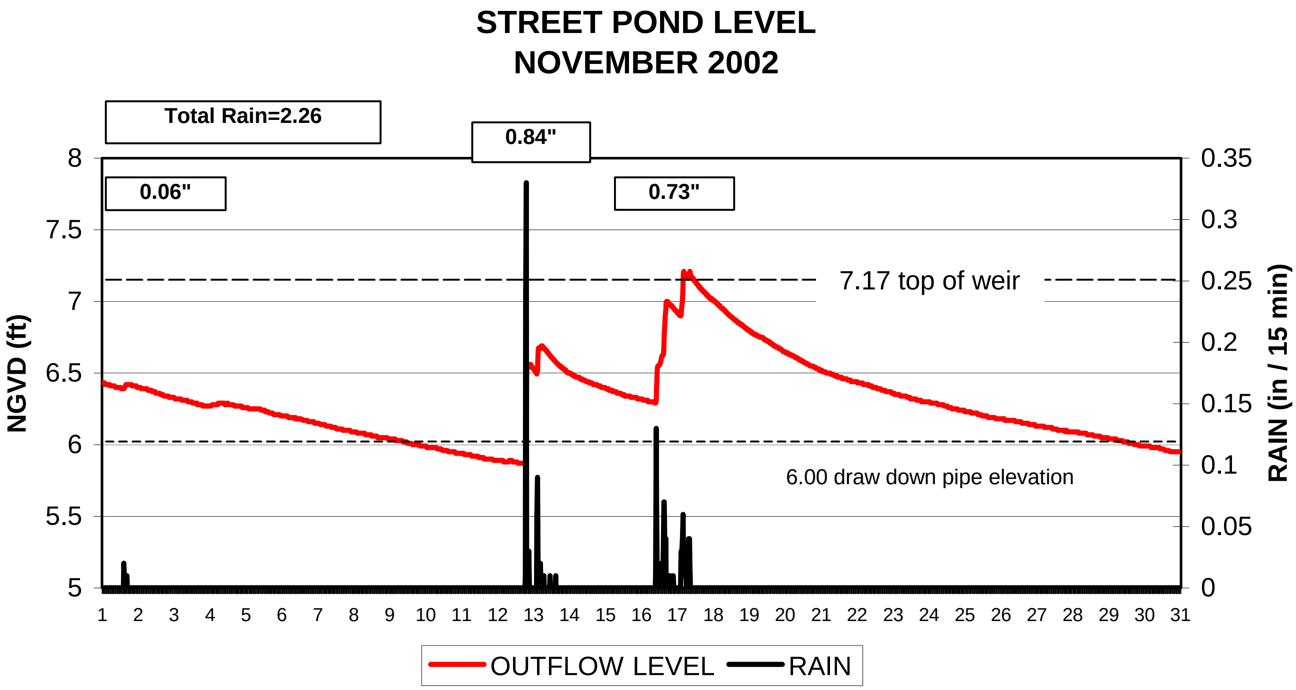

BUILDING POND LEVEL
AUGUST 2002
7.49 ft
5.83 ft
NGVD (ft)
RAIN (in/15 min)
DAY
BUILDING POND
RAIN

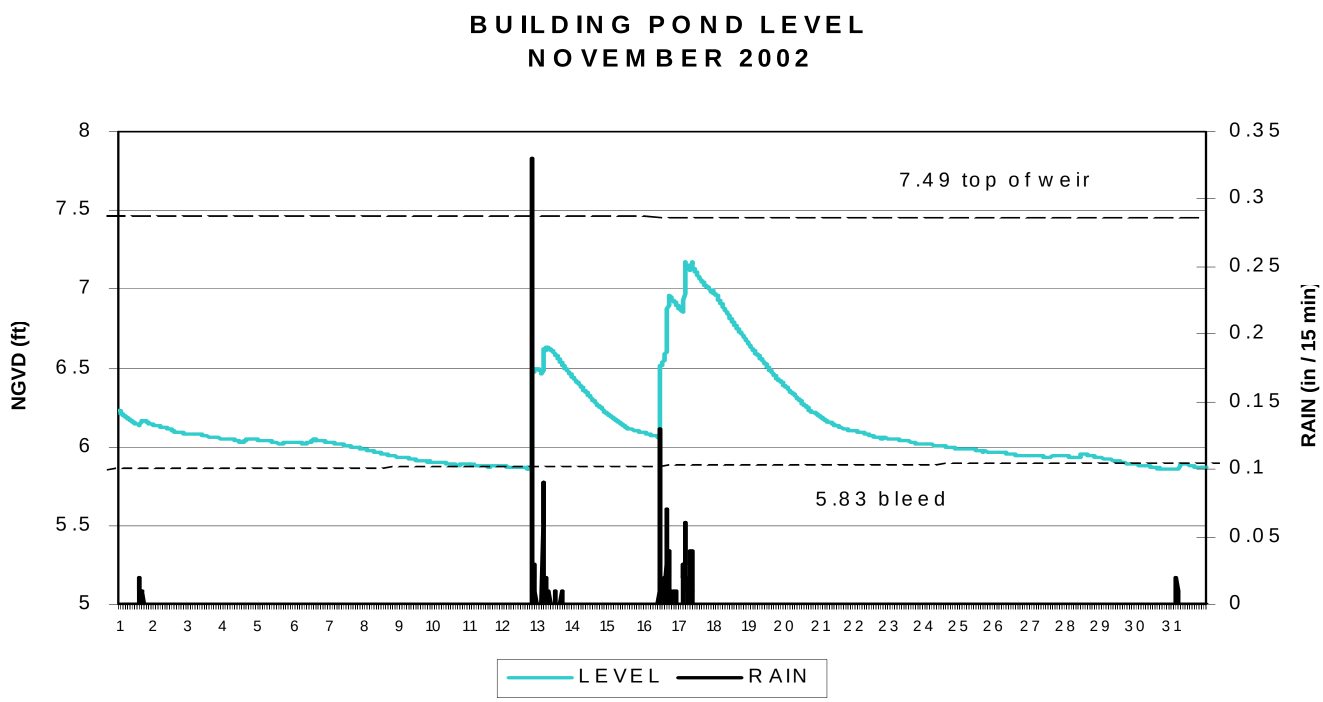

STREET POND LEVEL
SEPTEMBER 2002
0.18"
1.10"
2.51"
0.08"
1.58"
0.29"
0.72"
1.39"
0.22"
0.32"
0.41"
6.00 draw down pipe elevation
NGVD (ft)
RAIN (in / 15 min)
LEVEL
RAIN

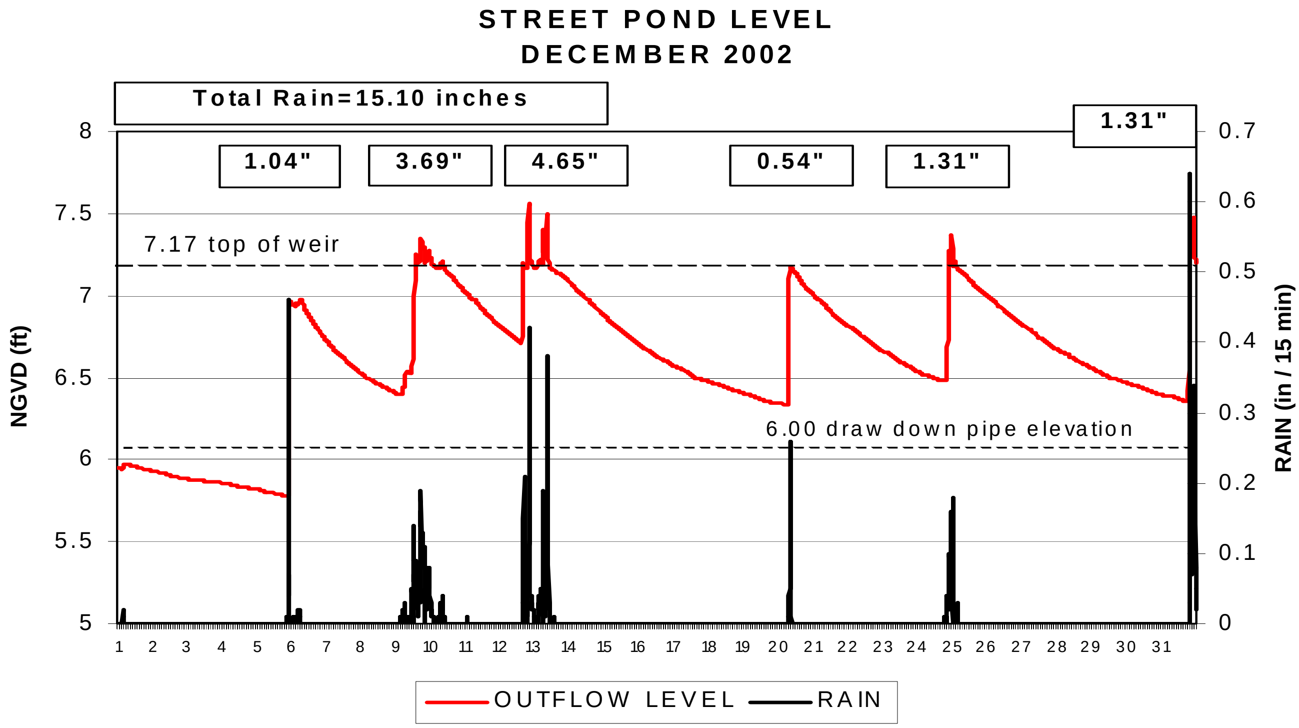

BUILDING POND LEVEL
SEPTEMBER 2002
7.49 top of weir
5.83 bleed down
NGVD (ft)
RAIN (in / 15 min)
LEVEL
RAIN

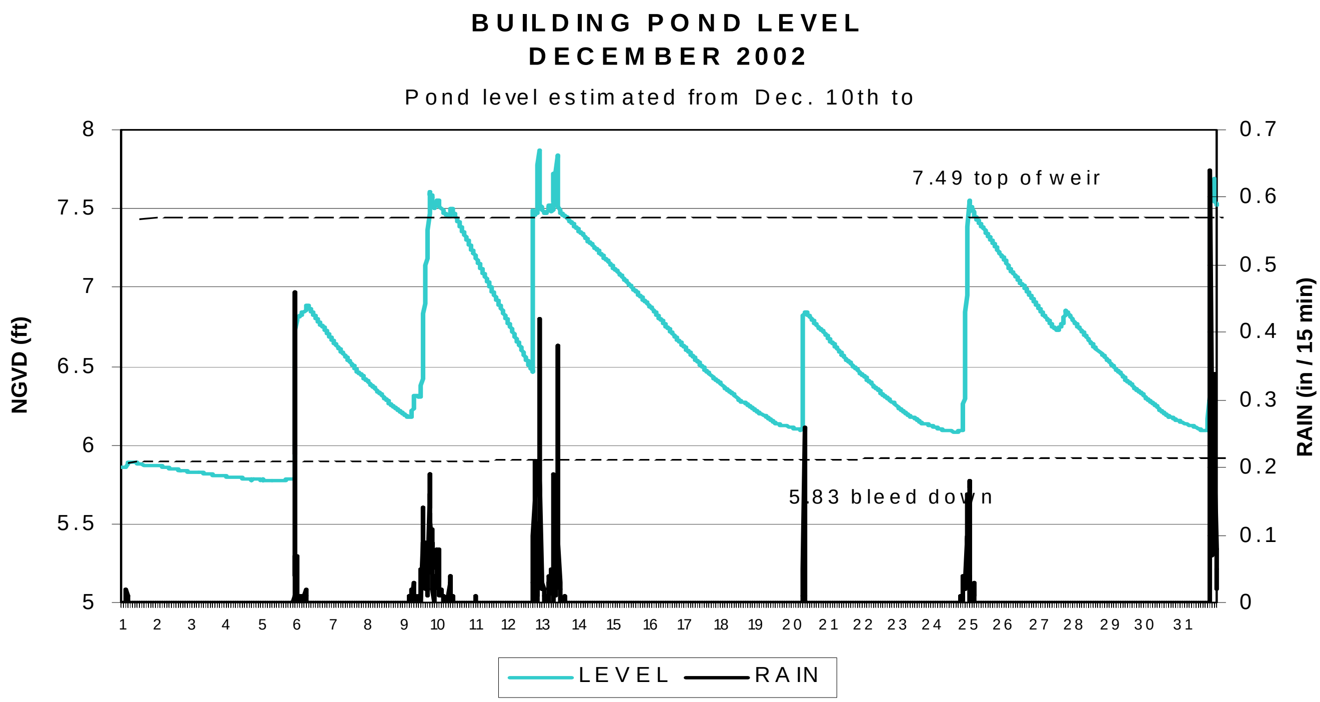

STREET POND LEVEL
OCTOBER 2002
0.92"
0.61"
0.28"
0.13"
0.51"
7.17 top of
6.00 draw down pipe
NGVD (ft)
RAIN (in / 15 min)
8
7.5
7
6.5
6
5.5
5
0.6
0.5
0.4
0.3
0.2
0.1
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
OUTFLOW LEVEL
RAIN

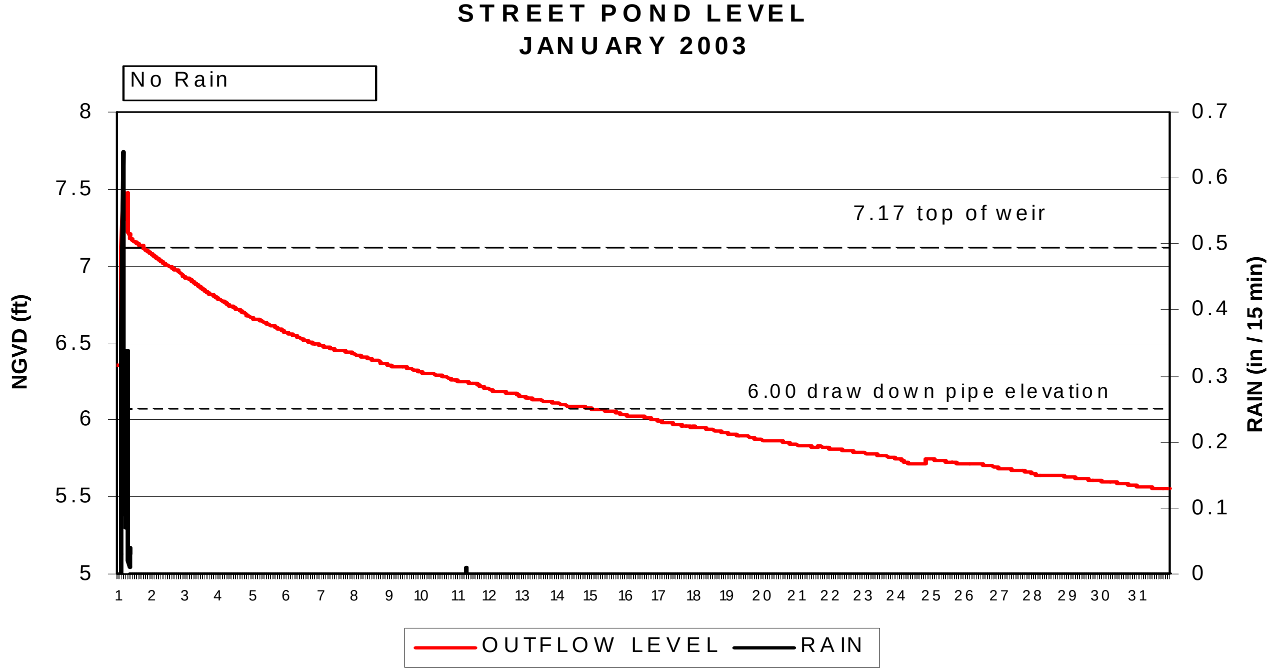

BUILDING POND LEVEL
OCTOBER 2002
7.49 top of weir
5.83 bleed down
NGVD (ft)
RAIN (in / 15 min)
8
7.5
7
6.5
6
5.5
5
0.6
0.5
0.4
0.3
0.2
0.1
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
LEVEL
RAIN

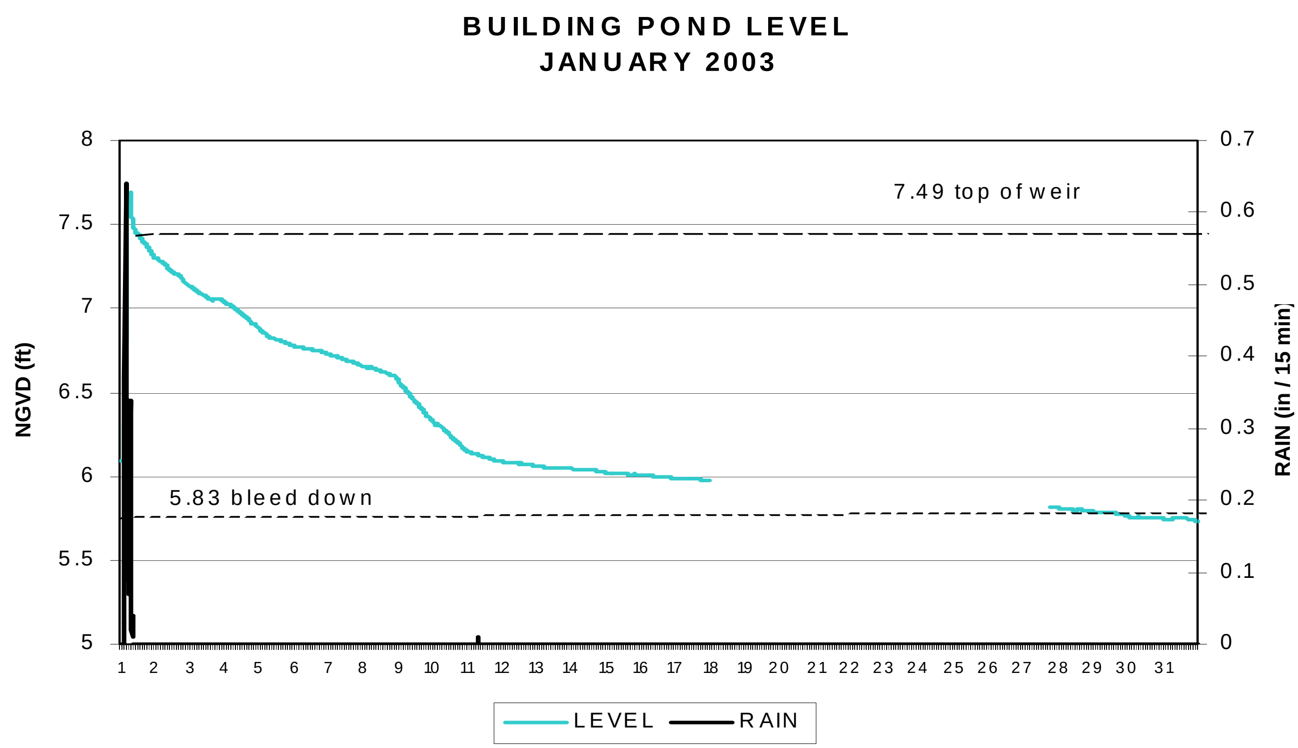

STREET POND LEVEL
NOVEMBER 2002
Total Rain=2.26
0.84"
0.06"
0.73"
7.17 top of weir
6.00 draw down pipe elevation
NGVD (ft)
RAIN (in / 15 min)
OUTFLOW LEVEL
RAIN

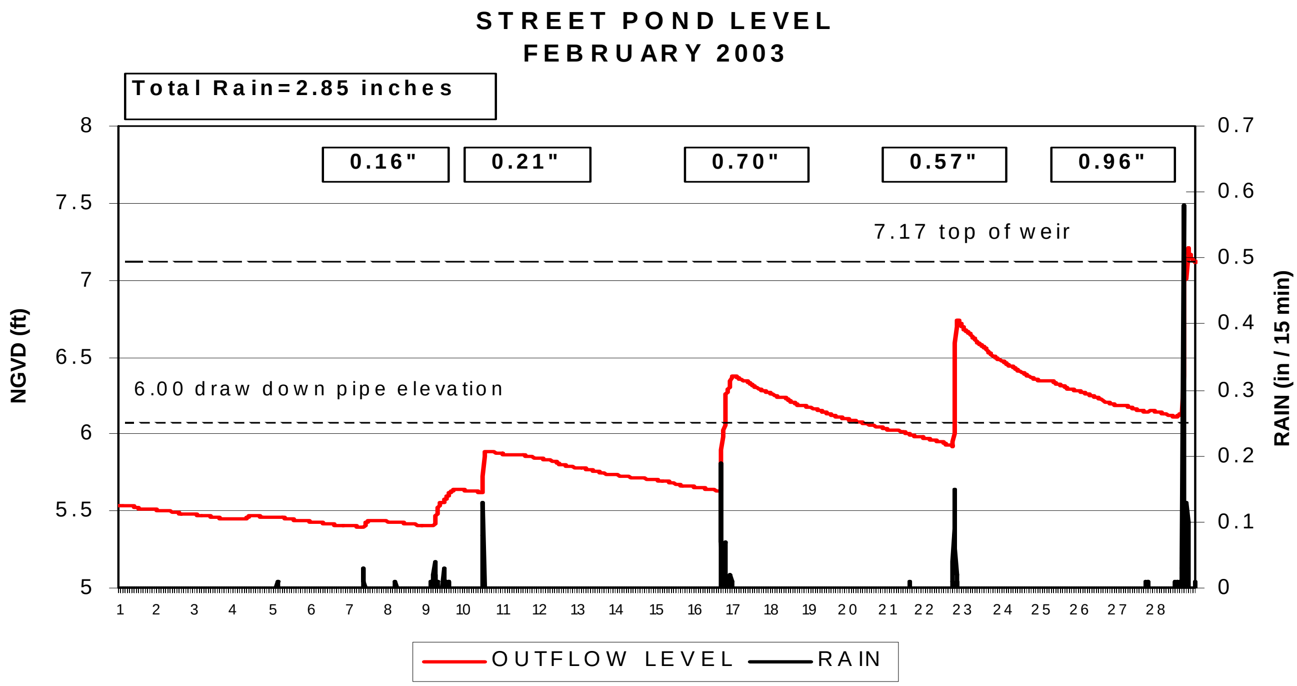

BUILDING POND LEVEL
NOVEMBER 2002
7.49 top of weir
5.83 bleed
NGVD (ft)
RAIN (in / 15 min)
LEVEL
RAIN


STREET POND LEVEL
DECEMBER 2002
Total Rain=15.10 inches
1.04"
3.69"
4.65"
0.54"
1.31"
1.31"
7.17 top of weir
6.00 draw down pipe elevation
NGVD (ft)
RAIN (in / 15 min)
OUTFLOW LEVEL
RAIN

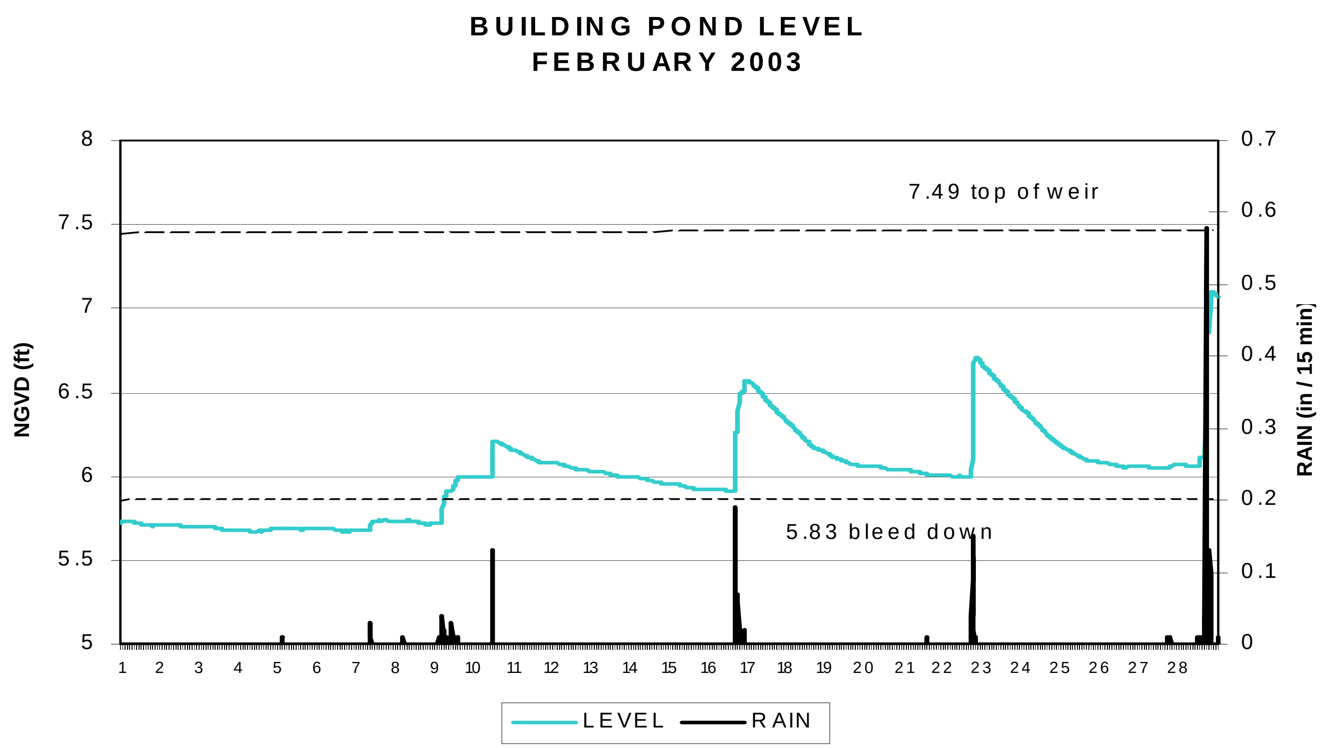

BUILDING POND LEVEL
DECEMBER 2002
Pond level estimated from Dec. 10th to
7.49 top of weir
5.83 bleed down
NGVD (ft)
RAIN (in / 15 min)
LEVEL
RAIN


STREET POND LEVEL
JANUARY 2003
No Rain
7.17 top of weir
6.00 draw down pipe elevation
NGVD (ft)
RAIN (in / 15 min)
OUTFLOW LEVEL
RAIN

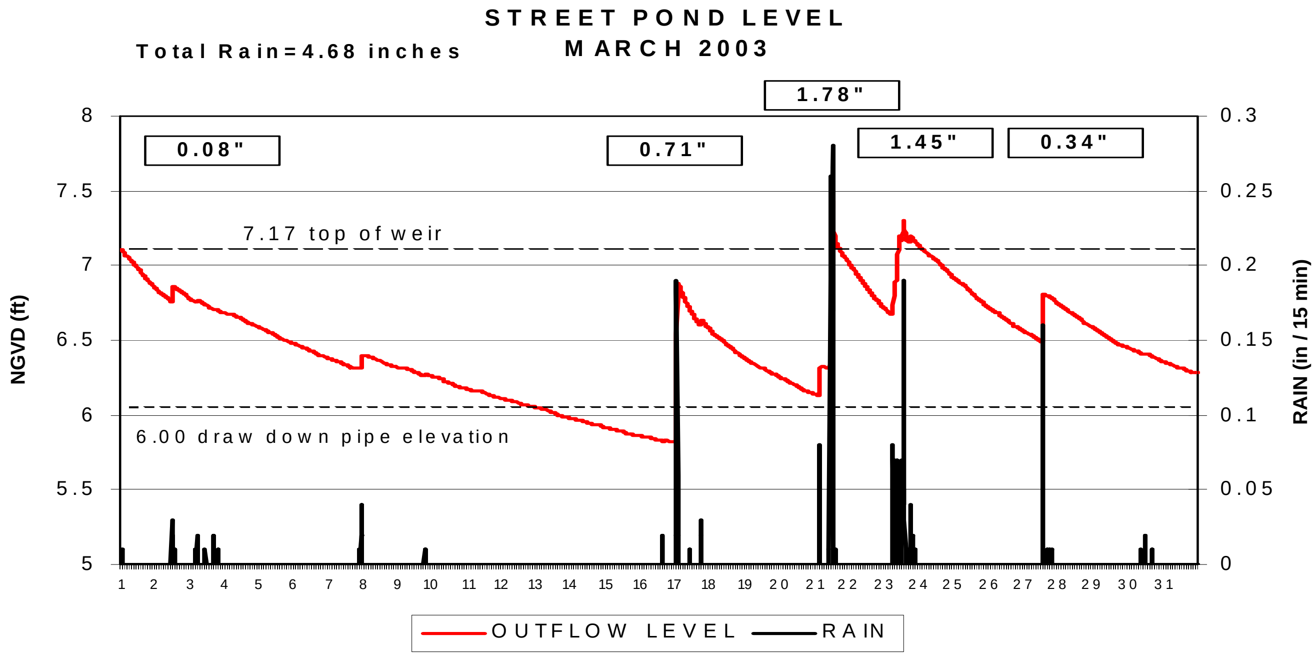

BUILDING POND LEVEL
JANUARY 2003
7.49 top of weir
5.83 bleed down
NGVD (ft)
RAIN (in / 15 min)
LEVEL
RAIN

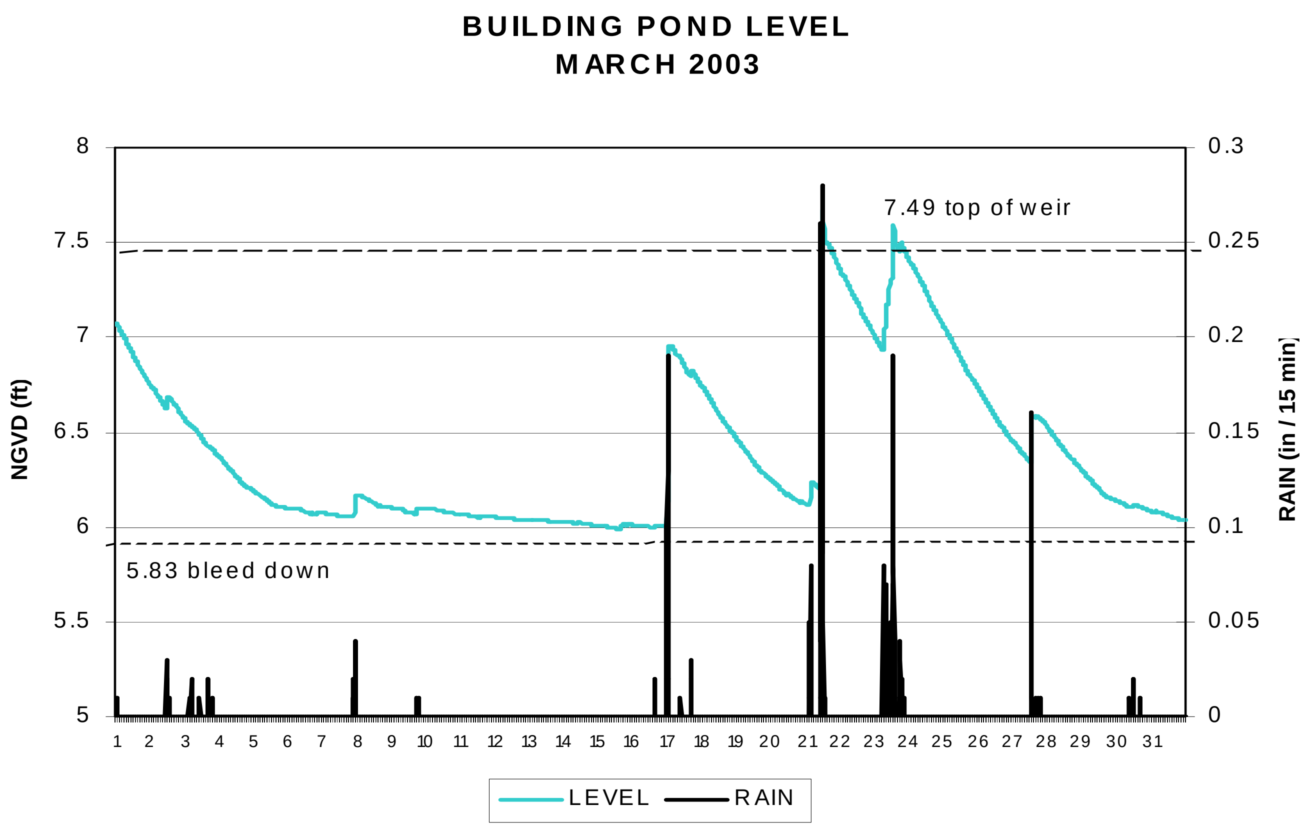


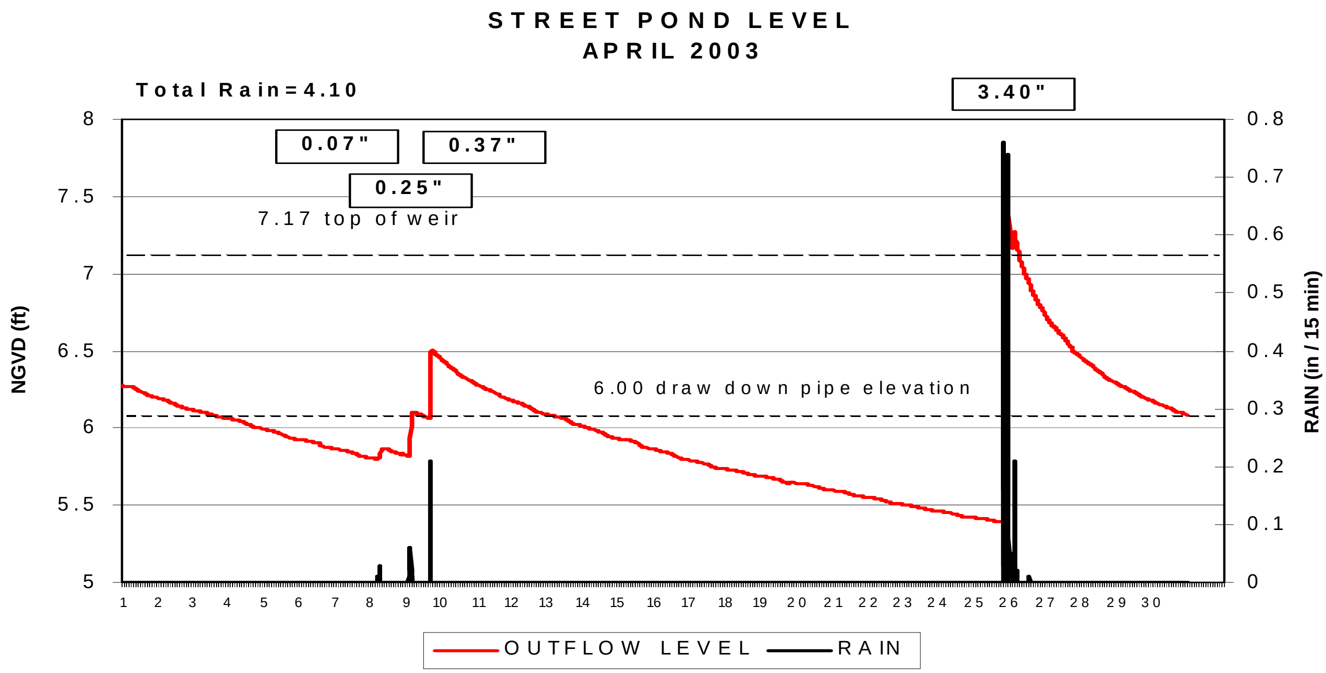
STREET POND LEVEL
FEBRUARY 2003
Total Rain=2.85 inches
0.16"
0.21"
0.70"
0.57"
0.96"
7.17 top of weir
6.00 draw down pipe elevation
NGVD (ft)
RAIN (in / 15 min)
8
7.5
7
6.5
6
5.5
5
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
OUTFLOW LEVEL
RAIN

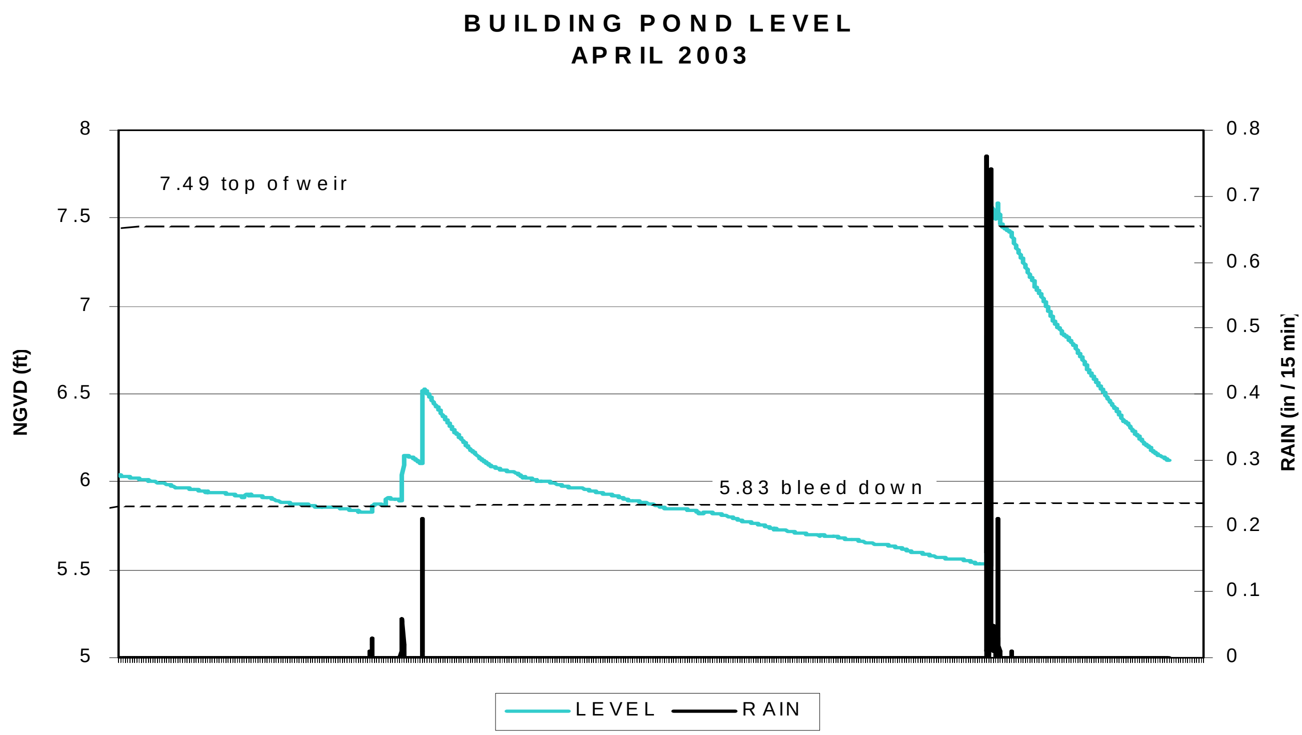


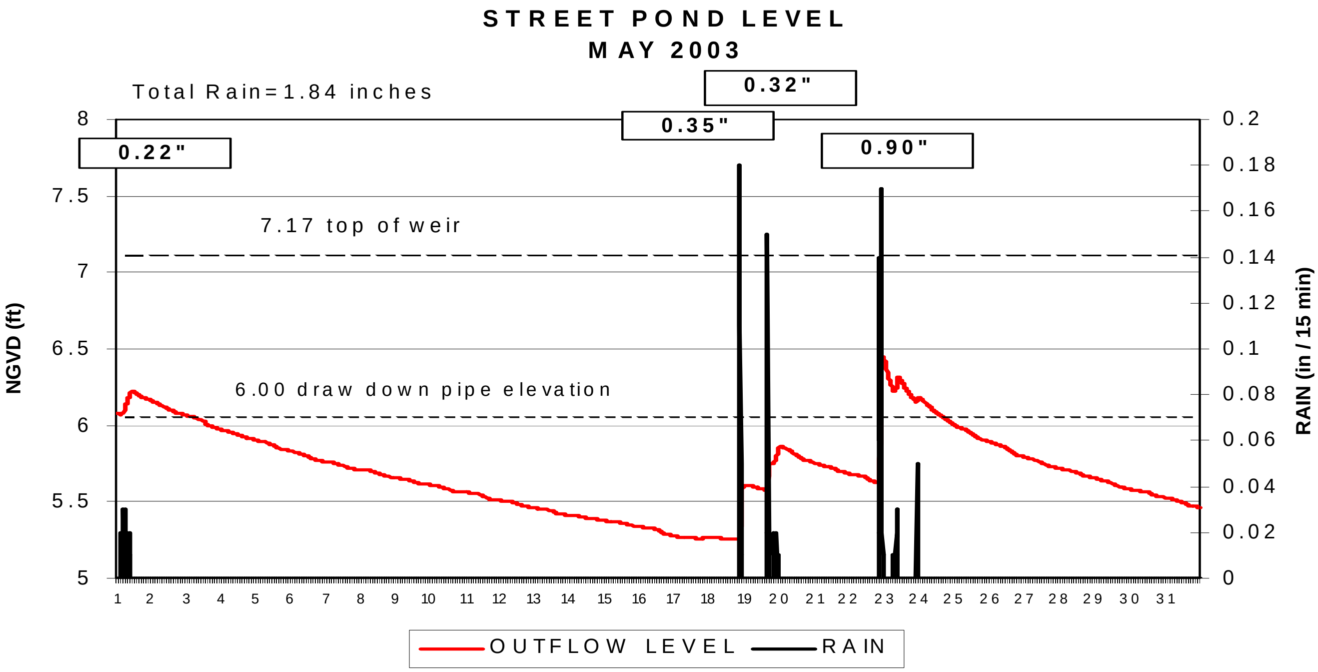
BUILDING POND LEVEL
FEBRUARY 2003
7.49 top of weir
5.83 bleed down
NGVD (ft)
RAIN (in / 15 min)
8
7.5
7
6.5
6
5.5
5
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
LEVEL
RAIN

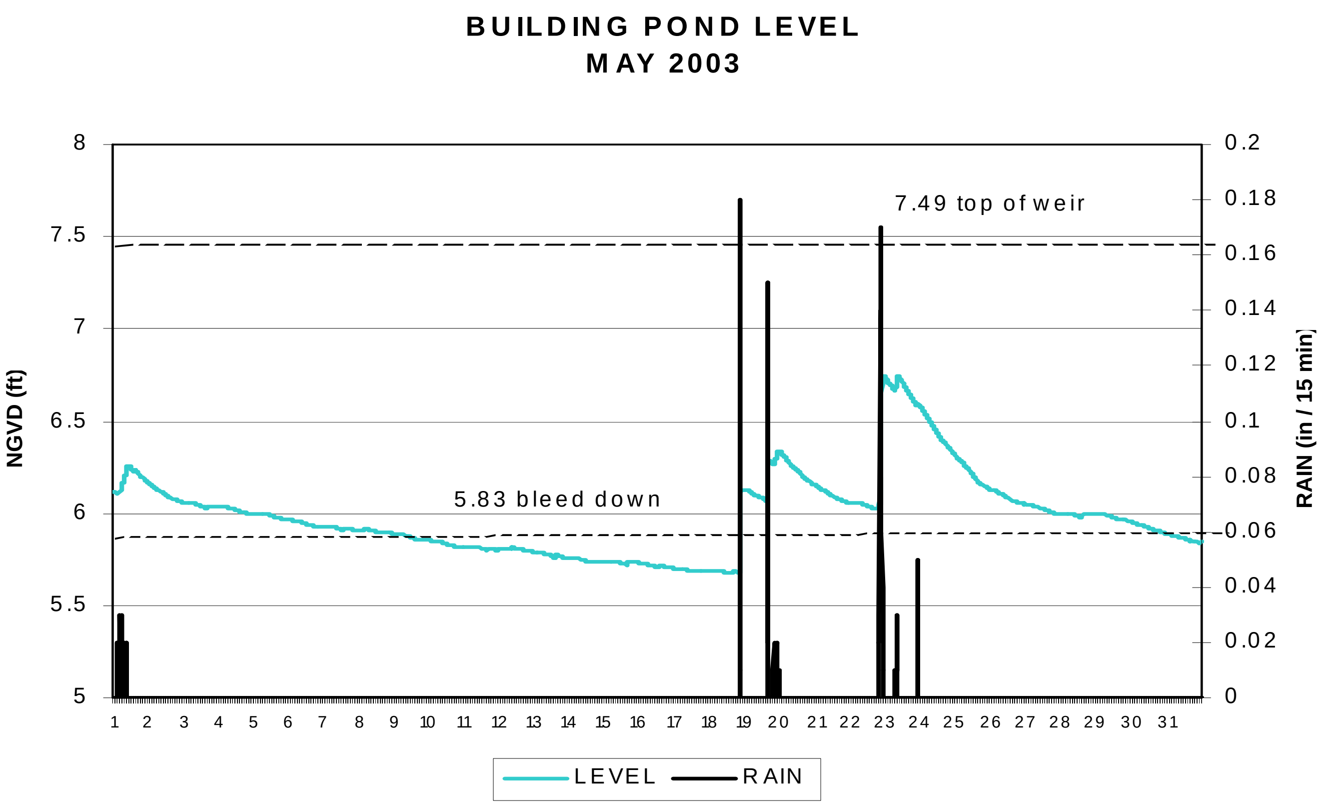

STREET POND LEVEL
MARCH 2003
Total Rain=4.68 inches
1.78"
0.08"
0.71"
1.45"
0.34"
7.17 top of weir
6.00 draw down pipe elevation
NGVD (ft)
RAIN (in / 15 min)
OUTFLOW LEVEL
RAIN

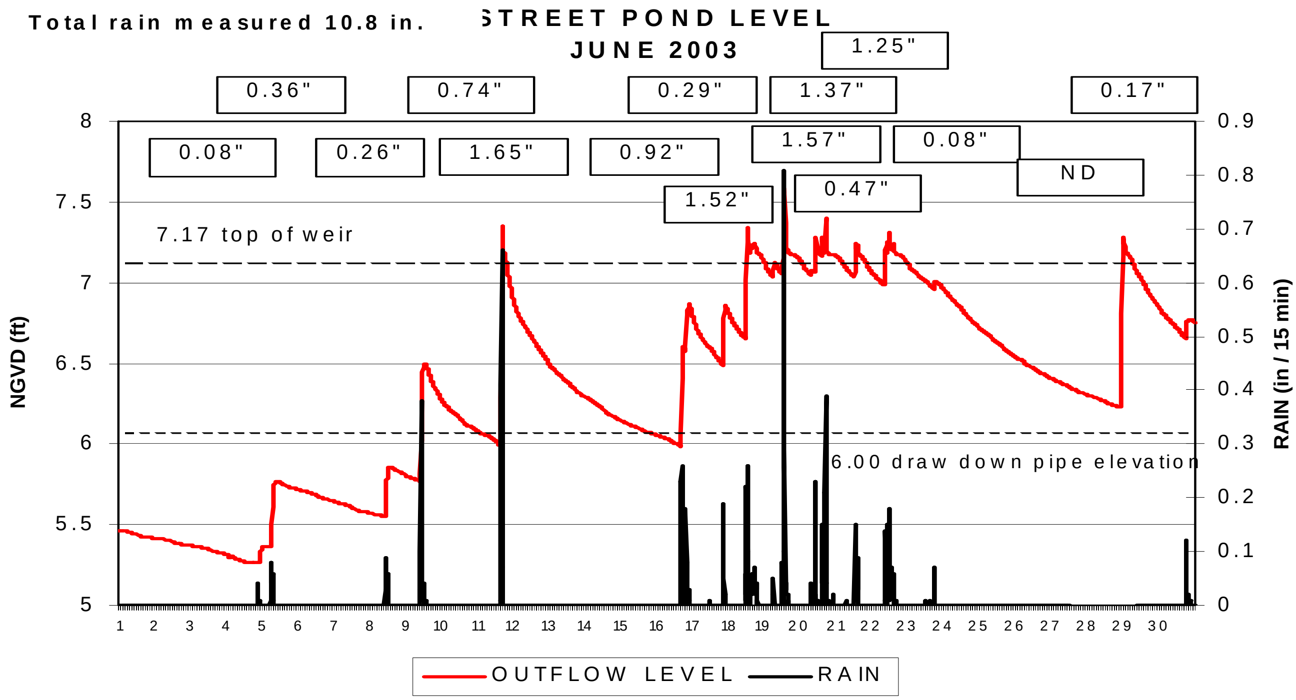

BUILDING POND LEVEL
MARCH 2003
7.49 top of weir
5.83 bleed down
NGVD (ft)
RAIN (in / 15 min)
LEVEL
RAIN

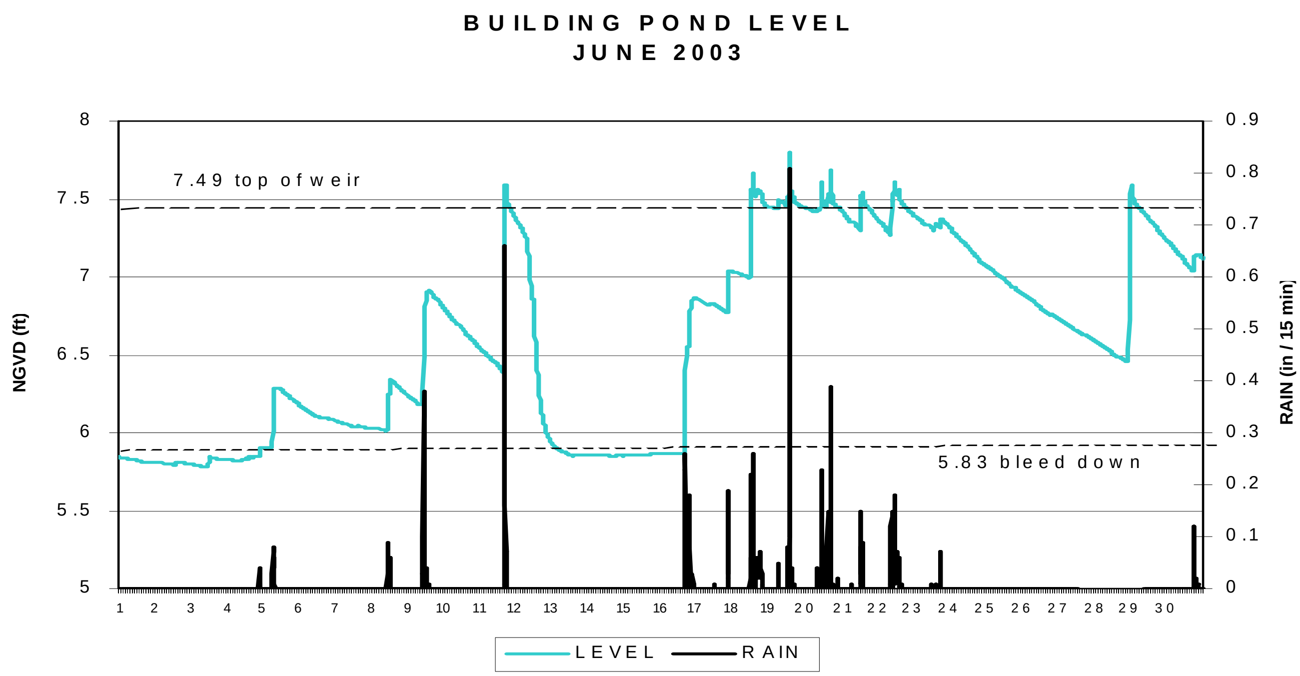

STREET POND LEVEL
APRIL 2003
Total Rain=4.10
3.40"
0.07"
0.37"
0.25"
7.17 top of weir
6.00 draw down pipe elevation
NGVD (ft)
RAIN (in / 15 min)
OUTFLOW LEVEL
RAIN

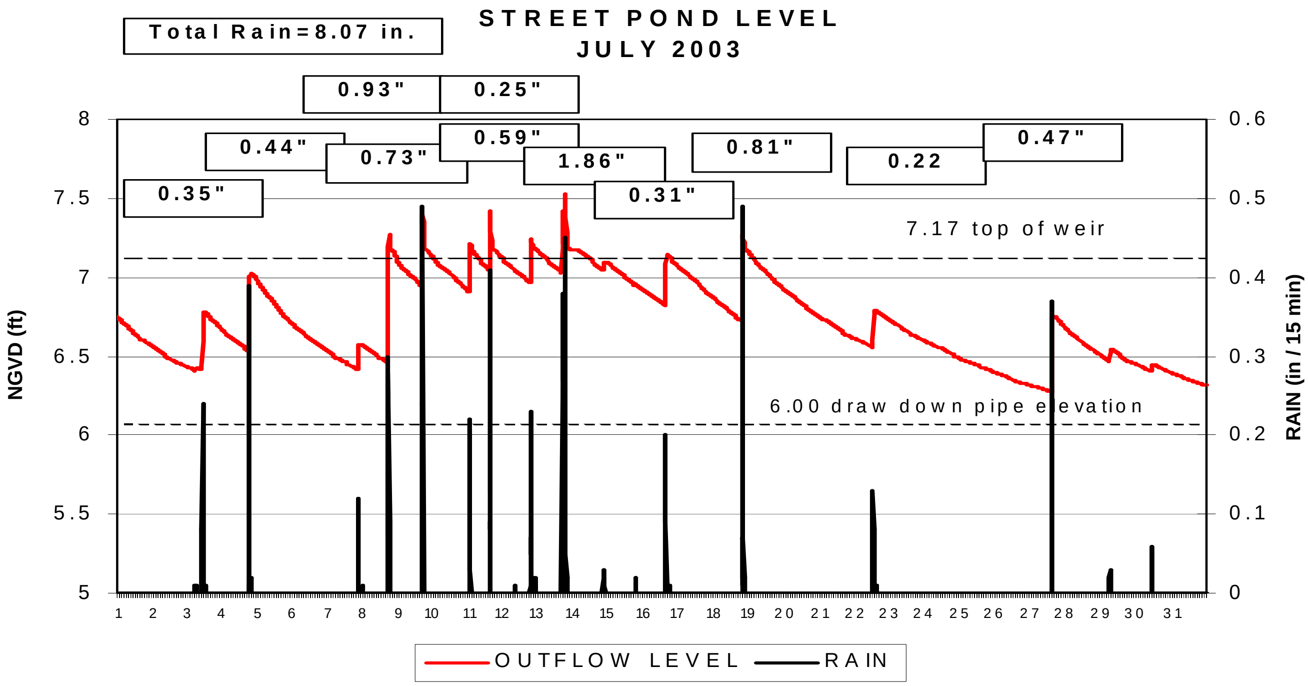

BUILDING POND LEVEL
APRIL 2003
7.49 top of weir
5.83 bleed down
NGVD (ft)
RAIN (in / 15 min)
LEVEL
RAIN

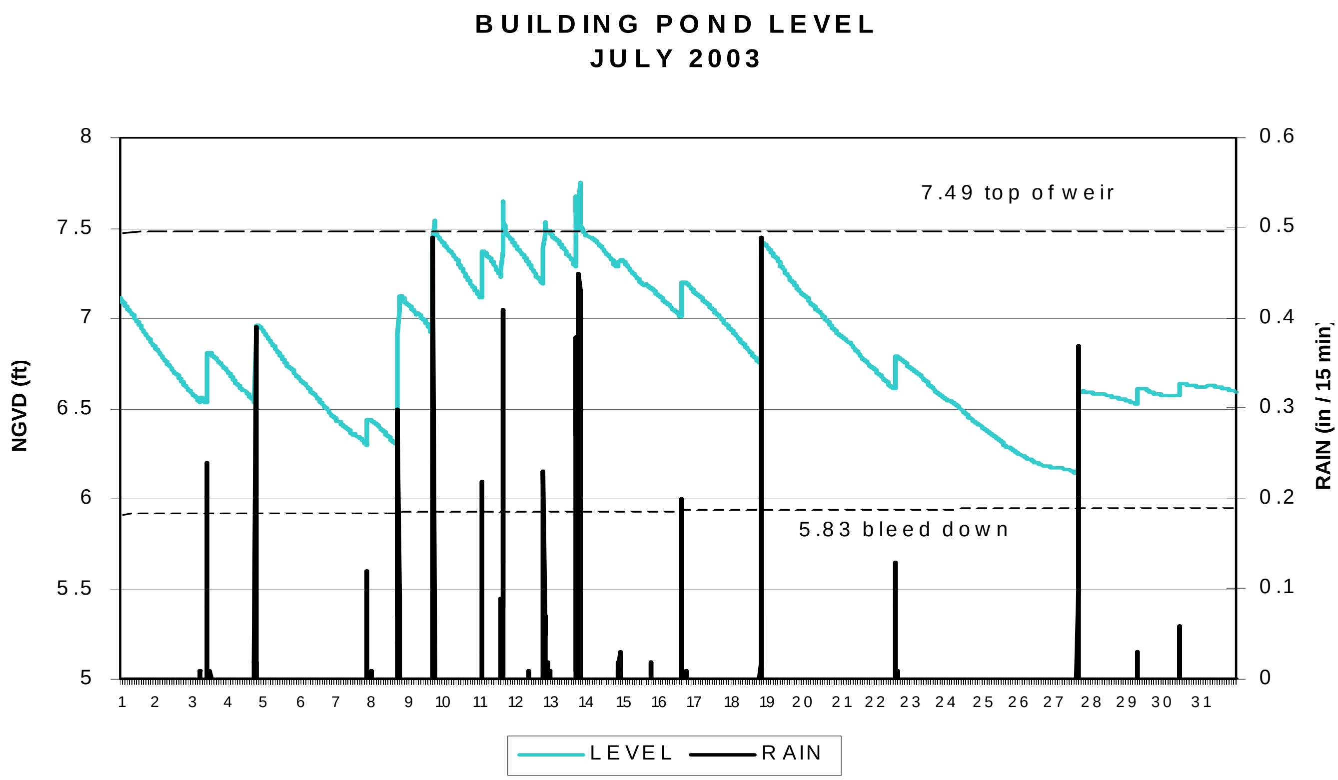

STREET POND LEVEL
MAY 2003
Total Rain=1.84 inches
0.22"
0.35"
0.32"
0.90"
7.17 top of weir
6.00 draw down pipe elevation
NGVD (ft)
RAIN (in / 15 min)
OUTFLOW LEVEL
RAIN

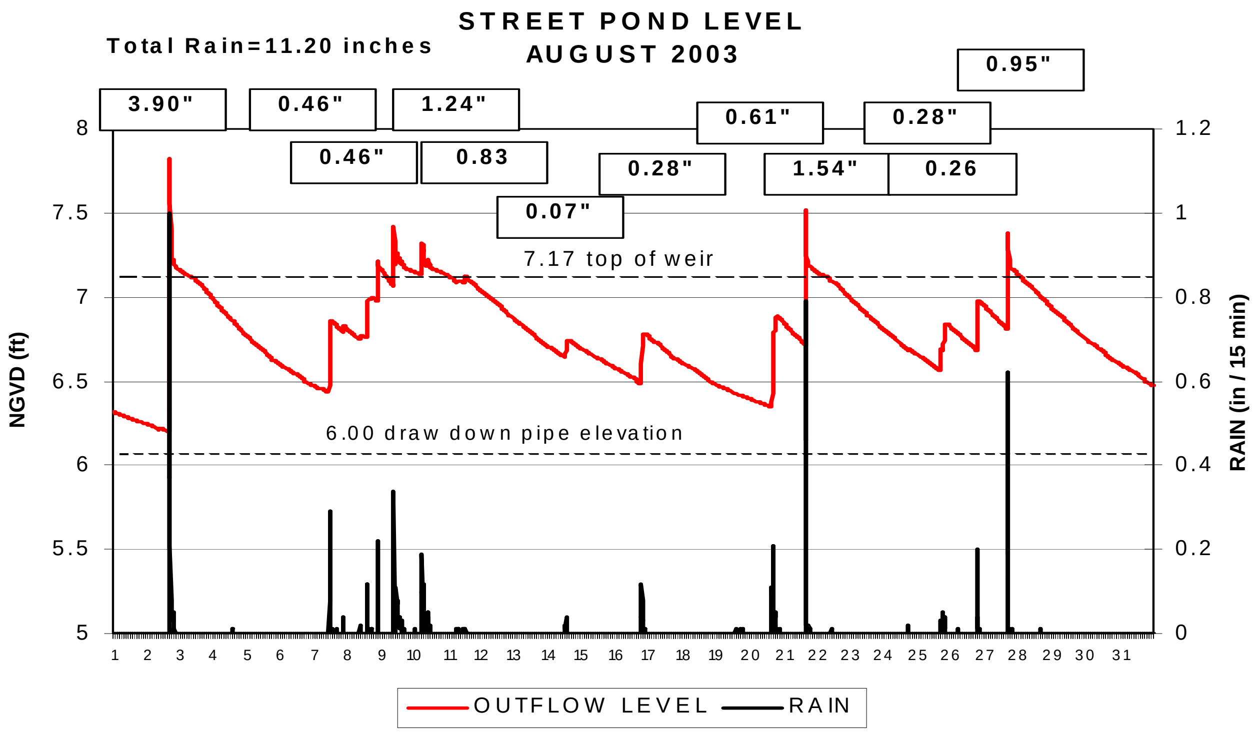

BUILDING POND LEVEL
MAY 2003
7.49 top of weir
5.83 bleed down
NGVD (ft)
RAIN (in / 15 min)
LEVEL
RAIN

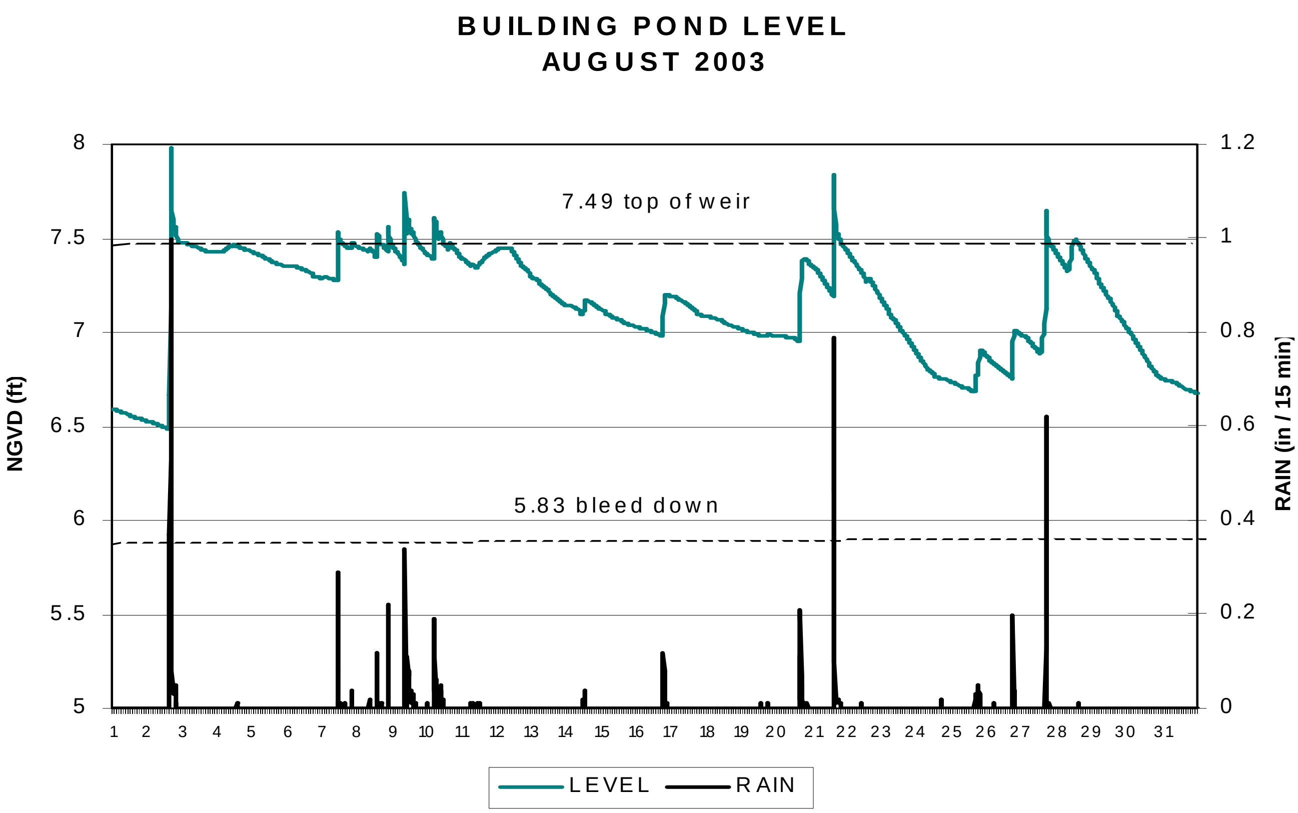

Total rain measured 10.8 in.
STREET POND LEVEL
JUNE 2003
0.36"
0.74"
0.29"
1.37"
1.25"
0.17"
0.08"
0.26"
1.65"
0.92"
1.57"
0.08"
ND
1.52"
0.47"
7.17 top of weir
6.00 draw down pipe elevation
NGVD (ft)
RAIN (in / 15 min)
OUTFLOW LEVEL
RAIN

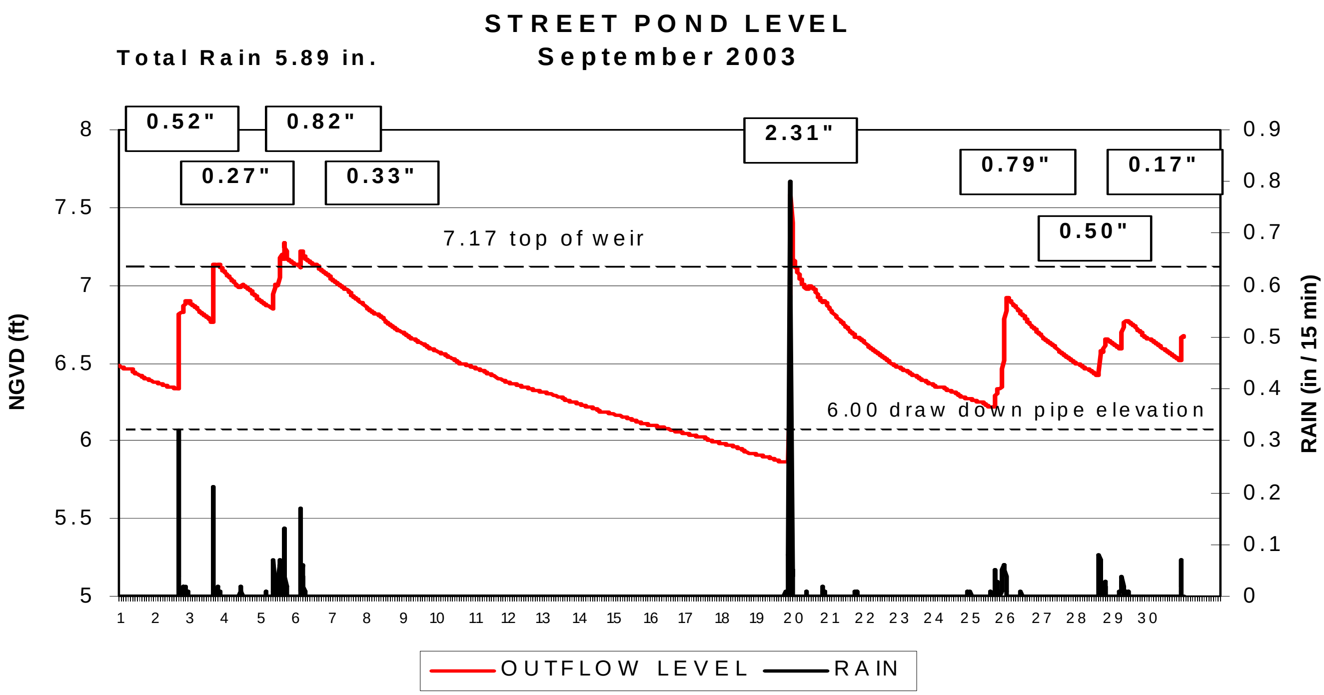

BUILDING POND LEVEL
JUNE 2003
7.49 top of weir
5.83 bleed down
NGVD (ft)
RAIN (in / 15 min)
LEVEL
RAIN

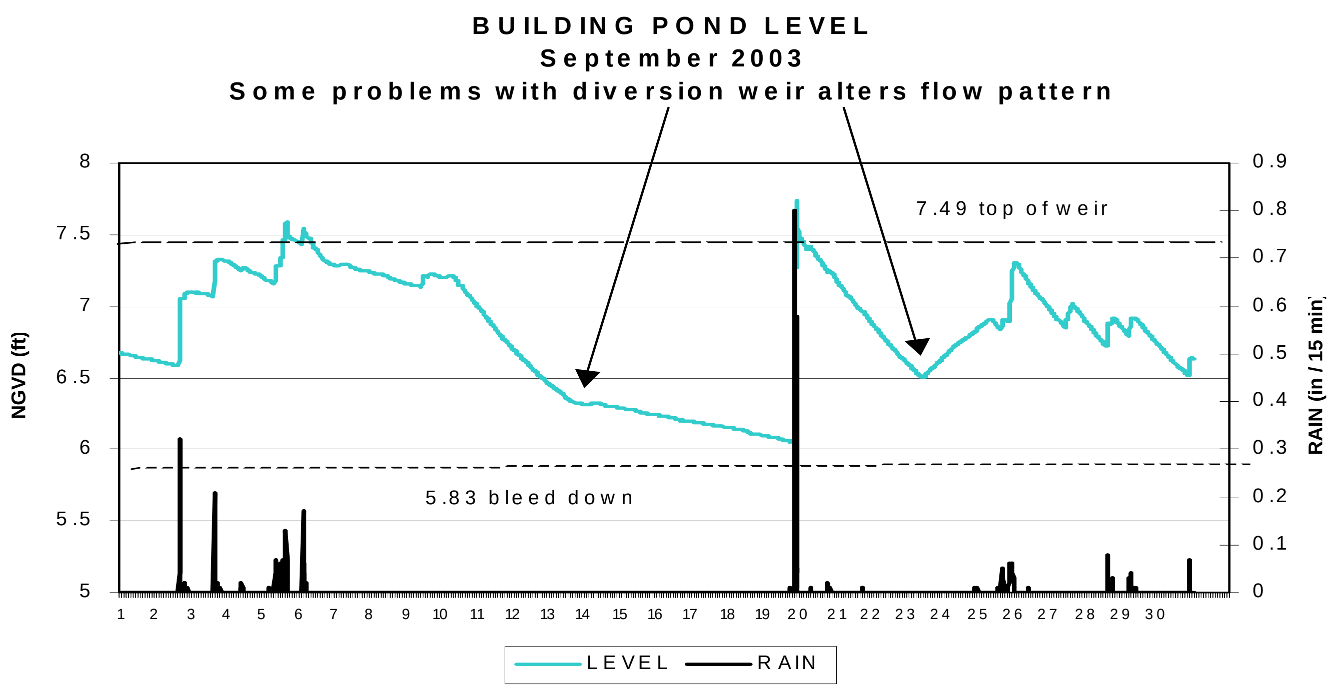

Total Rain=8.07 in.
STREET POND LEVEL
JULY 2003
0.93"
0.25"
0.44"
0.73"
0.59"
1.86"
0.81"
0.22
0.47"
0.35"
0.31"
7.17 top of weir
6.00 draw down pipe elevation
NGVD (ft)
RAIN (in / 15 min)
OUTFLOW LEVEL
RAIN

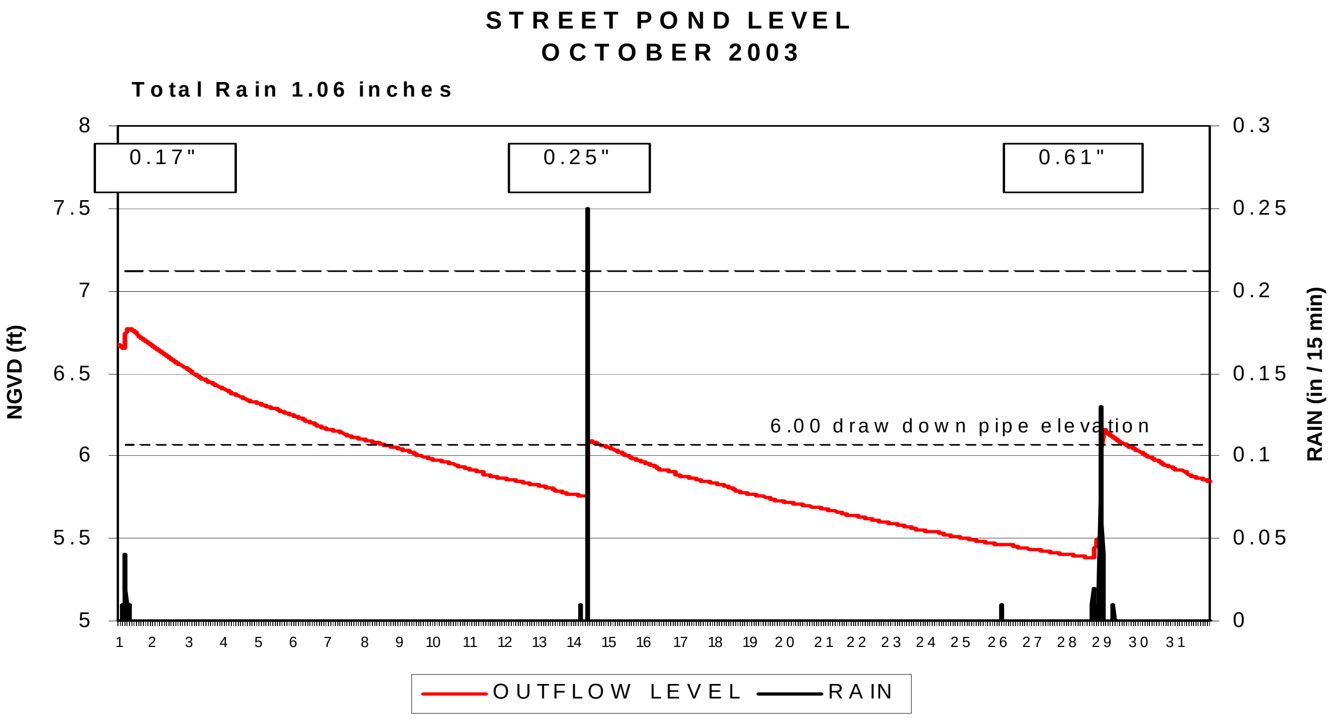

BUILDING POND LEVEL
JULY 2003
7.49 top of weir
5.83 bleed down
NGVD (ft)
RAIN (in / 15 min)
LEVEL
RAIN

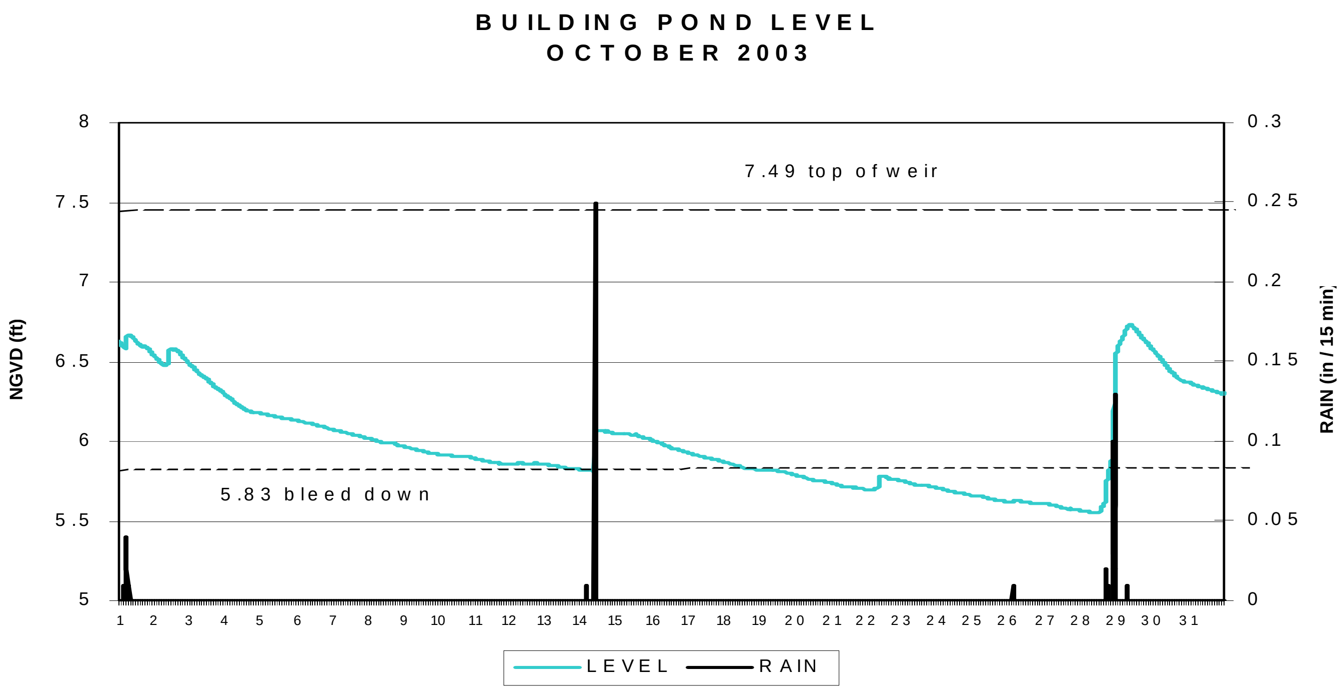

STREET POND LEVEL
AUGUST 2003
Total Rain=11.20 inches
3.90"
0.46"
1.24"
0.46"
0.83
0.07"
0.28"
0.61"
1.54"
0.28"
0.26
0.95"
7.17 top of weir
6.00 draw down pipe elevation
NGVD (ft)
RAIN (in / 15 min)
OUTFLOW LEVEL
RAIN


BUILDING POND LEVEL
AUGUST 2003
7.49 top of weir
5.83 bleed down
NGVD (ft)
RAIN (in / 15 min)
LEVEL
RAIN


STREET POND LEVEL
September 2003
Total Rain 5.89 in.
0.52"
0.82"
0.27"
0.33"
2.31"
0.79"
0.17"
0.50"
7.17 top of weir
6.00 draw down pipe elevation
NGVD (ft)
RAIN (in / 15 min)
OUTFLOW LEVEL
RAIN


BUILDING POND LEVEL
September 2003
Some problems with diversion weir alters flow pattern
7.49 top of weir
5.83 bleed down
NGVD (ft)
RAIN (in / 15 min)
LEVEL
RAIN


STREET POND LEVEL
OCTOBER 2003
Total Rain 1.06 inches
0.17"
0.25"
0.61"
6.00 draw down pipe elevation
NGVD (ft)
RAIN (in / 15 min)
OUTFLOW LEVEL
RAIN


BUILDING POND LEVEL
OCTOBER 2003
7.49 top of weir
5.83 bleed down
NGVD (ft)
RAIN (in / 15 min)
LEVEL
RAIN

APPENDIX D

Storm Event Water Quality
Intensive Study

Original data in EXCEL file: WQ_BLDG_ST-FINAL

Table D-1. Concentration of constituents measured in rainfall and at the outflow weirs of the Building and Street ponds for one (November 2000 through Autust 2001).

NUTRIENTS

RAIN inches	STORM #		TYPE		AMMONIA mg/L			NITRATE + NITRITE mg/L			ORGANIC NITROGEN mg/L			TOTAL NITROGEN mg/L			ORTHO- PHOSPHATE mg/L			TOTAL - PHOSPHATE mg/L		
		L.O.Q.**			0.01			0.01			0.01			0.07			0.01			0.01		
		DATE	B	S	RAIN	BLDG	STREET	RAIN	BLDG	STREET	RAIN	BLDG	STREET	RAIN	BLDG	STREET	RAIN	BLDG	STREET	RAIN	BLDG	STREET
1.50	1	11/26/00	g	g	0.12	0.03	0.08	0.08	0.22	0.17	0.14	0.57	0.64	0.34	0.82	0.88	0.02	0.06	0.11	0.03	0.17	0.17
0.43	2	12/17/00	g	g	0.07	0.14	0.01	0.05	0.15	0.02	0.31	1.32	0.75	0.43	1.60	0.77	0.01	0.11	0.02	0.02	0.18	0.07
0.94	3	01/08/01	g	g	0.09	0.03	0.02	0.08	0.19	0.11	0.20	0.88	0.38	0.38	1.10	0.51	0.01	0.06	0.05	0.03	0.12	0.10
1.59	4	03/04/01	g	g	0.19	0.02	0.01	0.10	0.08	0.07	0.90	0.78	0.91	1.20	0.87	0.99	0.15	0.03	0.05	0.18	0.11	0.11
0.72	5	03/19/01	g	g	0.23	0.07	0.04	0.24	0.08	0.03	0.43	0.62	0.70	0.90	0.78	0.77	0.01	0.04	0.03	0.04	0.09	0.08
3.61	6	03/29/01	c	c	0.30	0.13	0.08	0.34	0.24	0.10	0.14	0.58	0.37	0.78	0.96	0.55	0.02	0.06	0.03	0.05	0.12	0.08
1.98	7	06/06/01	c	g	0.16	0.29	0.03	0.29	0.20	0.18	0.53	0.35	0.46	0.40	0.83	0.67	0.01	0.07	0.07	0.01	0.20	0.16
0.64	8	06/19/01	g	---	0.51	0.51	------	0.87	0.02	------	0.22	1.07	------	1.60	1.60	------	0.02	0.09	------	0.03	0.19	------
1.00	9	06/22/01	c	c	0.09	0.27	0.03	0.20	0.04	0.02	0.12	0.80	0.00	0.41	1.10	------	0.01	0.06	0.02	0.02	0.12	0.06
0.56		06/24/01	c	c	------	0.11	0.03	------	0.01	0.02	------	0.59	0.51	------	0.70	0.56	------	0.05	0.03	------	0.10	0.07
0.27		06/28/01	c	g	------	0.01	0.18	------	0.01	0.08	------	0.74	0.44	------	0.76	0.70	------	0.02	0.10	------	0.11	0.12
2.15	10	06/29/01	c	c	0.09	0.18	0.01	0.08	0.08	0.06	0.23	0.84	0.46	0.40	1.10	0.52	0.01	0.06	0.06	0.01	0.11	0.13
0.86		07/03/01	c	---	------	0.01	------	------	0.01	------	------	0.66	------	------	0.67	------	------	0.02	------	------	0.06	------
0.23		07/06/01	c	---	------	0.06	------	------	0.01	------	------	0.88	------	------	0.95	------	------	0.02	------	------	0.05	------
0.33		07/08/01	c	---	------	0.16	------	------	0.05	------	------	0.79	------	------	1.00	------	------	0.03	------	------	0.08	------
1.05	11	07/11/01	c	c	0.11	0.21	0.01	0.44	0.04	0.01	0.24	1.08	0.73	0.79	1.33	0.74	0.01	0.04	0.04	0.01	0.11	0.06
0.64	12	07/13/01	c	c	------	0.19	0.02	------	0.04	0.01	------	0.53	0.42	------	0.76	0.45	------	0.05	0.04	------	0.09	0.08
0.16		07/16/01	c	c	------	0.20	0.01	------	0.03	0.01	------	0.53	0.46	------	0.76	0.47	------	0.06	0.05	------	0.09	0.08
0.46		07/17/01	c	c	------	0.08	0.01	------	0.02	0.01	------	0.93	0.54	------	1.03	0.55	------	0.05	0.02	------	0.12	0.05
0.98	13	07/21/01	c	g	------	0.18	0.01	------	0.08	0.01	------	0.77	0.66	------	1.03	0.67	------	0.06	0.01	------	0.12	0.08
1.18	14	07/23/01	c	g	0.03	0.26	0.02	0.01	0.07	0.01	0.03	0.32	0.25	0.03	0.66	0.28	0.01	0.07	0.05	0.01	0.10	0.08
0.22		07/27/01	c	---	------	0.16	------	------	0.01	------	------	0.23	------	------	0.40	------	------	0.04	------	------	0.08	------
0.48	15	07/28/01	c	g	0.13	0.09	0.04	0.26	0.03	0.01	0.07	0.56	0.34	0.46	0.68	0.39	0.01	0.04	0.04	0.02	0.10	0.06
0.26		07/30/01	c	---	------	0.10	------	------	0.01	------	------	0.65	------	------	0.76	------	------	0.02	------	------	0.04	------
0.41		07/31/01	c	g	------	0.06	0.17	------	0.07	0.01	------	0.62	0.46	------	0.75	0.64	------	0.02	0.08	------	0.06	0.08
0.98	16	08/02/01	c	c	------	0.09	0.01	------	0.02	0.01	------	1.86	0.86	------	1.97	0.88	------	0.01	0.02	------	0.05	0.03
0.46	17	08/06/01	---	c	0.07	------	0.04	0.05	------	0.01	4.73	------	2.38	4.85	------	2.42	0.01	------	0.02	0.01	------	0.03
1.05	18	08/07/01	c	c	0.38	0.14	0.01	0.48	0.17	0.06	0.52	0.87	0.68	1.39	1.19	0.74	0.01	0.04	0.03	0.02	0.10	0.05
0.60	19	08/09/01	c	c	------	0.13	0.04	------	0.18	0.01	------	0.18	0.27	------	0.49	0.32	------	0.03	0.03	------	0.04	0.04
TOTAL		Count			15	28	23	15	28	23	15	28	23	15	28	22	15	28	23	15	28	23
RAIN		Average			0.17	0.14	0.04	0.24	0.08	0.04	0.59	0.74	0.59	0.96	0.95	0.70	0.02	0.04	0.04	0.03	0.10	0.08
inches		Median			0.12	0.13	0.02	0.20	0.05	0.02	0.23	0.70	0.46	0.46	0.85	0.66	0.01	0.04	0.04	0.02	0.10	0.08
		Max.			0.51	0.51	0.18	0.87	0.24	0.18	4.73	1.86	2.38	4.85	1.97	2.42	0.15	0.11	0.11	0.18	0.20	0.17
25.74		Min.			0.03	0.01	0.01	0.01	0.01	0.01	0.03	0.18	0.00	0.03	0.40	0.28	0.01	0.01	0.01	0.01	0.04	0.03
		Std. Dev.			0.13	0.10	0.05	0.22	0.07	0.05	1.13	0.33	0.43	1.12	0.34	0.42	0.04	0.02	0.03	0.04	0.04	0.04
		C.V.*			0.75	0.75	1.26	0.92	0.95	1.18	1.92	0.45	0.73	1.17	0.36	0.59	1.86	0.52	0.59	1.30	0.40	0.46

"Type" refers to the sampling method (grab or composite). ** Numbers in italics are below the laboratory limit of quantification (LOQ).

Table D-1. Concentration of constituents measured in rainfall and at the outflow weirs of the Building and Street ponds for one (November 2000 through Autust 2001).

METALS

RAIN	STORM #		TYPE		TOTAL LEAD			TOTAL ZINC			MANGANESE			TOTAL IRON			TSS		TOTAL COPPER			TOTAL CADMIUM		
inches					ug/L			ug/L			ug/L			ug/L			mg/L		ug/L			ug/L		
		L.O.Q.**			2.00			12.0			1.0			25.0			0.05		2.3			0.2		
		DATE	B	S	RAIN	BLDG	STREET	RAIN	BLDG	STREET	RAIN	BLDG	STREET	RAIN	BLDG	STREET	BLDG	STREET	RAIN	BLDG	STREET	RAIN	BLDG	STREET
1.50	1	11/26/00	g	g	0.75	3.10	1.50	30.0	100.0	------	1.4	54.3	11.3	40.0	200.0	200.0	7.61	6.39	3.7	18.9	9.5	0.2	0.3	0.2
0.43	2	12/17/00	g	g	0.75	3.30	0.75	60.0	130.0	7.5	2.7	120.0	6.5	160.0	300.0	80.0	2.43	3.55	3.8	19.7	7.4	0.2	0.5	0.2
0.94	3	01/08/01	g	g	0.75	2.50	2.20	20.0	130.0	20.0	2.0	11.4	8.8	50.0	100.0	130.0	2.25	4.45	4.2	12.8	5.5	0.2	0.3	0.2
1.59	4	03/04/01	g	g	0.75	1.60	2.00	60.0	80.0	20.0	2.5	21.1	8.5	130.0	140.0	140.0	2.48	3.03	21.7	12.3	9.2	0.2	0.2	0.2
0.72	5	03/19/01	g	g	0.75	0.75	0.75	40.0	80.0	7.5	2.6	17.1	7.1	40.0	70.0	70.0	4.89	2.82	4.4	9.3	2.9	0.2	0.2	0.2
3.61	6	03/29/01	c	c	3.00	3.11	1.60	50.0	78.0	25.0	5.5	11.6	6.4	260.0	216.0	156.0	9.82	6.27	7.1	13.6	3.4	0.2	0.3	0.2
1.98	7	06/06/01	c	g	0.75	1.80	2.00	20.0	98.0	20.0	1.4	23.8	11.5	40.0	120.0	150.0	4.15	5.30	1.0	14.8	5.0	0.2	0.2	0.2
0.64	8	06/19/01	g	---	1.70	2.50	------	30.0	100.0	------	4.6	43.0	------	80.0	150.0	------	9.30	------	7.4	14.1	------	0.2	0.4	------
1.00	9	06/22/01	c	c	0.75	3.30	0.75	7.5	70.0	7.5	1.3	36.7	10.7	40.0	120.0	80.0	6.58	4.31	2.9	12.0	4.4	0.2	0.2	0.2
0.56		06/24/01	c	c	------	0.75	0.75	------	50.0	7.5	------	23.8	7.5	------	90.0	60.0	3.74	------	------	7.7	2.4	------	0.2	0.2
0.27		06/28/01	c	g	------	0.75	0.75	------	30.0	7.5	------	17.9	5.9	------	100.0	50.0	3.74	1.12	------	6.4	2.3	------	0.2	0.2
2.15	10	06/29/01	c	c	0.75	1.60	3.40	7.5	40.0	7.5	1.4	11.6	8.9	30.0	90.0	330.0	4.13	13.63	1.0	5.7	3.4	0.2	0.2	0.2
0.86		07/03/01	c	---	------	0.75	------	------	30.0	------	------	11.0	------	------	90.0	------	2.06	------	------	4.6	------	------	0.2	------
0.23		07/06/01	c	---	------	0.75	------	------	20.0	------	------	8.2	------	------	100.0	------	2.66	------	------	4.7	------	------	0.2	------
0.33		07/08/01	c	---	------	0.75	------	------	50.0	------	------	12.7	------	------	70.0	------	3.37	------	------	5.6	------	------	0.2	------
1.05	11	07/11/01	c	c	0.75	1.60	0.75	7.5	40.0	7.5	1.8	12.4	9.5	12.5	110.0	100.0	6.41	2.58	2.2	6.6	2.5	0.2	0.2	0.2
0.64	12	07/13/01	c	c	------	0.75	0.75	------	50.0	7.5	------	7.6	6.9	------	100.0	70.0	3.88	2.82	------	4.3	1.0	------	0.2	0.2
0.16		07/16/01	c	c	------	0.75	0.75	------	30.0	7.5	------	7.3	5.4	------	60.0	80.0	3.09	3.18	------	4.5	2.9	------	0.2	0.2
0.46		07/17/01	c	c	------	1.70	0.75	------	30.0	7.5	------	11.2	4.5	------	180.0	60.0	6.29	4.28	------	5.7	2.8	------	0.2	0.2
0.98	13	07/21/01	c	g	------	2.30	0.75	------	20.0	20.0	------	12.0	17.1	------	260.0	60.0	8.34	2.41	------	3.9	1.0	------	0.2	0.2
1.18	14	07/23/01	c	g	0.75	2.20	0.75	7.5	50.0	20.0	0.5	9.6	11.4	12.5	330.0	130.0	11.27	3.87	2.1	5.9	2.5	0.2	0.2	0.2
0.22		07/27/01	c	---	------	0.75	------	------	40.0	------	------	9.0	------	------	140.0	------	3.29	------	------	4.0	------	------	0.2	------
0.48	15	07/28/01	c	g	0.75	0.75	0.75	70.0	30.0	7.5	1.4	14.7	12.9	60.0	180.0	70.0	6.30	2.11	1.0	4.1	2.2	0.2	0.2	0.2
0.26		07/30/01	c	---	------	0.75	------	------	30.0	------	------	9.6	------	------	90.0	------	3.00	------	------	3.8	------	------	0.2	------
0.41		07/31/01	c	g	------	0.75	0.75	------	40.0	20.0	------	11.3	17.0	------	120.0	60.0	4.55	0.92	------	5.5	4.1	------	0.2	0.2
0.98	16	08/02/01	c	c	------	0.75	0.75	------	50.0	7.5	------	12.6	4.9	------	150.0	60.0	3.36	0.93	------	6.0	2.0	------	0.2	0.2
0.46	17	08/06/01	---	c	0.75	------	0.75	7.5	------	7.5	1.3	------	4.5	40.0	------	60.0		2.00	1.0	------	1.0	0.2	------	0.2
1.05	18	08/07/01	c	c	1.50	3.40	2.20	40.0	60.0	7.5	1.9	15.3	9.1	90.0	230.0	240.0	11.00	12.05	2.3	6.6	2.7	0.2	0.2	0.2
0.60	19	08/09/01	c	c	------	1.70	0.75	------	50.0	7.5	------	8.1	8.8	------	110.0	50.0	3.69	2.75	------	5.0	2.2	------	0.2	0.2
TOTAL		Count			15	28	23	15	28	22	15	28	23	15	28	23	28	22	15	28	23	15	28	23
RAIN		Average			1.01	1.62	1.17	30.5	57.4	11.7	2.2	20.2	8.9	72.3	143.4	108.1	5.13	4.13	4.4	8.1	3.6	0.2	0.2	0.2
inches		Median			0.75	1.60	0.75	30.0	50.0	7.5	1.8	12.2	8.8	40.0	120.0	80.0	4.01	3.11	2.9	6.0	2.8	0.2	0.2	0.2
		Max.			3.00	3.40	3.40	70.0	130.0	25.0	5.5	120.0	17.1	260.0	330.0	330.0	11.27	13.63	21.7	19.7	9.5	0.2	0.5	0.2
25.74		Min.			0.75	0.75	0.75	7.5	20.0	7.5	0.5	7.3	4.5	12.5	60.0	50.0	2.06	0.92	1.0	3.8	1.0	0.2	0.2	0.2
		Std. Dev.			0.60	0.95	0.71	21.2	30.6	6.2	1.3	22.1	3.4	64.0	68.7	68.7	2.68	3.13	5.0	4.6	2.3	0.0	0.1	0.0
		C.V.*			0.60	0.59	0.61	0.7	0.5	0.5	0.6	1.1	0.4	0.9	0.5	0.6	0.52	0.76	1.1	0.6	0.6	0.0	0.5	0.0

Table D-1. Concentration of constituents measured in rainfall and at the outflow weirs of the Building and Street ponds for year one (November 2000 through Autust 2001).

MAJOR IONS

RAIN inches	STORM #	L.O.Q.**	TYPE		CHLORIDE mg/L 0.4			POTASSIUM mg/L 0.07			SODIUM mg/L 0.06			SULFATE mg/L 0.01		
		DATE	B	S	RAIN	BLDG	STREET	RAIN	BLDG	STREET	RAIN	BLDG	STREET	RAIN	BLDG	STREET
1.50	1	11/26/00	g	g	1.1	251.0	27.7	0.10	8.89	8.86	0.38	145.00	24.50	1.25	60.60	39.20
0.43	2	12/17/00	g	g	1.4	549.0	29.5	0.07	19.30	9.44	0.63	312.00	26.00	1.21	130.00	40.70
0.94	3	01/08/01	g	g	2.2	209.0	20.7	0.02	7.80	6.90	1.13	131.00	17.80	2.26	61.70	27.70
1.59	4	03/04/01	g	g	2.7	293.0	24.3	0.52	9.69	6.78	1.66	172.00	21.20	2.22	72.20	31.30
0.72	5	03/19/01	g	g	1.8	351.0	17.8	0.15	10.60	6.07	0.88	210.00	15.60	2.46	66.50	24.50
3.61	6	03/29/01	c	c	2.2	187.7	13.7	0.02	5.15	4.98	1.13	98.76	12.60	2.81	36.29	19.80
1.98	7	06/06/01	c	g	1.1	448.4	12.4	0.04	12.36	5.17	0.20	256.60	11.00	3.25	78.70	23.90
0.64	8	06/19/01	g	---	1.2	885.0		0.05	23.00		0.61	500.00		5.64	43.00	
1.00	9	06/22/01	c	c	0.5	526.0	12.9	0.02	13.90	4.98	0.20	298.00	11.50	1.70	88.50	20.60
0.56		06/24/01	c	c		434.0	9.4		12.00	4.47		243.00	8.42		71.20	16.00
0.27		06/28/01	c	g		426.0	56.0		11.60	7.29		238.00	35.70		76.90	26.90
2.15	10	06/29/01	c	c	0.5	290.0	6.2	0.18	8.48	3.77	1.40	165.00	5.50	1.83	51.10	10.90
0.86		07/03/01	c	---		189.0			5.98			109.00			40.70	
0.23		07/06/01	c	---		206.0			6.40			119.00			40.30	
0.33		07/08/01	c	---		242.0			7.59			141.00			56.10	
1.05	11	07/11/01	c	c	0.7	233.0	8.8	0.14	7.13	4.68	0.30	135.00	8.99	3.21	43.10	13.20
0.64	12	07/13/01	c	c		167.0	6.8		5.54	3.82		96.50	7.08		35.80	10.90
0.16		07/16/01	c	c		154.0	6.7		5.16	3.82		88.90	6.90		29.10	10.40
0.46		07/17/01	c	c		220.0	5.8		6.60	3.79		130.00	5.81		39.50	9.14
0.98	13	07/21/01	c	g		204.0	8.5		5.94	4.11		116.00	7.65		34.10	10.80
1.18	14	07/23/01	c	g	2.7	146.0	7.9	0.02	4.84	3.60	1.35	82.70	6.46	1.57	27.00	11.60
0.22		07/27/01	c	---		140.0			4.53			83.00			29.80	
0.48	15	07/28/01	c	g	1.8	169.0	10.4	0.02	4.86	4.35	0.86	97.90	9.18	3.04	33.40	13.10
0.26		07/30/01	c	---		198.0			5.56			115.00			38.10	
0.41		07/31/01	c	g		223.0	51.8		6.67	6.07		128.00	32.30		38.40	20.50
0.98	16	08/02/01	c	c		224.0	11.7		6.86	4.66		125.00	10.80		40.30	15.50
0.46	17	08/06/01	---	c	1.2		10.1	0.02		4.32	0.14		9.30	2.30		15.70
1.05	18	08/07/01	c	c	0.9	241.0	8.2	0.02	6.53	4.19	0.11	137.00	8.18	3.41	44.10	16.20
0.60	19	08/09/01	c	c		211.0	6.4		6.24	3.84		121.00	6.26		42.40	14.30
TOTAL		Count			15	28	23	15	28	23	15	28	23	15	28	23
RAIN		Average			1.5	286.3	16.3	0.09	8.54	5.22	0.73	164.08	13.42	2.54	51.75	19.25
inches		Median			1.2	223.5	10.4	0.04	6.77	4.66	0.63	130.50	9.30	2.30	42.70	16.00
		Max.			2.7	885.0	56.0	0.52	23.00	9.44	1.66	500.00	35.70	5.64	130.00	40.70
25.74		Min.			0.5	140.0	5.8	0.02	4.53	3.60	0.11	82.70	5.50	1.21	27.00	9.14
		Std. Dev.			0.7	159.9	13.4	0.13	4.31	1.61	0.50	89.91	8.54	1.08	22.35	8.80
		C.V.*			0.5	0.6	0.8	1.38	0.50	0.31	0.68	0.55	0.64	0.42	0.43	0.46

Table D-2. Concentration of constituents measured in rainfall and at the outflow weirs of the Building and Street ponds for two (June 2002 through September 2003).

NUTRIENTS

RAIN inches	STORM #		TYPE		AMMONIA mg/L			NITRATE + NITRITE mg/L			ORGANIC NITROGEN mg/L			TOTAL NITROGEN mg/L			ORTHO- PHOSPHATE mg/L			TOTAL - PHOSPHATE mg/L		
		L.O.Q.**			0.01			0.01			0.01			0.07			0.01			0.01		
		DATE	B	S	RAIN	BLDG	STREET	RAIN	BLDG	STREET	RAIN	BLDG	STREET	RAIN	BLDG	STREET	RAIN	BLDG	STREET	RAIN	BLDG	STREET
3.26	1	06/24/02	c	c	-------	0.10	0.05	-------	0.13	0.10	-------	0.77	0.60	-------	1.00	0.75	-------	0.091	0.035	-------	0.203	0.098
2.73	2	06/28/02	c	c	-------	0.13	0.03	-------	0.38	0.30	-------	0.90	0.68	-------	1.40	1.00	-------	0.085	0.036	-------	0.204	0.079
1.32	3	06/29/02	c	g	-------	0.10	0.04	-------	0.27	0.07	-------	0.42	7.30	-------	0.80	7.40	-------	0.045	0.024	-------	0.85	0.034
0.91	4	07/02/02	c	c	-------	0.03	0.05	-------	0.07	0.07	-------	0.65	0.88	-------	0.75	1.00	-------	0.042	0.024	-------	0.079	0.043
0.86	5	07/12/02	c		-------	0.45	-------	-------	0.06	-------	-------	0.05	-------	-------	0.56	-------	-------	0.105	-------	-------	0.134	-------
0.41	6	07/25/02	c		-------	1.06	-------	-------	0.11	-------	-------	0.86	-------	-------	2.03	-------	-------	0.082	-------	-------	0.195	-------
0.30	7	08/02/02	g		-------	0.16	-------	-------	0.06	-------	-------	0.78	-------	-------	0.99	-------	-------	0.016	-------	-------	0.082	-------
1.48	8	08/07/02	c	c	-------	0.19	0.04	-------	0.28	0.05	-------	0.47	0.49	-------	0.94	0.57	-------	0.036	0.015	-------	0.092	0.079
0.33	9	08/08/02	c		-------	0.37	-------	-------	0.13	-------	-------	0.36	-------	-------	0.85	-------	-------	0.053	-------	-------	0.082	-------
2.39	10	08/14/02	c	c	-------	0.08	0.04	-------	0.16	0.14	-------	0.36	0.24	-------	0.59	0.41	-------	0.073	0.027	-------	0.114	0.074
0.68	11	08/27/02	c		-------	0.18	0.01	-------	0.23	0.01	-------	0.37	0.23	-------	0.78	0.24	-------	0.044	0.005	-------	0.113	0.028
1.18	12	08/30/02	c	c	0.29	0.20	0.01	0.25	0.16	0.10	0.00	0.29	0.26	0.49	0.65	0.36	0.005	0.045	0.015	0.005	0.083	0.049
1.10	13	09/02/02	c	c	0.16	0.29	0.01	0.35	0.11	0.01	0.00	0.38	0.33	0.45	0.78	0.35	0.005	0.063	0.01	0.005	0.119	0.051
1.58	14	09/11/02	g	c	0.04	0.27	0.01	0.09	0.11	0.01	0.04	0.20	0.36	0.17	0.58	0.38	0.005	0.059	0.013	0.005	0.131	0.053
0.72	15	09/12/02	g	c	0.04	0.14	0.01	0.06	0.01	0.01	0.06	0.55	0.35	0.17	0.70	0.36	0.005	0.047	0.005	0.005	0.083	0.046
1.39	16	09/17/02	c	c	-------	0.13	0.03	-------	0.24	0.08	-------	0.41	0.32	-------	0.77	0.43	-------	0.039	0.016	-------	0.09	0.055
0.41	17	09/26/02	c		-------	0.07	-------	-------	0.27	-------	-------	0.29	-------	-------	0.63	-------	-------	0.035	-------	-------	0.071	-------
0.92	18	10/13/02	c	g	0.32	0.68	0.17	0.39	0.47	0.03	0.03	0.32	2.67	0.74	1.47	2.86	0.016	0.13	0.072	0.034	0.213	0.676
0.61	19	10/15/02	c	g	0.08	0.34	0.06	0.16	0.15	0.02	0.00	0.40	0.64	0.22	0.90	0.71	0.005	0.072	0.033	0.021	0.135	0.108
0.84	20	11/12/02	g	c	0.10	0.59	0.05	0.18	0.27	0.01	0.00	0.68	0.79	0.20	1.53	0.85	0.005	0.092	0.005	0.005	0.25	0.103
0.73	21	11/16/02	c	c	0.07	0.12	0.03	0.06	0.12	0.01	0.04	0.44	0.66	0.17	0.67	0.69	0.005	0.045	0.012	0.005	0.085	0.097
3.69	22	12/09/02	c	c	0.02	0.12	0.02	0.05	0.14	0.08	0.11	0.45	0.33	0.18	0.71	0.43	0.005	0.041	0.027	0.005	0.083	0.06
4.65	23	12/12/02	c	c	0.07	0.14	0.03	0.07	0.23	0.06	0.01	0.19	0.31	0.15	0.55	0.40	0.005	0.039	0.027	0.005	0.1	0.052
0.54	24	12/20/02	c		0.03	0.10	-------	0.05	0.08	-------	0.00	0.42	-------	0.05	0.60	-------	0.005	0.031	-------	0.005	0.097	-------
0.57	25	02/22/03	c	c	0.04	0.14	-------	0.06	0.19	-------	0.00	0.85	-------	0.10	1.18	-------	0.005	0.083	-------	0.005	0.148	-------
0.96	26	02/28/03	c	c	0.08	0.49	0.02	0.15	0.03	0.01	0.05	0.91	0.47	0.27	1.43	0.49	0.01	0.128	0.018	0.005	0.282	0.069
0.71	27	03/17/03	c	c	0.07	0.48	0.05	0.06	0.37	0.02	0.09	1.10	1.24	0.21	1.95	1.30	0.013	0.089	0.032	0.005	0.241	0.157
1.45	28	03/23/03	c		0.55	0.52	-------	0.16	0.08	-------	0.22	0.61	-------	0.94	1.21	-------	0.005	0.089	-------	0.005	0.138	-------
0.34	29	03/27/03	c		-------	0.31	-------	-------	0.09	-------	-------	0.49	-------	-------	0.89	-------	-------	0.054	-------	-------	0.094	-------
3.40	30	04/25/03	c	c	0.72	0.39	0.13	0.24	0.37	0.30	0.06	0.78	0.66	1.02	1.55	1.09	0.005	0.0562	0.02	0.005	0.2132	0.108
0.67	31	05/19/03	c		-------	0.22	-------	-------	0.18	-------	-------	1.19	-------	-------	1.59	-------	-------	0.012	-------	-------	0.099	-------
0.77	32	05/22/03	c		0.02	0.32	-------	0.08	0.26	-------	0.08	0.69	-------	0.18	1.27	-------	0.005	0.027	-------	0.005	0.064	-------
1.65	33	06/11/03		c	0.28	-------	0.06	0.69	-------	0.21	0.08	-------	0.64	1.06	-------	0.91	0.005	-------	0.005	0.005	-------	0.086
1.52	34	06/18/03		c	0.22	-------	0.01	0.09	-------	0.03	0.11	-------	0.44	0.41	-------	0.48	0.005	-------	0.013	0.005	-------	0.051
1.40	35	06/19/03		c	0.04	-------	0.01	0.04	-------	0.03	0.04	-------	0.25	0.12	-------	0.29	0.005	-------	0.013	0.005	-------	0.041
0.59	36	07/11/03	c		0.05	0.02	-------	0.27	0.04	-------	0.01	0.52	-------	0.33	0.58	-------	0.005	0.005	-------	0.005	0.059	-------
2.31	37	09/20/03	c	c	0.14	0.22	0.08	0.19	0.33	0.21	0.04	0.83	0.43	0.36	1.39	0.71	0.005	0.059	0.12	0.005	0.316	0.207
TOTAL		Count			22	34	25	22	34	25	22	34	25	22	34	25	22	34	25	22	34	25
RAIN		Average			0.156	0.269	0.040	0.170	0.182	0.077	0.05	0.56	0.86	0.36	1.01	0.98	0.006	0.059	0.025	0.007	0.157	0.100
inches		Median			0.075	0.196	0.032	0.121	0.156	0.048	0.04	0.48	0.47	0.22	0.87	0.57	0.005	0.054	0.018	0.005	0.114	0.069
		Max.			0.724	1.060	0.170	0.694	0.467	0.301	0.22	1.19	7.30	1.06	2.03	7.40	0.016	0.130	0.120	0.034	0.850	0.676
49.37		Min.			0.016	0.020	0.005	0.038	0.008	0.005	0.00	0.05	0.23	0.05	0.55	0.24	0.005	0.005	0.005	0.005	0.059	0.028
		Std. Dev.			0.179	0.215	0.039	0.151	0.113	0.086	0.05	0.26	1.40	0.30	0.41	1.41	0.003	0.030	0.024	0.007	0.138	0.124
		C.V.*			1.15	0.80	0.95	0.89	0.62	1.12	1.07	0.47	1.62	0.82	0.41	1.44	0.47	0.50	0.96	0.96	0.88	1.24
Data-year-two - Data for the same months as represented by year one (November 2002 through August 2003)																						
TOTAL		Count			18	17	13	18	17	13	18	17	13	18	17	13	18	17	13	18	17	13
RAIN		Average			0.161	0.306	0.055	0.165	0.201	0.077	0.05	0.64	0.73	0.37	1.15	0.86	0.006	0.062	0.031	0.008	0.154	0.140
inches		Median			0.075	0.309	0.047	0.117	0.184	0.027	0.04	0.61	0.64	0.22	1.21	0.71	0.005	0.056	0.020	0.005	0.135	0.097
		Max.			0.724	0.683	0.170	0.694	0.467	0.301	0.22	1.19	2.67	1.06	1.95	2.86	0.016	0.130	0.120	0.034	0.316	0.676
26.79		Min.			0.016	0.020	0.005	0.038	0.008	0.005	0.00	0.05	0.23	0.05	0.41	0.24	0.003	0.005	0.005	0.005	0.059	0.028
		Std. Dev.			0.192	0.189	0.047	0.157	0.125	0.093	0.05	0.27	0.61	0.32	0.42	0.64	0.003	0.035	0.031	0.007	0.079	0.161
		C.V.*			1.19	0.62	0.86	0.95	0.62	1.22	1.01	0.42	0.83	0.86	0.36	0.74	0.50	0.57	1.01	0.99	0.51	1.15

"Type" refers to the sampling method (grab or composite). B=Building and S=Street pond ** Numbers in italics are below the laboratory limit of quantification (LOQ).

Table D-2. Concentration of constituents measured in rainfall and at the outflow weirs of the Building and Street ponds for year two (June through September 2003). After November 2002, discontinued analyzing for manganese for all samples and for cadmium in rainfall.

METALS

RAIN	STORM #		TYPE		TOTAL LEAD			TOTAL ZINC			MANGANESE			TOTAL IRON			SUSPENDED SOLIDS		TOTAL COPPER			TOTAL CADMIUM		
inches					ug/L			ug/L			ug/L			ug/L			mg/L		ug/L			ug/L		
		L.O.Q.**			10.00			12.0			1.0			25.0			0.05		2.3			0.2		
		DATE	B	S	RAIN	BLDG	STREET	RAIN	BLDG	STREET	RAIN	BLDG	STREET	RAIN	BLDG	STREET	BLDG	STREET	RAIN	BLDG	STREET	RAIN	BLDG	STREET
3.26	1	06/24/02	c	c	-------	18.90	2.40	-------	60.0	20.0	-------	8.3	7.2	-------	650.0	270.0	26.0	14.0	-------	10.9	8.4	-------	0.15	0.28
2.73	2	06/28/02	c	c	-------	18.00	1.60	-------	40.0	6.0	-------	11.0	4.5	-------	590.0	150.0	22.0	7.3	-------	12.5	6.6	-------	0.30	0.10
1.32	3	06/29/02	c	g	-------	3.30	1.00	-------	40.0	6.0	-------	6.2	3.2	-------	160.0	60.0	3.7	2.0	-------	6.1	2.3	-------	0.10	0.10
0.91	4	07/02/02	c	c	-------	2.10	1.00	-------	40.0	6.0	-------	12.7	2.9	-------	140.0	70.0	1.6	-------	-------	4.8	1.2	-------	0.10	0.10
0.86	5	07/12/02	c	---	-------	1.50	-------	-------	50.0	-------	-------	18.4	-------	-------	70.0	-------	0.9	-------	-------	5.8	-------	-------	0.21	-------
0.41	6	07/25/02	c	---	-------	3.60	-------	-------	120.0	-------	-------	37.9	-------	-------	140.0	-------	8.9	-------	-------	11.2	-------	-------	0.25	-------
0.30	7	08/02/02	g	---	-------	3.10	-------	-------	60.0	-------	-------		-------	-------	100.0	-------	4.1	-------	-------	7.8	-------	-------	0.10	-------
1.48	8	08/07/02	c	c	-------	2.10	1.40	-------	60.0	40.0	-------	10.3	18.5	-------	100.0	180.0	3.8	6.7	-------	6.8	4.2	-------	0.15	0.10
0.33	9	08/08/02	c	---	-------	1.50	-------	-------	50.0	-------	-------	12.8	-------	-------	90.0	-------	1.3	-------	-------	6.2	-------	-------	0.40	-------
2.39	10	08/14/02	c	c	-------	5.10	2.00	-------	40.0	20.0	-------	26.1	10.5	-------	160.0	280.0	7.0	7.2	-------	5.6	4.1	-------	0.10	0.10
0.68	11	08/27/02	c	---	-------	2.00	1.00	-------	40.0	6.0	-------	12.9	2.5	-------	60.0	40.0	4.1	2.3	-------	6.6	1.2	-------	0.10	0.10
1.18	12	08/30/02	c	c	0.60	2.00	1.00	6.0	40.0	30.0	1.1	7.9	10.8	30.0	90.0	160.0	5.8	2.2	7.8	6.7	3.4	0.41	0.10	0.10
1.10	13	09/02/02	c	c	0.40	4.30	0.70	6.0	40.0	20.0	0.5	10.6	17.6	30.0	150.0	150.0	5.2	4.0	1.2	5.1	3.3	0.10	0.10	0.10
1.58	14	09/11/02	g	c	0.80	6.70	1.00	6.0	70.0	30.0	0.5	10.2	16.6	12.5	230.0	200.0	8.0	12.0	1.2	25.0	2.8	0.10	0.10	0.10
0.72	15	09/12/02	g	c	0.60	1.60	1.00	6.0	40.0	20.0	0.5	13.0	8.0	12.5	90.0	140.0	1.4	3.3	1.2	4.6	3.0	0.10	0.10	0.10
1.39	16	09/17/02	c	c	-------	2.80	2.00	-------	40.0	30.0	-------	8.0	9.9	-------	100.0	170.0	3.6	4.5	-------	5.3	4.2	-------	0.10	0.10
0.41	17	09/26/02	c	---	-------		-------	-------	30.0	-------	-------	5.4	-------	-------	70.0	-------	1.9	-------	-------	5.2	-------	-------	0.10	-------
0.92	18	10/13/02	c	g	1.20	6.20	2.70	20.0	50.0	40.0	1.2	16.6	31.9	80.0	200.0	500.0	5.5	33.9	2.5	7.5	4.7	0.23	0.24	0.10
0.61	19	10/15/02	c	g	1.20	2.20	0.90	20.0	40.0	20.0	1.0	9.4	26.5	70.0	120.0	190.0	2.1	5.6	3.1	5.3	2.6	0.27	0.10	0.10
0.84	20	11/12/02	g	c	0.50	5.20	1.60	30.0	70.0	20.0	na	na	na	12.5	240.0	120.0	10.9	13.1	1.2	11.6	1.2	na	0.27	0.10
0.73	21	11/16/02	c	c	1.00	1.10	0.90	6.0	40.0	30.0	na	na	na	12.5	80.0	300.0	2.2	8.2	1.2	5.6	6.5	na	0.10	0.10
3.69	22	12/09/02	c	c	0.50	1.90	1.70	6.0	60.0	20.0	na	na	na	12.5	110.0	300.0	3.4	6.3	1.2	14.6	11.3	na	0.24	0.10
4.65	23	12/12/02	c	c	1.00	3.30	1.20	6.0	60.0	20.0	na	na	na	-------	240.0	210.0	6.3	4.1	1.2	10.6	9.5	na	0.10	0.10
0.54	24	12/20/02	c	---	1.00	2.20	-------	6.0	40.0	-------	na	na	na	30.0	180.0	-------	8.2	-------	1.2	7.7	-------	na	0.10	-------
0.57	25	02/22/03	c	c	5.00	5.00	-------	5.8	79.7	-------	na	na	na	13.7	91.9	-------	7.6	-------	1.2	12.8	-------	na	0.50	-------
0.96	26	02/28/03	c	c	5.00	5.00	5.00	7.9	99.4	25.9	na	na	na	19.9	141.0	254.0	11.4	-------	1.5	8.8	3.9	na	0.50	0.50
0.71	27	03/17/03	c	c	5.00	5.00	5.00	16.9	101.0	58.2	na	na	na	18.4	247.0	111.0	10.6	11.3	1.5	17.4	8.8	na	0.50	0.50
1.45	28	03/23/03	c	---	5.00	5.00	-------	6.6	56.5	-------	na	na	na	18.5	83.4	-------	4.2	-------	1.5	6.6	-------	na	0.50	-------
0.34	29	03/27/03	c	---	-------	5.00	-------	-------	48.0	-------	na	na	na	-------	80.1	-------	2.0	-------		5.9	-------	na	0.50	-------
3.40	30	04/25/03	c	c	5.00	5.00	5.00	3.7	84.7	35.1	na	na	na	36.6	347.8	270.0	10.4	6.3	1.5	16.0	11.6	na	0.50	0.50
0.67	31	05/19/03	c	---	-------	5.00	-------	-------	76.4	-------	na	na	na	-------	81.6	-------	11.8	-------		11.2	-------	na	0.50	-------
0.77	32	05/22/03	c	---	5.00	5.00	-------	9.5	61.7	-------	na	na	na	6.3	88.9	-------	4.3	-------	1.5	10.8	-------	na	0.50	-------
1.65	33	06/11/03	---	c	5.00	-------	5.00	8.7	-------	27.8	na	na	na	35.3	-------	295.0	-------	8.5	1.5	-------	5.2	na	-------	0.50
1.52	34	06/18/03	---	c	5.00	-------	5.00	3.4	-------	15.2	na	na	na	13.9	-------	221.0	-------	5.5	1.5	-------	5.5	na	-------	0.50
1.40	35	06/19/03	---	c	5.00	-------	5.00	6.4	-------	12.9	na	na	na	29.0	-------	183.0	-------	4.4	1.5	-------	4.3	na	-------	0.50
0.59	36	07/11/03	c	---	5.00	5.00	32.70	4.8	14.2	236.0	na	na	na	70.5	317.0	2060.0	4.8	-------	1.5	1.5	102.0	na	0.50	1.14
2.31	37	09/20/03	c	c	5.00	20.70	5.00	2.95	162	25.8	na	na	na	15.9	1240.0	293.0	48.7	7.9	1.5	46.4	7.4	na	0.50	0.50
TOTAL		Count			22	33	26	22	34	26	6	18	14	21	34	26	34	23	22	34	26	6	34	26
RAIN		Average			2.90	5.04	3.57	8.8	58.9	31.6	0.8	13.2	12.2	27.6	202.3	276.0	7.76	7.85	1.8	9.9	8.8	0.2	0.3	0.3
inches		Median			3.10	4.30	1.65	6.0	50.0	20.0	0.8	10.8	10.2	18.5	130.0	195.0	5.02	6.27	1.5	7.2	4.3	0.2	0.2	0.1
		Max.			5.00	20.70	32.70	30.0	162.0	236.0	1.2	37.9	31.9	80.0	1240.0	2060.0	48.70	33.90	7.8	46.4	102.0	0.4	0.5	1.1
49.37		Min.			0.40	1.10	0.70	3.0	14.2	6.0	0.5	5.4	2.5	6.3	60.0	40.0	0.90	2.00	1.2	1.5	1.2	0.1	0.1	0.1
		Std. Dev.			2.11	4.74	6.06	6.6	28.1	42.5	0.3	7.6	8.7	20.6	224.2	369.2	8.93	6.47	1.4	7.8	18.9	0.1	0.2	0.2
		C.V.*			0.73	0.94	1.70	0.7	0.5	1.3	0.4	0.6	0.7	0.7	1.1	1.3	1.15	0.82	0.8	0.8	2.1	0.6	0.7	1.0
Data-year-two - Data for the same months as represented by year one (November 2002 through August 2003)																								
TOTAL		Count			18	17	14	18	17	14	2	2	2	17	17	14	17	12	18	17	14	2	17	14
RAIN		Average			3.4	5.2	5.5	9.5	67.3	41.9	1.1	13.0	29.2	29.1	228.7	379.1	9.1	9.6	1.5	11.8	13.2	0.3	0.4	0.4
inches		Median			5.0	5.0	5.0	6.2	60.0	25.9	1.1	13.0	29.2	18.5	141.0	262.0	6.3	7.1	1.5	10.6	6.0	0.3	0.5	0.5
		Max.			5.0	20.7	32.7	30.0	162.0	236.0	1.2	16.6	31.9	80.0	1240.0	2060.0	48.7	33.9	3.1	46.4	102.0	0.3	0.5	1.1
26.79		Min.			0.4	0.9	0.7	0.7	0.5	1.3	0.3	0.6	0.7	0.7	1.1	1.3	0.9	0.8	0.8	0.8	1.2	0.1	0.1	0.1
		Std. Dev.			2.0	4.1	7.7	7.1	32.2	55.0	0.1	3.6	2.7	22.2	266.5	475.2	10.5	7.8	0.5	9.6	24.8	0.0	0.2	0.3
		C.V.*			0.59	0.80	1.41	0.75	0.48	1.31	0.09	0.28	0.09	0.76	1.17	1.25	1.15	0.81	0.32	0.81	1.88	0.08	0.48	0.77

"Type" refers to the sampling method (grab or composite). B=Building and S=Street pond ** Numbers in italics are below the laboratory limit of quantification (LOQ).

Table D-2. Concentration of constituents measured in rainfall and at the outflow weirs of the Building and Street ponds for year two (June through September 2003). After November 2002, discontinued analyzing for manganese for all samples and for cadmium in rainfall.

MAJOR IONS

RAIN	STORM #		TYPE		HARDNESS			CALCIUM			MAGNESIUM			CHLORIDE			POTASSIUM			SODIUM			SULFATE		
inches					mg/L as CaCO3			(mg/l)			mg/L			mg/L			mg/L			mg/L			mg/L		
		L.O.Q.**			0.0			0.25			0.01			0.4			0.07			0.06			0.01		
		DATE	B	S	RAIN	BLDG	STREET	RAIN	BLDG	STREET	RAIN	BLDG	STREET	RAIN	BLDG	STREET	RAIN	BLDG	STREET	RAIN	BLDG	STREET	RAIN	BLDG	STREET
3.26	1	06/24/02	c	c		59.3	35.2		18.5	13.3		3.17	0.48		39	2.74		1.83	1.89		23.9	2.63		11.4	5.78
2.73	2	06/28/02	c	c		72.2	37.1		22	14		3.95	0.51		50.2	2.99		2.4	2.09		30.8	2.65		15.7	7.87
1.32	3	06/29/02	c	g		70.0	46.0		24.2	17.4		3.82	0.61		40.8	3.33		2.26	2.13		26.2	2.3		15.3	7.7
0.91	4	07/02/02	c	c		85.9	48.9		28.4	18.5		3.63	0.65		37.6	2.99		2.28	2.2		24	2.87		15.7	8.28
0.86	5	07/12/02	c	---		136.1			28.6			15.7			235			7.42			137			44.5	
0.41	6	07/25/02	c	---		295.0			46.9			43.2			64.9			17.2			370			12.6	
0.30	7	08/02/02	g	---		253.6			44.5			34.6			493			14.6			298			97.5	
1.48	8	08/07/02	c	c		129.9	74.4		25.3	27.5		16.2	1.39		244	1.39		7.31	3.61		138	10.4		51	18.3
0.33	9	08/08/02	c	---		170.9			36.3			19.5			286			8.88			174			58.3	
2.39	10	08/14/02	c	c		77.4	48.9		22.5	18.4		5.16	0.72		63.1	4.57		2.78	2.37		40.7	4.35		19.5	9.38
0.68	11	08/27/02	c	---		172.0	47.1		35.4	17.9		20.3	0.59		301	3.21		8.9	1.97		184	2.96		60	7.23
1.18	12	08/30/02	c	c	1.1	118.1	59.9	0.125	22.9	22.2	0.26	14.8	1.09	1.67	221	7.62	0.035	6.61	2.73	0.52	127	7.98	2.95	42.9	13.9
1.10	13	09/02/02	c	c	1.1	127.4	72.3	0.125	27.6	27.3	0.26	14.2	1	0.23	208	6.2	0.035	6.78	3.38	0.125	121	6.18	1.85	41.3	11.5
1.58	14	09/11/02	g	c	1.1	72.0	34.4	0.125	19	12.3	0.26	5.96	0.89	0.31	81.4	5.21	0.035	3.27	2.49	0.125	49.6	4.79	0.98	17.5	9.01
0.72	15	09/12/02	g	c	1.1	70.6	56.9	0.125	20.6	21.6	0.26	4.64	0.71	0.65	57.9	3.89	0.035	2.98	2.13	0.25	35.3	3.61	1.69	16	8.45
1.39	16	09/17/02	c	c		93.6	63.7		26	24.1		6.96	0.86		89.5	4.92		3.64	2.52		53.2	4.52		21.3	10.4
0.41	17	09/26/02	c	---		118.9			30.3			10.5			153			5.12			88.7			31.7	
0.92	18	10/13/02	c	g	1.1	181.4	127.1	0.125	37.2	47.7	0.26	21.5	1.95	0.53	325	12.7	0.035	9.87	6	0.28	184	9.91	2.17	61.4	14.8
0.61	19	10/15/02	c	g	2.1	164.2	106.7	0.65	34.9	40	0.26	18.7	1.66	0.88	280	11	0.035	8.7	4.95	0.54	159	8.92	0.91	51.7	13.2
0.84	20	11/12/02	g	c	0.0	259.2	129.0		48.4	48.4		33.6	1.99												
0.73	21	11/16/02	c	c		190.5	100.1		39	37.6		22.6	1.51												
3.69	22	12/09/02	c	c		159.5	54.6		28.1	20.9		21.7	0.579												
4.65	23	12/12/02	c	c		203.0	42.6		25.4	16.3		33.9	0.454												
0.54	24	12/20/02	c	---		117.2			26.5			12.4													
0.57	25	02/22/03	c	c		246.5			41			35													
0.96	26	02/28/03	c	c		233.7	76.0		40.5	27.8		32.2	1.59												
0.71	27	03/17/03	c	c		305.4	208.7		47.1	42.5		45.6	24.9												
1.45	28	03/23/03	c	---		346.5			44.6			57.1						Changed lab constituents							
0.34	29	03/27/03	c	---		290.2			37.4			47.8													
3.40	30	04/25/03	c	c		218.9	49.5		30.77	18.5		34.51	0.81												
0.67	31	05/19/03	c	---		334.9			49.7			51.2													
0.77	32	05/22/03	c	---		271.4			39.9			41.7													
1.65	33	06/11/03	---	c			62.4			23.7			0.78												
1.52	34	06/18/03	---	c			52.0			20			0.5												
1.40	35	06/19/03	---	c			44.2			17			0.42												
0.59	36	07/11/03	c	---		60.6	121.6		23	29.9		0.78	11.4												
2.31	37	09/20/03	c	c		56.5	55.5		17.1	20.6		3.36	0.99												
TOTAL		Count			7	34	26	6	34	26	6	34	26	6	19	14	6	19	14	6	19	14	6	19	14
RAIN		Average			1.1	169.5	71.3	0.21	32.05	24.82	0.26	21.76	2.27	0.7	172.1	5.2	0.04	6.46	2.89	0.31	119.18	5.29	1.76	36.07	10.41
inches		Median			1.1	161.8	56.2	0.13	29.45	21.25	0.26	19.10	0.84	0.6	153.0	4.2	0.04	6.61	2.43	0.27	121.00	4.44	1.77	31.70	9.20
		Max.			2.1	346.5	208.7	0.65	49.70	48.40	0.26	57.10	24.90	1.7	493.0	12.7	0.04	17.20	6.00	0.54	370.00	10.40	2.95	97.50	18.30
49.37		Min.			0.0	56.5	34.4	0.13	17.10	12.30	0.26	0.78	0.42	0.2	37.6	1.4	0.04	1.83	1.89	0.13	23.90	2.30	0.91	11.40	5.78
		Std. Dev.			0.6	86.8	39.0	0.20	9.46	10.14	0.00	15.95	4.97	0.5	125.7	3.1	0.00	4.17	1.18	0.17	93.62	2.77	0.70	22.68	3.37
		C.V.*			0.5	0.5	0.5	0.92	0.30	0.41	0.00	0.73	2.19	0.7	0.7	0.6	0.00	0.65	0.41	0.55	0.79	0.52	0.40	0.63	0.32

Data-year-two - Data for the same months as represented by year one (November 2002 through August 2003)

TOTAL		Count			3	17	14	2	17	14	2	17	14	2	2	2	2	2	2	2	2	2	2	2	2
RAIN		Average			1.1	214.1	87.9	0.4	35.9	29.4	0.3	30.2	3.5	0.7	302.5	11.9	0.0	9.3	5.5	0.4	171.5	9.4	1.5	56.6	14.0
inches		Median			1.1	218.9	69.2	0.4	37.4	25.8	0.3	33.6	1.3	0.7	302.5	11.9	0.0	9.3	5.5	0.4	171.5	9.4	1.5	56.6	14.0
		Max.			2.1	346.5	208.7	0.7	49.7	48.4	0.3	57.1	24.9	0.9	325.0	12.7	0.0	9.9	6.0	0.5	184.0	9.9	2.2	61.4	14.8
26.79		Min.			0.0	0.5	0.5	0.1	0.3	0.4	0.0	0.7	0.4	0.2	0.7	0.6	0.0	0.6	0.4	0.1	0.8	0.5	0.4	0.6	0.3
		Std. Dev.			0.9	83.3	45.6	0.3	9.2	11.2	0.0	15.6	6.5	0.2	22.5	0.8	0.0	0.6	0.5	0.1	12.5	0.5	0.6	4.9	0.8
		C.V.*			0.79	0.39	0.52	0.68	0.26	0.38	0.00	0.52	1.84	0.25	0.07	0.07	0.00	0.06	0.10	0.32	0.07	0.05	0.41	0.09	0.06

APPENDIX E

Comparison of Metal concentrations to Metal Standards
For All Storm Events Sampled – 1996 to 2003

Original data: Excel spreadsheet APP E Metals vs Standards
Excel stdsold and Quattro Pro MDLIMIT

Appendix E-1. Comparison of metal concentrations measured at the outflow of the ponds to metal class III standards. Bolded values exceed Class III WQ stds. Exceed(%) represents percent of samples in non-compliance with standards. When values are below the laboratory quantification limit (MDL) one-half the MDL was substituted. See table 3a for formulas used to calculate state standards from water hardness. Data are for 1997 sample year.

DATE	COPPER (ug/L)						LEAD (ug/L)						ZINC (ug/L)						HARDNESS (mg/L)		
	(MDL 1.0 ug/l)						(MDL 2.0 ug/l)						(MDL 3.0 ug/l)						(MDL 2 mg/l)		
	Building		Street		Parking Lot		Building		Street		Parking Lot		Building		Street		Parking Lot		Build	Street	Pk Lot
	Result	std.	Result	std	Result	std.	Result	std.	Result	std	Result	std.	Result	std.	Result	std	Result	std.			
11/25/96	**294.0**	38.7	9.0	13.9	3.0	38.7	1.7	18.6	2.0	4.1	0.7	18.6	44.0	343.1	16.0	124.6	19.0	343.1	644	121	1108
11/26/96	0.7	15.5	7.7	13.5	8.0	38.7	0.0	4.7	1.2	3.9	0.4	18.6	87.0	138.4	29.0	121.1	8.0	343.1	137	117	984
11/27/96	**68.0**	31.7	**28.0**	12.6	10.0	38.7	2.5	13.8	2.6	3.5	1.2	18.6	68.0	281.7	28.0	113.1	10.0	343.1	317	108	1012
12/02/96	**58.0**	22.6	**18.0**	12.5	17.0	38.7	2.2	8.3	1.4	3.5	3.3	18.6	58.0	201.1	18.0	112.2	17.0	343.1	213	107	965
12/03/96	**52.0**	25.8	10.0	12.3	9.6	38.7	1.2	10.2	1.3	3.4	1.2	18.6	46.0	229.6	24.0	110.5	22.0	343.1	249	105	943
12/06/96	**54.4**	34.6	5.9	12.1	8.0	38.7	1.4	15.7	1.2	3.3	0.4	18.6	39.0	307.1	26.0	108.7	11.0	343.1	351	103	973
12/11/96	27.8	29.4	8.8	9.4	14.6	38.7	1.3	12.3	1.9	2.2	0.0	18.6	43.0	261.3	48.0	84.0	18.0	343.1	290	76	760
01/31/97	**163.6**	38.7	11.7	14.3	35.6	38.7	3.0	18.6	1.7	4.2	0.1	18.6	80.0	343.1	52.0	128.1	13.0	343.1	889	125	700
02/04/97	**98.5**	38.7	13.2	14.3	38.1	38.7	1.2	18.6	1.5	4.2	0.5	18.6	35.0	343.1	8.0	128.1	13.0	343.1	1119	125	700
02/07/97	**48.0**	38.7	8.3	14.6	21.6	38.7	5.1	18.6	1.6	4.4	0.3	18.6	33.0	343.1	6.0	130.7	11.0	343.1	1050	128	721
02/28/97	25.9	38.7	**25.1**	15.5	dry	dry	2.0	18.6	3.7	4.7	dry	dry	21.0	343.1	15.0	138.4	dry	dry	849	137	dry
03/24/97	**128.0**	9.6	**18.7**	13.8	**182.0**	38.7	**8.6**	2.3	**6.7**	4.0	1.0	18.6	56.0	86.4	23.0	123.7	22.0	343.1	79	120	843
04/15/97	9.6	15.3	**18.5**	8.7	30.1	38.7	2.0	4.7	2.6	2.0	2.0	18.6	54.0	136.7	22.0	78.3	14.0	343.1	135	70	551
04/30/97	**25.9**	15.6	1.3	6.2	4.7	9.1	2.1	4.8	1.0	1.2	1.0	2.1	38.0	139.2	18.0	56.3	25.0	81.7	138	47	74
06/24/97	**55.5**	38.7	**18.3**	13.2	10.7	31.7	1.0	18.6	**5.5**	3.8	1.0	13.8	78.0	343.1	15.0	118.4	15.0	281.7	928	114	317
06/26/97	32.4	38.7	10.5	12.4	dry	dry	1.0	18.6	**3.7**	3.4	dry	dry	85.0	343.1	15.0	111.4	dry	dry	417	106	dry
06/27/97	21.5	36.3	5.4	10.9	13.4	30.2	3.3	16.9	2.1	2.8	1.0	12.9	62.0	322.6	15.0	98.0	15.0	268.9	372	91	300
07/07/97	**338.0**	13.0	**6.8**	6.7	13.3	25.4	2.0	3.7	**2.1**	1.4	1.0	10.0	15.0	116.7	15.0	60.1	15.0	226.5	112	51	245
07/20/97	24.2	36.8	7.0	8.6	8.2	28.8	3.1	17.3	**2.1**	2.0	1.0	12.0	66.0	327.0	15.0	77.4	15.0	255.9	378	69	283
07/23/97	15.7	25.6	4.3	7.4	3.3	32.2	1.0	10.1	1.0	1.6	1.0	14.2	40.0	228.0	15.0	66.8	15.0	286.2	247	58	323
07/28/97	16.1	32.9	3.6	8.1	2.4	35.2	1.0	14.6	1.0	1.8	1.0	16.1	59.0	292.2	15.0	73.2	15.0	312.3	331	65	358
07/29/97	27.4	38.7	4.7	8.2	1.6	35.9	1.0	18.6	1.0	1.8	1.0	16.7	55.0	343.1	15.0	73.6	15.0	318.9	410	65	367
07/31/97	24.7	38.7	5.7	8.3	2.6	37.2	1.0	18.6	1.0	1.9	1.0	17.6	15.0	343.1	15.0	74.3	15.0	330.7	594	66	383
08/21/97	15.6	27.4	7.1	7.7	4.5	32.0	1.0	11.1	**2.5**	1.7	1.0	14.0	33.0	243.6	15.0	69.3	15.0	284.7	267	61	321
08/22/97	18.1	25.0	2.8	8.1	2.4	34.2	1.0	9.7	1.0	1.8	1.0	15.5	31.0	222.5	15.0	72.9	15.0	304.2	240	64	347
09/24/98	**23.0**	20.9	7.0	7.4	22.2	33.2	1.0	7.4	1.0	1.6	1.0	14.8	56.4	186.6	15.0	66.9	15.0	295.2	195	58	335
09/26/97	6.6	6.8	**5.2**	3.6	**10.5**	4.7	1.0	1.4	**2.6**	0.5	1.0	0.8	34.6	61.3	15.0	32.7	15.0	42.8	52	19	34
09/27/97	7.4	9.2	2.2	4.4	**5.8**	4.1	**3.2**	2.2	1.0	0.7	1.0	0.6	37.3	82.7	15.0	39.7	15.0	36.7	75	31	29
09/28/97	**9.2**	8.5	3.3	5.9	5.3	6.7	1.0	2.0	1.0	1.1	1.0	1.4	15.0	76.8	15.0	53.3	15.0	60.7	68	44	52
10/27/98	**13.7**	11.9	**8.9**	8.5	**21.7**	18.6	2.8	3.2	1.0	1.9	3.0	6.3	53.4	106.9	15.0	76.3	15.0	166.2	101	68	170
Number	30	30	30	30	28	28	30	30	30	30	28	28	30	30	30	30	28	28	30	30	28
Average	56.8	26.7	9.6	10.1	17.6	28.9	2.0	11.5	2.0	2.6	1.0	14.0	47.9	237.9	19.1	90.7	14.8	256.8	375	84	490
Median	25.9	28.4	7.4	9.0	9.8	35.2	1.4	11.7	1.6	2.1	1.0	16.4	45.0	252.4	15.0	81.2	15.0	312.3	279	73	363
Exceed%	50%		30%		14%		7%		23%		0%		0%		0%		0%				

Appendix E-2. Comparison of metal concentrations measured at the outflow of the ponds to metal class III standards. Bolded values exceed Class III WQ stds. Exceed(%) represents percent of samples in non-compliance with standards. When values are below the laboratory quantification limit (MDL) one-half the MDL was substituted. See table 3a for formulas used to calculate state standards from water hardness. Data are for 1998 sample year.

DATE	COPPER (ug/L) (MDL 1.0 ug/l)						LEAD (ug/L) (MDL 2.0 ug/l)						ZINC (ug/L) (MDL 3.0 ug/l)						HARDNESS (mg/L) (MDL 2 mg/l)		
	Building		Street		Parking Lot		Building		Street		Parking Lot		Building		Street		Parking Lot		Build	Street	Pk Lot
	Result	std.	Result	std	Result	std.	Result	std.	Result	std	Result	std.	Result	std.	Result	std	Result	std.			
11/13/97	**25.4**	17.4	15.6	26.8	8.1	8.1	4.3	5.6	**2.6**	1.8	2.6	10.8	48.4	155.3	15.0	238.9	15.0	72.4	157	261	64
11/14/97	11.5	11.7	6.8	24.6	3.6	6.1	1.0	3.1	1.0	1.2	1.0	9.5	41.5	105.2	15.0	219.4	15.0	55.2	99	236	46
01/23/98	7.9	14.9	2.0	8.0	**23.5**	26.8	1.0	4.5	1.0	1.8	1.0	10.7	65.9	133.0	15.0	72.2	43.2	238.2	131	64	260
02/02/98	**38.7**	16.1	**15.2**	9.9	**33.2**	30.1	1.0	5.1	1.0	2.4	1.0	12.8	61.2	144.4	15.0	88.6	15.0	267.3	144	81	298
02/15/98	**17.6**	5.6	**14.0**	5.6	**29.2**	22.5	**3.5**	1.0	**4.6**	1.0	4.6	8.3	50.0	50.2	30.0	50.6	30.0	200.3	41	42	212
03/09/98	**15.2**	8.5	1.9	9.3	**25.1**	16.3	1.0	1.9	1.0	2.2	1.0	5.2	**90.0**	76.0	15.0	83.7	15.0	146.1	68	76	146
03/19/98	7.0	7.0	2.9	6.6	**11.3**	10.5	**2.0**	1.5	3.0	1.3	**3.0**	2.7	50.0	63.1	15.0	59.2	15.0	94.5	54	50	87
03/20/98	**10.6**	6.6	**7.2**	6.2	**11.5**	7.2	**4.3**	1.3	2.0	1.2	**2.0**	1.5	14.5	59.4	15.0	55.9	15.0	64.9	51	47	56
05/29/98	**18.4**	10.6	**10.1**	5.2	na	na	2.0	2.7	**2.9**	2.3	na	na	50.0	95.1	15.0	46.7	na	na	88	38	na
06/17/98	**27.9**	26.6	na	na	**48.4**	16.5	1.0	10.6	na	na	3.3	5.2	50.0	236.6	na	na	30.0	147.8	258	na	148
06/18/98	**59.9**	28.5	na	na	**56.0**	17.2	2.1	11.8	na	na	4.6	5.6	50.0	253.6	na	na	15.0	153.7	280	na	155
06/19/98	15.2	28.7	na	na	**54.7**	18.3	1.0	11.9	na	na	5.3	6.1	40.0	255.1	na	na	15.0	163.7	282	na	167
06/24/98	22.0	24.7	na	na	**47.6**	5.3	2.6	9.5	na	na	**4.6**	1.0	90.0	220.2	na	na	30.0	48.1	237	na	39
06/22/98	15.0	31.2	na	na	**71.3**	3.6	1.0	13.5	na	na	**5.6**	0.5	49.9	277.2	na	na	15.0	32.7	311	na	25
06/26/98	**18.3**	14.5	na	na	**16.5**	6.8	1.0	4.3	na	na	**2.9**	1.4	60.0	129.8	na	na	40.0	60.9	127	na	52
06/29/98	9.4	19.7	na	na	**20.0**	8.6	1.0	6.8	na	na	**2.1**	2.0	30.0	176.0	na	na	30.0	77.4	182	na	69
07/01/98	11.6	24.8	na	na	**23.0**	9.7	1.0	9.6	na	na	1.0	2.4	15.0	221.0	na	na	15.0	87.5	238	na	80
07/02/98	20.3	27.3	na	na	**21.0**	10.2	1.0	11.1	na	na	1.0	2.6	40.0	242.8	na	na	15.0	91.9	266	na	84
07/06/98	26.1	28.5	na	na	**37.2**	11.6	1.0	11.8	na	na	1.0	3.1	50.0	253.6	na	na	30.0	104.3	280	na	98
07/08/98	**13.5**	9.3	na	na	**18.9**	5.4	1.0	2.2	na	na	1.0	1.0	**110.0**	83.8	na	na	15.0	49.1	76	na	40
07/09/98	8.9	11.2	na	na	**15.7**	6.1	1.0	2.9	na	na	1.0	1.2	30.0	100.0	na	na	15.0	54.6	93	na	46
07/13/98	**10.5**	9.2	na	na	**8.8**	7.5	**3.2**	2.2	na	na	1.0	1.6	**110.0**	82.4	na	na	15.0	67.6	74	na	59
07/17/98	7.4	11.1	na	na	8.4	9.4	1.0	2.9	na	na	1.0	2.3	30.0	99.7	na	na	15.0	84.5	93	na	77
07/28/98	10.4	20.1	**10.1**	9.5	8.2	12.0	1.0	7.0	na	na	1.0	3.3	15.0	179.0	na	na	15.0	107.8	186	na	102
08/26/98	18.2	24.9	6.5	8.7	4.1	11.9	2.4	9.7	**3.7**	2.0	**15.5**	3.2	40.0	222.2	30.0	78.1	80.0	106.5	240	70	101
09/02/98	19.7	20.6	na	na	**15.4**	12.6	1.0	7.3	na	na	1.0	3.5	60.0	184.2	na	na	15.0	112.8	192	na	108
09/19/98	6.4	3.6	0.1	9.5	7.5	12.7	1.0	8.8	1.0	0.5	1.0	3.5	**60.0**	32.7	15.0	32.7	15.0	113.8	13	70	109
11/05/98	15.5	17.7	**19.5**	8.7	12.9	29.6	1.0	5.8	**4.9**	2.0	1.0	12.5	**160.0**	157.8	50.0	78.3	15.0	263.5	160	70	293
count	28	28	13	13	27	27	28	28	12	12	27	27	28	28	12	12	27	27	28	12	27
Average	17.4	17.2	8.6	10.7	23.7	14.1	1.9	8.8	2.2	2.3	1.8	9.2	51.0	197.1	19.6	89.3	17.8	190.3	282	83	320
Median	15.2	16.8	7.2	8.7	18.9	11.9	1.1	7.9	1.7	2.0	1.0	8.9	49.9	201.1	15.0	78.3	15.0	166.2	237	70	229
%exceed	39%		46%		54%		14%		42%		26%		18%		0%		0%				

Appendix E-3. Comparison of metal concentrations measured at the outflow of the ponds to metal class III standards. Bolded values exceed Class III WQ stds. Exceed(%) represents percent of samples in non-compliance with standards. When values are below the laboratory quantification limit (LOQ) one-half the LOQ was substituted. See table 3a for formulas used to calculate state standards from water hardness. Data are for the Street pond for the 2001 sample year.

STREET POND							
DATE	TOTAL COPPER	STD. COPPER	TOTAL LEAD	STD. LEAD	TOTAL ZINC	STD. ZINC	Hardness
	(ug/l)	(ug/l)	(ug/l)	(ug/l)	(ug/l)	(ug/l)	
LOQ==>	2		1.5		15		
YEAR 1							
11/25/00	9.5	10.02	1.50	2.49	------	89.94	82.4
12/18/00	7.4	12.75	0.75	3.56	7.5	114.20	109.2
01/08/01	5.5	10.09	2.20	2.51	20.0	90.54	83.0
03/04/01	9.2	10.97	2.00	2.85	20.0	98.43	91.6
03/19/01	2.9	9.79	0.75	2.40	7.5	87.90	80.2
03/29/01	3.2	5.97	**1.83**	1.15	21.2	53.80	44.9
06/06/01	5.0	8.84	2.00	2.06	20.0	79.47	71.2
06/22/01	4.4	9.60	0.75	2.33	7.5	86.18	78.3
06/28/01	3.4	7.29	**3.40**	1.55	7.5	65.60	56.8
07/11/01	2.5	10.10	0.75	2.52	7.5	90.65	83.2
07/13/01	*1.0*	8.99	0.75	2.12	7.5	80.80	72.6
07/22/01	*1.0*	9.12	0.75	2.16	20.0	81.90	73.8
07/23/01	2.5	9.03	0.75	2.13	20.0	81.09	72.9
07/27/01	2.2	9.45	0.75	2.28	7.5	84.91	77.0
08/05/01	*1.0*	9.41	0.75	2.26	7.5	84.48	76.5
08/07/01	2.7	17.23	2.20	5.57	7.5	153.95	155.4
Number	16	16	16	16	15	16	16
Average	4.0	9.9	1.4	2.5	12.6	89.0	81.8
Median	3.0	9.5	0.8	2.3	7.5	85.5	77.7
Exceedance (%)	0.0		12.5%		0.0		

Appendix E-4. Comparison of metal concentrations measured at the outflow of the ponds to metal class III standards. Bolded values exceed Class III WQ stds. Exceed(%) represents percent of samples in non-compliance with standards. When values are below the laboratory quantification limit (LOQ) one-half the LOQ was substituted. See table 3a for formulas used to calculate state standards from water hardness. Data are for the Building pond for the 2001 sample

BUILDING POND							
DATE	TOTAL COPPER	STD. COPPER	TOTAL LEAD	STD. LEAD	TOTAL ZINC	STD. ZINC	Hardness
	(ug/l)	(ug/l)	(ug/l)	(ug/l)	(ug/l)	(ug/l)	
LOQ==>	2		1.5		15		
YEAR 1							
11/26/00	18.9	14.54	3.10	4.33	100.0	130.11	127.4
12/17/00	19.7	30.26	3.30	12.90	130.0	269.14	300.4
01/08/01	12.8	15.89	2.50	4.94	130.0	142.05	141.3
03/04/01	12.3	19.46	1.60	6.68	80.0	173.71	179.2
03/19/01	9.3	20.78	0.75	7.37	80.0	185.36	193.4
03/29/01	**13.6**	11.37	**3.11**	3.00	78.0	101.94	95.5
06/06/01	14.8	23.22	1.80	8.70	98.0	207.01	220.4
06/19/01	14.1	18.93	2.50	6.42	100.0	169.06	173.5
06/22/01	12.0	35.17	3.30	16.14	70.0	312.39	358.1
06/24/01	7.7	24.71	0.75	9.54	50.0	220.17	237.0
06/28/01	6.4	21.32	0.75	7.65	30.0	190.13	199.3
06/29/01	5.7	15.55	1.60	4.79	40.0	139.10	137.8
07/03/01	4.6	13.15	0.75	3.73	30.0	117.74	113.2
07/06/01	4.7	14.61	0.75	4.36	20.0	130.71	128.1
07/08/01	5.6	17.77	0.75	5.84	50.0	158.75	161.1
07/11/01	6.6	15.59	1.60	4.80	40.0	139.45	138.2
07/13/01	4.3	13.00	0.75	3.66	50.0	116.41	111.7
07/16/01	4.5	13.04	0.75	3.68	30.0	116.81	112.2
07/17/01	5.7	16.53	1.70	5.24	30.0	147.80	148.1
07/21/01	3.9	30.41	2.30	13.00	20.0	270.47	302.1
07/23/01	5.9	16.01	2.20	5.00	50.0	143.13	142.6
07/27/01	4.0	15.16	0.75	4.61	40.0	135.59	133.7
07/28/01	4.1	17.06	0.75	5.50	30.0	152.49	153.6
07/30/01	3.8	17.60	0.75	5.75	30.0	157.25	159.3
07/31/01	5.5	18.07	0.75	5.99	40.0	161.43	164.3
08/02/01	6.0	17.33	0.75	5.62	50.0	154.82	156.4
08/07/01	6.6	17.24	3.40	5.58	60.0	154.01	155.4
08/09/01	5.0	17.23	1.70	5.57	50.0	153.95	155.4
Number	28	28	28	28	28	28	28
Average	8.1	18.6	1.6	6.4	57.4	166.1	171.4
Median	6.0	17.2	1.6	5.6	50.0	154.0	155.4
Exceedance (%)	3.57%		3.57%		0.00%		

Appendix E-5. Comparison of metal concentrations measured at the outflow of the ponds to metal class III standards. Bolded values exceed Class III WQ stds. Exceed(%) represents percent of samples in non-compliance with standards. When values are below the laboratory quantification limit (LOQ) one-half the LOQ was substituted. See table 3a for formulas used to calculate state standards from water hardness. Data are for the Street pond for the 2002 sample year.

STREET POND							
DATE	TOTAL COPPER	STD. COPPER	TOTAL LEAD	STD. LEAD	TOTAL ZINC	STD. ZINC	Hardness
	(ug/l)	(ug/l)	(ug/l)	(ug/l)	(ug/l)	(ug/l)	
LOQ==>	2		1.5		15		
YEAR 2							
06/18/02	3.00	5.19	**1.30**	0.93	20.0	46.84	38.14
06/24/02	**8.40**	4.84	**2.40**	0.84	20.0	43.74	35.19
06/28/02	**6.60**	5.06	**1.60**	0.90	*7.5*	45.71	37.06
06/29/02	2.30	6.09	*1.00*	1.18	*7.5*	54.85	45.96
07/01/02	*1.15*	6.41	*1.00*	1.28	*7.5*	57.78	48.87
08/07/02	4.20	9.18	1.40	2.18	40.0	82.49	74.39
08/14/02	4.10	6.42	**2.00**	1.28	20.0	57.82	48.91
08/17/02	*1.15*	6.22	*1.00*	1.22	*7.5*	56.03	47.13
08/30/02	3.40	7.63	*1.00*	1.66	30.0	68.68	59.92
09/02/02	3.30	8.96	*1.00*	2.10	20.0	80.51	72.29
09/11/02	2.80	4.75	*1.00*	0.82	30.0	42.89	34.38
09/12/02	3.00	7.30	*1.00*	1.55	20.0	65.69	56.86
09/17/02	4.20	8.04	**2.00**	1.79	30.0	72.35	63.72
12/09/02	**11.30**	7.05	**1.70**	1.47	20.0	63.45	54.57
12/12/02	**9.50**	5.70	*1.00*	1.07	20.0	51.41	42.57
02/28/03	3.87	9.35	*1.00*	2.24	25.9	83.96	75.96
03/21/03	3.78	6.79	*1.00*	1.39	21.9	61.13	52.23
03/23/03	3.63	5.90	*1.00*	1.13	25.2	53.21	44.34
04/25/03	**11.60**	6.49	*1.00*	1.30	35.1	58.44	49.53
06/11/03	5.23	7.90	*1.00*	1.75	27.8	71.07	62.39
06/18/03	5.53	6.76	*1.00*	1.38	15.2	60.90	52.00
06/19/03	4.34	5.88	*1.00*	1.12	12.9	53.05	44.18
06/29/03	*1.50*	9.07	*1.00*	2.14	9.5	81.45	73.28
07/11/03	**102.00**	13.97	**32.70**	4.08	**236.0**	125.10	121.61
08/27/03	*1.50*	8.00	*1.00*	1.78	15.7	71.98	63.34
09/19/03	**7.35**	7.15	*1.00*	1.50	26	64.37	55.52
Number	26	26	26	26	26	26	26
Average	8.4	7.2	2.4	1.5	28.9	64.4	55.9
Median	4.0	6.8	1.0	1.4	20.0	61.0	52.1
Exceedance (%)	26.9%		26.9%		3.8%		

Appendix E-6. Comparison of metal concentrations measured at the outflow of the ponds to metal class III standards. Bolded values exceed Class III WQ stds. Exceed(%) represents percent of samples in non-compliance with standards. When values are below the laboratory quantification limit (LOQ) one-half the LOQ was substituted. See table 3a for formulas used to calculate state standards from water hardness. Data are for the Building pond for the 2002 sample year.

BUILDING POND							
DATE	TOTAL COPPER	STD. COPPER	TOTAL LEAD	STD. LEAD	TOTAL ZINC	STD. ZINC	Hardness
	(ug/l)	(ug/l)	(ug/l)	(ug/l)	(ug/l)	(ug/l)	
LOQ==>	2		1.5		15		
YEAR 2							
06/24/02	**10.9**	7.56	**18.90**	1.63	60.0	68.03	59.3
06/28/02	**12.5**	8.95	**18.00**	2.10	40.0	80.43	72.2
06/29/02	6.1	8.71	**3.30**	2.02	40.0	78.32	70.0
07/02/02	4.8	10.38	2.10	2.62	40.0	93.15	85.9
07/12/02	5.8	15.38	1.50	4.71	50.0	137.60	136.1
07/25/02	11.2	29.80	3.60	12.61	120.0	265.07	295.0
08/02/02	7.8	26.19	3.10	10.40	60.0	233.19	253.6
08/07/02	6.8	14.78	2.10	4.44	60.0	132.28	129.9
08/08/02	6.2	18.69	1.50	6.30	50.0	166.94	170.9
08/14/02	5.6	9.50	**5.10**	2.30	40.0	85.34	77.4
08/27/02	6.6	18.79	2.00	6.35	40.0	167.81	172.0
08/30/02	6.7	13.63	2.00	3.93	40.0	122.06	118.1
09/02/02	5.1	14.54	4.30	4.33	40.0	130.12	127.4
09/11/02	**25.0**	8.93	**6.70**	2.09	70.0	80.23	72.0
09/12/02	4.6	8.78	1.60	2.04	40.0	78.87	70.6
09/17/02	5.3	11.17	2.80	2.92	40.0	100.20	93.6
10/13/02	7.5	19.67	6.20	6.79	50.0	175.58	181.4
10/15/02	5.3	18.06	2.20	5.98	40.0	161.30	164.2
11/12/02	11.6	26.68	5.20	10.70	70.0	237.56	259.2
11/16/02	5.6	20.50	1.10	7.22	40.0	182.95	190.5
12/09/02	14.6	17.62	1.90	5.77	60.0	157.45	159.5
12/12/02	10.6	21.65	3.30	7.84	60.0	193.13	203.0
12/20/02	7.7	13.54	2.20	3.90	40.0	121.28	117.2
02/22/03	12.8	25.56	*1.00*	10.03	79.7	227.65	246.5
02/28/03	8.8	24.42	*1.00*	9.38	99.4	217.61	233.7
03/17/03	17.4	30.69	*1.00*	13.18	101.0	272.95	305.4
03/23/03	6.6	34.19	*1.00*	15.48	56.5	303.79	346.5
03/27/03	5.9	29.39	*1.00*	12.35	48.0	261.43	290.2
04/25/03	16.0	23.10	*1.00*	8.63	84.7	205.89	218.9
05/19/03	11.2	33.22	*1.00*	14.82	76.4	295.17	334.9
05/22/03	10.8	27.75	*1.00*	11.34	61.7	246.95	271.4
07/11/03	1.5	7.71	*1.00*	1.68	14.2	69.38	60.6
09/20/03	**46.4**	7.26	**20.70**	1.54	**162**	65.37	56.5
Number	33	33	33	33	33	33	33
Average	10.0	18.4	4.0	6.6	59.8	164.1	171.0
Median	7.5	18.1	2.1	6.0	50.0	161.3	164.2
Exceedance (%)	12.1%		18.2%		3.0%		

Appendix E-7. Summary statistics and percent non-compliance of standards,

	TOTAL COPPER (ug/l)	STD. COPPER (ug/l)	TOTAL LEAD (ug/l)	STD. LEAD (ug/l)	TOTAL ZINC (ug/l)	STD. ZINC (ug/l)	Hardness
LOQ==>	2		1.5		15		
Year1997 Street Pond							
Observations	30	30	30	30	30	30	30
Average	9.6	10.1	2.0	2.6	19.1	90.7	84.0
Median	7.4	9.0	1.6	2.1	15.0	81.2	73.0
Exceedance	30%		23%		0%		
Year1997 Building Ponc							
Observations	30	30	30	30	30	30	30
Average	56.8	26.7	2.0	11.5	47.9	237.9	375.0
Median	25.9	28.4	1.4	11.7	45.0	252.4	279.0
Exceedance	50%		7%		0%		
Year1997 Parking Lot Pond							
Observations	28	28	28	28	28	28	28
Average	17.5	28.9	1.0	14.0	14.8	256.0	490.0
Median	9.8	34.2	1.0	16.4	15.0	312.3	363.0
Exceedance	14%		0%		0%		
Year1998 Street Pond							
Observations	13	13	12	12	12	12	12
Average	8.6	10.7	2.2	2.3	19.6	89.3	83.0
Median	7.2	8.7	1.7	2.0	15.0	78.3	70.0
Exceedance	46%		42%		0%		
Year1998 Building Ponc							
Observations	28	28	28	28	28	28	28
Average	17.4	17.2	1.9	8.8	51.0	197.1	282.0
Median	15.2	16.8	1.1	7.9	49.9	201.1	237.0
Exceedance	39%		14%		18%		
Year 1998 Parking Lot Pond							
Observations	27	27	27	27	27	27	27
Average	13.7	14.1	1.8	9.2	17.8	190.3	320.0
Median	18.9	11.9	1.0	8.9	15.0	166.2	229.0
Exceedance	54%		26%		0%		
Year 2001 Street Pond							
Observations	16	16	16	16	15	16	16
Average	3.96	9.91	1.37	2.50	12.58	88.99	81.80
Median	3.04	9.53	0.75	2.31	7.50	85.54	77.65
Exceedance	0%		13%		0%		
Year 2001 Building Pond							
Observations	28	28	28	28	28	28	28
Average	8.15	18.61	1.62	6.44	57.36	166.11	171.37
Median	5.95	17.23	1.60	5.58	50.00	153.98	155.39
Exceedance	4%		4%		0%		
Year 2002 Street Pond							
Observations	26	26	26	26	26	26	26
Average	8.41	7.16	2.43	1.54	28.88	64.42	55.94
Median	3.99	6.77	1.00	1.39	20.00	61.02	52.11
Exceedance	27%		27%		4%		
Year 2002 Building Pond							
Observations	33	33	33	33	33	33	33
Average	10.04	18.39	3.95	6.59	59.81	164.09	171.02
Median	7.50	18.06	2.10	5.98	50.00	161.30	164.15
Exceedance	12%		18%		3%		

APPENDIX F

Comparison of Water Quality Concentrations in the Under Drains
Intensive Study 2000 to 2003

Original data: DEMO/FINAL COMPARISON/WQyr2conc/AppK_ud comparisons

Appendix F-1: Concentration of constituents measured from rainfall samples at the Florida Aquarium for year 2001. (November 2000 through July 2001). Numbers in italics are below the lab detection limit and 1/2 the detection limit used in the calculations.

Building and Street Pond Underdrains - YEAR ONE

DATE	AMMONIA		NITRITE		NITRATE		ORGANIC NITROGEN		TOTAL NITROGEN		ORTHO-PHOSPHORUS		TOTAL - PHOSPHATE	
	mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L	
L.O.Q.**	0.01		0.005		0.01		0.06		0.05		0.01		0.01	
	Building	Street	Building	Street	Building	Street	Building	Street	Building	Street	Building	Street	Building	Street
11/17/00	-----	0.673	-----	*0.0025*	-----	*0.005*	-----	0.920	-----	1.600	-----	0.331	-----	0.359
11/26/00	-----	0.099	-----	0.005	-----	0.190	-----	0.416	-----	0.710	-----	0.113	-----	0.158
1/9/01	-----	0.108	-----	*0.0025*	-----	0.114	-----	0.336	-----	*0.560*	-----	0.085	-----	0.110
3/5/01	-----	0.143	-----	*0.0025*	-----	0.058	-----	0.557	-----	0.760	-----	0.084	-----	0.107
3/29/01	-----	0.078	-----	*0.0025*	-----	0.184	-----	0.246	-----	0.510	-----	0.061	-----	0.079
3/30/01	0.079	0.080	0.006	*0.0025*	0.043	0.131	0.452	0.217	0.580	0.430	0.062	0.063	0.084	0.072
4/2/01	0.087	0.194	*0.0025*	*0.0025*	0.013	0.021	0.408	0.343	0.510	0.560	0.090	0.095	0.111	0.101
4/6/01	-----	0.305	-----	*0.0025*	-----	0.051	-----	0.262	-----	0.620	-----	0.146	-----	0.157
4/9/01	0.099	-----	*0.0025*	-----	*0.005*	-----	0.404	-----	0.510	-----	0.107	-----	0.127	-----
4/30/01	0.173	0.741	*0.0025*	0.0025	0.065	*0.005*	0.420	0.352	0.660	1.100	0.065	0.282	0.088	0.313
5/25/01	-----	0.695	-----	*0.0025*	-----	0.016	-----	0.287	-----	1.000	-----	0.280	-----	0.353
6/7/01	0.294	0.335	0.020	0.013	0.003	0.538	0.533	0.514	0.850	1.400	0.102	0.157	0.164	0.229
6/11/01	0.269	0.094	0.038	*0.0025*	0.014	0.227	0.609	0.177	0.930	0.500	0.112	0.088	0.205	0.122
6/18/01	-----	0.635	-----	*0.0025*	-----	*0.005*	-----	0.338	-----	0.980	-----	0.234	-----	0.273
6/20/01	0.405	0.499	0.014	0.005	0.017	0.280	0.664	0.416	1.100	1.200	0.094	0.189	0.128	0.223
6/23/01	0.445	0.044	0.009	*0.0025*	0.006	0.043	0.410	0.531	0.870	0.620	0.110	0.055	0.150	0.096
6/25/01	0.390	0.078	0.006	0.028	0.004	0.023	0.700	0.331	1.100	0.460	0.110	0.055	0.142	0.076
6/27/01	0.292	0.182	0.007	*0.0025*	0.006	0.079	0.385	0.437	0.690	0.700	0.114	0.101	0.154	0.115
6/29/01	0.300	0.151	0.007	0.006	0.019	0.096	0.274	0.297	0.600	0.550	0.106	0.084	0.152	0.105
7/3/01	0.295	0.290	0.006	0.005	0.025	0.164	0.324	0.191	0.650	0.650	0.133	0.135	0.168	0.151
7/6/01	0.260	0.316	0.006	0.006	0.022	0.186	0.402	0.892	0.690	1.400	0.123	0.147	0.163	0.144
7/9/01	0.289	0.209	*0.0025*	*0.0025*	0.065	0.098	0.314	0.231	0.670	0.540	0.118	0.119	0.141	0.104
7/11/01	0.329	0.150	*0.0025*	*0.0025*	0.024	0.034	0.455	0.404	0.810	0.590	0.115	0.084	0.153	0.098
7/13/01	0.162	0.200	0.005	*0.0025*	0.005	0.075	0.538	0.333	0.710	0.610	0.066	0.109	0.122	0.118
7/16/01	0.234	0.166	0.006	*0.0025*	0.030	0.111	0.900	0.401	1.170	0.680	0.117	0.104	0.164	0.115
7/18/01	0.278	0.202	0.006	*0.0025*	0.012	0.087	0.574	0.389	0.870	0.680	0.130	0.116	0.154	0.139
7/20/01	0.271	0.212	0.005	*0.0025*	0.012	0.086	0.292	0.280	0.580	0.580	0.116	0.104	0.160	0.125
7/22/01	0.225	0.130	0.007	*0.0025*	0.024	*0.005*	0.544	0.783	0.800	0.920	0.113	0.072	0.145	0.084
7/24/01	0.271	0.231	0.006	*0.0025*	0.032	0.063	0.321	0.134	0.630	0.430	0.104	0.084	0.174	0.090
7/27/01	0.240	0.213	0.006	*0.0025*	0.007	0.122	0.507	0.303	0.760	0.640	0.103	0.092	0.152	0.087
Count	22	29	22	29	22	29	22	29	22	29	22	29	22	29
Average	0.259	0.257	0.008	0.004	0.021	0.107	0.474	0.390	0.761	0.758	0.105	0.127	0.146	0.148
Median	0.271	0.200	0.006	0.003	0.016	0.086	0.436	0.338	0.700	0.640	0.110	0.104	0.152	0.115
Max.	0.445	0.741	0.038	0.028	0.065	0.538	0.900	0.920	1.170	1.600	0.133	0.331	0.205	0.359
Min.	0.079	0.044	0.003	0.003	0.003	0.005	0.274	0.134	0.510	0.430	0.062	0.055	0.084	0.072
Std. Dev.	0.095	0.199	0.008	0.005	0.018	0.110	0.152	0.194	0.188	0.313	0.019	0.072	0.027	0.082
C.V.*	0.37	0.775	1.00	1.19	0.86	1.03	0.32	0.50	0.25	0.41	0.18	0.57	0.19	0.55

Appendix F-2: Concentration of constituents measured from rainfall samples at the Florida Aquarium for year 2001. (November 2000 through July 2001). Numbers in italics are below the lab detection limit and 1/2 the detection limit used in the calculations.

Building and Street Pond Underdrains

DATE	TOTAL CADMIUM		TOTAL COPPER		TOTAL IRON		TOTAL LEAD		MANGANESE		TOTAL ZINC		HARDNESS	
	ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		(mg/l as CaCO3)	
L.O.Q.**	0.3		2.0		25		1.5		1.0		15.0		20.0	
	Building	Street	Building	Street	Building	Street	Building	Street	Building	Street	Building	Street	Building	Street
11/17/00	-----	0.30	-----	4.70	-----	70.00	-----	*0.75*	-----	12.80	-----	20.00	-----	240.81
11/26/00	-----	*0.15*	-----	4.10	-----	80.00	-----	*0.75*	-----	3.60	-----	*7.50*	-----	165.99
1/9/01	-----	*0.15*	-----	5.40	-----	80.00	-----	*0.75*	-----	3.20	-----	*7.50*	-----	102.96
3/5/01	-----	*0.15*	-----	5.80	-----	100.00	-----	*0.75*	-----	3.70	-----	*7.50*	-----	117.24
3/29/01		*0.15*		2.10		70.00		*0.75*		2.40		*7.50*		70.06
3/30/01	0.30	*0.15*	3.20	8.10	1110.00	250.00	1.25	4.10	59.40	4.30	20.00	40.00	394.41	53.23
4/2/01	1.40	0.40	10.60	*1.00*	550.00	430.00	*0.75*	4.30	64.70	13.90	30.00	40.00	271.29	118.85
4/6/01	-----	*0.15*	-----	*1.00*	-----	70.00	-----	*0.75*	-----	7.20	-----	*7.50*	-----	129.44
4/9/01	*0.15*	-----	2.30	-----	710.00	-----	*0.75*	-----	52.70	-----	*7.50*	-----	201.62	-----
4/30/01	*0.15*	*0.15*	3.80	2.30	530.00	40.00	*0.75*	*0.75*	69.60	13.80	*7.50*	*7.50*	617.09	238.09
5/25/01	-----	*0.15*	-----	*1.00*	-----	40.00	-----	*0.75*	-----	13.70	-----	20.00	-----	299.47
6/7/01	*0.15*	*0.15*	4.70	6.50	610.00	190.00	*0.75*	*0.75*	166.00	6.40	20.00	*7.50*	704.11	173.14
6/11/01	*0.15*	*0.15*	4.30	5.40	310.00	*12.50*	*0.75*	*0.75*	58.40	1.80	*7.50*	*7.50*	441.96	110.91
6/18/01	-----	***0.15***	-----	3.00	-----	60.00	-----	*0.75*	-----	16.20	-----	*7.50*	-----	127.90
6/20/01	*0.15*	*0.15*	4.00	4.20	110.00	60.00	*0.75*	*0.75*	92.10	10.80	*7.50*	*7.50*	452.77	192.47
6/23/01	*0.15*	*0.15*	3.20	5.20	110.00	70.00	*0.75*	*0.75*	76.00	3.40	*7.50*	*7.50*	408.07	95.14
6/25/01	*0.15*	*0.15*	2.20	2.10	90.00	30.00	*0.75*	*0.75*	69.20	3.50	*7.50*	*7.50*	327.97	101.49
6/27/01	*0.15*	*0.15*	***1.00***	2.30	70.00	50.00	*0.75*	*0.75*	50.40	5.90	*7.50*	*7.50*	254.77	126.32
6/29/01	*0.15*	*0.15*	2.00	*1.00*	180.00	50.00	*0.75*	*0.75*	42.80	4.00	*7.50*	*7.50*	220.45	101.57
7/3/01	*0.15*	*0.15*	3.00	2.80	110.00	80.00	*0.75*	*0.75*	39.80	8.70	*7.50*	*7.50*	170.76	143.48
7/6/01	*0.15*	*0.15*	4.00	*1.00*	110.00	50.00	*0.75*	*0.75*	36.10	8.70	*7.50*	*7.50*	166.18	154.67
7/9/01	*0.15*	*0.15*	2.30	*1.00*	100.00	40.00	*0.75*	*0.75*	40.00	5.80	*7.50*	*7.50*	178.14	121.80
7/11/01	*0.15*	*0.15*	3.20	2.10	80.00	*12.50*	*0.75*	*0.75*	43.80	4.80	*7.50*	*7.50*	192.66	112.35
7/13/01	*0.15*	*0.15*	*1.00*	*1.00*	50.00	30.00	*0.75*	*0.75*	44.00	6.20	*7.50*	*7.50*	183.46	120.99
7/16/01	*0.15*	*0.15*	2.00	5.60	100.00	30.00	*0.75*	*0.75*	37.80	5.80	*20.00*	*7.50*	171.04	130.68
7/18/01	*0.15*	*0.15*	*1.00*	2.40	70.00	40.00	*0.75*	*0.75*	41.30	6.60	*7.50*	*7.50*	165.16	123.14
7/20/01	*0.15*	*0.15*	*1.00*	*1.00*	80.00	40.00	*0.75*	*0.75*	45.90	6.30	*7.50*	*7.50*	180.03	131.35
7/22/01	*0.15*	*0.15*	2.40	2.00	160.00	30.00	*0.75*	*0.75*	49.20	7.10	*20.00*	*7.50*	196.56	116.70
7/24/01	*0.15*	*0.15*	4.20	*1.00*	270.00	30.00	*0.75*	*0.75*	46.60	11.30	*30.00*	*7.50*	202.03	143.78
7/27/01	*0.15*	*0.15*	*3.10*	2.50	110.00	40.00	*0.75*	*0.75*	33.70	5.90	*7.50*	*7.50*	175.32	140.56
Count	22	29	22	29	22	29	22	29	22	29	22	29	22	29
Average	0.214	0.164	3.114	3.021	255.45	75.00	0.77	0.99	57.250	7.166	11.818	10.603	285.266	138.09
Median	0.150	0.150	3.050	2.300	110.00	50.00	0.75	0.75	47.900	6.200	7.500	7.500	201.822	126.32
Max.	1.400	0.400	10.600	8.100	1110.00	430.00	1.25	4.30	166.000	16.200	30.000	40.000	704.106	299.47
Min.	0.150	0.150	1.000	1.000	50.00	12.50	0.75	0.75	33.700	1.800	7.500	7.500	165.160	53.228
Std. Dev.	0.267	0.053	2.027	2.034	275.75	84.15	0.11	0.89	28.390	3.934	7.645	8.754	154.677	51.18
C.V. *	1.25	0.33	0.65	0.67	1.08	1.12	0.14	0.90	0.50	0.55	0.65	0.83	0.54	0.37

Appendix E-3: Concentration of constituents measured from rainfall samples at the Florida Aquarium for year 2001. (November 2000 through July 2001). Numbers in italics are below the lab detection limit and 1/2 the detection limit used in the calculations.

Building and Street Pond Underdrains - YEAR ONE

DATE	CALCIUM		CHLORIDE		POTASSIUM		SODIUM		SULFATE		MAGNESIUM		TSS	
	(mg/l)		mg/L		mg/L		mg/L		mg/L		mg/L		(mg/l)	
L.O.Q.**			0.4		0.04		0.06						0.05	
	Building	Street	Building	Street	Building	Street	Building	Street	Building	Street	Building	Street	Build	Street
11/17/00	-----	68.90	-----	235.00	-----	15.10	-----	142.00	-----	55.40	-----	16.70	-----	-----
11/26/00	-----	56.40	-----	38.60	-----	10.10	-----	48.00	-----	41.50	-----	6.11	-----	-----
1/9/01	-----	35.00	-----	33.60	-----	7.48	-----	27.60	-----	30.50	-----	3.78	-----	-----
3/5/01	-----	39.50	-----	41.60	-----	7.74	-----	31.50	-----	33.80	-----	4.52	-----	-----
3/29/01	-----	23.90	-----	22.10	-----	5.65	-----	17.90	-----	21.60	-----	2.52	-----	-----
3/30/01	71.70	18.20	843.00	17.20	19.20	4.02	475.00	13.00	148.00	13.90	52.30	1.89	-----	-----
4/2/01	50.10	41.00	463.00	44.20	13.50	5.48	297.00	29.40	108.00	19.70	35.50	4.00	-----	-----
4/6/01	-----	41.20	-----	78.70	-----	7.67	-----	50.90	-----	31.00	-----	6.45	-----	-----
4/9/01	37.70	-----	325.00	-----	10.50	-----	195.00	-----	63.40	-----	26.10	-----	-----	-----
4/30/01	118.00	68.80	1240.00	209.00	26.10	14.80	694.00	134.00	219.00	61.00	78.30	16.10	-----	-----
5/25/01	-----	82.00	-----	302.00	-----	19.40	-----	189.00	-----	80.70	-----	23.00	-----	-----
6/7/01	123.00	54.00	1510.00	126.00	35.60	11.90	840.00	78.60	275.00	58.40	96.40	9.30	-----	-----
6/11/01	69.80	38.10	1020.00	41.90	28.00	6.96	606.00	28.30	185.00	32.10	65.00	3.83	-----	-----
6/18/01	-----	75.30	-----	174.00	-----	14.60	-----	106.00	-----	67.40	-----	14.60	-----	-----
6/20/01	83.20	59.60	942.00	125.00	25.90	11.20	533.00	76.40	133.00	49.40	59.50	10.60	-----	-----
6/23/01	71.40	33.50	901.00	24.40	24.40	5.78	498.00	17.80	137.00	24.00	55.80	2.79	1.25	2.21
6/25/01	57.30	35.60	724.00	28.20	21.30	5.69	413.00	19.60	113.00	21.40	44.90	3.06	1.26	1.27
6/27/01	45.30	41.70	525.00	56.00	17.20	7.29	307.00	35.70	86.00	26.90	34.40	5.39	-----	-----
6/29/01	39.80	33.90	430.00	41.80	14.40	6.31	252.00	26.20	66.80	20.90	29.40	4.11	2.13	1.61
7/3/01	32.60	47.40	287.00	72.00	10.50	7.76	172.00	43.20	40.30	26.60	21.70	6.10	1.23	0.94
7/6/01	33.90	50.10	240.00	88.80	9.13	8.72	146.00	54.60	29.90	30.40	19.80	7.18	1.18	1.29
7/9/01	37.70	40.50	235.00	55.80	8.43	7.00	140.00	35.70	28.90	21.40	20.40	5.02	1.11	1.45
7/11/01	41.70	38.30	247.00	36.70	8.40	6.20	147.00	26.80	37.90	18.90	21.50	4.06	1.38	1.39
7/13/01	39.50	40.80	234.00	50.20	8.23	6.39	141.00	32.40	38.20	20.00	20.60	4.64	0.94	0.34
7/16/01	37.00	43.00	203.00	66.30	7.67	6.97	122.00	40.80	26.70	23.40	19.10	5.66	2.25	1.25
7/18/01	35.80	39.60	192.00	69.30	7.10	7.01	112.00	41.80	18.90	22.30	18.40	5.89	1.10	1.00
7/20/01	40.60	41.70	207.00	75.10	7.25	7.26	120.00	45.50	21.70	24.50	19.10	6.61	1.10	1.20
7/22/01	45.90	39.10	239.00	48.90	7.15	5.98	133.00	30.20	27.50	18.20	19.90	4.63	2.25	0.08
7/24/01	47.10	46.50	261.00	82.50	7.60	6.51	147.00	46.20	36.30	27.40	20.50	6.72	9.58	0.64
7/27/01	43.00	44.50	193.00	88.70	6.28	6.76	114.00	53.80	26.00	27.20	16.50	7.15	3.08	1.09
Count	22	29	22	29	22	29	22	29	22	29	22	29	14	26
Average	54.641	45.452	520.955	81.848	14.720	8.404	300.182	52.514	84.841	32.755	36.141	6.980	2.1	1.1
Median	44.150	41.200	306.000	56.000	10.500	7.010	183.500	40.800	51.850	26.900	23.900	5.660	1.3	1.2
Max.	123.000	82.000	1510.000	302.000	35.600	19.400	840.000	189.000	275.000	80.700	96.400	23.000	9.6	2.2
Min.	32.600	18.200	192.000	17.200	6.280	4.020	112.000	13.000	18.900	13.900	16.500	1.890	0.939	0.083
Std. Dev.	25.503	14.349	390.136	68.368	8.627	3.566	217.174	41.359	71.935	16.823	22.499	4.869	2.2	0.5
C.V. *	0.47	0.32	0.75	0.84	0.59	0.42	0.72	0.79	0.85	0.51	0.62	0.70	1.05	0.47

Appendix F-4. Constituent concentrations measured from composite samples collected in Year 2 at the South Underdrain. The North Underdrain was installed during constuction and is included in Year 2. *Sampling event covers two storms. **Numbers in italics were below the lab detection limit, and 1/2 the detection limit was used in the calculations. ***C.V. = Coefficient of Variation (Standard Deviation/Mean).

STORM #		AMMONIA		NITRATE + NITRITE		ORGANIC NITROGEN		TOTAL NITROGEN		ORTHO-PHOSPHATE		TOTAL - PHOSPHATE		TSS	
		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L	
	L.O.Q**	0.01		0.01		0.05		0.05		0.01		0.01		0.05	
	DATE	South	North	South	North	South	North	South	North	South	North	South	North	South	North
	06/10/02	0.012	0.418	0.035	0.011	1.733	0.051	1.780	0.480	0.322	0.182	0.353	0.201	6.62	*0.25*
	06/12/02	1.680	0.334	0.026	0.014	0.255	0.133	1.960	0.480	0.333	0.175	0.353	0.204	*0.25*	1.30
2	06/18/02	0.181	0.031	0.488	0.040	0.391	0.340	1.060	0.410	0.067	0.040	0.156	0.062	2.60	2.60
3	06/24/02	0.109	0.195	0.142	0.093	0.229	0.232	0.480	0.520	0.107	0.116	0.139	0.123	9.10	3.70
5	06/29/02	0.170	0.208	0.249	0.149	0.211	0.173	0.630	0.530	0.085	0.101	0.101	0.102	5.00	2.40
6	07/01/02	0.185	0.166	0.216	0.160	0.209	0.244	0.610	0.570	0.091	0.090	0.110	0.104	2.90	1.60
	07/02/02	0.163	0.191	0.094	0.083	0.323	0.276	0.580	0.550	0.093	0.094	0.970	0.099	1.70	1.10
	07/10/02	0.688	0.246	0.135	0.074	0.337	0.310	1.160	0.630	0.238	0.096	0.259	0.230	0.80	2.00
	07/16/02	0.180	0.125	0.112	0.125	0.129	0.682	0.421	0.932	0.105	0.070	0.134	0.111	0.90	-----
7	07/25/02	0.852	0.526	0.137	0.112	0.161	0.242	1.150	0.880	0.265	0.128	0.304	0.173	1.60	2.70
8	08/02/02	0.795	0.462	0.086	0.083	0.349	0.355	1.230	0.900	0.254	0.121	0.291	0.141	2.10	1.20
9	08/07/02	0.220	0.127	0.343	0.278	0.327	0.355	0.890	0.760	0.109	0.058	0.136	0.086	1.40	2.70
	08/12/02	0.288	0.168	0.130	0.188	0.182	0.154	0.600	0.510	0.116	0.061	0.133	0.071	1.60	1.30
10	08/14/02	-----	0.163	-----	0.408	-----	0.147	-----	0.718	-----	0.069	-----	0.080	-----	2.20
	08/19/02	-----	0.085	-----	0.211	-----	0.064	-----	0.360	-----	0.060	-----	0.074	-----	1.10
12	08/30/02	0.634	0.246	0.198	0.066	0.060	0.141	0.892	0.453	0.219	0.066	0.214	0.086	*0.25*	1.10
	08/31/02	0.128	0.114	0.263	0.069	0.179	0.179	0.570	0.362	0.086	0.047	0.090	0.076	*0.25*	1.40
13	09/02/02	0.083	0.064	0.091	0.083	0.174	0.210	0.348	0.357	0.075	0.049	0.086	0.065	0.90	1.10
14	09/11/02	0.240	0.210	0.151	0.079	0.266	0.282	0.657	0.571	0.093	0.072	0.118	0.109	1.80	1.30
15	09/12/02	0.083	0.161	0.079	0.033	0.205	0.142	0.367	0.336	0.052	0.059	0.066	0.082	0.60	1.80
	09/16/02	0.091	0.204	0.095	0.049	0.189	0.322	0.375	0.575	0.062	0.094	0.081	0.132	0.90	2.20
16	09/17/02	0.421	0.327	0.164	0.092	0.272	0.178	0.857	0.597	0.140	0.102	0.160	0.119	1.30	0.60
17	09/27/02	0.154	0.420	0.054	0.066	0.284	0.350	0.492	0.836	0.072	0.112	0.093	0.146	1.12	1.30
	09/30/02	0.122	0.039	0.052	0.064	0.299	1.183	0.472	1.286	0.081	0.120	0.106	0.170	1.68	3.26
18	10/12/02	0.386	0.435	0.301	0.142	0.143	0.233	0.830	0.810	0.103	0.066	0.139	0.104	4.09	2.65
19	10/15/02	0.131	0.464	0.047	0.032	0.322	0.354	0.500	0.850	0.074	0.091	0.117	0.186	1.87	3.78
	11/04/02	0.711	1.102	0.124	0.096	0.085	0.272	0.920	1.470	0.206	0.211	0.206	0.235	0.40	1.86
21	11/12/02	0.211	0.266	0.354	0.093	0.305	0.451	0.870	0.810	0.075	0.056	0.111	0.099	2.33	2.49
	11/18/02	0.140	0.217	0.109	0.128	0.281	0.295	0.530	0.640	0.069	0.063	0.077	0.087	1.15	1.58
	11/25/02	0.583	0.545	0.064	0.201	0.263	0.304	0.910	1.050	0.187	0.152	0.202	0.175	0.69	1.74
22	12/09/02	0.125	0.110	0.345	0.333	0.250	0.257	0.720	0.700	0.069	0.064	0.082	0.088	1.12	2.08
23	12/12/02	0.148	0.204	0.441	0.183	0.201	0.213	0.790	0.600	0.076	0.066	0.089	0.083	2.35	1.53
	01/14/03	0.674	1.060	0.086	0.087	0.310	0.173	1.070	1.320	0.265	0.256	0.286	0.279	1.05	1.24
24	02/22/03	0.235	0.345	0.198	0.023	0.209	0.298	0.642	0.666	0.119	0.097	0.147	0.128	1.31	2.24
25	02/28/03	0.144	0.246	0.104	0.044	0.132	0.230	0.380	0.520	0.083	0.092	0.095	0.113	0.59	*1.50*
	03/10/03	0.409	0.797	0.086	0.042	0.159	0.231	0.654	1.070	0.178	0.216	0.191	0.241	0.70	3.72
26	03/16/03	0.422	0.345	0.333	0.068	0.223	0.351	0.978	0.764	0.171	0.103	0.201	0.144	1.58	1.50
28	03/23/03	0.108		0.101		0.212	0.000	0.421		0.074		0.089		1.09	*1.50*
	03/27/03	0.179	0.106	0.101	0.060	0.197	0.368	0.477	0.534	0.098	0.062	0.105	0.087	0.80	*1.50*
	04/21/03	0.902	1.460	0.067	0.057	0.281	0.323	1.250	1.840	0.303	0.294	0.334	0.355	2.04	3.50
29	04/25/03	0.116	0.361	0.532	0.314	0.350	0.365	0.998	1.040	0.071	0.091	0.100	0.121	3.11	4.57
	04/28/03	0.146	0.037	0.161	0.100	0.152	0.206	0.459	0.343	0.085	0.036	0.094	0.047	0.42	3.25
	05/12/03	0.799	1.270	0.071	0.042	0.360	0.338	1.230	1.650	0.277	0.280	0.295	0.323	1.01	*1.50*
	05/21/03	0.561	0.353	0.299	0.129	0.200	0.301	1.060	0.783	0.202	0.090	0.227	0.110	1.96	*1.50*
30	05/22/03	0.303	0.098	0.368	0.090	0.293	0.381	0.964	0.569	0.120	0.043	0.136	0.059	0.88	*1.50*
	06/02/03	0.869	1.590	0.046	0.040	0.285	0.280	1.200	1.910	0.287	0.311	0.302	0.343	0.51	*1.50*
31*	06/09/03	0.572	0.349	0.261	0.090	0.277	0.401	1.110	0.840	0.200	0.094	0.228	0.123	0.77	*1.50*
	06/11/03	0.296	0.066	0.107	0.025	0.227	0.379	0.630	0.470	0.122	0.030	0.149	0.058	0.61	*1.50*
32	06/11/03	0.114	0.045	0.145	0.095	0.291	0.350	0.550	0.490	0.068	0.025	0.092	0.067	1.01	*1.50*
	06/16/03	0.409	0.264	0.076	0.067	0.338	0.446	0.823	0.777	0.163	0.089	0.175	0.112	0.75	*1.50*
33	06/16/03	0.148	0.045	0.117	0.048	0.346	0.272	0.611	0.365	0.076	0.026	0.090	0.047	0.49	*1.50*
34	06/18/03	0.125	0.030	0.079	0.024	0.196	0.266	0.400	0.320	0.077	0.031	0.086	0.044	2.81	*1.50*
35	06/19/03	0.160	0.044	0.203	0.036	0.157	0.150	0.520	0.230	0.085	0.042	0.089	0.054	0.58	*1.50*
36	06/29/03	0.312	0.187	0.162	0.086	0.475	0.223	0.949	0.496	0.111	0.065	0.156	0.102	8.66	*1.50*
	07/01/03	0.163	0.068	0.098	0.069	0.549	0.213	0.810	0.350	0.093	0.048	0.309	0.064	37.60	14.50
37	07/11/03	0.217	0.176	0.079	0.040	0.334	0.227	0.630	0.443	0.096	0.075	0.333	0.116	47.00	6.84
	07/23/03	0.282	0.397	0.087	0.062	0.264	0.132	0.633	0.591	0.117	0.121	0.398	0.138	74.60	10.40
	08/12/03	0.213	0.202	0.108	0.052	0.277	0.189	0.598	0.443	0.094	0.091	0.113	0.095	3.70	*1.50*
	08/18/03	0.128	0.226	0.085	0.085	0.155	0.153	0.368	0.464	0.079	0.100	0.097	0.109	5.46	*1.50*
38	08/27/03	0.135	0.139	0.077	0.058	0.288	0.263	0.500	0.460	0.075	0.064	0.181	0.073	27.10	4.95
	09/05/03	0.164	0.172	0.048	0.037	0.263	0.286	0.475	0.495	0.077	0.066	0.103	0.082	3.45	*1.50*
	09/10/03	0.197	0.293	0.092	0.055	0.396	0.277	0.685	0.625	0.089	0.099	0.157	0.121	8.58	*1.50*
39	09/19/03	0.212	0.163	0.199	0.118	0.300	0.260	0.711	0.541	0.106	0.068	0.168	0.089	11.80	5.51
	10/03/03	0.164	0.193	0.064	0.056	0.198	0.175	0.426	0.424	0.087	0.084	0.102	0.091	1.66	*1.50*
	10/13/03	0.404	0.792	0.069	0.012	0.283	0.356	0.756	1.160	0.181	0.213	0.196	0.238	1.13	*1.50*
	Count	63	64	63	64	63	65	63	64	63	64	63	64	63	64
	Average	0.321	0.320	0.156	0.094	0.279	0.277	0.756	0.696	0.131	0.099	0.179	0.126	4.99	2.37
	Median	0.197	0.206	0.108	0.072	0.264	0.266	0.654	0.573	0.096	0.090	0.139	0.107	1.40	1.50
	Max.	1.680	1.590	0.532	0.408	1.733	1.183	1.960	1.910	0.333	0.311	0.970	0.355	74.60	14.50
	Min.	0.012	0.030	0.026	0.011	0.060	0.000	0.348	0.230	0.052	0.025	0.066	0.044	0.25	0.25
	Std. Dev.	0.289	0.334	0.116	0.078	0.206	0.156	0.328	0.358	0.074	0.065	0.132	0.071	12.03	2.20
	C.V.***	0.900	1.043	0.740	0.821	0.736	0.564	0.434	0.515	0.568	0.651	0.739	0.562	2.41	0.93

Appendix F-5. Constituent concentrations measured from composite samples collected in Year 2 at the South Underdrain. The North Underdrain was installed during constuction and is included in Year 2. *Sampling event covers two storms. **Numbers in italics were below the lab detection limit, and 1/2 the detection limit was used in the calculations. ***C.V. = Coefficient of Variation (Standard Deviation/Mean).

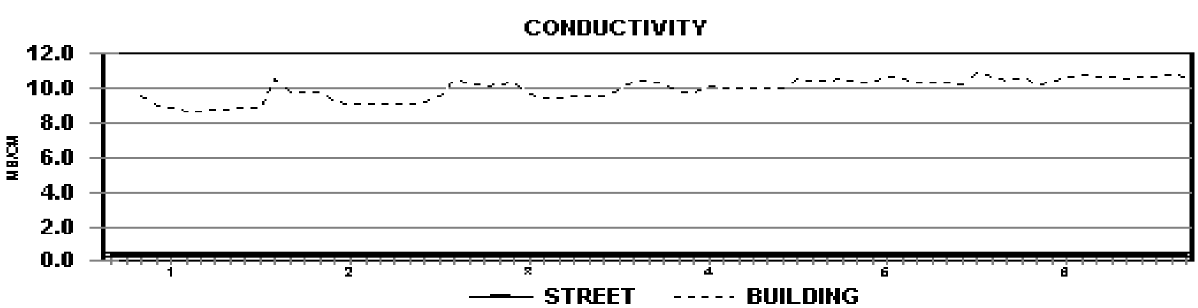
STORM #		TOTAL COPPER		TOTAL LEAD		TOTAL ZINC		MANGANESE		TOTAL IRON		TOTAL CADMIUM		HARDNESS	
		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		mg/L as CaCO3	
	L.O.Q**	2.0		1.50		15.0		1.0		25.0		0.3		20.0	
	DATE	South	North	South	North	South	North	South	North	South	North	South	North	South	North
	06/10/02	2.50	*1.15*	0.40	*1.00*	30.0	*6.0*	39.4	41.9	90.0	130.0	0.28	*0.10*	344.40	116.31
	06/12/02	3.30	*1.15*	0.20	*1.00*	*6.0*	*6.0*	37.0	38.7	80.0	100.0	*0.10*	*0.10*	341.94	111.48
2	06/18/02	3.20	2.60	*2.40*	0.50	20.0	20.0	15.7	10.0	460.0	160.0	*0.08*	*0.04*	116.14	75.11
3	06/24/02	2.80	2.70	2.20	1.30	*6.0*	*6.0*	10.4	11.6	320.0	190.0	*0.10*	*0.10*	78.45	65.03
5	06/29/02	3.10	*1.15*	*1.00*	*1.00*	50.0	*6.0*	10.8	11.1	110.0	110.0	*0.10*	*0.10*	94.32	93.53
6	07/01/02	2.60	*1.15*	*1.00*	*1.00*	30.0	*6.0*	12.7	8.6	110.0	90.0	*0.10*	*0.10*	120.74	87.68
	07/02/02	2.80	*1.15*	*1.00*	*1.00*	*6.0*	*6.0*	12.1	10.2	110.0	70.0	*0.10*	*0.10*	107.28	84.82
	07/10/02	*1.15*	*1.15*	*1.00*	*1.00*	30.0	*6.0*	29.0	13.4	110.0	90.0	*0.10*	*0.10*	279.74	87.24
	07/16/02	2.50	1.70	*1.00*	*1.00*	20.0	*7.5*	7.3	14.8	80.0	100.0	*0.07*	*0.05*	128.60	80.24
7	07/25/02	*1.15*	*1.15*	*1.00*	*1.00*	*7.5*	*7.5*	30.3	59.7	70.0	100.0	1.09	*0.10*	306.93	125.33
8	08/02/02	*1.15*	*1.15*	1.60	*1.00*	*30.0*	20.0	22.1	31.0	80.0	90.0	*0.10*	*0.10*	309.22	133.27
9	08/07/02	*1.15*	*1.15*	*1.00*	*1.00*	20.0	20.0	12.1	15.7	80.0	100.0	*0.10*	*0.10*	169.32	103.14
	08/12/02	*1.15*	2.40	*1.00*	*1.00*	*7.5*	*7.5*	9.3	10.9	70.0	80.0	*0.10*	*0.10*	162.21	99.90
10	08/14/02	-----	*1.15*	-----	*1.00*	-----	*7.5*	-----	14.9	-----	130.0	-----	*0.10*	-----	88.72
	08/19/02	-----	*1.15*	-----	*1.00*	-----	*7.5*	-----	11.4	-----	60.0	-----	*0.10*	-----	83.90
12	08/30/02	2.60	2.50	*1.00*	*1.00*	*7.5*	*20.0*	16.2	12.1	30.0	60.0	*0.10*	0.60	207.52	91.86
	08/31/02	2.60	*1.15*	*1.00*	*1.00*	*7.5*	*7.5*	8.9	11.6	70.0	60.0	*0.10*	*0.10*	113.64	88.51
13	09/02/02	*1.15*	*1.15*	*1.00*	*1.00*	*7.5*	*7.5*	7.0	14.3	40.0	60.0	0.41	*0.10*	125.46	108.10
14	09/11/02	*1.15*	*1.15*	*1.00*	*1.00*	*7.5*	30.0	25.5	37.5	100.0	110.0	*0.10*	*0.10*	154.49	133.46
15	09/12/02	*1.15*	2.60	*1.00*	1.20	20.0	20.0	9.6	32.2	60.0	100.0	*0.10*	*0.10*	106.27	111.48
	09/16/02	*1.15*	*1.15*	*1.00*	*1.00*	*7.5*	*7.5*	7.7	71.6	60.0	140.0	*0.10*	*0.10*	121.47	144.45
16	09/17/02	*1.15*	*1.15*	*1.00*	*1.00*	20.0	20.0	29.1	61.4	100.0	130.0	*0.10*	*0.10*	214.60	132.45
17	09/27/02	3.00	*1.15*	*1.00*	*1.00*	*7.5*	*7.5*	20.7	50.7	160.0	220.0	*0.10*	*0.10*	157.35	180.89
	09/30/02	*1.15*	*1.15*	*1.00*	*1.00*	*7.5*	*7.5*	16.0	91.1	110.0	280.0	*0.10*	*0.10*	175.09	205.28
18	10/12/02	2.50	2.50	*1.00*	*1.00*	*7.5*	20.0	26.0	102.0	110.0	190.0	0.33	*0.10*	176.84	159.83
19	10/15/02	*1.15*	*1.15*	*1.00*	*1.00*	20.0	20.0	32.9	128.0	180.0	510.0	*0.10*	*0.10*	143.90	159.19
	11/04/02	*1.15*	2.40	*1.00*	*1.00*	20.0	50.0	33.6	73.2	110.0	240.0	*0.10*	*0.10*	246.81	223.32
21	11/12/02	*1.15*	*1.15*	*1.00*	*1.00*	70.0	*7.5*			80.0	160.0	-----	-----	171.95	156.31
	11/18/02	*1.15*	*1.15*	*1.00*	*1.00*	20.0	*7.5*			70.0	110.0	*0.10*	*0.10*	143.97	139.75
	11/25/02	*1.15*	*3.30*	*1.00*	*1.00*	*7.5*	*7.5*			70.0	180.0	*0.10*	*0.10*	225.36	176.75
22	12/09/02	3.80	3.80	*1.00*	*1.00*	*7.5*	*7.5*	Changed Lab Constituents		60.0	130.0	*0.10*	*0.10*	120.08	84.20
23	12/12/02	4.20	3.50	*1.00*	*1.00*	*7.5*	*7.5*			120.0	120.0	*0.10*	*0.10*	125.08	89.15
	01/14/03	*1.15*	2.30	*1.00*	*1.00*	*7.5*	*7.5*			90.0	110.0	*0.10*	*0.10*	275.63	160.16
24	02/22/03	*1.50*	*1.50*	*5.00*	*5.00*	4.3	5.4			44.9	47.3	*0.50*	*0.50*	173.58	129.93
25	02/28/03	0.94	4.40	*5.00*	*5.00*	18.8	9.2			40.6	79.3	*0.50*	*0.50*	136.63	126.62
	03/10/03	1.54	*1.50*	*5.00*	*5.00*	9.0	5.4			78.5	88.9	*0.50*	*0.50*	222.84	191.89
26	03/16/03	1.77	*1.50*	*5.00*	*5.00*	16.8	7.7			66.7	113.0	*0.50*	*0.50*	215.03	134.69
28	03/23/03			*5.00*		13.8				31.6		*0.50*		109.71	
	03/27/03	0.66	*1.50*	*5.00*	*5.00*	26.3	5.8			39.7	123.0	*0.50*	*0.50*	135.18	93.60
	04/21/03	1.71	*1.50*	*5.00*	*5.00*	4.4	8.7			69.4	99.2	*0.50*	*0.50*	318.18	220.09
29	04/25/03	3.73	4.66	*5.00*	*5.00*	5.6	5.6			130.0	193.0	*0.50*	*0.50*	108.21	101.54
	04/28/03	0.57	3.67	*5.00*	*5.00*	2.9	4.9			40.7	44.9	*0.50*	*0.50*	111.77	65.96
	05/12/03	2.22	*1.50*	*5.00*	*5.00*	18.6	35.6			51.2	81.1	*0.50*	*0.50*	303.78	213.78
	05/21/03	0.45	*1.50*	*5.00*	*5.00*	16.7	30.4			69.8	64.2	*0.50*	*0.50*	234.91	131.11
30	05/22/03	1.18	3.13	*5.00*	*5.00*	6.2	14.4			64.0	63.5	*0.50*	*0.50*	185.61	106.86
	06/02/03	1.57	*1.50*	*5.00*	*5.00*	6.3	3.4			50.6	86.5	*0.50*	*0.50*	313.75	229.60
31*	06/09/03	1.46	*1.50*	*5.00*	*5.00*	3.9	3.2			47.4	66.3	*0.50*	*0.50*	256.26	126.94
	06/11/03	1.22	*1.50*	*5.00*	*5.00*	5.2	2.1			64.3	57.6	*0.50*	*0.50*	177.60	98.88
32	06/11/03	1.89	*1.50*	*5.00*	*5.00*	4.3	22.8			62.3	91.3	*0.50*	*0.50*	121.10	82.26
	06/16/03	1.47	*1.50*	*5.00*	*5.00*	3.2	8.8	Changed Lab Constituents		70.8	151.0	*0.50*	*0.50*	211.14	120.26
33	06/16/03	1.38	*1.50*	*5.00*	*5.00*	3.1	12.2			41.6	86.1	*0.50*	*0.50*	130.49	85.02
34	06/18/03	2.00	*1.50*	*5.00*	*5.00*	5.1	2.3			102.0	74.5	*0.50*	*0.50*	122.73	81.57
35	06/19/03	0.72	*1.50*	*5.00*	*5.00*	5.6	5.0			53.1	95.3	*0.50*	*0.50*	139.79	75.86
36	06/29/03		*1.50*	*5.00*	*5.00*	5.7	3.6			223.0	369.0	*0.50*	*0.50*	187.87	103.67
	07/01/03	0.60	*1.50*	*5.00*	*5.00*	25.9	2.5			1140.0	72.1	*0.50*	*0.50*	162.01	84.95
37	07/11/03	4.51	*1.50*	*5.00*	*5.00*	20.2	5.4			1160.0	518.0	*0.50*	*0.50*	176.67	98.34
	07/23/03	0.98	*1.50*	12.60	*5.00*	24.2	3.9			1280.0	215.0	*0.50*	*0.50*	208.66	130.52
	08/12/03	0.74	*1.50*	*5.00*	*5.00*	3.5	3.3			87.7	109.0	*0.50*	*0.50*	139.19	103.24
	08/18/03	1.26	*1.50*	*5.00*	*5.00*	4.6	*1.0*			78.9	105.0	*0.50*	*0.50*	142.64	125.04
38	08/27/03	0.68	*1.50*	*5.00*	*5.00*	10.2	3.9			503.0	69.2	*0.50*	*0.50*	133.24	92.51
	09/05/03	0.59	*1.50*	*5.00*	*5.00*	2.6	*1.0*			89.8	59.3	*0.50*	*0.50*	125.70	97.45
	09/10/03	0.97	*1.50*	*5.00*	*5.00*	4.8	*1.0*			199.0	104.0	*0.50*	*0.50*	150.16	123.58
39	09/19/03	2.20	*1.50*	*5.00*	*5.00*	7.4	3.1			296.0	66.9	*0.50*	*0.50*	148.09	86.51
	10/03/03	1.34	*1.50*	*5.00*	*5.00*	2.3	*1.0*			49.7	102.0	*0.50*	*0.50*	124.26	97.59
	10/13/03	2.34	*1.50*	*5.00*	*5.00*	*1.0*	*1.0*			51.2	74.3	*0.50*	*0.50*	206.47	176.74
	Count	61	64	63	64	63	64	25	27	63	64	62	63	63	64
	Average	1.73	1.76	3.18	2.94	12.9	9.8	19.3	36.7	155.0	126.2	0.33	0.30	177.75	120.59
	Median	1.26	1.50	5.00	1.25	7.5	7.5	16.0	15.7	80.0	100.0	0.50	0.50	157.35	107.48
	Max.	4.51	4.66	12.60	5.00	70.0	50.0	39.4	128.0	1280.0	518.0	1.09	0.60	344.40	229.60
	Min.	0.45	1.15	0.20	0.50	1.0	1.0	7.0	8.6	30.0	44.9	0.07	0.04	78.45	65.03
	Std. Dev.	0.97	0.84	2.33	2.02	12.0	9.2	10.4	32.8	250.4	91.3	0.22	0.21	67.62	41.03
	C.V.***	0.56	0.48	0.73	0.69	0.9	0.9	0.5	0.9	1.6	0.7	0.66	0.68	0.38	0.34

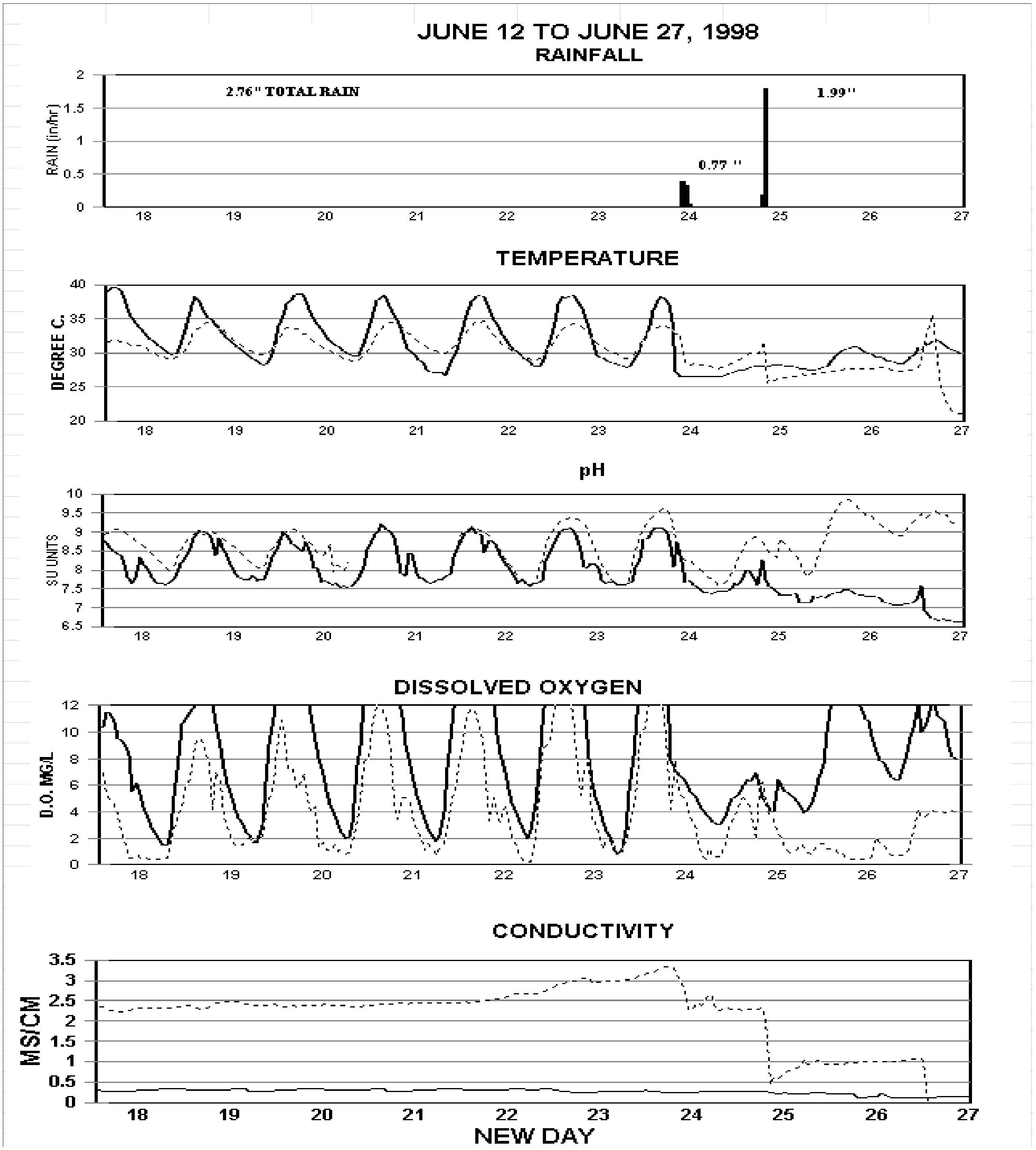
Appendix F-6. Constituent concentrations measured from composite samples collected in Year 2 at the South Underdrain.

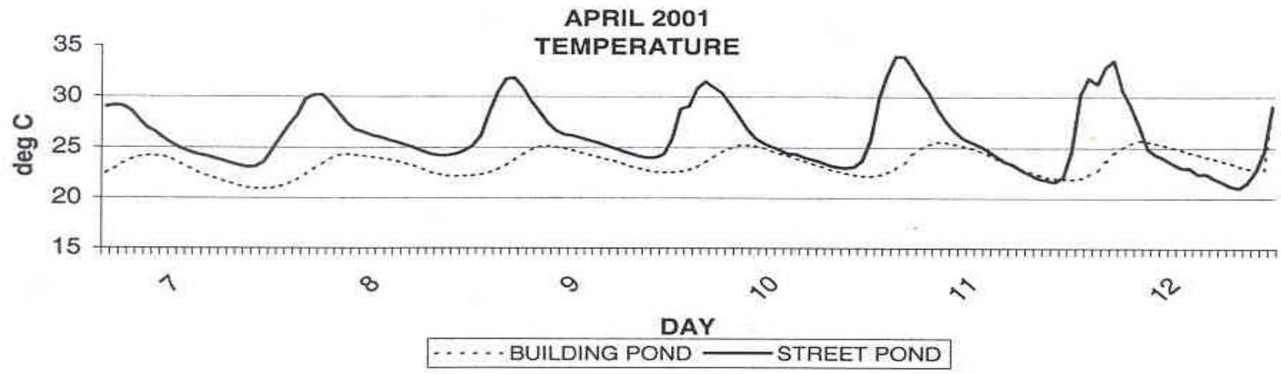
STORM #		CALCIUM		MAGNESIUM		CHLORIDE		POTASSIUM		SODIUM		SULFATE	
		mg/l		mg/L		mg/L		mg/L		mg/L		mg/L	
	L.O.Q**					0.4		0.04		0.06			
	DATE	South	North	South	North	South	North	South	North	South	North	South	North
	06/10/02	99.50	43.00	23.30	2.17	0.3	13.9	23.00	7.52	247.00	14.80	109.00	18.70
	06/12/02	100.00	41.20	22.40	2.09	413.0	13.3	21.10	7.00	239.00	14.30	106.00	18.30
2	06/18/02	41.40	28.10	3.10	1.20	31.6	8.1	4.88	3.15	22.30	8.17	24.20	15.20
3	06/24/02	28.20	24.00	1.95	1.24	18.9	8.7	3.61	2.90	13.70	7.76	18.40	10.80
5	06/29/02	33.80	33.50	2.41	2.40	30.0	19.6	4.46	4.41	20.20	20.20	27.00	18.80
6	07/01/02	42.60	31.70	3.49	2.07	43.8	18.0	5.66	3.83	29.20	13.30	33.90	18.20
	07/02/02	38.10	31.10	2.95	1.74	36.5	13.0	5.11	3.60	23.90	9.92	27.00	15.20
	07/10/02	89.60	32.10	13.60	1.72	206.0	8.8	15.00	3.56	134.00	8.43	89.60	13.40
	07/16/02	44.00	29.20	7.30	1.78	54.6	12.8	38.30	2.92	38.30	11.20	35.20	17.90
7	07/25/02	90.10	44.70	19.90	3.33	294.0	29.7	19.10	4.27	185.00	24.10	135.00	24.20
8	08/02/02	89.70	47.50	20.70	3.56	277.0	31.6	18.80	4.42	174.00	25.30	127.00	27.00
9	08/07/02	56.30	37.10	6.98	2.55	81.9	19.9	7.96	3.96	56.10	18.20	53.70	26.70
	08/12/02	55.20	36.00	5.92	2.43	73.3	19.6	7.82	4.10	51.90	16.80	47.60	23.40
10	08/14/02	-----	32.00	-----	2.14	-----	12.3	-----	3.77	-----	11.00	-----	19.90
	08/19/02	-----	30.30	-----	2.00	-----	14.3	-----	3.23	-----	11.90	-----	17.30
12	08/30/02	68.20	32.70	9.04	2.48	133.0	17.7	12.20	3.29	92.50	16.00	92.20	21.30
	08/31/02	40.10	32.10	3.28	2.03	33.8	13.2	5.29	3.20	25.90	12.50	29.50	19.60
13	09/02/02	44.80	39.30	3.30	2.42	38.1	16.7	5.73	4.10	28.30	14.80	30.40	21.50
14	09/11/02	54.50	48.40	4.47	3.06	51.0	19.8	6.34	4.07	35.90	16.00	31.90	19.40
15	09/12/02	38.80	41.00	2.28	2.21	21.2	11.4	3.71	3.25	15.50	9.69	19.50	14.90
	09/16/02	43.40	51.50	3.18	3.85	32.8	26.5	4.63	4.76	22.80	19.60	25.80	22.70
16	09/17/02	72.60	47.60	8.09	3.30	102.0	20.7	10.10	4.22	66.10	16.00	57.80	19.90
17	09/27/02	56.70	65.30	3.83	4.33	35.6	27.5	6.00	5.88	25.80	20.70	26.70	21.10
	09/30/02	62.70	73.70	4.50	5.16	45.8	35.1	6.43	6.45	31.80	26.00	31.40	25.70
18	10/12/02	61.70	58.70	5.53	3.22	49.3	20.2	7.91	6.33	36.20	16.50	33.20	20.00
19	10/15/02	52.40	57.80	3.17	3.61	24.6	21.4	5.86	6.01	19.30	17.00	20.60	17.20
	11/04/02	82.40	78.50	9.97	6.63	49.3	43.5	10.30	7.50	69.70	31.10	23.80	29.10
21	11/12/02	62.30	57.90	3.98	2.85								
	11/18/02	52.20	51.30	3.31	2.83								
	11/25/02	74.80	63.10	9.37	4.66								
22	12/09/02	43.80	31.10	2.60	1.59								
23	12/12/02	44.80	32.80	3.21	1.76	Changed Lab Constituents							
	01/14/03	86.80	53.90	14.30	6.21								
24	02/22/03	59.80	46.00	5.89	3.66								
25	02/28/03	48.60	45.40	3.71	3.22								
	03/10/03	77.60	65.80	7.06	6.70								
26	03/16/03	73.40	48.40	7.71	3.36								
28	03/23/03	39.40		2.75									
	03/27/03	48.20	34.60	3.60	1.75								
	04/21/03	98.40	73.20	17.60	9.06								
29	04/25/03	38.90	35.80	2.69	2.95								
	04/28/03	39.70	24.70	3.07	1.04								
	05/12/03	95.60	69.80	15.80	9.59								
	05/21/03	77.80	47.00	9.87	3.34								
30	05/22/03	63.20	39.20	6.75	2.18								
	06/02/03	95.80	76.20	18.10	9.55								
31*	06/09/03	83.00	45.00	11.90	3.54								
	06/11/03	62.40	36.60	5.29	1.82								
32	06/11/03	43.80	30.90	2.85	1.24								
	06/16/03	72.70	43.10	7.19	3.07								
33	06/16/03	46.80	32.20	3.31	1.12	Changed Lab Constituents							
34	06/18/03	44.40	31.00	2.88	1.01								
35	06/19/03	49.50	28.60	3.93	1.08								
36	06/29/03	63.00	37.10	7.42	2.68								
	07/01/03	56.80	31.40	4.90	1.59								
37	07/11/03	63.30	36.20	4.52	1.93								
	07/23/03	72.30	46.20	6.83	3.68								
	08/12/03	48.80	37.70	4.21	2.21								
	08/18/03	49.90	44.50	4.38	3.38								
38	08/27/03	48.00	33.80	3.25	1.97								
	09/05/03	44.90	35.40	3.30	2.20								
	09/10/03	52.70	43.80	4.51	3.45								
39	09/19/03	52.20	31.10	4.31	2.15								
	10/03/03	44.80	35.80	3.01	1.99								
	10/13/03	71.90	59.50	6.54	6.84								
	Count	63	64	63	64	25	27	25	27	25	27	25	27
	Average	59.99	43.19	6.83	3.09	87.1	19.2	10.37	4.51	68.18	15.97	50.26	19.90
	Median	55.20	39.25	4.50	2.46	45.8	18.0	6.43	4.10	35.90	16.00	31.90	19.60
	Max.	100.00	78.50	23.30	9.59	413.0	43.5	38.30	7.52	247.00	31.10	135.00	29.10
	Min.	28.20	24.00	1.95	1.01	0.3	8.1	3.61	2.90	13.70	7.76	18.40	10.80
	Std. Dev.	18.74	13.53	5.37	1.94	102.2	8.5	8.17	1.42	70.38	5.86	36.38	4.30
	C.V.***	0.31	0.31	0.79	0.63	1.2	0.4	0.79	0.32	1.03	0.37	0.72	0.22

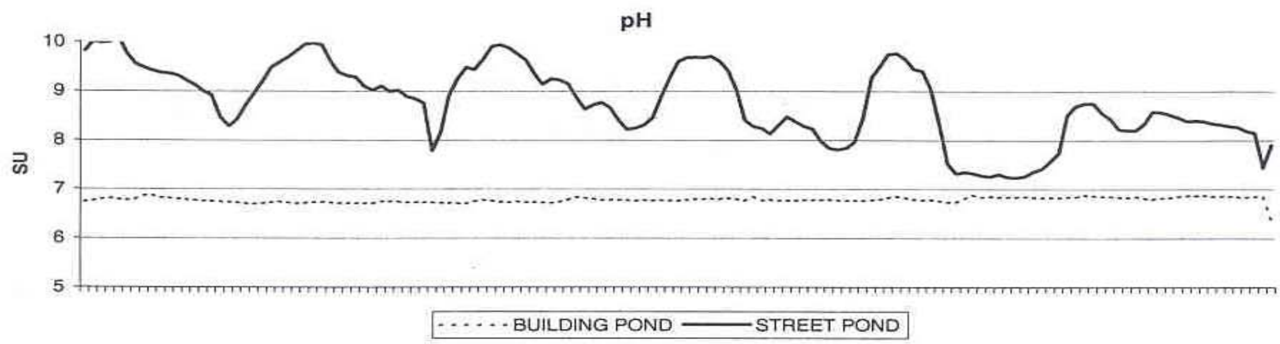
APPENDIX G

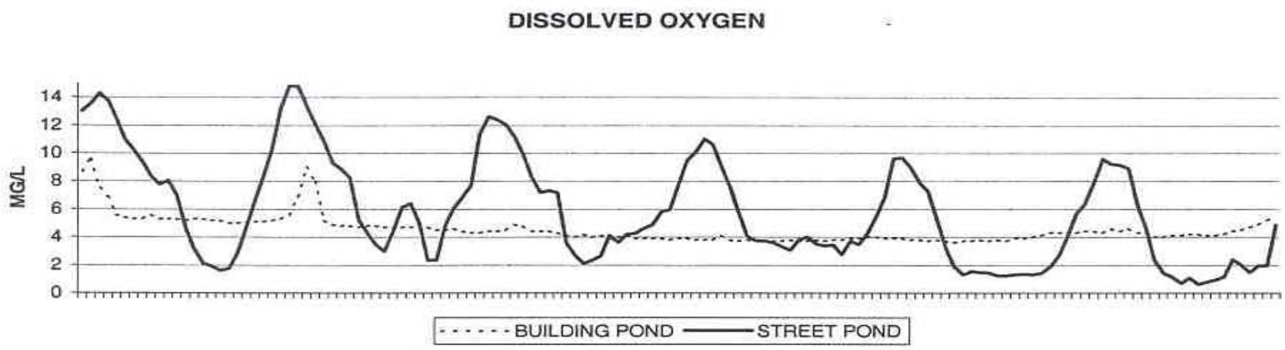
CONTINUOUS READINGS OF *IN SITU* FIELD MEASUREMENTS TEMPERATURE, pH, DISSOLVED OXYGEN, CONDUCTIVITY

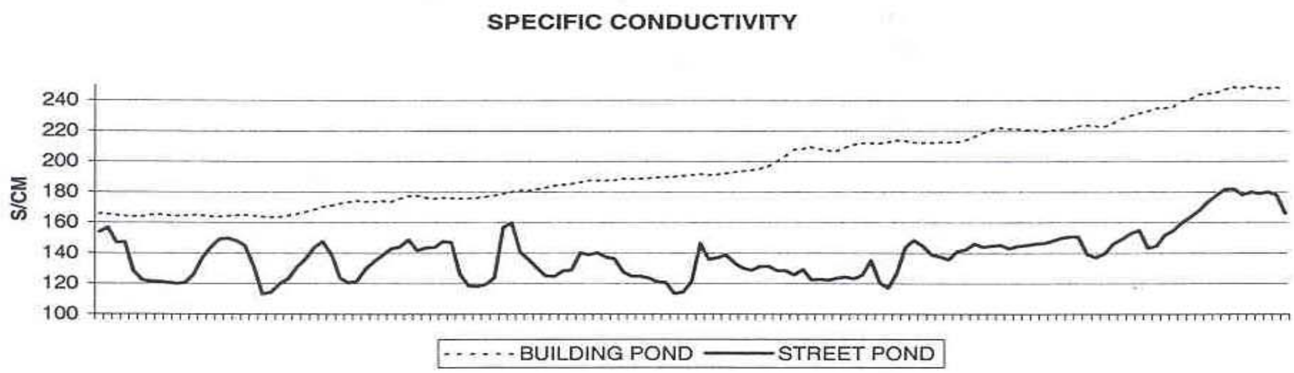

CONDUCTIVITY
12.0
10.0
8.0
6.0
4.0
2.0
0.0
MS/CM
STREET
BUILDING


JUNE 12 TO JUNE 27, 1998
RAINFALL
2.76" TOTAL RAIN
1.99"
0.77 "
RAIN (in/hr)
TEMPERATURE
DEGREE C.
pH
SU UNITS
DISSOLVED OXYGEN
D.O. MG/L
CONDUCTIVITY
MS/CM
NEW DAY

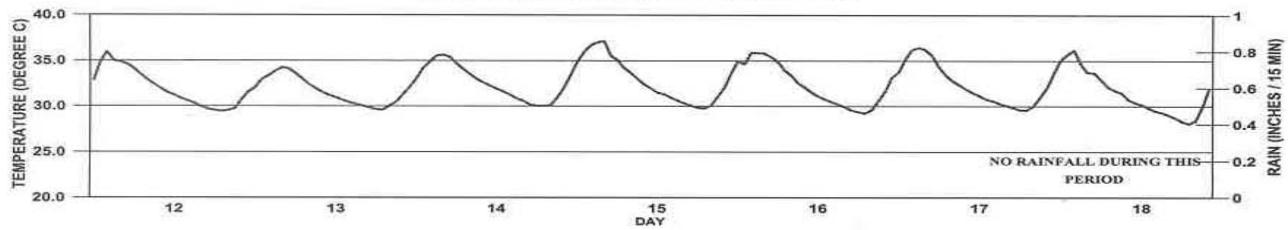

APRIL 2001
TEMPERATURE
35
30
25
20
15
deg C
7
8
9
10
11
12
DAY
BUILDING POND
STREET POND


pH
10
9
8
7
6
5
SU
BUILDING POND
STREET POND

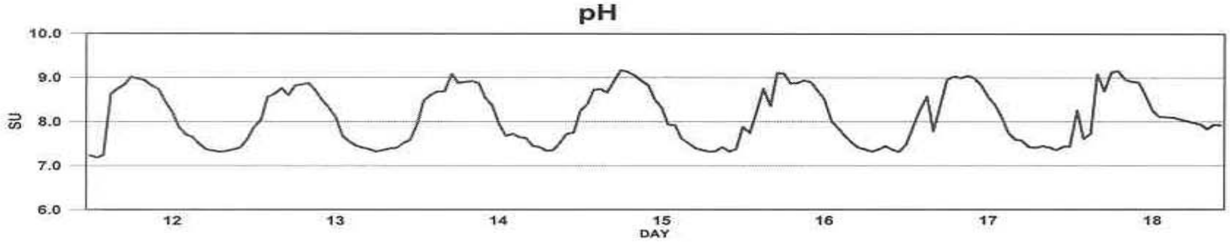

DISSOLVED OXYGEN
14
12
10
8
6
4
2
0
MG/L
BUILDING POND
STREET POND


SPECIFIC CONDUCTIVITY
240
220
200
180
160
140
120
100
S/CM
BUILDING POND
STREET POND

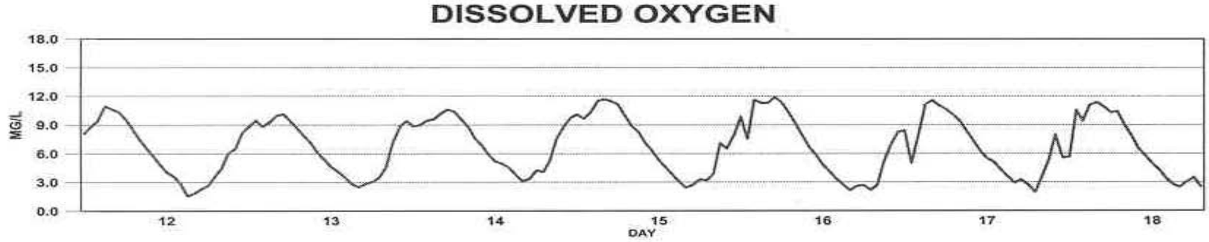
BUILDING OUTFLOW JUNE 2001
TEMPERATURE AND RAINFALL



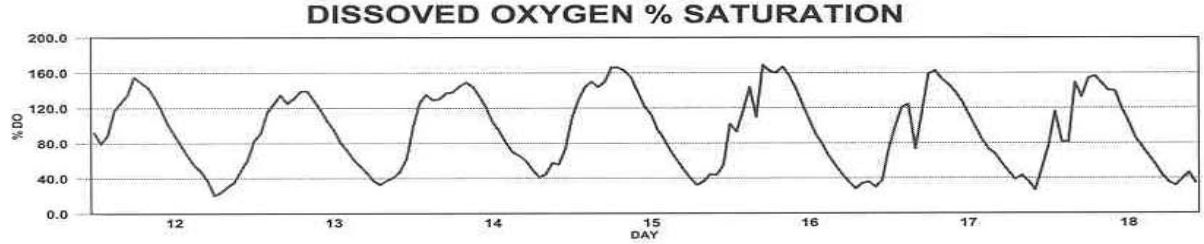
pH



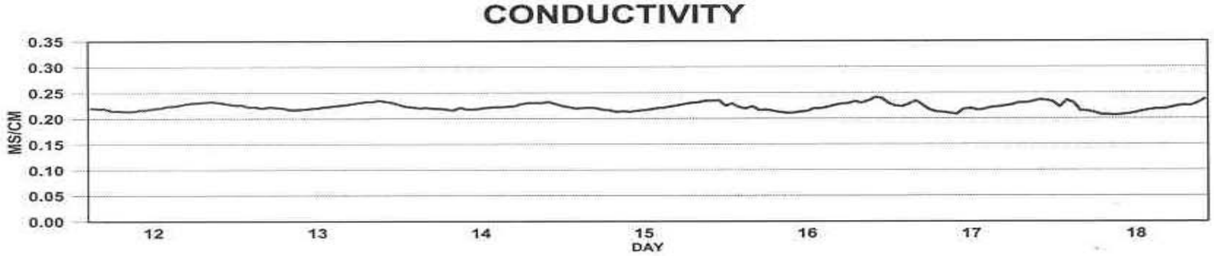
DISSOLVED OXYGEN



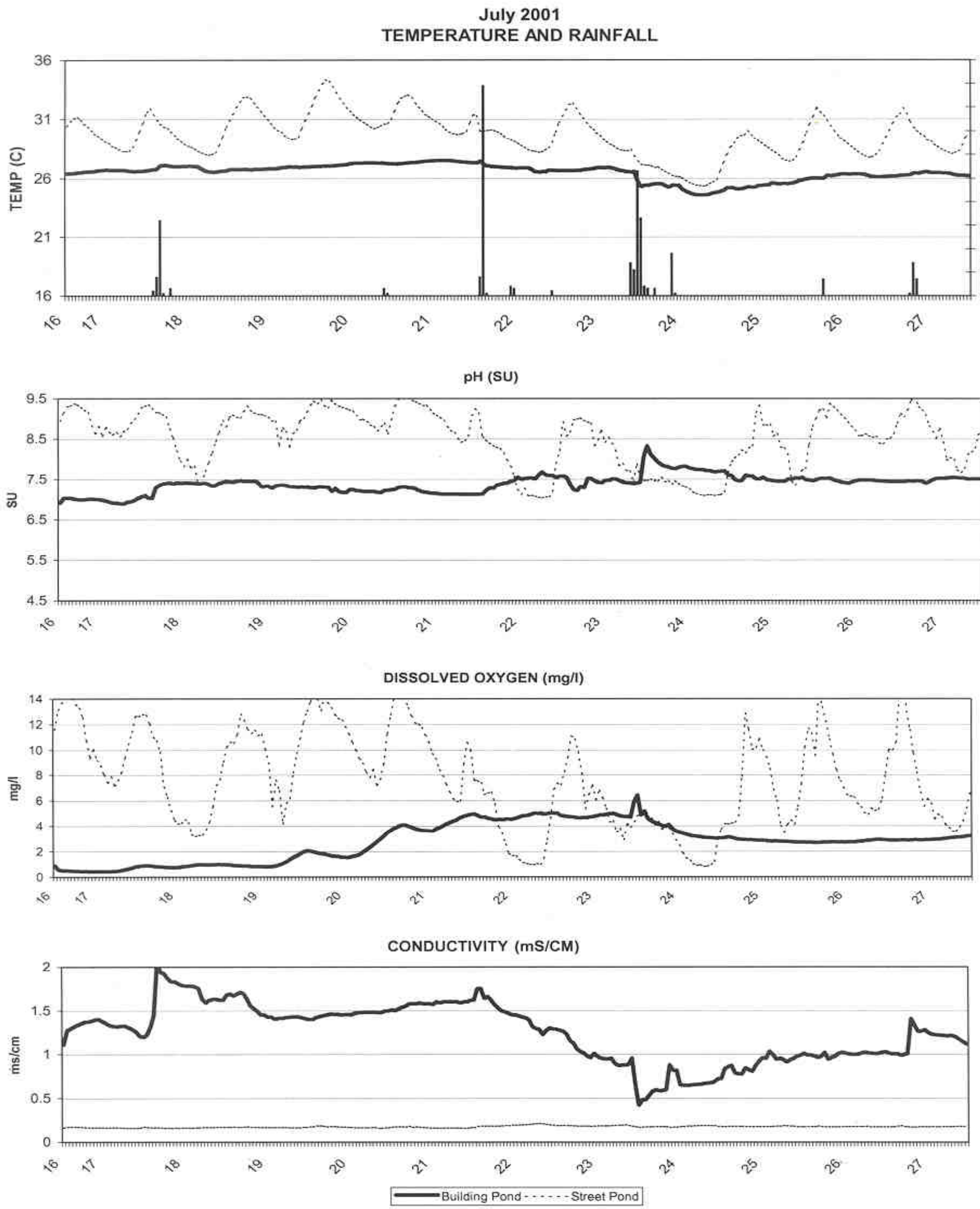
DISSOVED OXYGEN % SATURATION



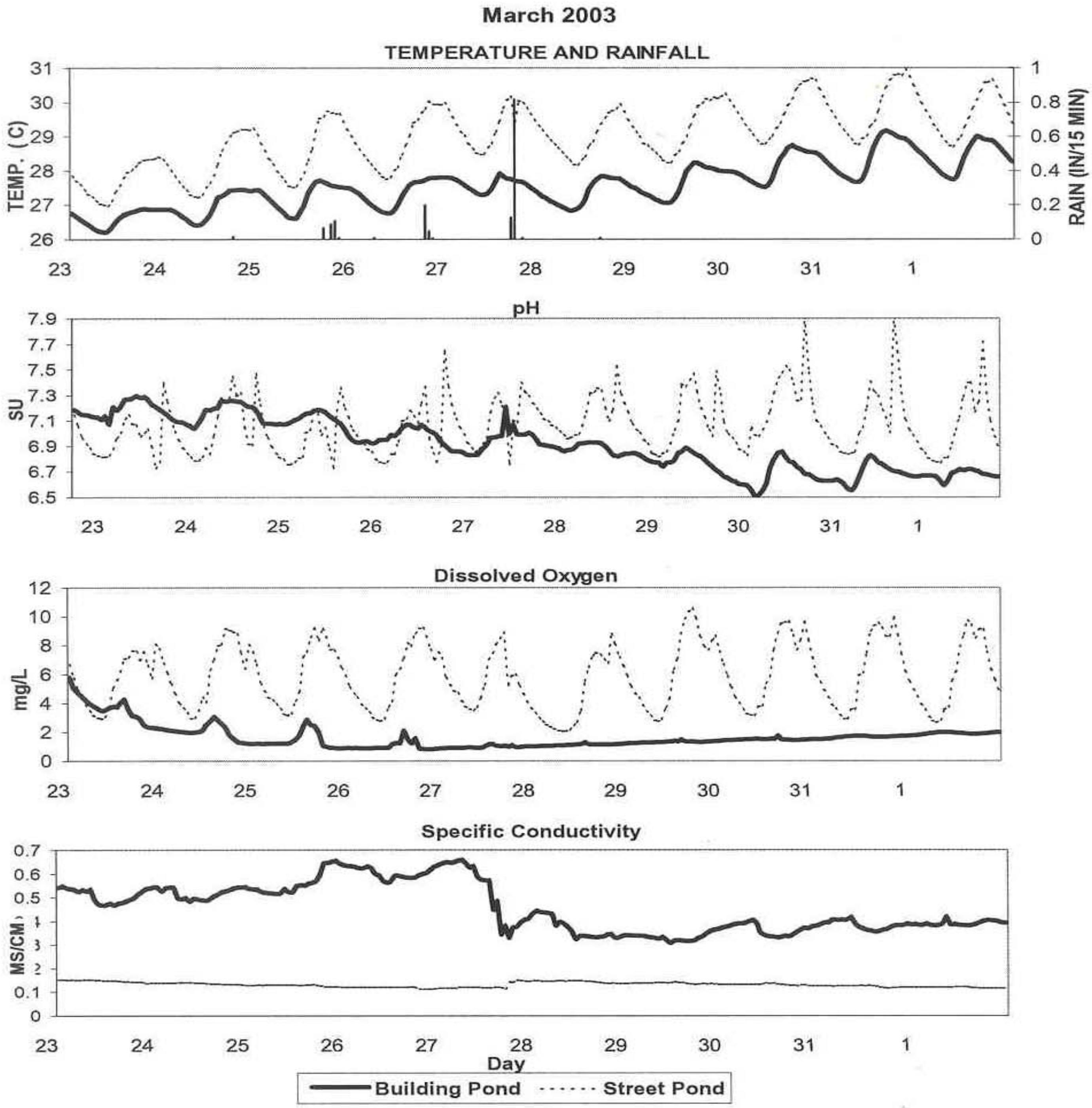
CONDUCTIVITY



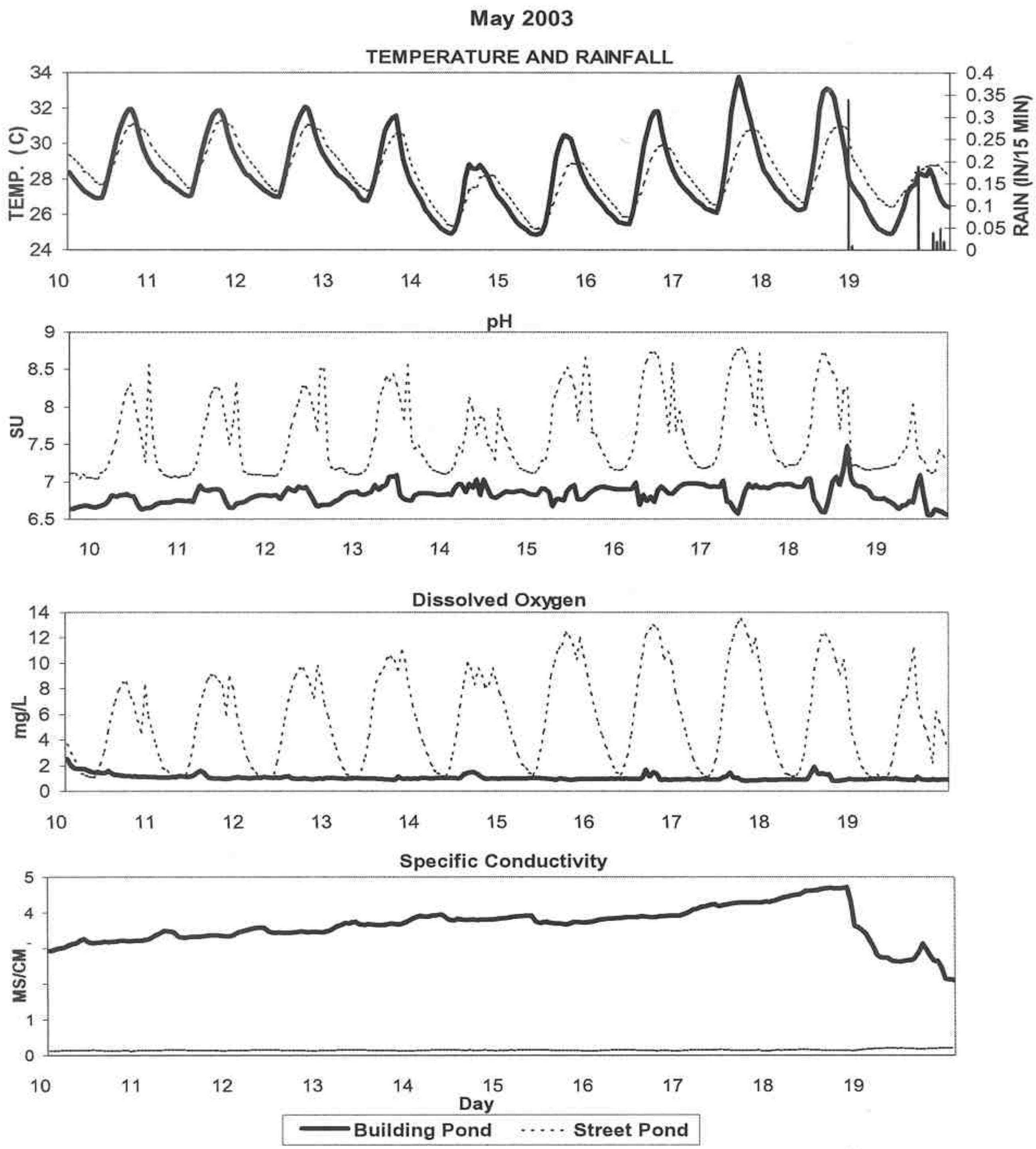
\Data\Hydrolab\Dwayne\BO18JN01dh.wb2



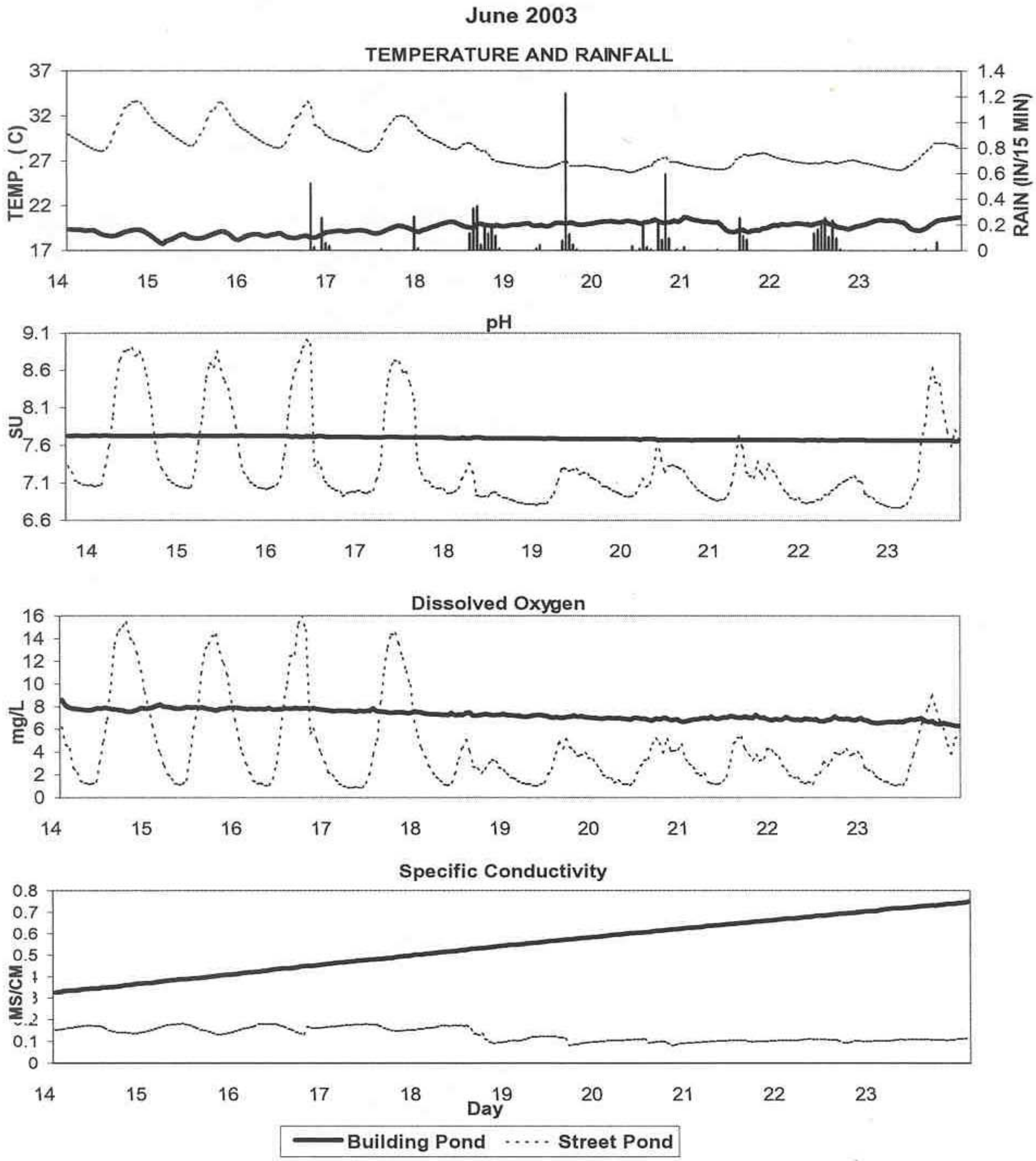
OLD HYDROLAB 05/03/2004 6:20 PM



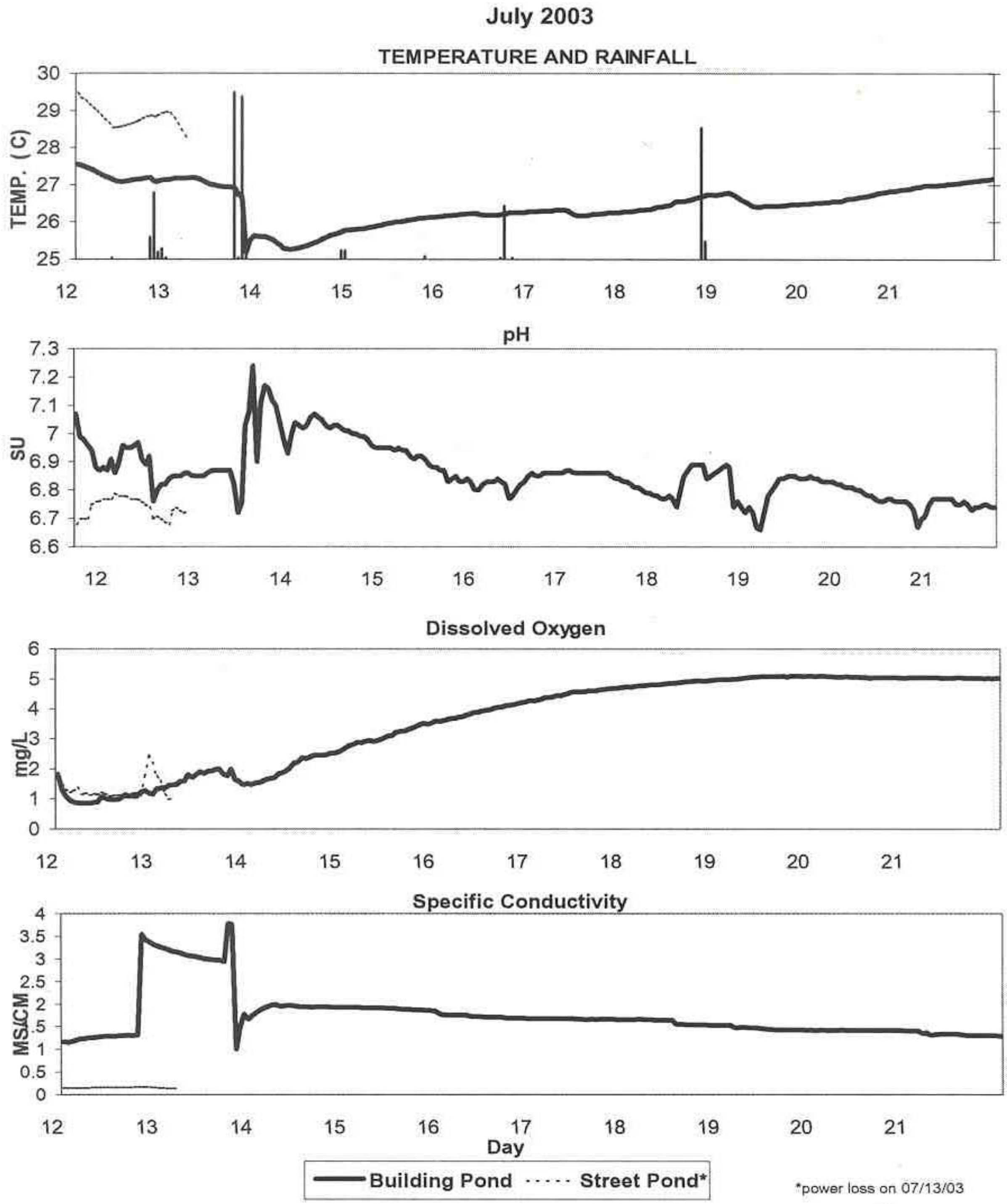
AugSep03_bld-st ponds



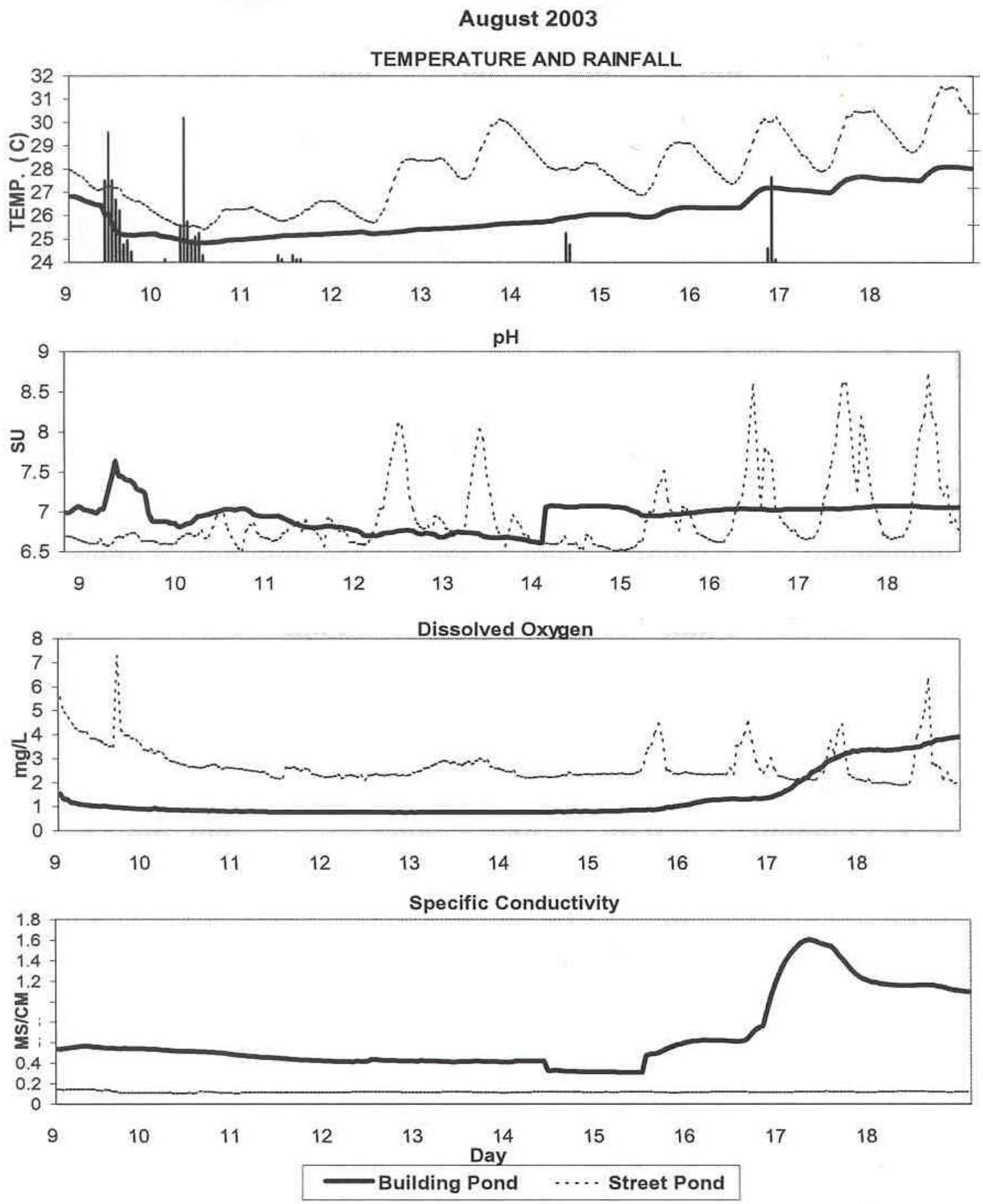
May03_bld-st ponds



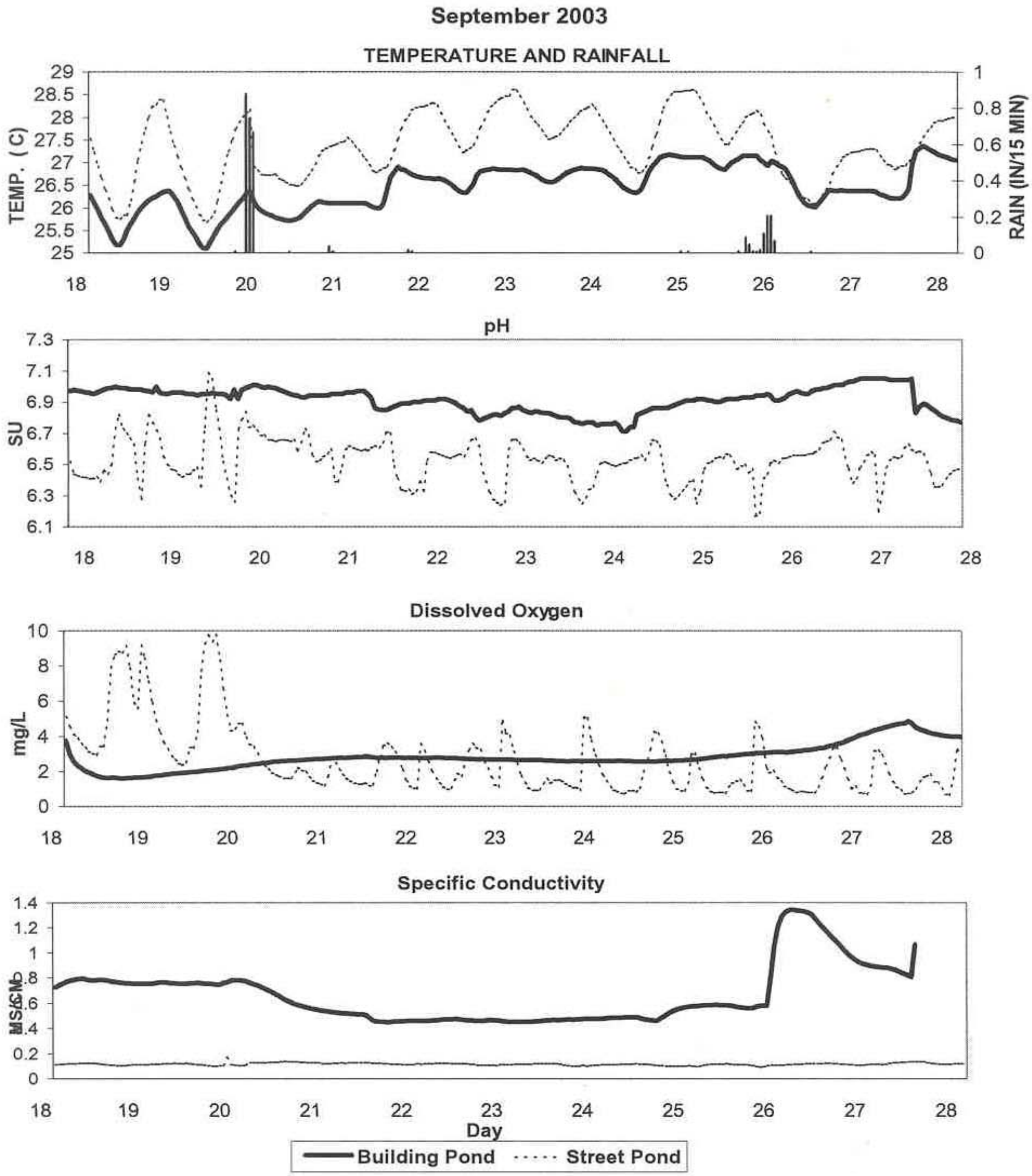
Jun03_bld-st ponds



Jul03_bld-st ponds



Aug03_bld-st ponds



Sep03_bld-st ponds

APPENDIX H

SEDIMENT SAMPLES

Table H-1. Concentrations measured in sediment cores taken at two depth (1 to 2 inches and 4 to 5 inches below the surface) and water quality samples collected during September 1997.

	STREET POND								BUILDING POND				PARKING LOT POND					
CONSTITUENT	3-1	3-4	4-1	4-4	5-1	5-4	6-1	6-4	7-1	7-4	8-1	8-4	1-1	1-1DUP	1-4	1-4 DUP	2-1	2-4
PARTICLE SIZE -SOIL																		
Gravel (%)	10.3	X	8.6	X	13.6	X	2.6	X	28.2	X	14.5	X	18.0	42.0 G	X	X	27.0	X
Sand (%)	78.3	X	81.3	X	71.1	X	96.2	X	65.0	X	75.1	X	69.1	48.1	X	X	58.7	X
Silt (%)	9.0	X	9.3	X	12.4	X	0.7	X	3.3	X	5.5	X	11.7	7.8	X	X	11.4	X
Clay (%)	2.4	X	0.9	X	2.9	X	0.5	X	3.5	X	4.9	X	1.3	2.0	X	X	1.9	X
Organic Carbon (%)	0.0	X	0.8	X	0.9	X	0.4	X	2.1	X	5.3	X	2.2	3.3	X	X	4.7	X
NUTRIENTS - SOIL																		
TKN (mg N/kg)	66.0	67.0	240.0	100.0	230.0	85.0	73.0	28.0	230.0	190.0	650.0	120.0	290.0	300.0	230.0	350.0	970.0	300.0
Total - P (mg P/kg)	210	130	470	330	440	330	190	97	1100	1100	620	780	930	1300	1100	1100	1200	860
METALS - SOIL																		
Aluminum (mg/kg)	1740 J	1190 J	2450 J	6850 J	4240 J	4650 J	1970	1560	4340	5320	4610	2510	4560 J	2850 J	4600 J	3930 J	5730 J	4990 J
Cadmium (mg/kg)	U	U	U	1.7 I	U	U	U	U	U	U	0.8 I	U	U	U	U	U	U	U
Chromium (mg/kg)	11.0 J	5.4 J	9.9 J	21.8 J	15.0 J	21.0 J	2.5 I	2.4 I	5.8	8.3	6.9	7.9	16.0 J	12.0 J	17.0 J	14.0 J	21.0 J	19.0 J
Copper (mg/kg)	2.9 I	1.8 I	19.0	3.2 I	8.4	U	4.2	U	34.1	6.5	441.0	11.7	64.2	31.3	14.0	13.0	516.0	170.0
Iron (mg/kg)	1030 J	406 J	2650 J	3410 J	3140 J	1780 J	842 J	504 J	993 J	1110 J	1260 J	1260 J	4300 J	2640 J	3040 J	2580 J	4210 J	4340 J
Lead (mg/kg)	U	U	15.0	8.7	U	U	U	U	9.6 J	4.1 I	17.4 J	9.6 J	17.0	24.8	13.0	15.0	30.3	109.0
Manganese (mg/kg)	8.0 J	3.6 J	29.2 J	15.0 J	20.3 J	7.9 J	6.8 J	2.9 J	10.3 J	10.8 J	11.2 J	13.9 J	34.4 J	24.4 J	26.9 J	24.8 J	54.3 J	44.7 J
Nickel (mg/kg)	2.0 J	1.0 J	3.4 J	6.4 J	4.2 J	4.5 J	1.2 I	0.8 I	2.0 I	2.1	3.0	2.4	4.9 J	3.2 J	4.0 J	3.1 J	5.1 J	20.0 J
Zinc (mg/kg)	8.3 I	9.7	41.7	17.3	24.7	11.0 I	13.3 I	U	28.6	18.2	80.4	23.1	46.9	32.6	37.1	40.1	91.7	156.0
PCB-SOIL																		
PCB-1260 (ug/kg)	U	X	22.0 I	X	U	X	U	X	9.5 I	X	12.0 I	X	11.0 I	9.1 I	X	X	22.0 I	X
CHLORINATED PESTICIDES-SOIL																		
Chlordane (ug/kg)	U	X	8.8 I	X	U	X	U	X	9.5 I	X	19.0 I	X	8.6 I	9.5 I	X	X	38.0 I	X
DDD-p,p' (ug/kg)	U	X	1.9 I	X	1.3 I	X	U	X	2.2 I	X	2.7 I	X	0.9 I	1.2 I	X	X	1.5 I	X
DDE-p,p' (ug/kg)	U	X	5.8	X	1.5 I	X	U	X	1.6 I	X	2.5 I	X	5.9	5.2	X	X	13.0	X
ORGANOPHOSPHORUS PESTICIDES - SOILS																		
Chlorpyrifos Ethyl ug/k	U	X	U	X	U	X	U	X	U	X	16.0 I	X	U	U	X	X	U	X
Diazinon (ug/kg)	U	X	U	X	U	X	U	X	18.0	X	35.0	X	U	U	X	X	U	X
CONCENTRATIONS IN WATER COLUMN																		
Kjeldahl Nitrogen (mg	0.68	X	0.64	X	0.47	X	0.55	X	0.75	X	0.73	X	3.2	X	X	X	2.6	X
Total Phosphous (mg/	0.05	X	0.07	X	0.06	X	0.06	X	0.04	X	0.03	X	1.2	X	X	X	1.3	X
Total Copper (ug/L)	2.70	X	4.90	X	2.10	X	11.00	X	18.30	X	28.10	X	3.5	X	X	X	17.3	X
Total Iron (ug/L)	73.00	X	122.00	X	112.00	X	79.00	X	56.00	X	97.00	X	126.0	X	X	X	529.0	X
Total Lead (ug/L)	1.00	X	1.00	X	1.00	X	1.00	X	1.00	X	1.00	X	1.0	X	X	X	7.5	X
T. Manganese (ug/L)	7.20	X	7.40	X	8.70	X	8.00	X	7.80	X	11.00	X	79.4	X	X	X	64.2	X
Total Zinc (ug/L)	15.00	X	15.00	X	15.00	X	15.00	X	15.00	X	15.00	X	15.0	X	X	X	15.0	X
FIELD PARAMETERS IN WATER COLUMN																		
Depth (cm)	4.6	X	37.0	X	41.0	X	28.0	X	46.0	X	44.5	X	30.0	X	X	X	10.0	X
D.O. (mg/L)	6.8	X	7.7	X	6.5	X	9.5	X	3.6	X	4.6	X	1.3	X	X	X	1.6	X
pH (SU)	8.4	X	8.6	X	8.5	X	8.8	X	8.6	X	8.9	X	7.6	X	X	X	7.7	X
Salinity (PPth)	0.1	X	0.1	X	0.1	X	0.1	X	2.4	X	2.3	X	0.6	X	X	X	0.6	X
Sp. Cond. (umho/cm)	0.2	X	0.2	X	0.2	X	0.2	X	4.4	X	4.2	X	1.1	X	X	X	1.1	X
Temperature (Deg C)	29.5	X	30.8	X	30.6	X	29.5	X	26.4	X	26.7	X	26.9	X	X	X	27.7	X
Time (hhmm)	12:00 PM	X	01:30 PM	X	02:00 PM	X	11:30 AM	X	10:30 AM	X	11:00 AM	X	10:00 AM	X	X	X	11:00 AM	X

KEY:
I - Value reported is less than the minimum quantitation limit, and greater than or equal to the minimum detection limit.
J - Estimated Value
U - Material was analyzed but not detected; value reported is the minimum detection limit.
X - site not sampled for these constituents
G - Chunk of gravel in sample

Table H-2. FLORIDA AQUARIUM DEMONSTRATION PROJECT - NOVEMBER 2000 (-1=top inch, -4=4 to 5 inch depth)

		Street Pond																		Building Pond							
		6-1		6-1		6-4		6-4		BOX		3-1		3-4		4-1		4-4		7-1		7-4		8-1		8-4	
		1088-1		1088-1		1088-4		1088-4		1088-B		1089-1		1089-4		638-1		638-4		1084-1		1084-4		640-1		640-4	
CONSTITUENT		Inflow		Dup		Inflow		Dup		Box		2nd Inflow		2nd Inflow		Outfall		Outfall		Inflow		Inflow		Outfall		Outfall	
SEDIMENT PARTICLE SIZE																											
>2.0 mm		**2.3**		**3.3**			X		X		X	**1.9**	A		X	**1.8**			X	**6.1**			X	**6.9**			X
0.5 - 2.0 mm		**16.2**		**13.6**			X		X		X	**10.0**	A		X	**6.7**			X	**12.3**			X	**8.2**			X
0.25 - 0.5 mm		**25.4**		**25.6**			X		X		X	**19.0**	A		X	**17.5**			X	**18.6**			X	**17.1**			X
0.125 - 0.25 mm		**40.2**		**41.3**			X		X		X	**44.0**	A		X	**39.5**			X	**34.3**			X	**35.2**			X
0.063 - 0.125 mm		**8.1**		**8.5**			X		X		X	**10.0**	A		X	**8.4**			X	**8.5**			X	**11.7**			X
<0.063 mm		**10.1**		**11.0**			X		X		X	**16.0**	A		X	**28.0**			X	**26.3**			X	**27.8**			X
% ORGANIC		**1.0**		**1.1**			X		X		X	**1.5**	A		X	**2.5**			X	**6.1**			X	**8.0**			X
SEMI-VOLATILE ORGANIC POLLUTANTS - SEDIMENT																											
Acenaphthene	ug/kg	U		U		U		U		U		U		U		U		U		U		U		U		**130**	I
Anthracene	ug/kg	U		U		U		U		U		U		U		U		U		U		U		U		**130**	I
Benzo(a)anthracene	ug/kg	**370**	I	**530**	I	U		U		U		U		U		U		U		**2400**	I	U		U		**380**	
Benzo(a)pyrene	ug/kg	**340**	I	**470**	I	U		U		U		U		U		U		U		**1400**	I	U		U		**300**	
Benzo(b)fluoranthene	ug/kg	**660**	I	**900**	I	U		U		U		U		U		U		U		**2500**	I	**340**	I	U		**530**	
Benzo(k)fluoranthene	ug/kg		X	**270**	I	U		U		U		U		U		U		U		U		U		U		**160**	I
Benzo(g,h,i)perylene	ug/kg	**300**	I	**350**	I	U		U		U		U		U		U		U		U		U		U		**200**	I
Bis(2-ethylhexyl)phthalate	ug/kg	U		U		U		U		U		U		U		U		U		**11000**	I			U		U	
Butyl benzyl phthalate	ug/kg	U		U		U		U		U		U		U		U		U						U		U	
Chrysene	ug/kg	**620**	I	**860**	I	U		U		U		U		U		U		U		**2100**	I	**230**	I	U		**400**	
Di-n-octyl phthalate	ug/kg	**250**	I	**240**	I	U		U		U		U		U		U		U		U		U		U		U	
Dibenzo(a,h)anthracene	ug/kg	U		U		U		U		U		U		U		U		U		U		U		U		**78**	I
Fluoranthene	ug/kg	**630**	I	**1200**	J	U		U		U		U		U		U		U		**5000**	I	**390**	I	U		**1000**	
Indeno(1,2,3-cd)pyrene	ug/kg	**350**	I	**450**	I	U		U		U		U		U		U		U		**1300**	I	U		U		**250**	I
Phenanthrene	ug/kg	**310**	I	**480**	I	U		U		U		U		U		U		U		**2100**	I	U		U		**290**	
Pyrene	ug/kg	**770**	I	**1300**	J	**77**	I	U		U		U		U		U		U		**4300**	I	**320**	I	U		U	
METALS, TOTAL RECOVERABLE - SEDIMENT																											
Aluminum_308	mg/kg	**1040**	AJ	**1070**	J	**1050**	J	**408**	J	**1870**	J	**1660**	J	**250**	A	**2480**		**719**		**3470**		**1570**		**11200**		**1150**	A
Cadmium	mg/kg	**0.31**	I	**0.34**	I	**0.24**	I	**0.19**	I	**0.69**		**0.71**		**0.18**	I	**0.95**		**0.16**	I	**2.4**		**0.36**	I	**7.1**		**0.36**	I
Chromium	mg/kg	**7**	AJ	**6.8**	J	**1.8**	J	**1.9**	J	**20.5**	J	**11.1**	J	**1.3**	A	**13.7**		**1.9**		**23.1**		**5.2**		**48.3**		**4.1**	A
Copper	mg/kg	**12.1**	A	**13.6**		**2**		**2.5**		**45.5**		**29.3**		**0.59**	I	**228**		**0.81**	I	**472**		**5.8**		**3740**		**10.7**	A
Iron_271	mg/kg	**1030**	A	**1100**		**462**		**292**		**2570**		**1370**		**153**	A	**1740**		**224**		**4870**		**860**		**9680**		**1010**	A
Lead	mg/kg	**8.6**	A	**8.4**		**1.9**	I	**2.6**	I	**28.6**		**15.4**		**U**		**36.6**		**1.2**	I	**58.3**		**9.9**		**134**		**9.7**	A
Manganese	mg/kg	**10.1**	A	**9**		**4.3**		**3.7**		**27.2**		**10.6**		**2.2**	AJ	**22.7**	J	**2.3**	J	**47.4**	J	**11.5**	J	**82**	J	**14.9**	AJ
Nickel	mg/kg	U		U		U		U		**5.8**	I	**2**	I	U		**6.4**	I	U		**12.9**		U		**25.4**		U	
Zinc	mg/kg	**48**	A	**56**		**9.9**	I	U		**180**		**79**		U		**125**		U		**500**		**22**	I	**1100**	I	**31**	A
PESTICIDES-SEDIMENTS																											
Bromacil	ug/kg	U		U		U		U		U		U		U		U		U		**38**	I	U		**92**	I	U	
Chlorpyrifos Ethyl	ug/kg	U		U		U		U		U		U		U		U		U		U		U		**120**		U	
Diazinon	ug/kg	U		U		U		U		U		U		U		U		U		14	I	U		**17**	I	U	
Beta-BHC	ug/kg	U		U		U		U		U		U		U		U		U		U		U		**18**	N	U	
Chlordane	ug/kg	U		U		U		U		**24**	I	**21**	I	U		U		U		**32**	I	U		U		U	
DDD-p.p'	ug/kg	U		U		U		U		U		U		U		U		U		**5**	I	U		**11**	I	U	
DDE-p,p'	ug/kg	U		U		U		U		U		U		U		**6.1**		U		**7**		U		**11**	I	U	
Endosulfan Sulfate	ug/kg	U		U		U		U		U		U		**4.6**	N	U		U		U		U		U		U	
Endrin Aldehyde	ug/kg	U		U		U		U		U		U		U		U		U		U		U		U		U	
Methoxychlor	ug/kg	U		U		U		U		U		U		U		U		U		U		U		U		U	
NUTRIENTS - SEDIMENTS																											
Kjeldahl Nitrogen	mg/kg	**380**		**460**		**56**		**52**		**2100**		**1200**		**30**	A	**1600**		**28**		**2600**		**160**		**5600**		**170**	
Total - P	mg/kg	**300**		**370**		**130**		**180**		**750**		**440**		**76**	A	**920**		**86**		**1600**		**690**		**2900**		**620**	
CONCENTRATIONS -WATER COLUMN																											
CADMIUM	ug/kg	**0.15**		**0.15**			X		X		X	**0.15**			X	**0.15**			X	**0.15**			X	**0.15**			X
COPPER	ug/kg	**1**		**1**			X		X		X	**1**			X	**4.8**			X	**6.5**			X	**8.5**			X
IRON	ug/kg	**220**		**200**			X		X		X	**170**			X	**100**			X	**110**			X	**130**			X
LEAD	ug/kg	**0.75**		**1.5**			X		X		X	**0.75**			X	**1.6**			X	**0.75**			X	**0.75**			X
MANGANESE	ug/kg	**17.2**		**13.1**			X		X		X	**42**			X	**4.7**			X	**13.7**			X	**13.7**			X
ZINC	mg/kg	**20**	I	**7.5**			X		X		X	**7.5**			X	**20**			X	**30**			X	**30**	I		X
TSS	mg/kg	**17.884**		**13.14**			X		X		X	**3.49**			X	**2.89**			X	**10.96**			X	**6.316**			X
PHOSPHOROUS, TOTAL	mg/kg	**0.078**		**0.068**			X		X		X	**0.209**			X	**0.055**			X	**0.05**			X	**0.056**			X
PHOSPHOROUS, ORTHO	mg/kg	**0.024**	I	**0.014**	I		X		X		X	**0.129**			X	**0.005**			X	**0.011**	I		X	**0.011**	I		X
NITROGEN, TOTAL	mg/kg	**0.79**	Q	**0.78**	Q		X		X		X	**1.1**	Q		X	**0.99**	Q		X	**0.92**	Q		X	**0.93**	Q		X
AMMONIA	mg/kg	**0.06**		**0.044**			X		X		X	**0.057**			X	**0.031**	I		X	**0.038**	I		X	**0.037**	I		X
NITRATE	mg/kg	**0.004**		**0.008**	I		X		X		X	***0.005***			X	***0.005***			X	***0.005***	Q		X	**0.037**	Q		X
NITRITE	mg/kg	**0.006**	I	**0.0025**			X		X		X	**0.0025**			X	**0.0025**			X	**0.005**			X	**0.006**	I		X
ORGANIC NITROGEN	mg/kg	**0.72**		**0.7255**			X		X		X	**1.0355**			X	**0.9515**			X	**0.872**			X	**0.85**			X
CHLORIDE	mg/kg	**43.3**		**40.8**			X		X		X	**43**			X	**26.8**			X	**1464**			X	**1448**			X
POTASSIUM	mg/kg	**11**		**10.6**			X		X		X	**14.7**			X	**8.29**			X	**37**			X	**37.5**			X
SODIUM	mg/kg	**40.1**		**36.1**			X		X		X	**44.6**			X	**24.5**			X	**821**			X	**815**			X
SULFATE	mg/kg	**40.8**		**37.1**			X		X		X	**28.7**			X	**25.5**			X	**281**			X	**283**			X
CALCIUM	mg/kg	**43.3**		**39.3**			X		X		X	**51.1**			X	**23.4**			X	**89.5**			X	**89.5**			X
MAGNESIUM	mg/kg	**5.38**		**4.9**			X		X		X	**6.86**			X	**0.05**			X	**97**			X	**153**			X
HARDNESS	mg/kg	**130.27**		**118.31**			X		X		X	**155.85**			X	**58.64**			X	**622.9**			X	**853.5**			X
FIELD PARAMETERS - WATER COLUMN																											
Depth	cm		X		X		X		X	**0.53**			X		X		X		X	**0.06**			X	**0.17**			X
D.O.	mg/l	**5.54**			X		X		X	**1.54**		**1.51**			X	**12.04**			X	**9.6**			X	**4.13**			X
pH	SU	**7.63**			X		X		X	**7.39**		**7.13**			X	**9.1**			X	**8.58**			X	**7.88**			X
Salinity	PPth	**0.32**			X		X		X	**0.45**		**0.28**			X	**0.14**			X	**3.01**			X	**2.19**			X
Sp. Cond.	umho/cm	**0.631**			X		X		X	**0.863**		**0.549**			X	**0.828**			X	**5.46**			X	**5.304**			X
Temperature	Deg C	**23.67**			X		X		X	**16.13**		**24.27**			X	**27.79**			X	**24.85**			X	**24.01**			X
Time	hhmm	**10:30**			X		X		X	**14:30**		**11:30**			X	**12:25**			X	**13:40**			X	**13:00**			X

KEY: **X** - Not sampled **Q** - Sample held beyond holding time **N** - Presumptive evidence of presence of material **J** - Estimated Value **U** - Undetected
A - Value reported is the mean of two or more determinations **I** - Value reported is less than the minimum quantitation limit, and greater than or equal to the minimum detection limit.

Table H-2 (CONTINUED). FLORIDA AQUARIUM DEMONSTRATION PROJE SEDIMENT SAMPLING - NOVEMBER 2000

		Parking Lot Pond															
		2-1		2-4		1-1		1-4		0-1		0-4					
		639-1		639-4		1234-1		1234-4		1276-1		1276-4		1082-1		1082-4	
CONSTITUENT		Outfall		Outfall		S. Gauge		S. Gauge		Underdr		Underdr		Weir		Weir	
SEDIMENT PARTICLE SIZE																	
>2.0 mm		16.0			X	21.0			X	41.0	A		X	0.65			X
0.5 - 2.0 mm		15.6			X	21.6			X	38.0	A		X	13.0			X
0.25 - 0.5 mm		16.0			X	12.8			X	21.0	A		X	25.0			X
0.125 - 0.25 mm		25.4			X	23.6			X	22.2	A		X	40.0			X
0.063 - 0.125 mm		9.7			X	9.4			X	7.2	A		X	14.0			X
<0.063 mm		33.3			X	32.6			X	11.6	A		X	8.0			X
% ORGANIC		8.5			X	8.2			X	8.8	A		X	3.6			X
SEMI-VOLATILE ORGANIC POLLUTANTS - SEDIMENT																	
Acenaphthene	ug/kg	U		U		U		U		U		U		U		U	
Anthracene	ug/kg	U		U		U		U		U		U		U		U	
Benzo(a)anthracene	ug/kg	U		430	I	U		280	I	U		180	I	U		U	
Benzo(a)pyrene	ug/kg	U		370	I	U		250	I	U		150	I	U		U	
Benzo(b)fluoranthene	ug/kg	U		590	I	U		U		U		250	I	U		U	
Benzo(k)fluoranthene	ug/kg	U		180	I	U		U		U		U		U		U	
Benzo(g,h,i)perylene	ug/kg	U		260	I	U		170	I	U		U		U		U	
Bis(2-ethylhexyl)phthalate	ug/kg	U		U		U		U		U		U		U		U	
Butyl benzyl phthalate	ug/kg	U		U		U		U		U		U		U		390	I
Chrysene	ug/kg	U		440	I	U		310	I	U		190	I	U		U	
Di-n-octyl phthalate	ug/kg	U		U		U		U		U		U		U		U	
Dibenzo(a,h)anthracene	ug/kg	U		U		U		U		U		U		U		U	
Fluoranthene	ug/kg	U		550	I	U		610	I	U		220	I	U		U	
Indeno(1,2,3-cd)pyrene	ug/kg	U		250	I	U		190	I	U		U		U		U	
Phenanthrene	ug/kg	U		350	I	U		320	I	U		U		U		U	
Pyrene	ug/kg	U		780		U		830		U		340	I	U		U	
METALS, TOTAL RECOVERABLE - SEDIMENT																	
Aluminum_308	mg/kg	5490		2940		4750		1800	J	1620	J	1290	J	303	AJ	1070	J
Cadmium	mg/kg	1.2		0.64		0.84		0.67		0.6	I	0.39	I	U		U	
Chromium	mg/kg	23.6		8.9		17.1		8.3		8.6		5.9		1.5	A	2.1	
Copper	mg/kg	241		19		323		32.4		18.1		11.1		3.6	A	1.3	I
Iron_271	mg/kg	4870		2680		3840		3410		2340		1100		148	A	279	
Lead	mg/kg	51.3		29.2		37.1		18.1		20.5		15.8		1.7	I	2.2	I
Manganese	mg/kg	46	J	37.7	J	52.3		33.8		69.2		15.6		3.8	A	2.5	
Nickel	mg/kg	6.4	I	2	I	4.5	I	2.2	I	U		U		U		U	
Zinc	mg/kg	178		66.9		90.4		37.5		55.9		31.1		U		U	
PESTICIDES-SEDIMENTS																	
Bromacil	ug/kg	U		U		U		U		U		U		U		U	
Chlorpyrifos Ethyl	ug/kg	U		U		U		U		U		U		U		U	
Diazinon	ug/kg	U		U		U		U		U		U		U		U	
Beta-BHC	ug/kg	U		U		U		U		U		U		U		U	
Chlordane	ug/kg	U		U		31	I	U		U		U		U		U	
DDD-p.p'	ug/kg	U		U		U		U		U		U		U		U	
DDE-p,p'	ug/kg	U		8.8		7.3		7.5		U		U		U		U	
Endosulfan Sulfate	ug/kg	U		U		7.6	N	U		U		U		U		0.77	N
Endrin Aldehyde	ug/kg	2.9	N	U		U		U		U		U		U		U	
Methoxychlor	ug/kg	23	N	13	N	18	N	U		U		U		U		U	
NUTRIENTS - SEDIMENTS																	
Kjeldahl Nitrogen	mg/kg	6000		370		3100		380		1400		770		1600		570	A
Total - P	mg/kg	2700		1600		2000		1200		1700		740		120		110	A
CONCENTRATIONS -WATER COLUMN																	
CADMIUM	ug/kg		X		X	0.3			X		X		X		X		X
COPPER	ug/kg		X		X	49.1			X		X		X		X		X
IRON	ug/kg		X		X	1930			X		X		X		X		X
LEAD	ug/kg		X		X	7.4			X		X		X		X		X
MANGANESE	ug/kg		X		X	162			X		X		X		X		X
ZINC	mg/kg		X		X	60			X		X		X		X		X
TSS	mg/kg		X		X	274.67			X		X		X		X		X
PHOSPHOROUS, TOTAL	mg/kg		X		X	1.4	Q		X		X		X		X		X
PHOSPHOROUS, ORTHO	mg/kg		X		X	0.105			X		X		X		X		X
NITROGEN, TOTAL	mg/kg		X		X	6.7	Q		X		X		X		X		X
AMMONIA	mg/kg		X		X	0.572			X		X		X		X		X
NITRATE	mg/kg		X		X	0.002	QI		X		X		X		X		X
NITRITE	mg/kg		X		X	0.016	I		X		X		X		X		X
ORGANIC NITROGEN	mg/kg		X		X	6.11			X		X		X		X		X
CHLORIDE	mg/kg		X		X	221			X		X		X		X		X
POTASSIUM	mg/kg		X		X	29.7			X		X		X		X		X
SODIUM	mg/kg		X		X	123			X		X		X		X		X
SULFATE	mg/kg		X		X	18.3			X		X		X		X		X
CALCIUM	mg/kg		X		X	147			X		X		X		X		X
MAGNESIUM	mg/kg		X		X	14.7			X		X		X		X		X
HARDNESS	mg/kg		X		X	427.59			X		X		X		X		X
FIELD PARAMETERS - WATER COLUMN																	
Depth	cm		X		X	1.27			X		X		X		X		X
D.O.	mg/l		X		X	1.46			X		X		X		X		X
pH	SU		X		X	7.13			X		X		X		X		X
Salinity	PPth		X		X	0.74			X		X		X		X		X
Sp. Cond.	umho/cm		X		X	1.392			X		X		X		X		X
Temperature	Deg C		X		X	23.46			X		X		X		X		X
Time	hhmm		X		X	10:50			X		X		X		X		X

Table H-3. FLORIDA AQUARIUM DEMONSTRATION PROJECT - DECEMBER 2003 (-1=top inch, -4=4 to 5 inch depth)

		Street Pond									Building Pond			
		6-1	6-4	BOX	3-1	3-4	4-1	4-4	4-1	4-4	7-1	7-4	8-1	8-4
		1088-1	1088-4	1088B-1	1087-1	1087-4	638-1	638-4	638-1	638-4	1084-1	1084-4	640-1	640-4
CONSTITUENT		Inflow	Inflow	Box	Eq. Pipe	Eq. Pipe	Outfall	Outfall	Dup	Dup	Inflow	Inflow	Outfall	Outfall
SEDIMENT PARTICLE SIZE														
>2.0 mm	%	2.7	X	18	10	X	4.7	X	3.3	X	3.8	X	6.2	X
0.5 - 2.0 mm	%	33.7	X	72.1	23.8	X	14.7	X	14.3	X	20.8	X	21	X
0.25 - 0.5 mm	%	41.9	X	18.2	22.8	X	21.4	X	21.3	X	18.1	X	17.9	X
0.125 - 0.25 mm	%	16.4	X	4.31	33.4	X	42.3	X	41.7	X	28.1	X	25.5	X
0.063 - 0.125 mm	%	2.69	X	1.16	5.66	X	9.66	X	9.18	X	10.6	X	11.2	X
<0.063 mm	%	5.3	X	4.32	14.2	X	12	X	13.6	X	22.4	X	24.4	X
% ORGANIC		1	X	3.1	1	X	1.1	X	1.4	X	5	X	4.1	X
SEMI-VOLATILE ORGANIC POLLUTANTS - SEDIMENT														
Acenaphthene	ug/Kg	U	U	U	U	U	U	U	U	U	U	U	U	310
Anthracene	ug/Kg	U	U	U	U	U	U	U	240 I	U	180 I	U	U	420
Benzo(a)anthracene	ug/kg	400	U	390	88 I	U	160 I	78 I	460	91 I	590	250 I	440 I	950
Benzo(a)pyrene	ug/kg	480	U	480	130 I	U	200 I	85 I	430	110 I	650	260 I	590 I	910
Benzo(b)fluoranthene	ug/kg	950	U	1100	240 I	86 I	280 I	120 I	500	150 I	U	360	1100	1300
Benzo(k)fluoranthene	ug/kg	300 I	U	380	U	U	U	U	130 I	U	1300	120 I	260 I	340
Benzo(g,h,i)perylene	ug/Kg	190 I	U	170 I	87 I	U	180 I	78 I	190 I	U	400 I	200 I	310 I	380
Bis(2-ethylhexyl)phthalate	ug/Kg	8700 I	U	2100	U	U	710 I	U	U	U	5600	U	6200	U
Butyl benzyl phthalate	ug/Kg	U	U	U	U	U	U	U	U	U	220 I	U	260 I	U
Chrysene	ug/kg	650	U	660	160 I	U	180 I	86 I	460	91 I	590 I	240 I	500 I	850
Di-n-octyl phthalate	ug/kg	U	U	U	U	U	U	U	U	U	U	U	U	U
Dibenzo(a,h)anthracene	ug/kg	U	U	U	U	U	U	U	U	U	U	U	U	120 I
Fluoranthene	ug/kg	1000	U	1000	U	U	290 I	150 I	900	160 I	1300	U	1000	2100 I
Indeno(1,2,3-cd)pyrene	ug/kg	200 I	U	180 I	83 I	U	130 I	U	160 I	U	380 I	170 I	260 I	400
Phenanthrene	ug/kg	410	U	300 I	U	U	130 I	U	900	81 I	650	240 I	330 I	1600
Pyrene	ug/kg	920	U	990	200 I	78 I	260 I	140 I	1000	140 I	890	410	720 I	1400
METALS, TOTAL RECOVERABLE - SEDIMENT														
Aluminum	mg/kg	2530 J	4360 J	1630 J	1760 J	5400 J	2510 J	1280 J	2860 J	1530 J	5390 J	2440 J	8440 J	2930 J
Cadmium	mg/kg	0.075 I	0.073 U	0.26 I	0.12 I	0.42	0.22 I	0.13 I	0.25 I	0.096 I	1.6	0.19 I	3	0.2 I
Chromium	mg/kg	6.83	4.84	9.78	8.68	22.8	8.69	6.9	11.3	8.22	28.2	8.3	32.5	10.9
Copper	mg/kg	10.7	2.3 I	13.7	9.6	2 I	8	2.8 I	11	2.2 I	322	4.4	1160	9.7
Iron	mg/kg	2230 J	2330 J	2490 J	1120 J	2230 J	1780 J	922 J	1920 J	1010 J	5560 J	1580	6820 J	1800 J
Lead	mg/kg	7.3	4	9.7	7.3	5.5	27.3	6.9	26.6	7.1	63.7	11.7	90.4	14.1
Manganese	mg/kg	11	25.9	38.7	8.2	10.1	15.6	10.8	17.3	9.9	45.8	23	59.8	19.9
Nickel	mg/kg	3.3	2.1	2.5	2.6	6	2.3	2	3.9	2.9	13	1.9 I	17.2	3.1
Zinc	mg/kg	44.7	7.3 I	64.7	25.9	8.7 I	24.1	12.4	36	10.5	419	23.2	589	32.1
PESTICIDES-SEDIMENTS														
Bromacil	ug/kg	U	U	U	U	U	U	U	U	U	U	U	43 I	U
Chlorpyrifos Ethyl	ug/kg	U	U	U	U	U	U	U	U	U	U	U	47 I	U
Diazinon	ug/kg	35	U	10 I	U	U	U	U	U	U	U	U	U	U
Beta-BHC	ug/kg	U	U	U	U	U	U	U	U	U	U	U	U	U
Chlordane	ug/kg	7.1 I	U	12 I	U	U	U	U	7 I	U	55	7.8 I	38 I	9 I
DDD-p,p'	ug/kg	U	U	1.2 I	U	U	U	U	U	U	4.1 I	2.7 I	3.5 I	3.6
DDE-p,p'	ug/kg	U	U	1.5 I	U	U	1.4 I	U	1.5 I	0.91 I	11	2 I	8.4 I	2.6 I
Endosulfan sulfate	ug/kg	U	U	U	U	U	U	U	U	U	U	U	U	U
Endrin aldehyde	ug/kg	U	U	U	U	U	U	U	U	U	U	U	U	U
Methoxychlor	ug/kg	U J	U J	U J	U J	U J	U	U	U	U	U	U	U J	U J
NUTRIENTS - SEDIMENTS														
N_KJEL_TOT	mg/kg	12000 J	4200 J	14000 J	12000 J	2500 J	24000 JQ	7900 AJQ	19000 JQ	5300 JQ	130000 JQ	8400 JQ	190000 JQ	6400 JQ
Total - P	mg/kg	20000	26000	57000	19000	14000	28000 Q	16000 AQ	22000 Q	19000 Q	60000 Q	810000 Q	88000 Q	76000 Q
CONCENTRATIONS -WATER COLUMN														
CADMIUM	ug/kg	U	X	0.02	2.77	X	*0.5*	X	X	X	*0.5*	X	*0.5*	X
COPPER	ug/kg	5.39	X	2.28	193	X	14.4	X	X	X	9.71	X	9.71	X
IRON	ug/kg	583	X	161	12700	X	1300	X	X	X	74.3	X	74.3	X
LEAD	ug/kg	4.16	X	3.74	75.7	X	12.4	X	X	X	*5*	X	*5*	X
MANGANESE	ug/kg	X	X	X	X	X	X	X	X	X	X	X	X	X
ZINC	mg/kg	23.7	X	16.3	395	X	61.3	X	X	X	33.3	X	33.3	X
TSS	mg/kg	15.72	X	2.04	395.4	X	134	X	X	X	1.56	X	1.56	X
PHOSPHOROUS, TOTAL	mg/kg	0.412	X	0.352	0.018	X	0.208	X	X	X	0.039	X	0.039	X
PHOSPHOROUS, ORTHO	mg/kg	0.209	X	0.303	0.002	X	0.014	X	X	X	0.016	X	0.016	X
NITROGEN, TOTAL	mg/kg	0.781	X	0.94	2.63	X	3.2	X	X	X	1.12	X	1.12	X
AMMONIA	mg/kg	0.2895	X	0.515	0.0825	X	0.152	X	X	X	0.106	X	0.106	X
NITRATE	mg/kg	0.124	X	0.043	0.005	X	0.006	X	X	X	0.489	X	0.489	X
NITRITE	mg/kg	X	X	X	X	X	X	X	X	X	X	X	X	X
ORGANIC NITROGEN	mg/kg	X	X	X	X	X	X	X	X	X	X	X	X	X
CHLORIDE	mg/kg	X	X	X	X	X	X	X	X	X	X	X	X	X
POTASSIUM	mg/kg	X	X	X	X	X	X	X	X	X	X	X	X	X
SODIUM	mg/kg	X	X	X	X	X	X	X	X	X	X	X	X	X
SULFATE	mg/kg	X	X	X	X	X	X	X	X	X	X	X	X	X
CALCIUM	mg/kg	49.1	X	49.2	70.1	X	36.2	X	X	X	79.6	X	79.6	X
MAGNESIUM	mg/kg	3.37	X	3.45	4.4	X	2.42	X	X	X	79.9	X	79.9	X
HARDNESS	mg/kg	136.48	X	137.06	193.16	X	100.36	X	X	X	527.79	X	527.79	X
FIELD PARAMETERS - WATER COLUMN														
Depth	cm	6.5	X	31.75	X	X	8.75	X	X	X	41.91	X	20.32	X
D.O.	mg/l	1.76	X	0.97	X	X	3.5	X	X	X	5.7	X	5.16	X
pH	SU	7.36	X	7.47	X	X	7.53	X	X	X	8.22	X	8.16	X
Salinity	PPth	0.22	X	0.22	X	X	0.14	X	X	X	2.66	X	X	X
Sp. Cond.	mho/c	0.446	X	0.446	X	X	0.294	X	X	X	4.847	X	4.631	X
Temperature	Deg C	19.8	X	23.06	X	X	17.77	X	X	X	14.82	X	14.3	X
Time	hhmm	10:00	X	10:45	X	X	13:30	X	X	X	12:05	X	11:15	X

KEY: **X** - Not samplec **Q** - Sample held beyond holding time **N** - Presumptive evidence of presence of material. **J** - Estimated Value **U** - Undetected
A - Value reported is the mean of two or more determination **I** - Value reported is less than the minimum quantitation limit, and greater than or equal to the minimum detection lin **DUP** - duplicate

APPENDIX I

MACROINVERTEBRATES

APPENDIX I macroinvertebrate samples

Appendix I-1. Macroinvertebrates measured at the Florida aquarium in Parking Lot Pond during the summer of 1997

	07/03/97		07/11/97		07/21/97		07/25/97		07/31/97		08/07/97		08/15/97		08/21/97		**TOTALS**	**TOTAL**	
	site1	site2	site1	site2	site1	site2	site1	site2	site1	site2	site1	site2	site1	site2	site1	site2	site1	site2	**ALL**
AMPHIPODA																			
Hyallela azteca	3	0	1	0	4	0	2	0	6	0	1	0	0	0	0	0	17	0	**17**
ANNELIDA																			
Limnodrilus hoffmeisteri	81	0	94	0	83	0	92	1	111	0	117	1	98	3	121	5	797	10	**807**
Tubifex templetoni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
DIPTERA																			
Chironomus sp.	0	0	0	0	0	0	0	0	0	0	0	0	3	0	25	0	28	0	**28**
GASTROPODA																			
Physella h. hendersoni	3	0	4	0	5	0	1	0	1	0	3	0	4	0	1	0	22	0	**22**
Physella h.heterostropha	10	7	12	5	14	6	11	2	12	1	13	2	12	0	16	1	100	24	**124**
Planorbella duryi	105	46	98	32	97	23	78	38	62	22	84	20	61	25	68	19	653	225	**878**
ODONATA																			
Enallagma doubledayi	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	3	**3**
Anax sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
HIRUDINEA																			
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
PELECYPODA																			
Juvenile	3	10	4	8	3	10	6	9	7	11	3	7	8	9	12	11	46	75	**121**
TOTALS - EACH SITE	205	65	213	45	206	39	190	51	199	34	221	30	186	37	243	36	1663	337	
TOTALS - POND		257		246		232		226		215		241		206		256		2000	2000
H' DIVERSITY	1.50	1.27	1.52	1.15	1.63	1.37	1.54	1.16	1.60	1.08	1.46	1.30	1.68	1.17	1.86	1.55	1.68	1.35	1.77
E EQUITABILITY	0.58	0.64	0.59	0.72	0.63	0.86	0.60	0.50	0.62	0.68	0.57	0.65	0.65	0.74	0.72	0.77	0.60	0.58	0.59

Appendix I-2. Macroinvertebrates measued at the Florida aquarium in the Building Pond during the summer of 1997

	07/03/97		07/11/97		07/21/97		07/25/97		07/31/97		08/07/97		08/15/97		08/21/97		**TOTALS**		**TOTAL**
	site7	site8	site7	site8	site7	site8	site7	site8	site7	site8	site7	site8	site7	site8	site7	site8	site7	site8	**ALL**
AMPHIPODA																			
Hyallela azteca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ANNELIDA																			
Limnodrilus hoffmeisteri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tubifex templetoni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DIPTERA																			
Chironomus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GASTROPODA																			
Physella h. hendersoni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Physella h.heterostropha	57	31	32	42	3	16	15	26	18	32	22	32	51	8	43	32	241	219	460
Planorbella duryi	0	0	0	1	1	0	0	0	0	0	2	0	0	0	0	0	3	1	4
ODONATA																			
Enallagma doubledayi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anax sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HIRUDINEA																			
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PELECYPODA																			
Juvenile	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS - EACH SITE	57	31	32	43	4	16	15	26	18	32	24	32	51	8	43	32	244	220	
TOTALS - POND		88		75		20		41		50		56		59		75		464	464
H' DIVERSITY	0	0	0	0.16	0.811	0	0	0	0	0	0.414	0	0	0	0	0	0.096	0.042	0.08
E EQUITABILITY	NA	NA	NA	0.16	0.811	NA	NA	NA	NA	NA	0.414	NA	NA	NA	NA	NA	0.096	0.042	0.05

Appendix I-3. Macroinvertebrates measured at the florida aquarium in the sedimentation basin of the Street Pond during the summer of 1997. Site 6 is right at the inflow and site 5 is at the equalizer pipe.

	07/03/97		07/11/97		07/21/97		07/25/97		07/31/97		08/07/97		08/15/97		08/21/97		**TOTALS**		**TOTAL**
STREET (POND 3)	site5	site6	site5	site6	site5	site6	site5	site6	site5	site6	site5	site6	site5	site6	site5	site6	site5	site6	**ALL**
AMPHIPODA																			
Hyallela azteca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ANNELIDA																			
Limnodrilus hoffmeisteri	154	539	162	535	143	489	193	521	192	513	213	541	261	493	253	507	1571	4138	5709
Tubifex templetoni	0	35	0	33	0	31	0	38	0	27	0	32	0	33	0	34	0	263	263
DIPTERA																			
Chironomus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GASTROPODA																			
Physella h. hendersoni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Physella h.heterostropha	32	3	84	15	36	7	28	5	38	11	40	10	39	7	42	12	339	70	409
Planorbella duryi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ODONATA																			
Enallagma doubledayi	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Anax sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HIRUDINEA																			
	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	2	2
PELECYPODA																			
Juvenile	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STREET (POND 3)																			
TOTALS - EACH SITE	186	577	246	584	180	527	221	564	230	551	253	584	300	533	295	553	1911	4473	
TOTALS - POND		763		830		707		785		781		837		833		848		6384	6384
H' DIVERSITY	0.662	0.377	0.926	0.501	0.77	0.423	0.548	0.428	0.648	0.422	0.63	0.448	0.556	0.436	0.59	0.482	0.681	0.443	0.593
E EQUITABILITY	0.662	0.238	0.926	0.251	0.486	0.267	0.548	0.27	0.647	0.266	0.63	0.224	0.56	0.28	0.59	0.32	0.45	0.22	0.256

Appendix I-4. Macroinvertebrates measured at the Florida Aquarium in the filtration basin of the Street Pond during the summer of 1997.

	07/03/97		07/11/97		07/21/97		07/25/97		07/31/97		08/07/97		08/15/97		08/21/97		**TOTALS**		**TOTAL**
STREET (POND 4)	site3	site4	site3	site4	site3	site4	site3	site4	site3	site4	site3	site4	site3	site4	site3	site4	site3	site4	**ALL**
AMPHIPODA																			
Hyallela azteca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ANNELIDA																			
Limnodrilus hoffmeisteri	212	521	252	283	249	274	310	225	217	298	248	243	362	276	384	208	2234	2328	4562
Tubifex templetoni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DIPTERA																			
Chironomus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GASTROPODA																			
Physella h. hendersoni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Physella h.heterostropha	7	11	8	13	7	11	11	12	17	8	4	13	9	12	12	14	75	94	169
Planorbella duryi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ODONATA																			
Enallagma doubledayi	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	2	0	2
Anax sp.	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	2	2
HIRUDINEA																			
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PELECYPODA																			
Juvenile	9	0	10	0	8	0	14	0	11	0	11	0	9	0	12	0	84	0	84
STREET (POND 4)																			
TOTALS - EACH SITE	228	532	270	297	265	285	335	237	245	306	264	256	380	289	408	222	2395	2424	
TOTALS - POND		751		557		542		558		540		509		660		618		4735	4735
H' DIVERSITY	0.44	0.15	0.42	0.29	0.41	0.24	0.46	0.29	0.62	0.18	0.40	0.29	0.32	0.28	0.38	0.34	0.43	0.25	0.36
E EQITABILITY	0.28	0.15	0.27	0.18	0.20	0.24	0.29	0.29	0.39	0.18	0.20	0.29	0.20	0.17	0.23	0.34	0.21	0.16	0.15

APPENDIX J

**ANALYSIS OF GROSS SOLIDS IN
DROP BOXES AT
FLORIDA AQUARIUM
COMPARING THREE CLEAN OUT PERIODS**

This has been kept as a stand-alone summary report with all the data

:\DEMO\DROPBOX\GROSS SOLIDS\DROPBOX_SED_ALL

Introduction **page 1**

Seven skimmer box inserts (Figure J-1) were installed at the Florida Aquarium to help treat runoff from 5.67 acres of rooftop, sidewalks, garden areas, loading docks, streets and a plant nursery. The skimmer boxes were cleaned out about every six months and the data from the first three cleanouts are presented here. For the first two clean outs, the solids collected from the drop boxes were quantified by volume and two representative samples were sent to Columbia Laboratory for analysis by particle size. Five particle sizes were analyzed for nutrients, metals, and Polycyclic Aromatic Hydrocarbons and a total sample concentration was calculated on a mass weighted basis. For the third clean out the laboratory changed its procedure and only two particle sizes were analyzed but another sample was analyzed without being sieved which produced quite different results. During the second clean out period a smaller screen size was installed in the skimmer boxes, but since the boxes tended to hold water, the screen sizes were changed back to a larger screen size in July 2002.

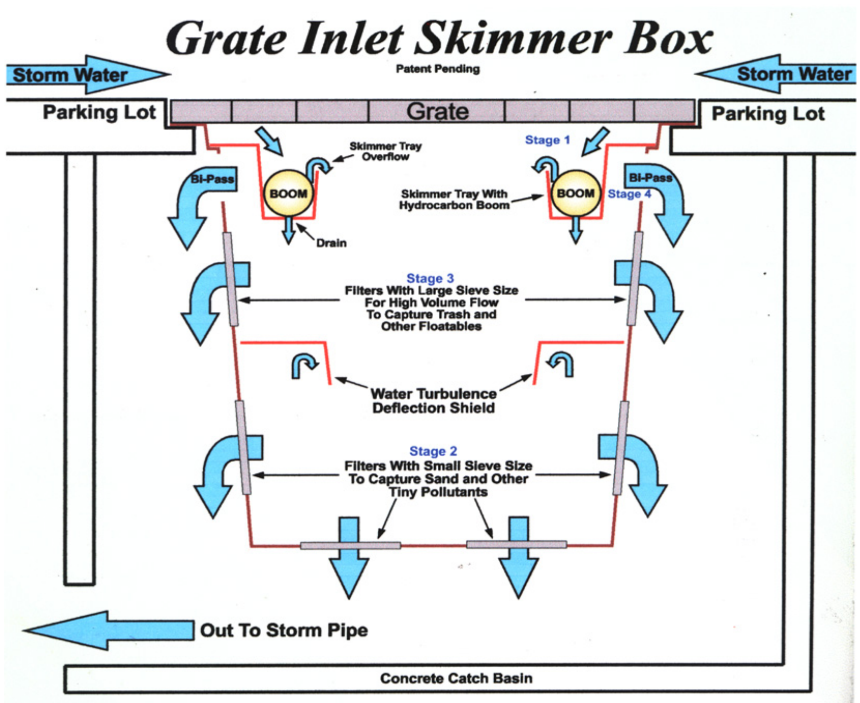


Figure J-1. Diagram of drop box insert.

Summary of Method

Representative aliquots of the material from the seven skimmer boxes were mixed together on a volume-weighted basis and two samples were extracted from the mixed material and sent to the laboratory for analysis. The data include: 1) tables for particle size, 2) tables with the concentrations analyzed by particle size, and 3) figures showing the analysis for each particle size. For the third cleanout, only two particle sizes were analyzed, but for comparison a sample was also analyzed without being sieved.

Summary of Results

The preliminary data presented here are being analyzed for a future report and the figures and tables are poorly organized and a haphazard numbering system has been used.

- Similar particle size ranges were measured for all three cleanout periods. Most of the particles (30 to 40%) were measured in the 180 to 425 micron size range (Figure J-2, page 7). Usually less than 10% of particles were smaller than 75 microns, which is about the largest size particle that can be sampled using automatic water quality samplers (Tables XX-1 to XX-3 and Figure J-2 pages 4-7).

- All the constituent concentrations are reported for each clean out event in Tables X-1 through X-3, pages 8,9 and 10. The data for individual constituents are presented in Figures J-4 through J-11, pages 12 – 17. Constituent concentrations for samples that have been combined on a mass- weighted basis show that duplicate samples usually measured comparable concentrations, but that there were often differences between sampling events (Figure J-3, page 11).

- When the samples were analyzed by particle size, the smallest particle size usually had the highest concentrations of pollutants (Figures J-4 through Figure J-9, pages 12-16).

- An exception to the pattern showing the smallest particle size with the highest concentrations was seen for organic carbon and nitrogen during the third clean out period when the largest particle size range had the highest concentrations. The leaves captured on the largest sieve may have caused this result (Figure J-6, page 14).

- Of some concern is the comparison of concentrations measured in the samples that were not sieved compared to the samples that were sieved. There appears to be a significant difference between concentrations with some much higher and others much lower. This brings into question whether the physical process of sieving the sample changes the concentrations (Figure J-6 and Figure J-9, page 14 and page17). If the differences were caused by samples that were not well mixed or homogeneous then it would be expected that the duplicate samples would have shown more variation (FigureJ-3, page 11). This result was also noted for another site that is being studied.

Conclusions

Drop box inserts are effective for collecting coarse solids from the stormwater flow stream. The drop boxes removed about fifteen cubic feet of material per year from this six-acre drainage basin. Although the smallest particle size had the highest concentrations of pollutants, the larger particle sizes contributed a greater mass of pollutants. Of some concern is that sieving samples into separate particle size ranges is changing the concentration of pollutants measured in samples.

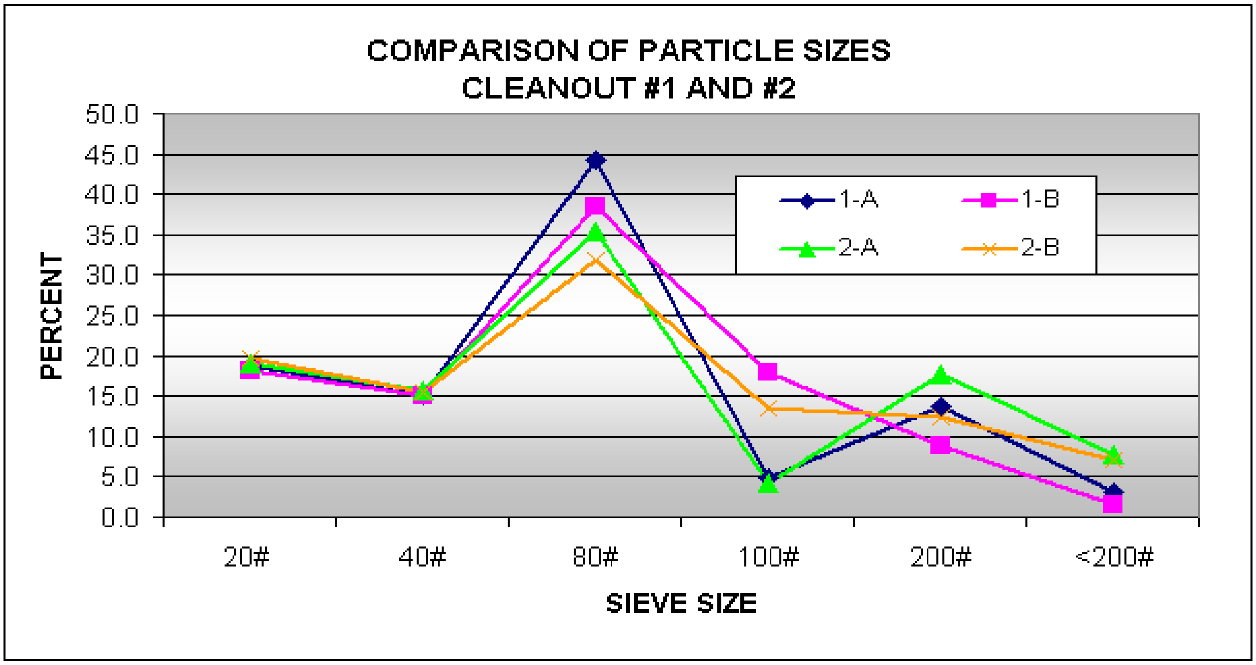
Table XX-1. Particle size analsysis for gross solids at Florida Aquarium. December 17, 2002 to July 2003.

Standard Sieve Designation		Gross Mass grams	Tare Mass grams	Net Mass Retained indiv-ual grams	Net Mass Retained Accumu-lative grams	% retained %
Sample No.: D9260-1			**Sample A**			
	850 um	642.2	414	228.2	228.2	18.9
40#	425 um	577.1	394.4	182.7	410.9	15.1
80#	180 um	870.5	337.1	533.4	944.3	44.2
100#	150 um	416.9	357.7	59.2	1003.5	4.9
200#	75 um	475.7	308.9	166.8	1170.3	13.8
<200#	<75um	402.5	366.6	35.9	1206.2	3.0
Sample No.: D9260-2 duplicate				**Sample B**		
20#	850 um	629.3	428.1	201.2	201.2	18.2
40#	425 um	562.1	394.9	167.2	368.4	15.1
80#	180 um	778.6	353	425.6	794	38.4
100#	150 um	564.8	366.7	198.1	992.1	17.9
200#	75 um	464.1	366.2	97.9	1090.0	8.8
<200#	<75um	385.3	367.5	17.8	1107.8	1.6
Bulk Density (g/cm3)						
Sample No.: D9260-1 A			1.20			
Sample No.: D9260-2 B			1.35			

Table xx-2. Particle size for gross solids in the Florida Aquarium drop boxe						
July 2002 to December 2002						
Standard Sieve Designation		Gross Mass grams	Tare Mass grams	Net Mass Retained indiv-ual grams	Net Mass Retained Accumu-lative grams	% retained %
Sample No.: DA664-1				**Sample A**		
20#	850 um	700.60	414.00	286.6	286.6	19
40#	425 um	632.10	394.40	237.7	524.3	15.7
80#	180 um	872.60	337.00	535.6	1059.9	35.5
100#	150 um	420.40	357.40	63	1122.9	4.2
200#	75 um	634.80	366.20	268.6	1391.5	17.8
<200#	<75um	485.20	367.50	117.7	1509.2	7.8
Sample No.: DA664-2				**Sample B**		
20#	850 um	720.00	428.10	291.9	291.9	19.6
40#	425 um	623.50	394.70	228.8	520.7	15.4
80#	180 um	827.20	353.00	474.2	994.9	31.8
100#	150 um	568.90	366.70	202.2	1197.1	13.6
200#	75 um	496.00	309.20	186.8	1383.9	12.5
<200#	<75um	471.70	366.60	105.1	1489	7.1
Bulk Density (g/cm3)						
Sample No.: DA664-1			1.08			
Sample No.: DA664-2 duplicat			1.03			

Table xx-3. Particle size distribution - Fla. Aquarium
July 2003 to February 2004

	PARTICLE SIZE DISTRIBUTION				
	Sample A		**Sample B**		
	% GRAVEL	3.7	% GRAVEL	4	
	%SAND	83.4	%SAND	84.5	
	%SILT/CLAY	12.9	%SILT/CLAY	11.5	
				Sample	
	Sample A	% FINER	% RETAINED	percent	
	Total Sample	100			
	>#4	96.3	3.7		
	#10	91.9	4.4		
	#20	80.8	11.1	19.2	
	#40	68.1	12.7		
	#60	53.9	14.2		
	#140	19.5	34.4		
	#200	12.9	6.6		
	#230	10.7	2.2		
	<#230	0	10.7	80.8	
	Sample B				
	Total sample	100			
	#4	96	4		
	#10	91.4	4.6		
	#20	80.4	11	19.6	
	#40	67.7	12.7		
	#60	53.2	14.5		
	#140	17.5	35.7		
	#200	11.5	6		
	#230	9.6	1.9		
	<#230	0	9.6	80.4	



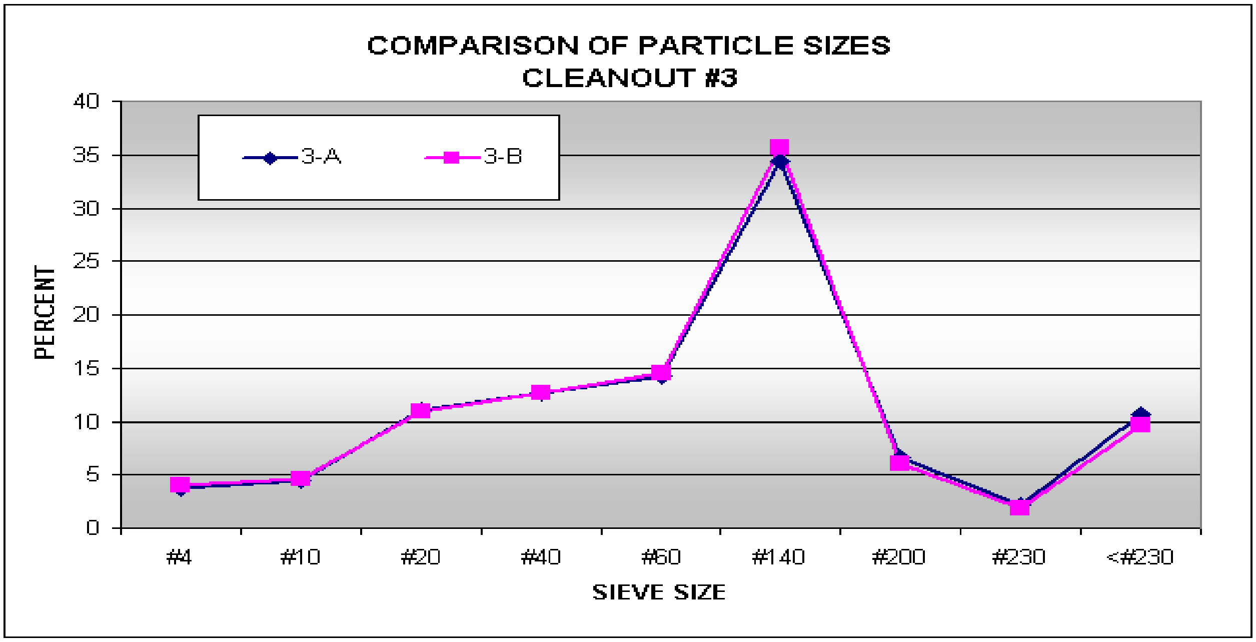


Figure J-2. Comparison of particle sizes. Different sieve sizes were used for the third cleanout period. See Table xx-1 to convert sieve size to particle size. A and B are duplicate samples.

Table X-1. Chemical analysis for drop box clean out covering the period from July 2002 to December 2002

		SAMPLE A						SAMPLE B					
Sieve Size		#20	#40	#80	#100	#200	**Total**	#20	#40	#80	#100	#200	**Total**
Particle Size	units	(840um)	(424 um)	(180 um)	(150um)	(75um)	**calculated**	(840um)	(424 um)	(180 um)	(150um)	(75um)	**calculated**
Ratio		0.19	0.15	0.44	0.05	0.17	**1.00**	0.18	0.15	0.38	0.18	0.11	**0.89**
POLYCYCLIC AROMATIC HYDROCARBONS													
Naphthalene	ug/kg	9.4	12	7.8	5.4	15	**10**	4	15	12	11	20	**10**
Acenaphtyhylene	ug/kg	2	2.3	1.6	1.5	4.1	**2**	1.6	3.1	2.5	2.6	4.5	**2**
acenaphthene	ug/kg	20	57	31	19	48	**35**	7	74	29	38	47	**39**
Fluorene	ug/kg	19	45	27	18	39	**30**	6.7	54	20	30	31	**28**
Phenanthrene	ug/kg	120	420	240	160	410	**269**	50	710	340	330	570	**375**
Anthracene	ug/kg	19	59	36	25	59	**40**	9	100	52	52	80	**54**
Fluoranthene	ug/kg	65	340	260	190	460	**265**	52	480	370	330	620	**293**
Pyrene	ug/kg	280	930	620	390	1000	**655**	220	1300	740	960	1100	**766**
Benzo (a) anthracene	ug/kg	34	260	200	140	380	**205**	60	290	250	250	440	**192**
Chrysene	ug/kg	74	300	320	180	570	**306**	82	370	440	330	830	**268**
Benzo (b) fluoranthene	ug/kg	68	430	330	240	730	**359**	100	450	470	430	1000	**318**
Benzo (a) pyrene	ug/kg	24	160	120	88	320	**140**	42	190	210	180	480	**136**
Benzo (k) pyrene	ug/kg	39	330	240	160	560	**266**	69	360	290	330	610	**236**
Indeno (1,2,3-cd) pyrene	ug/kg	46	320	240	200	650	**283**	76	310	250	370	540	**215**
Benzo (g,h,l) perylene	ug/kg	51	180	170	150	510	**206**	52	240	220	270	500	**168**
Dibenzo (a,h) anthracene	ug/kg	U	U	62	50	160	**57**	U	74	66	88	120	**50**
TOTAL PAH's		**870**	**3845**	**2905**	**2017**	**5915**	**3127**	**831**	**5020**	**3762**	**4002**	**6993**	**3150**
METALS													
Copper	mg/kg	84.3	14.9	48.3	17.0	60.3	**51**	63.9	19.8	16.8	26.4	61.9	**23**
Lead	mg/kg	6.2	14.9	14.9	23.3	58.7	**21**	8.1	31.9	28.6	24.5	58.1	**21**
Zinc	mg/kg	82.7	109.0	152.0	131.0	416.0	**176**	155.0	158.0	247.0	212.0	430.0	**151**
NUTRIENTS AND OTHER													
Organic carbon	mg/kg	29800	15000	20100	na	56800	**na**	12600	21300	18800	26100	64900	**16239**
Organic matter	%	5.2	2.6	3.5	3.0	9.9	**4.7**	2.2	3.7	3.3	4.6	11.3	**2.8**
pH	units	7.6	7.7	7.8	na	7.8	**na**	7.6	7.6	7.8	7.9	7.8	**6.3**
Total Kjeldahl Nitrogen	mg/kg	504	697	762	594	1960	**898**	571	784	952	683	2630	**630**
Total Phosphorus	mg/kg	2350	626	943	537	1220	**1190**	1340	626	1130	1220	1600	**776**
Bulk Density							**1.20**						**1.35**

U=Indicates that the compound was analyzed for but not detected

na=Not enough sample to do analysis

Table X-2. Drop Box Cemical Analysis for Cleanout at Florida Aquarium December 17, 2002 to July 2003

Sieve Size / Particle Size / Ratio	units	SAMPLE A #20 (840um) 0.19	#40 (424 um) 0.16	#80 (180 um) 0.36	#100 (150um) 0.22	#200 (75um) 0.08	TOTAL Calcs	SAMPLE B #20 (840um) 0.20	#40 (424 um) 0.15	#80 (180 um) 0.32	#100 (150um) 0.26	#200 (75um) 0.07	TOTAL Calcs
POLYCYCLIC AROMATIC HYDROCARBONS													
Naphthalene	ug/kg	6.6	26	9.2	4.8	17	**11**	19	39	8.3	7.9	19	**16**
Acenaphtyhylene	ug/kg	U	U	U	U	22	**U**	U	U	U	U	26	**U**
Acenaphthene	ug/kg	U	67	25	U	26	**22**	U	40	U	U	26	**U**
Fluorene	ug/kg	41	62	26	U	31	**30**	U	45	19	U	26	**16**
Phenanthrene	ug/kg	300	540	320	190	490	**298**	43	380	260	200	500	**236**
Anthracene	ug/kg	46	110	50	26	70	**56**	6	88	39	29	70	**39**
Fluoranthene	ug/kg	570	690	550	420	1100	**597**	69	530	570	450	1100	**470**
Pyrene	ug/kg	450	540	490	370	1200	**526**	83	500	560	500	1500	**506**
Benzo (a) anthracene	ug/kg	180	320	260	190	490	**260**	22	240	250	220	530	**215**
Chrysene	ug/kg	270	380	340	260	420	**325**	60	290	350	330	940	**319**
Benzo (b) fluoranthene	ug/kg	210	430	380	330	1000	**398**	77	310	420	390	1100	**375**
Benzo (k) fluoranthene	ug/kg	110	270	290	210	650	**267**	39	270	300	280	900	**280**
Benzo (a) pyrene	ug/kg	170	320	310	240	620	**298**	92	260	300	280	690	**275**
Indeno (1,2,3-cd) pyrene	ug/kg	130	220	230	180	480	**221**	79	170	210	230	600	**210**
Benzo (g,h,i) perylene	ug/kg	80	160	170	120	440	**164**	25	120	160	170	580	**159**
Dibenzo (a,h) anthracene	ug/kg	62	78	80	72	120	**79**	U	58	60	78	160	**61**
TOTAL PAHs		**2564**	**4135**	**3450**	**2541**	**7056**	**3514**	**614**	**3282**	**3446**	**3087**	**8607**	**3123**
METALS													
Copper	mg/kg	34.8	31.3	48.2	41.7	104.0	**46**	30.3	25.3	20.1	38.6	123.0	**35**
Lead	mg/kg	U	U	20.1	44.4	50.8	**21**	U	U	20.9	20.3	65.8	**17**
Zinc	mg/kg	153.0	222.0	370.0	219.0	807.0	**311**	120.0	292.0	266.0	327.0	1010.0	**309**
NUTRIENTS & OTHER													
Organic Carbon	mg/kg	26200	70300	46200	17400.0	70300	**42310**	15100	41300	32700	47500	83200	**37853**
Organic Matter	%	3.4	8.3	9.1	11.1	16.7	**9**	2.5	14.8	8.0	9.1	14.9	**8.7**
pH	units	7.4	7.3	7.4	7.7	7.6	**7.5**	7.5	7.4	7.5	7.6	7.5	**7.5**
Total Kjeldahl Nitrogen	mg/kg	1140	1930	1540	756	3020	**1488**	1220	1600	1260	1480	3440	**1513**
Total Phosphorus	mg/kg	452	559	631	541	1668	**655**	827	988	523	684	1440	**760**
Bulk Density	g/cm^3						**1.08**						**1.03**

U=Indicates that the compound was analyzed for but not detected.

Table F-3. Chemical Analysis for drop box cleanout July 2003 to February 2004 - Fla. Aquarium.

	SAMPLE A							SAMPLE B						
Particle size	>4.75 mm		<425 uM		total	**total**		>4.75 mm		<425 uM		total	**total**	
Sieve Size	1/2-#20		#40-#230		from	**from**		#4-#20		#40-#230		from	**from**	
RATIOS =====>	0.192		0.808		ratio	**lab**		0.20		0.80		ratio	**lab**	
Amount (ft^3)														
CALCULATIONS FOR PAHs (ug/kg)														
Naphthalene	ND	UQ	ND	UQ	ND	**ND**	UQ	ND	UQ	ND	UQ	ND	**ND**	UQ
Acenaphthylene	ND	UQ	ND	UQ	ND	**30**	Q	ND	UQ	ND	UQ	ND	**ND**	UQ
Acenaphthene	ND	UQ	ND	UQ	ND	**ND**	UQ	ND	UQ	ND	UQ	ND	**ND**	UQ
Fluorene	ND	UQ	ND	UQ	ND	**34**	Q	ND	UQ	ND	UQ	ND	**29**	Q
Phenanthrene	ND	UQ	81	Q	65	**430**	Q	100	Q	76	Q	80.704	**290**	Q
Anthracene	ND	UQ	24	Q	19	**67**	Q	ND	UQ	ND	UQ	ND	**55**	Q
Fluoranthene	140	Q	240	Q	221	**1000**	Q	170	Q	270	Q	250.4	**1100**	Q
Pyrene	86	Q	190	Q	170	**850**	Q	120	Q	210	Q	192.36	**970**	Q
Benzo (a) anthracene	56	UQ	88	Q	71	**360**	Q	56	UQ	120	Q	96.48	**530**	Q
Chrysene	130	Q	180	Q	170	**590**	Q	110	Q	230	Q	206.48	**690**	Q
Benzo (b) fluoranthene	180	Q	380	Q	342	**980**	Q	220	Q	500	Q	445.12	**1100**	Q
Benzo (k) fluoranthene	71	UQ	140	Q	113	**340**	Q	70	Q	160	Q	142.36	**360**	Q
Benzo (a) pyrene	160	Q	140	Q	144	**470**	Q	ND	UQ	220	Q	176.88	**540**	Q
Indeno (d,2,3-cd) pyrene	210	Q	130	Q	145	**310**	Q	ND	UQ	210	Q	168.84	**280**	Q
Benzo (g,h,l) perylene	700	Q	120	Q	231	**260**	Q	ND	UQ	180	Q	144.72	**220**	Q
Dibenz (a,h) anthracene	ND	UQ	ND	UQ	ND	**ND**	UQ	ND	UQ	ND	UQ	ND	**ND**	UQ
TOTAL PAH (ug/kg)	1733		1713		1692	**5691**		846		2176		1904	**6164**	
METALS (mg/kg)														
COPPER	59		200		173	**54**		85		250		217.66	**49**	
LEAD	11		16		15	**33**		8.4		18		16.1184	**19**	
ZINC	270		210		222	**310**		190		220		214.12	**270**	
NUTRIENTS & ORGANIC MATTER														
TOC	58500		24200		30786	**26300**		55600		22200		28746.4	**34500**	
Organic Content (%)						**6.81**							**7.87**	
pH	7.5		7.7		7.7	**7.3**		7.3		7.6		7.5412	**7.4**	
TOTAL NITROGEN (mg/Kg)	2200		1100		1311	**1800**		1500		1000		1098	**1900**	
TP (mg/kg)	360		470		449	**530**		280		490		448.84	**490**	
Solids, Total	97.4		99.3		99	**63.2**		98.9		99.8		99.6236	**61.5**	
Bulk Density (g/cm^3)						**61.6**							**64.1**	
Moisture Content (%)						**57.6**							**53.9**	

Q=Sample held two days beyond the accepted holding time

U=Indicates that the compound was analyzed for but not detected

ND=Not detected

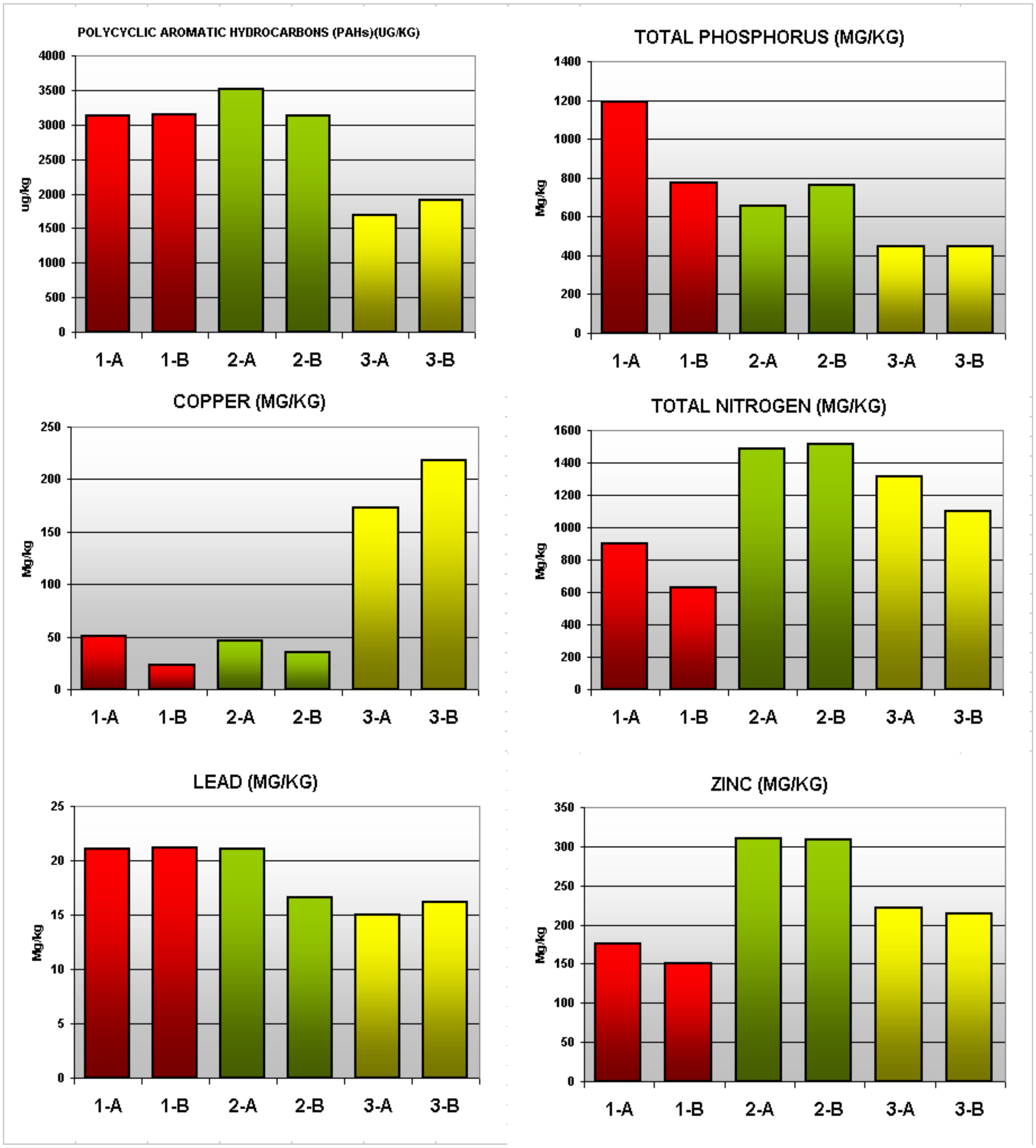


Figure J-3. Comparison of concentrations measures some differences for the three cleanout periods. A and B are duplicate samples.

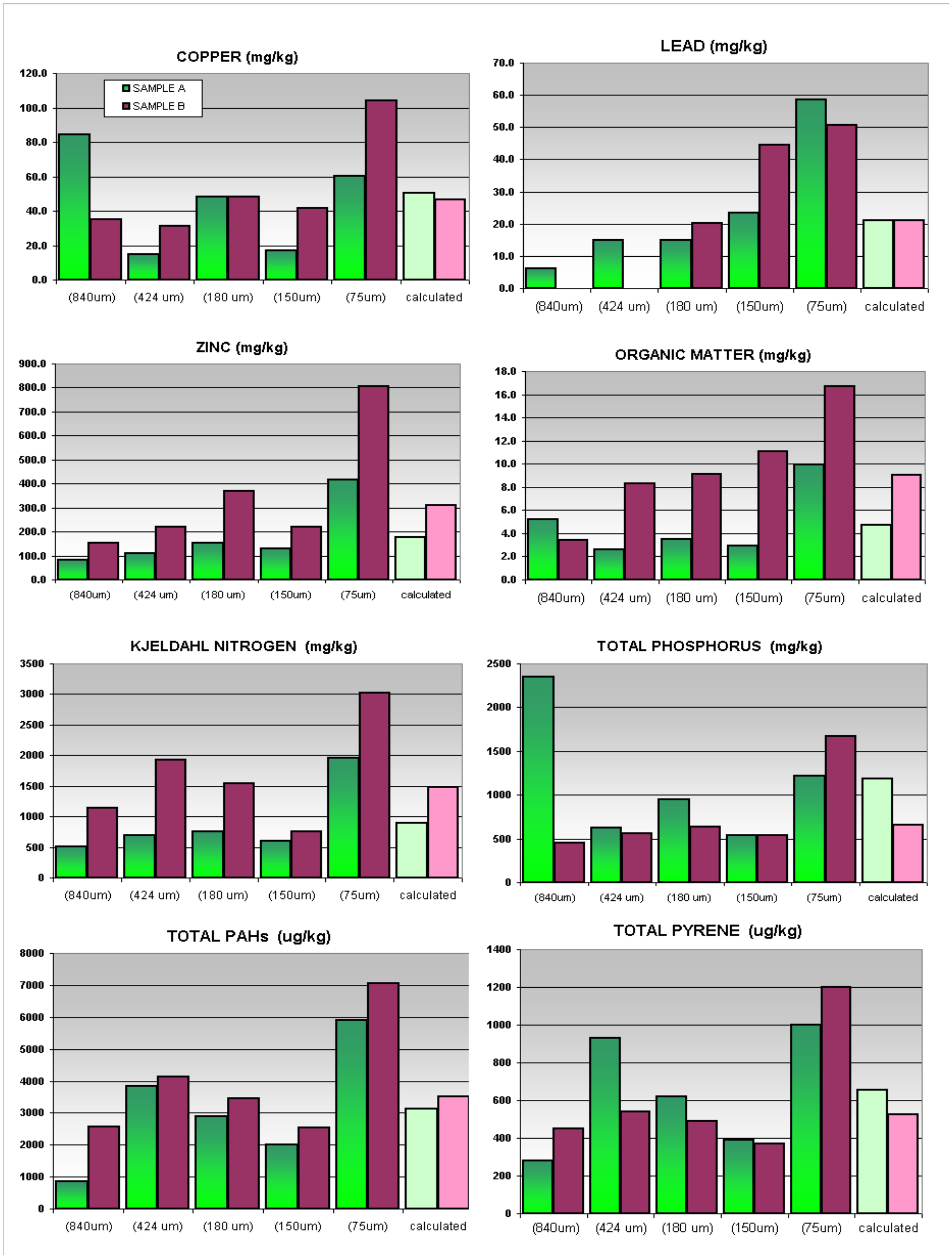


Figure J-4. Concentrations measured in drop boxes analyzed by particle size for period July 2002 to Dec 2002. Samples A & B represent duplicate samples. Calculated are all the particle sizes added together on a mass weight basis. Total mass in drop boxes=7.32 cubic feet.

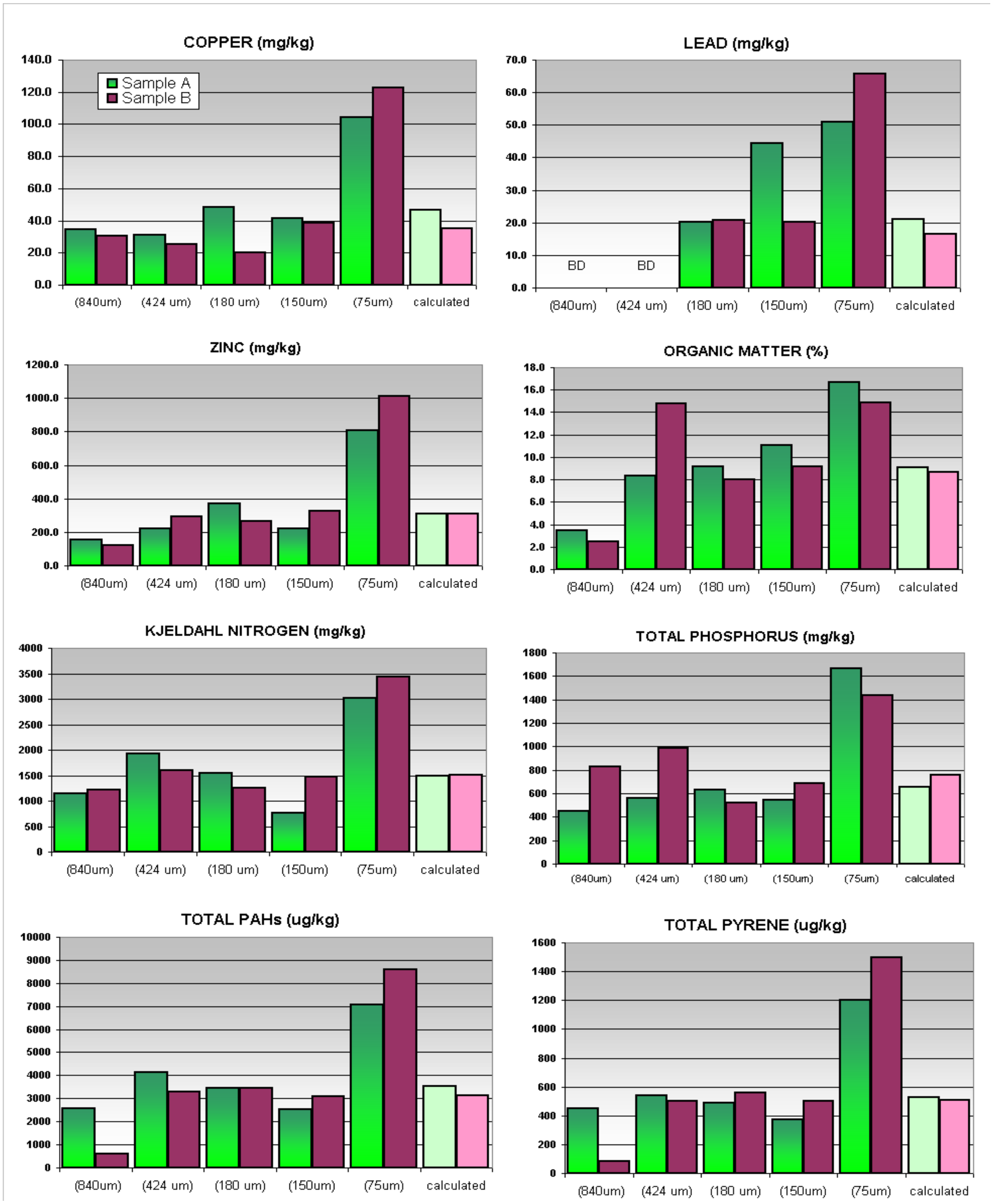


Figure J-5. Concentrations measured in drop boxes analyzed by particle size for Dec 2002 to July 2003. Samples A & B represent duplicate samples. Calculated are all the particle sizes added together on a mass weight basis. Total mass in drop boxes=7.18 cubic feet.

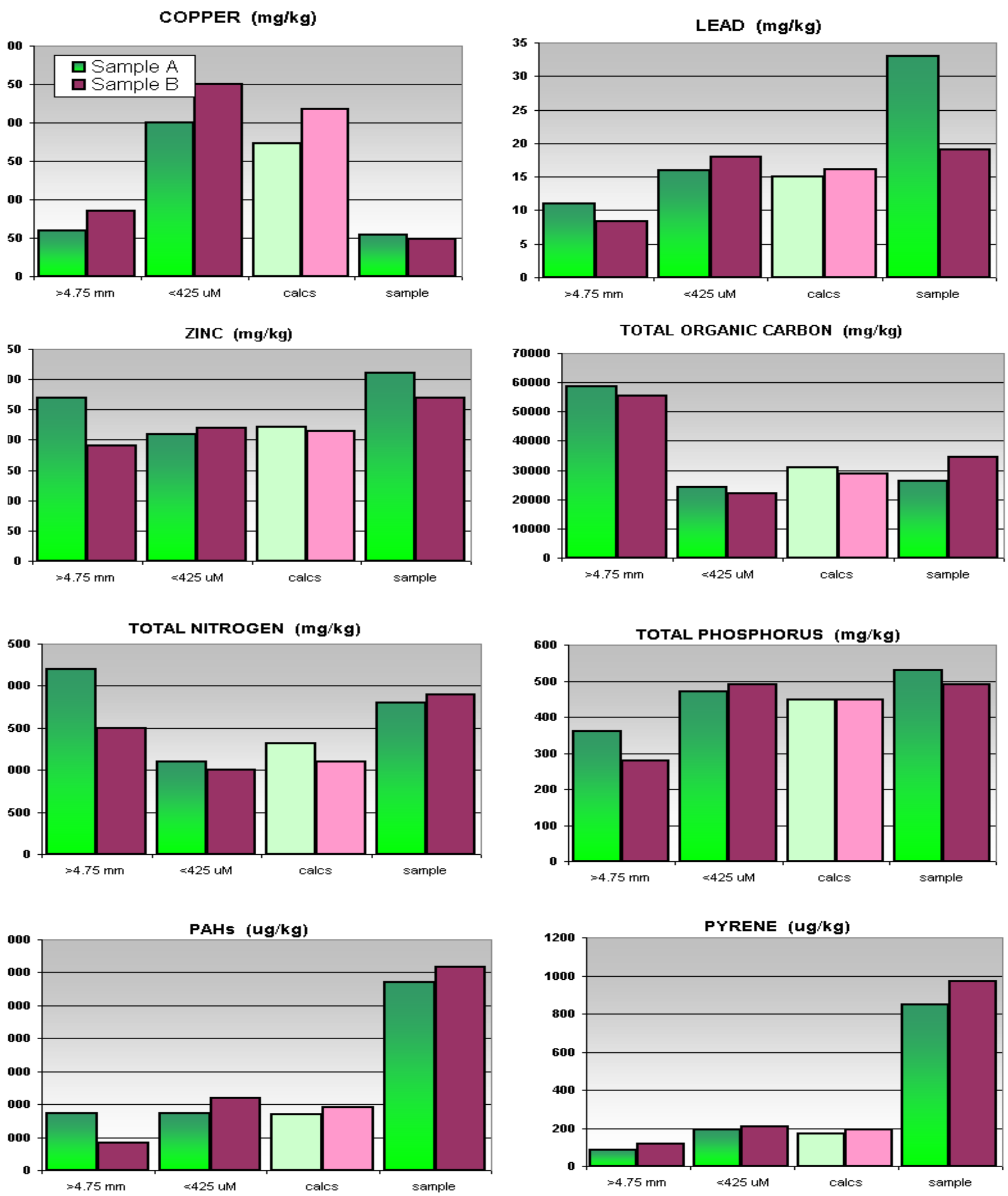
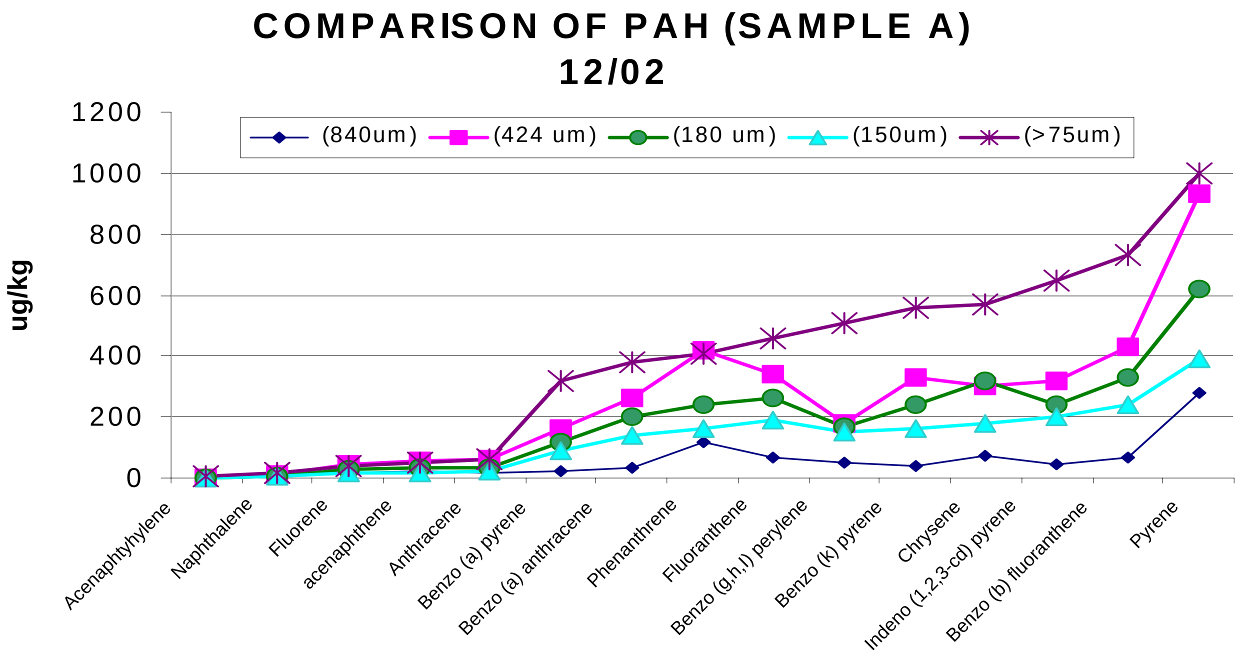


Figure J-6. Concentrations measured in drop boxes analyzed by particle size, July 2003 to February 2004. Calculated mass concentrations were mass weighted from individual particle sizes. The sample was analyzed without sieving. Total mass=8.34 cubic feet.



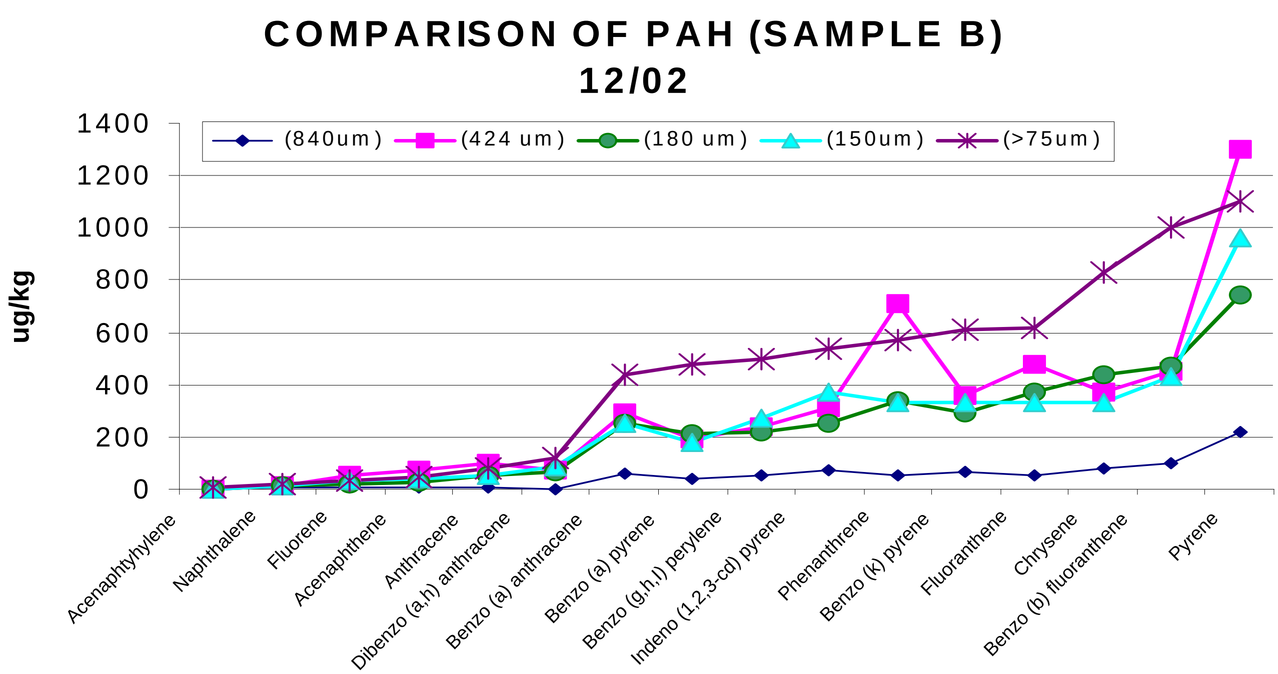
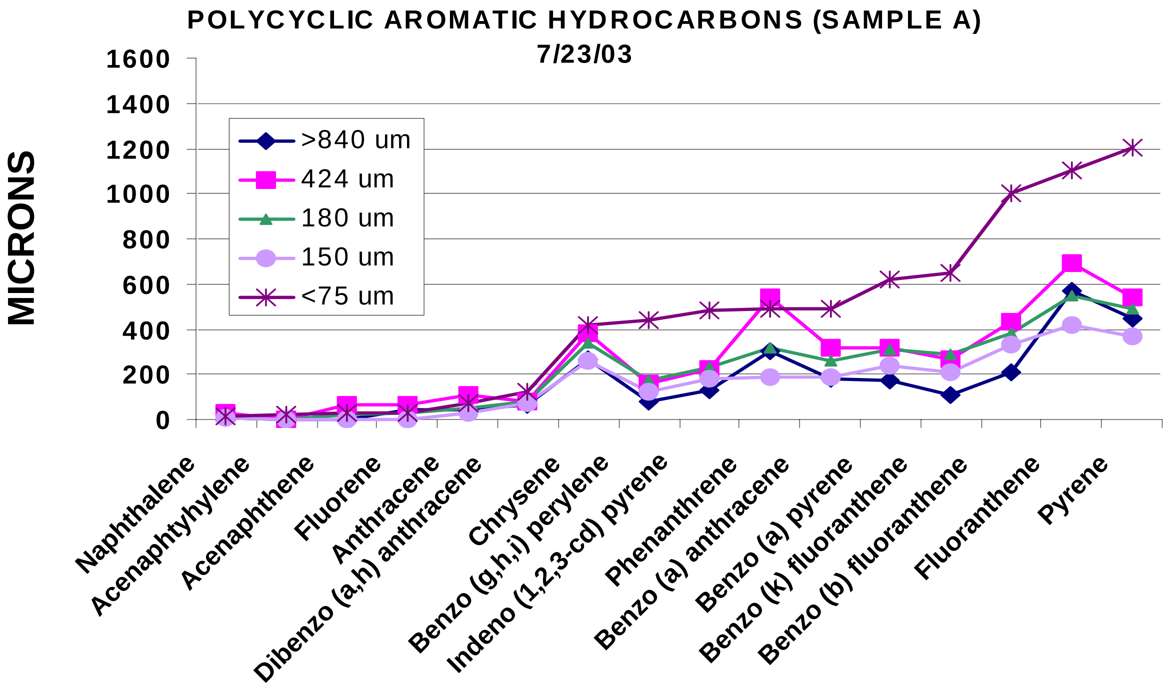


Figure J-7.. Concentrations of individual Polycyclic Aromatic Hydrocarbons species.



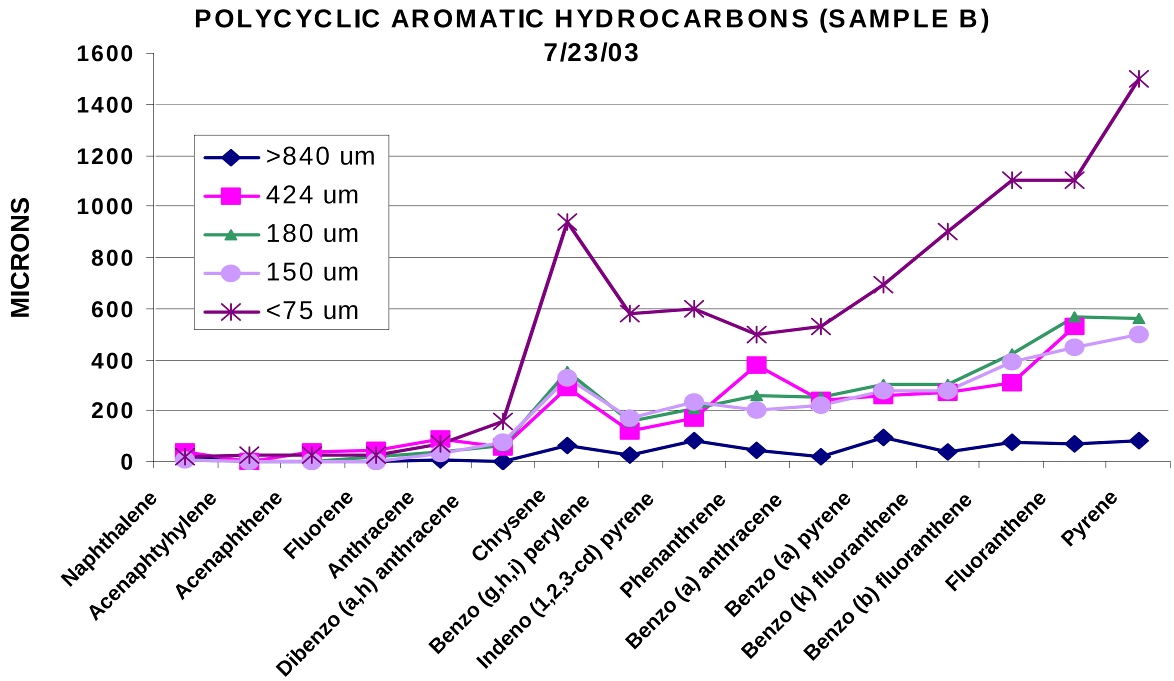


Figure J-8. Concentration of individual PAHs by particle size.

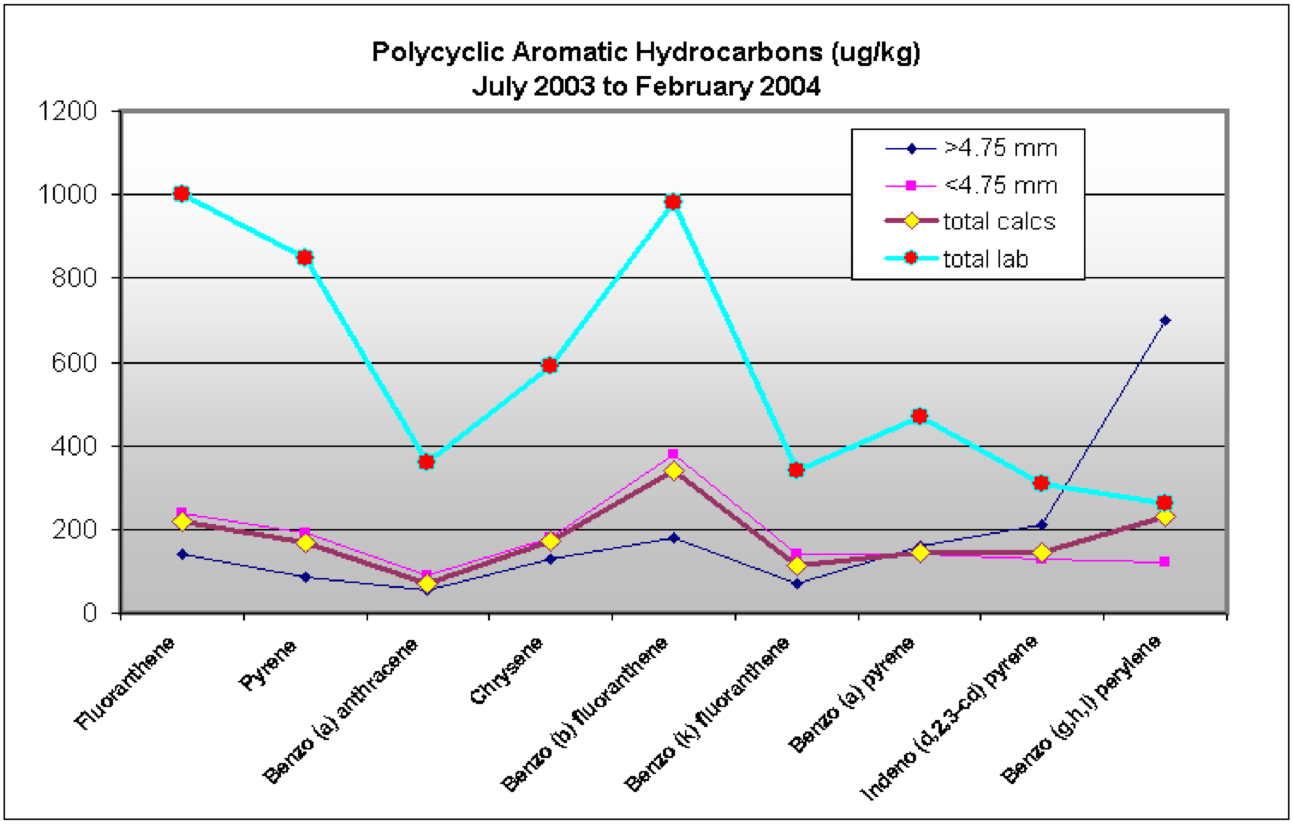


Figure J-9. Individual PAHs analyzed by particle size compared to a sample from the same batch that was analyzed before sieving (total lab).

APPENDIX K

Water Quality measured in the bottom of drop boxes
Includes data before installation and for two clean out periods

Drop Box Water Quality Data from the Building Pond at the Florida Aquarium

AMMONIA AS N (LABORATORY DETECTION LIMIT=0.01 MG/L & 1/2 MDL USED FOR CALCS

YEAR 2002		Outflow	Drain 1	Drain 2	Drain 3	Drain 4	Drain 5	Drain 6	Drain 7	Drain 8
	RAIN	POND	3453	3454	3455	3456	3457	3458	3459	3460
DATE	AMT	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
01/15/02	1.05	0.57	0.07	0.13	-----	-----	-----	-----	-----	0.07
01/23/02	no rain	0.12	1.45	0.07	-----	-----	0.07	-----	-----	0.51
02/07/02	1.07	0.47	0.09	0.11	0.31	0.21	0.11	-----	-----	0.09
02/11/02	0.11	0.10	0.18	0.10	3.11	0.24	0.12	-----	-----	0.02
02/22/02	1.54	0.11	0.29	3.81	0.08	-----	0.21	-----	0.10	*0.01*
02/25/02	no rain	0.03	0.06	0.03	0.69	*0.01*	*0.01*	-----	0.69	*0.01*
03/04/02	0.31	0.17	0.07	0.04	4.41	0.46	0.09	-----	0.33	0.02
04/03/02	1.38	0.65	0.15	0.04	0.12	0.56	0.24	-----	0.28	0.10
05/17/02	0.32	0.20	0.18	-----	0.11	-----	0.16	-----	1.25	-----
05/19/02	0.91	0.22	0.16	-----	0.23	0.51	0.11	0.16	0.14	-----
06/13/02	0.84	0.03	0.26	0.13	0.15	-----	0.09	-----	0.80	0.04
06/25/02	1.64	0.10	0.13	0.09	0.34	-----	-----	-----	-----	-----
08/02/02	0.29	0.16	0.17	-----	0.68	-----	0.15	0.23	0.27	0.03
08/08/02	1.48	0.19	0.82	0.22	0.13	0.29	0.09	0.11	0.28	0.11
08/15/02	0.09	0.08	0.59	0.12	0.10	0.46	0.06	0.17	0.07	0.08
09/03/02	1.10	0.29	0.38	0.10	0.31	0.23	0.04	0.02	0.02	0.06
09/11/02	1.53	0.27	0.08	0.04	0.09	0.31	0.04	0.05	0.05	0.02
10/14/02	0.11	0.68	1.71	0.06	0.47	0.75	0.31	0.45	1.02	0.08
11/13/02	0.88	0.59	1.43	0.06	0.22	0.44	0.14	0.17	0.20	0.06
12/20/02	0.54	0.10	0.10	0.02	0.08	0.38	0.05	0.05	-----	0.05
02/10/03	0.21	0.26	0.73	0.04	0.15	-----	0.24	0.18	0.25	0.06
03/17/03	0.71	0.48	1.90	*0.01*	0.15	0.41	0.24	0.37	0.14	0.03
05/24/03	0.77	0.32	2.14	0.03	0.10	0.27	0.10	0.10	0.09	0.05
07/09/03	0.93	0.28	1.08	-----	0.11	0.45	0.08	0.14	0.08	0.13
02/17/04	no rain		0.92		0.05		0.05	0.19	0.57	0.14
BEFORE INSTALLATION										
Count		11	11	9	9	6	10	1	7	9
Average		0.242	0.267	0.493	1.022	0.329	0.119	0.156	0.514	0.095
Median		0.168	0.156	0.101	0.225	0.349	0.108	0.156	0.331	0.035
Max.		0.653	1.446	3.810	4.405	0.558	0.236	0.156	1.250	0.508
Min.		0.029	0.056	0.025	0.081	0.005	0.005	0.156	0.103	0.005
Std. Dev.		0.219	0.398	1.244	1.595	0.214	0.068		0.419	0.159
C.V.*		0.904	1.488	2.524	1.561	0.650	0.568		0.815	1.675
FIRST CLEANOUT PERIOD										
Count		8	8	7	8	6	7	7	7	7
Average		0.295	0.664	0.097	0.291	0.415	0.118	0.173	0.273	0.063
Median		0.231	0.483	0.086	0.265	0.376	0.093	0.169	0.204	0.064
Max.		0.683	1.710	0.218	0.681	0.753	0.310	0.448	1.023	0.114
Min.		0.076	0.081	0.043	0.091	0.230	0.037	0.022	0.019	0.016
Std. Dev.		0.223	0.616	0.059	0.206	0.188	0.095	0.142	0.347	0.032
C.V.*		0.758	0.927	0.613	0.708	0.452	0.808	0.821	1.271	0.508
SECOND CLEANOUT PERIOD										
Count		5	6	4	6	4	6	6	5	6
Average		0.289	1.145	0.023	0.107	0.376	0.125	0.171	0.225	0.076
Median		0.280	1.000	0.025	0.105	0.395	0.091	0.159	0.137	0.057
Max.		0.482	2.140	0.035	0.152	0.448	0.237	0.369	0.571	0.139
Min.		0.101	0.100	0.006	0.050	0.267	0.046	0.048	0.081	0.026
Std. Dev.		0.136	0.759	0.012	0.040	0.078	0.089	0.110	0.205	0.045
C.V.*		0.472	0.663	0.551	0.373	0.206	0.713	0.646	0.911	0.594

*C.V. = Coefficient of Variation (Standard Deviation/Mean)

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Drop Box Water Quality Data from the Building Pond at the Florida Aquarium

NITRATE AS N (LABORATORY DETECTION LIMIT=0.01 MG/L & 1/2 MDL USED FOR CALCS										
YEAR 2002		Outflow	Drain 1	Drain 2	Drain 3	Drain 4	Drain 5	Drain 6	Drain 7	Drain 8
	RAIN	640	3453	3454	3455	3456	3457	3458	3459	3460
DATE	AMT	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
01/15/02	1.05	0.420	0.255	2.060	-----	-----	-----	-----	-----	0.170
01/23/02	no rain	0.754	0.868	2.550	-----	-----	0.057	-----	-----	0.047
02/07/02	1.07	0.253	0.116	0.758	0.332	0.239	0.248	-----	-----	0.129
02/11/02	0.11	0.055	0.688	6.200	0.373	1.760	0.467	-----	-----	0.121
02/22/02	1.54	0.034	1.018	20.200	1.036		0.096	-----	0.739	0.456
02/25/02	no rain	0.029	0.287	0.330	0.171	0.259	0.292	-----	1.840	0.018
03/04/02	0.31	0.289	0.458	0.610	0.774	1.540	0.630	-----	0.862	0.211
04/03/02	1.38	0.288	0.342	0.533	0.678	0.927	0.428	-----	0.473	0.333
05/17/02	0.32	0.141	0.499	-----	3.900	-----	1.290	-----	4.240	-----
05/19/02	0.91	0.214	0.477	-----	0.691	0.772	0.395	0.449	0.529	-----
06/13/02	0.84	0.339	0.929	0.225	0.794	-----	0.497	-----	0.798	0.240
06/25/02	1.64	0.104	0.132	0.086	0.200	-----	-----	-----	-----	-----
08/02/02	0.29	0.029	5.070	-----	0.476	-----	0.471	0.566	1.370	0.216
08/08/02	1.48	0.218	0.028	0.089	1.010	0.144	0.461	0.637	1.370	0.505
08/15/02	0.09	0.138	0.033	0.028	0.236	0.114	0.249	0.501	0.408	0.169
09/03/02	1.10	0.082	0.248	0.022	0.259	0.213	0.546	0.575	0.639	0.357
09/11/02	1.53	0.093	0.100	*0.005*	0.191	0.145	0.123	0.177	0.182	0.063
10/14/02	0.11	0.359	0.014	1.380	0.644	0.346	0.917	2.200	2.420	0.765
11/13/02	0.88	0.269	0.026	0.309	0.522	0.692	0.364	0.577	0.614	0.138
12/20/02	0.54	0.081	0.142	0.179	0.173	0.223	0.184	0.181		0.107
02/10/03	0.21	0.600	0.902	1.080	0.800		0.448	0.532	1.520	0.208
03/17/03	0.71	0.371	0.045	0.887	0.516	0.501	0.307	0.306	0.373	0.088
05/24/03	0.77	-----	0.021	0.081	0.687	0.405	0.338	0.328	0.319	0.117
07/09/03	0.93	-----	0.022	-----	0.777	0.292	0.711	0.627	0.792	0.609
02/17/04	no rain	-----	-----	-----	-----	-----	-----	-----	-----	-----
BEFORE INSTALLATION										
Count		11	11	11	11	10	11	11	11	11
Average		0.256	0.540	3.718	0.972	0.916	0.440	0.449	1.354	0.192
Median		0.253	0.477	0.758	0.691	0.850	0.412	0.449	0.798	0.170
Max.		0.754	1.018	20.200	3.900	1.760	1.290	0.449	4.240	0.456
Min.		0.029	0.116	0.225	0.171	0.239	0.057	0.449	0.473	0.018
Std. Dev.		0.210	0.298	6.463	1.130	0.634	0.348	-----	1.351	0.138
C.V.*		0.819	0.551	1.738	1.163	0.692	0.790	-----	0.997	0.722
FIRST CLEANOUT PERIOD										
Count		8	8	8	8	8	8	8	8	8
Average		0.162	0.706	0.274	0.442	0.276	0.447	0.748	1.000	0.316
Median		0.121	0.067	0.086	0.368	0.179	0.461	0.575	0.639	0.216
Max.		0.359	5.070	1.380	1.010	0.692	0.917	2.200	2.420	0.765
Min.		0.029	0.014	0.005	0.191	0.114	0.123	0.177	0.182	0.063
Std. Dev.		0.111	1.765	0.498	0.285	0.220	0.253	0.658	0.773	0.247
C.V.*		0.687	2.499	1.818	0.644	0.799	0.565	0.881	0.773	0.782
SECOND CLEANOUT PERIOD										
Count		6	6	6	6	5	6	6	5	6
Average		0.351	0.226	0.557	0.591	0.355	0.398	0.395	0.751	0.226
Median		0.371	0.045	0.533	0.687	0.349	0.338	0.328	0.583	0.117
Max.		0.600	0.902	1.080	0.800	0.501	0.711	0.627	1.520	0.609
Min.		0.081	0.021	0.081	0.173	0.223	0.184	0.181	0.319	0.088
Std. Dev.		0.260	0.381	0.501	0.259	0.123	0.199	0.181	0.555	0.219
C.V.*		0.742	1.683	0.899	0.438	0.346	0.500	0.458	0.738	0.971

*C.V. = Coefficient of Variation (Standard Deviation/Mean)

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Drop Box Water Quality Data from the Building Pond at the Florida Aquarium

TOTAL NITROGEN AS N (LABORATORY DETECTION LIMIT=0.05 MG/L & 1/2 MDL USED FOR CALCS

YEAR 2002		Outflow	Drain 1	Drain 2	Drain 3	Drain 4	Drain 5	Drain 6	Drain 7	Drain 8
mm/dd/yy	RAIN	640	3453	3454	3455	3456	3457	3458	3459	3460
DATE	AMT	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
01/15/02	1.05	0.78	0.41	2.39	-----	-----	-----	-----	-----	0.74
01/23/02	no rain	1.58	2.67	5.59	-----	-----	0.83	-----	-----	1.33
02/07/02	1.07	1.29	0.28	1.65	1.40	1.53	0.75	-----	-----	1.15
02/11/02	0.11	0.18	1.16	6.50	13.85	2.64	0.92	-----	-----	0.68
02/22/02	1.54	1.03	3.30	29.00	3.25		1.94	-----	1.59	1.45
02/25/02	no rain	0.52	0.65	1.10	3.62	1.17	0.91	-----	3.42	0.32
03/04/02	0.31	1.08	0.82	2.44	30.50	3.68	1.04	-----	1.76	0.67
04/03/02	1.38	1.87	0.90	1.52	1.18	3.54	1.28	-----	1.05	1.60
05/17/02	0.32	1.60	2.66	-----	5.90		3.19	-----	4.58	-----
05/19/02	0.91	1.18	1.13	-----	1.56	2.74	0.91	0.78	0.85	-----
06/13/02	0.84	0.70	1.20	1.44	1.62		0.82	-----	1.80	0.40
06/25/02	1.64	1.00	0.96	1.80	1.10	-----	-----	-----	-----	-----
08/02/02	0.29	0.99	7.77	-----	3.65	-----	1.09	1.75	2.14	-----
08/08/02	1.48	0.94	1.33	2.34	1.35	1.19	1.13	1.17	2.17	1.15
08/15/02	0.09	0.59	1.24	1.02	0.66	1.37	0.47	1.20	0.56	0.42
09/03/02	1.10	0.78	1.01	0.88	1.04	0.94	0.76	0.76	0.90	0.78
09/11/02	1.53	0.58	0.38	0.77	0.55	1.25	0.34	0.45	0.44	0.40
10/14/02	0.11	1.47	2.25	2.56	1.73	2.10	1.61	3.02	3.46	1.48
11/13/02	0.88	1.53	2.02	1.25	1.13	3.11	0.08	1.01	1.19	0.36
12/20/02	0.54	0.60	0.34	0.67	0.30	1.23	0.28	0.28	-----	0.33
02/10/03	0.21	1.55	2.25	2.07	1.80	-----	1.11	1.00	2.41	0.64
03/17/03	0.71	1.95	3.00	1.55	1.19	1.80	1.15	1.41	1.24	0.48
05/24/03	0.77	-----	3.06	1.38	1.18	1.83	0.758	0.621	0.627	0.485
07/09/03	0.93	-----	1.66	-----	1.24	1.95	1.080	1.130	1.130	1.130
02/17/04	no rain	-----	2.87	-----	1.58	-----	0.790	1.840	4.670	0.493
BEFORE INSTALLATION										
Count		11	11	11	11	8	11	11	11	11
Average		1.073	1.381	5.737	6.987	2.550	1.259	0.780	2.150	0.927
Median		1.080	1.130	2.390	3.250	2.690	0.915	0.780	1.760	0.744
Max.		1.870	3.300	29.000	30.500	3.680	3.190	0.780	4.580	1.600
Min.		0.180	0.280	1.100	1.180	1.170	0.750	0.780	0.850	0.320
Std. Dev.		0.506	1.018	8.932	9.680	1.024	0.763		1.354	0.467
C.V.*		0.472	0.737	1.557	1.386	0.402	0.606		0.630	0.504
FIRST CLEANOUT PERIOD										
Count		8	8	8	8	8	8	8	8	8
Average		0.985	2.121	1.517	1.401	1.660	0.784	1.336	1.551	0.764
Median		0.965	1.284	1.250	1.115	1.309	0.762	1.170	1.190	0.595
Max.		1.530	7.770	2.560	3.650	3.110	1.610	3.020	3.460	1.480
Min.		0.578	0.383	0.773	0.552	0.944	0.082	0.445	0.438	0.360
Std. Dev.		0.358	2.359	0.721	0.981	0.810	0.529	0.845	1.091	0.464
C.V.*		0.363	1.112	0.475	0.700	0.488	0.675	0.632	0.704	0.608
SECOND CLEANOUT PERIOD										
Count		6	6	6	6	6	6	6	6	6
Average		1.367	2.062	1.418	1.142	1.703	0.876	0.888	1.352	0.614
Median		1.550	2.250	1.465	1.190	1.815	1.080	1.000	1.185	0.485
Max.		1.950	3.060	2.070	1.800	1.950	1.150	1.410	2.410	1.130
Min.		0.600	0.340	0.670	0.300	1.230	0.280	0.280	0.627	0.330
Std. Dev.		0.693	1.122	0.578	0.537	0.322	0.368	0.443	0.754	0.309
C.V.*		0.507	0.544	0.408	0.471	0.189	0.420	0.499	0.558	0.504

*C.V. = Coefficient of Variation (Standard Deviation/Mean)

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Drop Box Water Quality Data from the Building Pond at the Florida Aquarium										
ORTHO-PHOSPHORUS (LABORATORY DETECTION LIMIT=0.01 MG/L & 1/2 MDL USED FOR CALCS)										
YEAR 2002		Outflow	Drain 1	Drain 2	Drain 3	Drain 4	Drain 5	Drain 6	Drain 7	Drain 8
	RAIN	640	3453	3454	3455	3456	3457	3458	3459	3460
DATE	AMT	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
01/15/02	1.05	0.343	0.189	0.978	-----	-----	-----	-----	-----	0.530
01/23/02	no rain	0.047	0.172	0.689	1.370	-----	0.061	-----	-----	0.260
02/07/02	1.07	0.166	0.079	0.307	0.414	0.666	0.125	-----	-----	0.211
02/11/02	0.11	0.085	0.109	0.839	1.990	0.549	0.155	-----	-----	0.217
02/22/02	1.54	0.119	1.120	2.400	0.333	-----	0.305	-----	0.158	0.194
02/25/02	no rain	0.155	0.162	*0.005*	*0.005*	*0.005*	*0.005*	-----	0.152	0.145
03/04/02	0.31	0.159	0.099	0.633	0.950	0.611	0.191	-----	0.168	0.167
04/03/02	1.38	0.178	0.106	0.430	0.279	2.520	0.195	-----	0.157	0.107
05/17/02	0.32	1.650	0.096	-----	0.601	-----	0.530	-----	0.156	-----
05/19/02	0.91	0.927	0.094	-----	0.156	0.886	0.219	0.199	0.186	-----
06/13/02	0.84	0.025	0.098	0.244	0.197	-----	0.044	-----	0.108	0.017
06/25/02	1.64	0.091	0.088	0.293	0.175	-----	-----	-----	-----	-----
08/02/02	0.29	0.016	0.439	-----	0.370	-----	0.131	0.193	0.117	0.090
08/08/02	1.48	0.036	0.108	0.311	0.166	0.448	0.117	0.060	0.061	0.041
08/15/02	0.09	0.073	0.069	0.244	0.199	0.648	0.066	0.061	0.057	0.047
09/03/02	1.10	0.063	0.092	0.243	0.182	0.322	0.076	0.054	0.040	0.060
09/11/02	1.53	0.059	0.038	0.207	0.108	0.803	0.070	0.062	0.045	0.063
10/14/02	0.11	0.130	0.549	0.205	0.134	2.107	0.113	0.074	0.250	0.059
11/13/02	0.88	0.092	0.228	0.184	0.114	3.320	1.260	0.117	0.116	0.053
12/20/02	0.54	0.031	0.033	0.270	0.049	0.555	0.039	0.049	-----	0.042
02/10/03	0.21	0.082	0.126	0.308	0.096	-----	0.050	0.091	0.081	0.079
03/17/03	0.71	0.089	0.306	0.178	0.134	0.542	0.081	0.04	0.088	0.047
05/24/03	0.77	-----	0.198	0.216	0.106	0.611	0.089	0.092	0.09	0.06
07/09/03	0.93	-----	0.123	-----	0.058	0.417	0.092	0.127	0.044	0.056
02/17/04	no rain	-----	0.929	-----	0.529	-----	0.126	0.142	0.79	0.142
BEFORE INSTALLATION										
Count		11	11	11	11	11	11	11	11	11
Average		0.350	0.211	0.725	0.630	0.873	0.183	0.199	0.155	0.205
Median		0.159	0.106	0.633	0.374	0.639	0.173	0.199	0.157	0.194
Max.		1.650	1.120	2.400	1.990	2.520	0.530	0.199	0.186	0.530
Min.		0.025	0.079	0.005	0.005	0.005	0.005	0.199	0.108	0.017
Std. Dev.		0.498	0.304	0.699	0.629	0.858	0.152		0.024	0.141
C.V.*		1.422	1.437	0.964	0.999	0.983	0.828		0.153	0.686
FIRST CLEANOUT PERIOD										
Count		8	8	8	8	8	8	8	8	8
Average		0.070	0.201	0.241	0.181	1.275	0.262	0.089	0.098	0.059
Median		0.068	0.100	0.243	0.171	0.726	0.113	0.062	0.061	0.059
Max.		0.130	0.549	0.311	0.370	3.320	1.260	0.193	0.250	0.090
Min.		0.016	0.038	0.184	0.108	0.322	0.066	0.054	0.040	0.041
Std. Dev.		0.035	0.191	0.047	0.083	1.190	0.441	0.051	0.074	0.016
C.V.*		0.506	0.949	0.195	0.459	0.934	1.684	0.571	0.757	0.266
SECOND CLEANOUT PERIOD										
Count		6	6	6	6	6	6	6	6	6
Average		0.067	0.157	0.243	0.089	0.531	0.070	0.080	0.076	0.057
Median		0.082	0.126	0.243	0.096	0.549	0.081	0.091	0.085	0.056
Max.		0.089	0.306	0.308	0.134	0.611	0.092	0.127	0.090	0.079
Min.		0.031	0.033	0.178	0.049	0.417	0.039	0.040	0.044	0.042
Std. Dev.		0.032	0.102	0.057	0.035	0.082	0.024	0.035	0.022	0.014
C.V.*		0.470	0.647	0.236	0.396	0.154	0.344	0.445	0.284	0.252

*C.V. = Coefficient of Variation (Standard Deviation/Mean)

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Drop Box Water Quality Data from the Building Pond at the Florida Aquarium										
TOTAL PHOSPHORUS (LABORATORY DETECTION LIMIT=0.01 MG/L & 1/2 MDL USED FOR CALCS)										
YEAR 2002		Outflow	Drain 1	Drain 2	Drain 3	Drain 4	Drain 5	Drain 6	Drain 7	Drain 8
	RAIN	640	3453	3454	3455	3456	3457	3458	3459	3460
DATE	AMT	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
01/15/02	1.05	0.676	0.236	1.030	-----	-----	-----	-----	-----	1.560
01/23/02	no rain	0.292	0.200	0.736	2.100	-----	0.120	-----	-----	0.580
02/07/02	1.07	0.746	0.101	0.400	0.563	0.729	0.686	-----	-----	2.190
02/11/02	0.11	0.155	0.178	0.965	3.880	0.774	0.240	-----	-----	0.463
02/22/02	1.54	0.199	2.640	2.750	0.446		0.489	-----	1.040	2.520
02/25/02	no rain	0.226	0.183	0.667	0.849	0.502	0.575	-----	0.434	0.394
03/04/02	0.31	0.261	0.176	0.673	6.030	0.819	0.257	-----	0.260	0.756
04/03/02	1.38	0.772	0.150	0.523	0.326	2.730	1.230	-----	0.207	2.890
05/17/02	0.32	1.940	0.265	-----	0.742	-----	0.846	-----	0.218	-----
05/19/02	0.91	1.130	0.141	-----	0.221	0.985	0.330	0.311	0.264	-----
06/13/02	0.84	0.162	0.250	0.290	0.266	-----	0.125	-----	0.154	0.545
06/25/02	1.64	0.203	0.096	0.315	0.216	-----	-----	-----	-----	-----
08/02/02	0.29	0.082	0.496	-----	0.609	-----	0.222	0.502	0.214	0.159
08/02/02	1.48	-----	0.703	-----	-----	-----	-----	0.368	1.050	-----
08/08/02	0.09	0.092	0.166	0.360	0.198	0.532	0.201	0.133	0.144	0.081
08/15/02	1.10	0.114	0.119	0.259	0.243	0.676	0.105	0.093	0.095	0.060
09/03/02	1.53	0.119	0.156	0.253	1.200	3.800	0.122	0.099	0.096	0.089
09/11/02	0.11	0.131	0.056	0.245	0.137	0.943	0.108	0.119	0.094	0.075
10/14/02	0.88	0.213	0.648	0.242	0.233	2.250	0.192	0.148	0.301	0.141
11/13/02	0.54	0.250	0.303	0.198	0.165	3.640	0.197	0.160	0.163	0.064
12/20/02	0.21	0.097	0.047	0.309	0.064	0.637	0.079	0.089	-----	0.047
02/10/03	0.71	0.146	0.219	0.371	0.191	-----	0.190	0.214	0.260	0.089
03/17/03	0.77	0.241	0.494	0.187	0.188	0.749	0.207	0.223	0.195	0.076
07/09/03	0.93	-----	0.267	-----	0.093	0.538	0.139	0.167	0.103	0.07
02/17/04	no rain	-----	0.938	-----	0.63	-----	0.175	0.189	1.23	0.18
BEFORE INSTALLATION										
Count		11	11	11	11	10	11	11	11	11
Average		0.596	0.411	0.893	1.542	1.090	0.490	0.311	0.368	1.322
Median		0.292	0.183	0.673	0.653	0.797	0.410	0.311	0.260	0.756
Max.		1.940	2.640	2.750	6.030	2.730	1.230	0.311	1.040	2.890
Min.		0.155	0.101	0.290	0.221	0.502	0.120	0.311	0.154	0.394
Std. Dev.		0.551	0.741	0.737	1.945	0.819	0.355		0.309	0.986
C.V.*		0.924	1.803	0.825	1.261	0.751	0.724		0.839	0.746
FIRST CLEANOUT PERIOD										
Count		8	8	8	8	8	8	8	8	8
Average		0.151	0.305	0.267	0.375	1.974	0.164	0.203	0.270	0.096
Median		0.125	0.166	0.253	0.225	1.597	0.192	0.141	0.154	0.081
Max.		0.250	0.703	0.360	1.200	3.800	0.222	0.502	1.050	0.159
Min.		0.082	0.056	0.198	0.137	0.532	0.105	0.093	0.094	0.060
Std. Dev.		0.063	0.249	0.053	0.365	1.484	0.050	0.149	0.323	0.039
C.V.*		0.416	0.816	0.200	0.972	0.752	0.305	0.737	1.199	0.406
SECOND CLEANOUT PERIOD										
Count		6	6	6	6	6	6	6	6	6
Average		0.161	0.257	0.289	0.134	0.641	0.154	0.173	0.186	0.071
Median		0.146	0.243	0.309	0.141	0.637	0.165	0.191	0.195	0.073
Max.		0.241	0.494	0.371	0.191	0.749	0.207	0.223	0.260	0.089
Min.		0.097	0.047	0.187	0.064	0.538	0.079	0.089	0.103	0.047
Std. Dev.		0.073	0.184	0.094	0.065	0.106	0.058	0.061	0.079	0.018
C.V.*		0.454	0.718	0.324	0.486	0.165	0.375	0.354	0.424	0.249

*C.V. = Coefficient of Variation (Standard Deviation/Mean)

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Drop Box Water Quality Data from the Building Pond at the Florida Aquarium

TOTAL SUSPENDED SOLIDS (LABORATORY DETECTION LIMIT=0.05 MG/L & 1/2 MDL USED FOR CALCS)										
YEAR 2002		Outflow	Drain 1	Drain 2	Drain 3	Drain 4	Drain 5	Drain 6	Drain 7	Drain 8
	RAIN	640.00	3453	3454	3455	3456	3457	3458	3459	3460
DATE	AMT	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
01/15/02	1.05	49.24	0.55	-----	-----	-----	-----	-----	-----	1105.70
01/23/02	no rain	40.36	1.45	-----	-----	-----	4.99	-----	-----	42.54
02/07/02	1.07	156.00	5.58	8.30	8.95	5.35	123.00	-----	-----	463.00
02/11/02	0.11	4.13	27.90	-----	63.50	3.28	6.36	-----	-----	27.90
02/22/02	1.54	6.08	22.80	-----	14.30		125.00	-----	59.70	1660.00
02/25/02	no rain	7.08	1.12	-----	11.00	3.67	31.80	-----	130.00	35.00
03/04/02	0.31	8.34	1.77	-----	0.95		8.82	-----	3.92	69.52
04/03/02	1.38	260.00	5.40	5.80	6.20	11.00	510.00	-----	7.40	880.00
05/17/02	0.32	11.00	7.20	-----	-----	-----	14.00	-----	3.20	-----
05/19/02	0.91	15.00	1.40	-----	2.60	7.70	6.90	74.00	3.10	-----
06/13/02	0.84	22.00	11.00	2.30	-----	-----	11.00	-----	21.00	140.00
06/25/02	1.64	26.00	0.70	0.50	2.00	-----	-----	-----	-----	-----
08/02/02	0.29	4.10	5.10	-----	31.00	-----	80.00	7.90	14.00	12.00
08/08/02	1.48	3.80	3.70	2.40	1.90	6.70	4.50	3.30	2.80	5.30
08/15/02	0.09	7.00	3.20	2.10	2.90	1.90	2.60	6.40	0.70	2.50
09/03/02	1.10	5.20	8.80	0.50	1.20	3.80	2.00	1.60	0.90	1.80
09/11/02	1.53	8.00	3.40	1.10	1.20	8.80	1.70	1.60	0.60	5.10
10/14/02	0.11	5.49	8.15	-----	30.80	4.43	2.34	1.71	1.61	8.32
11/13/02	0.88	10.90	10.00	0.49	1.83	11.50	2.77	1.56	1.56	1.72
12/20/02	0.54	8.23	2.02	3.20	1.70	10.10	1.82	1.20	-----	2.15
02/10/03	0.21	11.10	9.90	3.86	7.01	-----	9.16	10.50	5.73	7.13
03/17/03	0.71	10.60	6.25	0.697	2.04	15.2	3.99	7.29	2.83	1.62
05/24/03	0.77	-----	5.26	8.54	1.22	9.15	3.37	2.31	12.5	11.6
07/09/03	0.93	-----	12.3	-----	1.77	6.39	5.44	2.01	1.97	1.34
02/17/04	no rain	-----	8.62	-----	12.4	-----	3.35	2.26	134	3.49
BEFORE INSTALLATION										
Count		11	11	11	11	9	11	11	11	11
Average		52.657	7.834	5.467	15.357	6.200	84.187	74.000	32.617	491.518
Median		15.000	5.400	5.800	8.950	5.350	12.500	74.000	7.400	140.000
Max.		260.000	27.900	8.300	63.500	11.000	510.000	74.000	130.000	1660.000
Min.		4.130	0.550	2.300	0.950	3.280	4.990	74.000	3.100	27.900
Std. Dev.		81.543	9.301	3.014	21.730	3.199	156.879		47.518	593.810
C.V.*		1.549	1.187	0.551	1.415	0.516	1.863		1.457	1.208
FIRST CLEANOUT PERIOD										
Count		8	8	8	8	8	8	8	8	8
Average		8.811	5.381	1.181	9.104	6.188	13.701	3.439	3.167	5.249
Median		6.245	4.400	0.800	1.950	5.565	2.600	1.710	1.560	5.100
Max.		26.000	10.000	2.400	31.000	11.500	80.000	7.900	14.000	12.000
Min.		3.800	0.700	0.488	1.200	1.900	1.700	1.560	0.600	1.720
Std. Dev.		7.321	3.256	0.865	13.464	3.535	29.249	2.645	4.836	3.807
C.V.*		0.831	0.605	0.733	1.479	0.571	2.135	0.769	1.527	0.725
SECOND CLEANOUT PERIOD										
Count		6	6	6	6	6	6	6	6	6
Average		9.977	7.146	4.074	2.748	10.210	4.756	4.662	5.758	4.768
Median		10.600	6.250	3.530	1.770	9.625	3.990	2.310	4.280	2.150
Max.		11.100	12.300	8.540	7.010	15.200	9.160	10.500	12.500	11.600
Min.		8.230	2.020	0.697	1.220	6.390	1.820	1.200	1.970	1.340
Std. Dev.		1.533	4.024	3.274	2.401	3.680	2.783	4.048	4.774	4.494
C.V.*		0.154	0.563	0.804	0.874	0.360	0.585	0.868	0.829	0.942

*C.V. = Coefficient of Variation (Standard Deviation/Mean)

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Drop Box Water Quality Data from the Building Pond at the Florida Aquarium

TOTAL COPPER (LABORATORY DETECTION LIMIT=3 uG/L & 1/2 MDL USED FOR CALCS)										
YEAR 2002		Outflow	Drain 1	Drain 2	Drain 3	Drain 4	Drain 5	Drain 6	Drain 7	Drain 8
	RAIN	640	3453	3454	3455	3456	3457	3458	3459	3460
DATE	AMT	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
01/15/02	1.05	11.5	11.7	10.7	-----	-----	-----	-----	-----	17.3
01/23/02	no rain	14.6	68.9	5.2	33.7	-----	5.1	-----	-----	7.5
02/07/02	1.07	26.1	16.7	6.8	18.7	6.2	20.6	-----	-----	35.6
02/11/02	0.11	6.9	16.7	6.5	29.8	15.0	18.7	-----	-----	10.9
02/22/02	1.54	6.1	62.1	44.1	20.3	-----	64.0	-----	31.0	213.0
02/25/02	no rain	7.5	11.8	5.7	14.0	42.9	20.9	-----	94.6	6.8
03/04/02	0.31	9.5	15.0	6.7	744.0	21.5	13.1	-----	93.5	13.3
04/03/02	1.38	24.8	16.0	8.2	14.9	19.8	54.4	-----	18.3	75.8
05/17/02	0.32	11.8	42.3	-----	11.0	-----	35.7	-----	78.5	-----
05/19/02	0.91	12.3	12.2	-----	13.6	11.5	18.0	15.9	20.3	-----
06/13/02	0.84	11.0	19.1	9.9	16.8	-----	9.9	-----	44.6	12.8
06/25/02	1.64	10.9	8.9	5.7	7.1	-----	-----	-----	-----	-----
08/02/02	0.29	7.8	18.0	-----	21.2	-----	18.0	38.3	38.0	7.2
08/08/02	1.48	6.8	7.2	5.2	6.4	7.3	9.1	11.2	22.1	4.3
08/15/02	0.09	5.6	8.5	7.0	6.2	18.5	7.0	21.8	10.6	4.0
09/03/02	1.10	5.1	9.0	4.9	6.0	7.1	8.9	14.3	12.6	4.6
09/11/02	1.53	25	6.0	5.0	6.3	15.6	5.0	8.5	7.5	5.6
10/14/02	0.11	7.5	6.6	6.1	15.1	7.5	14.1	21.7	263.0	8.4
11/13/02	0.88	11.6	21.3	5.9	9.2	14.0	15.9	12.1	18.7	4.2
12/20/02	0.54	7.7	5.4	6.4	4.2	6.3	5.9	7.2	-----	5.4
02/10/03	0.21	17.1	24.8	9.2	21.6	-----	17.4	15.3	32.5	14.7
03/17/03	0.71	17.4	14.2	5.1	9.73	12.8	9.43	10.9	15.6	6.32
05/24/03	0.77	-----	19.6	9.2	8.91	12.5	11.4	10.9	13.6	10.5
07/09/03	0.93	-----	20.3	-----	6.51	15.8	7.91	5.4	11.2	4.28
02/17/04	no rain	-----	32.3	-----	23.5		25.9	99.1	152	5.79
BEFORE INSTALLATION										
Count		11	11	11	11	11	11	11	11	11
Average		12.918	26.591	11.533	91.680	19.483	26.040	15.900	54.400	43.667
Median		11.500	16.700	6.800	17.750	17.400	19.650	15.900	44.600	13.300
Max.		26.100	68.900	44.100	744.000	42.900	64.000	15.900	94.600	213.000
Min.		6.100	11.700	5.200	11.000	6.200	5.100	15.900	18.300	6.800
Std. Dev.		6.700	21.080	12.351	229.317	12.750	19.378		33.752	67.159
C.V.*		0.519	0.793	1.071	2.501	0.654	0.744		0.620	1.538
FIRST CLEANOUT PERIOD										
Count		8	8	8	8	8	8	8	8	8
Average		10.038	10.688	5.680	9.688	11.667	11.143	18.271	53.214	5.471
Median		7.650	8.700	5.700	6.750	10.750	9.100	14.300	18.700	4.600
Max.		25.000	21.300	6.960	21.200	18.500	18.000	38.300	263.000	8.400
Min.		5.100	6.000	4.900	6.000	7.100	5.000	8.500	7.500	4.000
Std. Dev.		6.470	5.704	0.726	5.565	4.998	4.873	10.204	93.056	1.708
C.V.*		0.645	0.534	0.128	0.574	0.428	0.437	0.558	1.749	0.312
SECOND CLEANOUT PERIOD										
Count		6	6	6	6	5	6	6	6	6
Average		14.067	16.860	7.475	10.190	11.850	10.408	9.940	18.225	8.240
Median		17.100	19.600	7.800	8.910	12.650	9.430	10.900	14.600	6.320
Max.		17.400	24.800	9.200	21.600	15.800	17.400	15.300	32.500	14.700
Min.		7.700	5.400	5.100	4.200	6.300	5.900	5.400	11.200	4.280
Std. Dev.		5.516	7.430	2.061	6.735	3.989	4.399	3.831	9.685	4.309
C.V.*		0.392	0.441	0.276	0.661	0.337	0.423	0.385	0.531	0.523

*C.V. = Coefficient of Variation (Standard Deviation/Mean)

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Drop Box Water Quality Data from the Building Pond at the Florida Aquarium										
TOTAL IRON (LABORATORY DETECTION LIMIT=25 uG/L & 1/2 MDL USED IN TABLES)										
YEAR 2002		Outflow	Drain 1	Drain 2	Drain 3	Drain 4	Drain 5	Drain 6	Drain 7	Drain 8
	RAIN	640	3453	3454	3455	3456	3457	3458	3459	3460
DATE	AMT	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
01/15/02	1.05	760	40	60	-----	-----	-----	-----	-----	6850
01/23/02	no rain	430	70	30	270	-----	120	-----	-----	820
02/07/02	1.07	2500	250	170	360	80	1910	-----	-----	8280
02/11/02	0.11	130	50	40	170	260	170	-----	-----	780
02/22/02	1.54	160	410	2570	180	-----	1000	-----	1300	34100
02/25/02	no rain	200	70	150	280	320	1430	-----	490	920
03/04/02	0.31	210	120	*12.5*	25500	550	390	-----	260	1970
04/03/02	1.38	1860	200	90	320	160	5020	-----	250	15100
05/17/02	0.32	230	120	-----	90	-----	320	-----	240	-----
05/19/02	0.91	290	70	-----	80	100	420	190	130	-----
06/13/02	0.84	530	270	180	80	-----	230	-----	110	3450
06/25/02	1.64	650	110	60	100	-----	-----	-----	-----	-----
08/02/02	0.29	100	170	-----	590	-----	100	760	100	320
08/08/02	1.48	100	120	90	60	110	300	110	120	160
08/15/02	0.09	160	130	80	80	880	80	120	70	90
09/03/02	1.10	150	260	110	100	440	110	110	210	60
09/11/02	1.53	230	80	70	*15*	90	90	140	80	160
10/14/02	0.11	200	310	100	440	150	120	80	540	140
11/13/02	0.88	240	1090	50	40	80	270	80	350	50
12/20/02	0.54	180	80	60	60	90	120	120	-----	90
02/10/03	0.21	283	277	93.4	255	-----	534	308	246	229
03/17/03	0.71	247	231	26.2	34.6	317	111	189	81.2	32.6
05/24/03	0.77	-----	182	1290	35	239	158	148	141	319
07/09/03	0.93	-----	1110	-----	125	2110	120	103	138	157
02/17/04	no rain	-----	164	-----	285	-----	89.1	89.5	1500	96.4
BEFORE INSTALLATION										
Count		11	11	11	11	11	11	11	11	11
Average		664	152	367	2733	245	1101	190	397	8030
Median		290	120	90	225	210	405	190	250	3450
Max.		2500	410	2570	25500	550	5020	190	1300	34100
Min.		130	40	13	80	80	120	190	110	780
Std. Dev.		786	117	828	8000	176	1502		417	10862
C.V.*		1.184	0.773	2.258	2.927	0.717	1.364		1.050	1.353
FIRST CLEANOUT PERIOD										
Count		8	8	8	8	8	8	8	8	8
Average		229	284	80	178	292	153	200	210	140
Median		180	150	80	90	130	110	110	120	140
Max.		650	1090	110	590	880	300	760	540	320
Min.		100	80	50	15	80	80	80	70	50
Std. Dev.		178	335	22	214	318	92	248	176	91
C.V.*		0.779	1.181	0.270	1.200	1.091	0.599	1.239	0.837	0.653
SECOND CLEANOUT PERIOD										
Count		6	6	6	6	6	6	6	6	6
Average		237	376	367	102	689	209	174	152	166
Median		247	231	77	60	278	120	148	140	157
Max.		283	1110	1290	255	2110	534	308	246	319
Min.		180	80	26	35	90	111	103	81	33
Std. Dev.		52	417	616	93	952	183	82	69	113
C.V.*		0.221	1.108	1.676	0.914	1.382	0.876	0.472	0.453	0.682

*C.V. = Coefficient of Variation (Standard Deviation/Mean)

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Drop Box Water Quality Data from the Building Pond at the Florida Aquarium

ZINC (LABORATORY DETECTION LIMIT=12 uG/L & 1/2 MDL USED FOR CALCS)

YEAR 2002		Outflow	Drain 1	Drain 2	Drain 3	Drain 4	Drain 5	Drain 6	Drain 7	Drain 8
	RAIN	640	3453	3454	3455	3456	3457	3458	3459	3460
DATE	AMT	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
01/15/02	1.05	70	70	40	-----	-----	-----	-----	-----	120
-----	no rain	100	210	60	830	-----	40	-----	-----	100
02/07/02	1.07	180	140	30	670	40	160	-----	-----	280
02/11/02	0.11	40	170	20	470	140	80	-----	-----	60
02/22/02	1.54	130	370	290	100		220	-----	160	1150
02/25/02	no rain	60	300	90	390	620	240	-----	180	40
03/04/02	0.31	50	140	30	980	90	90	-----	50	70
04/03/02	1.38	170	200	30	270	50	260	-----	110	330
05/17/02	0.32	50	460	-----	6	-----	120	-----	130	-----
05/19/02	0.91	50	190	-----	190	40	60	40	50	-----
06/13/02	0.84	80	140	40	230	-----	60	-----	40	80
06/25/02	1.64	60	50	20	140	-----	-----	-----	-----	-----
08/02/02	0.29	60	180	-----	230	-----	110	140	120	60
08/08/02	1.48	60	60	20	180	30	60	100	130	20
08/15/02	0.09	40	50	20	130	70	40	60	40	20
09/03/02	1.10	40	60	20	170	30	60	60	60	20
09/11/02	1.53	70	70	30	160	30	30	70	50	20
10/14/02	0.11	50	40	20	280	30	70	60	790	30
11/13/02	0.88	70	140	20	170	70	60	70	70	30
12/20/02	0.54	40	70	6	70	30	40	40	-----	20
02/10/03	0.21	150	247	23.9	893	-----	125	124	230	76
03/17/03	0.71	101	73.7	11.9	285	40.4	76.4	109	101	36.6
05/24/03	0.77	-----	113	23	152	43.1	63.1	68.1	70.2	48.2
07/09/03	0.93	-----	140	-----	90	127	45	53.2	68.4	25.7
02/17/04	no rain	-----	107	-----	214		101	63.6	273	16.9
BEFORE INSTALLATION										
Count		11	11	11	11	10	11	11	11	11
Average		89	217	70	414	163	133	40	103	248
Median		70	190	40	330	70	105	40	110	100
Max.		180	460	290	980	620	260	40	180	1150
Min.		40	70	20	6	40	40	40	40	40
Std. Dev.		50	115	85	322	227	82		57	353
C.V.*		0.560	0.529	1.216	0.778	1.390	0.614		0.555	1.426
FIRST CLEANOUT PERIOD										
Count		8	8	8	8	8	8	8	8	8
Average		56	81	21	183	43	61	80	180	29
Median		60	60	20	170	30	60	70	70	20
Max.		70	180	30	280	70	110	140	790	60
Min.		40	40	20	130	30	30	60	40	20
Std. Dev.		12	51	4	49	21	25	30	271	15
C.V.*		0.211	0.622	0.176	0.271	0.477	0.414	0.375	1.507	0.512
SECOND CLEANOUT PERIOD										
Count		6	6	6	6	5	6	6	6	6
Average		97	129	16	298	60	70	79	117	41
Median		101	113	17	152	42	63	68	86	37
Max.		150	247	24	893	127	125	124	230	76
Min.		40	70	6	70	30	40	40	68	20
Std. Dev.		55	72	9	343	45	34	36	77	22
C.V.*		0.568	0.561	0.538	1.151	0.747	0.487	0.459	0.652	0.537

*C.V. = Coefficient of Variation (Standard Deviation/Mean)

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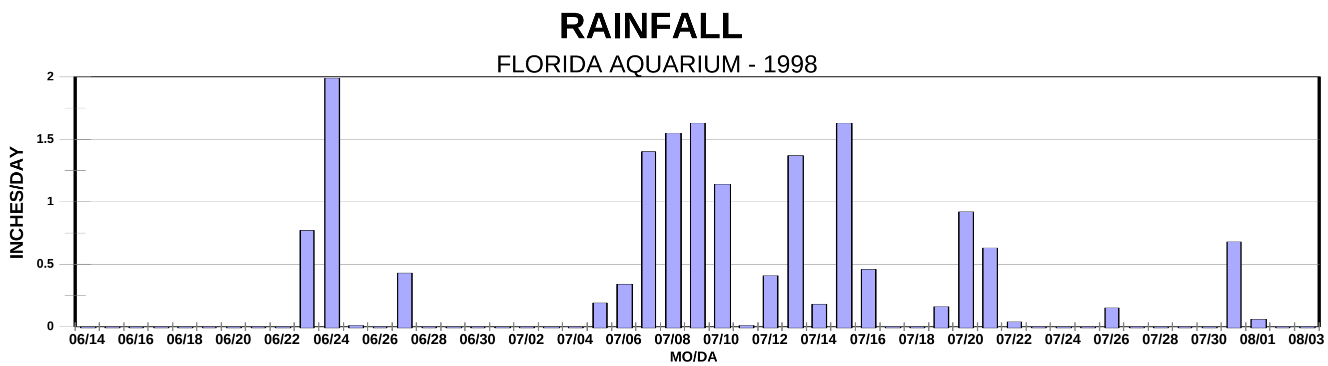
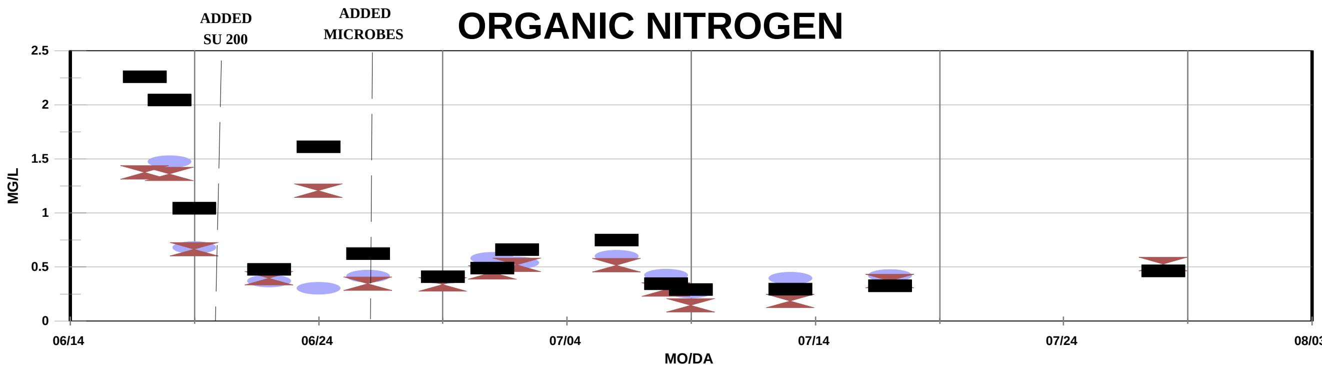
Drop Box Water Quality Data from the Building Pond at the Florida Aquarium										
LEAD (LABORATORY DETECTION LIMIT=4.0 uG/L & 1/2 MDL USED FOR CALCS)										
YEAR 2002		Outflow	Drain 1	Drain 2	Drain 3	Drain 4	Drain 5	Drain 6	Drain 7	Drain 8
	RAIN	640	3453	3454	3455	3456	3457	3458	3459	3460
DATE	AMT	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
01/15/02	1.05	42.1	0.8	0.8	-----	-----	-----	-----	-----	55.7
01/23/02	1.05(1/15)	10.3	0.8	0.8	4.3	-----	4.7	-----	-----	28.8
02/07/02	1.07	104.0	3.2	1.8	4.1	0.8	59.8	-----	-----	181.0
02/11/02	0.11	6.7	*0.8*	*0.8*	1.5	1.6	10.8	-----	-----	19.4
02/22/02	1.54	3.6	7.7	29.0	1.6	-----	123.0	-----	26.5	1030.0
02/25/02	1.54(2/22)	9.8	*0.8*	*0.8*	2.6	24.3	63.0	-----	21.9	23.7
03/04/02	0.31	10.6	1.6	*0.8*	232.0	4.5	16.9	-----	58.2	70.1
04/03/02	1.38	68.9	3.3	1.1	3.2	2.1	125.0	-----	8.1	243.0
05/17/02	0.32	7.0	3.6	-----	1.0	-----	320.0	-----	8.7	-----
05/19/02	0.91	9.6	1.1	-----	1.1	1.2	9.3	10.7	5.6	-----
06/13/02	0.84	15.5	2.4	1.9	1.1	-----	8.1	-----	3.8	22.6
06/25/02	1.64	18.9	110.0	60.0	1.1	-----	-----	-----	-----	-----
08/02/02	0.29	3.1	4.0	-----	5.2	-----	4.3	106.0	7.1	4.7
08/08/02	1.48	2.1	1.8	0.4	1.0	0.6	1.6	3.3	3.8	1.3
08/15/02	0.09	5.1	1.7	*0.2*	0.7	4.8	1.2	2.2	2.1	0.9
09/03/02	1.10	4.3	8.5	*0.2*	0.5	1.1	1.6	1.6	2.0	0.9
09/11/02	1.53	6.7	0.6	0.5	0.5	0.8	1.0	1.7	1.2	1.4
10/14/02	0.39	6.2	4.8	0.8	3.0	0.7	1.7	2.8	328.0	1.5
11/13/02	0.53	5.2	9.8	*0.2*	0.8	0.8	1.6	2.0	3.7	0.9
12/20/02	4.64	2.2	1.5	0.8	1.0	1.0	1.3	1.4	-----	1.2
02/10/03		6.7	6.1	*1.30*	3.30	-----	7.1	10.4	9.5	2.4
03/17/03		*0.2*	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*
05/24/03		-----	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*
07/09/03		-----	*0.2*	-----	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*
02/17/04		-----	*0.2*	-----	*0.2*	-----	*0.2*	10.9	33.1	*0.2*
BEFORE INSTALLATION										
Count		11	11	11	11	11	11	11	11	11
Average		26.2	2.4	4.2	25.3	5.7	74.1	10.7	19.0	186.0
Median		10.3	1.6	0.8	2.1	1.9	38.4	10.7	8.7	55.7
Max.		104.0	7.7	29.0	232.0	24.3	320.0	10.7	58.2	1030.0
Min.		3.6	0.8	0.8	1.0	0.8	4.7	10.7	3.8	19.4
Std. Dev.		32.5	2.1	9.3	72.7	9.2	98.0		19.3	326.3
C.V.*		1.240	0.893	2.234	2.877	1.600	1.323		1.018	1.754
FIRST CLEANOUT PERIOD										
Count		9	9	9	9	9	9	9	9	9
Average		6.0	15.9	7.9	1.5	1.4	1.8	15.1	49.7	1.6
Median		5.1	4.0	0.5	1.0	0.8	1.6	2.1	3.7	1.3
Max.		18.9	110.0	60.0	5.2	4.8	4.3	106.0	328.0	4.7
Min.		2.1	0.6	0.2	0.5	0.6	1.0	1.4	1.2	0.9
Std. Dev.		5.1	35.4	21.1	1.6	1.5	1.0	36.7	122.7	1.3
C.V.*		0.856	2.236	2.670	1.024	1.078	0.584	2.428	2.469	0.797
SECOND CLEANOUT PERIOD										
Count		4	4	4	4	4	4	4	4	4
Average		3.5	1.4	0.6	0.8	0.2	1.6	4.4	8.6	0.6
Median		3.5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Max.		6.7	6.1	1.3	3.3	0.2	7.1	10.4	9.5	2.4
Min.		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Std. Dev.		4.6	3.0	0.6	1.6	0.0	3.5	5.1	4.7	1.1
C.V.*		1.332	2.138	1.121	1.890	0.000	2.184	1.164	0.538	1.719

APPENDIX L

BIOCULTURE – "LIVING SOILS "

Quattro pro: WQ3POND2.WB2new.wb2


RAINFALL
FLORIDA AQUARIUM - 1998
INCHES/DAY
MO/DA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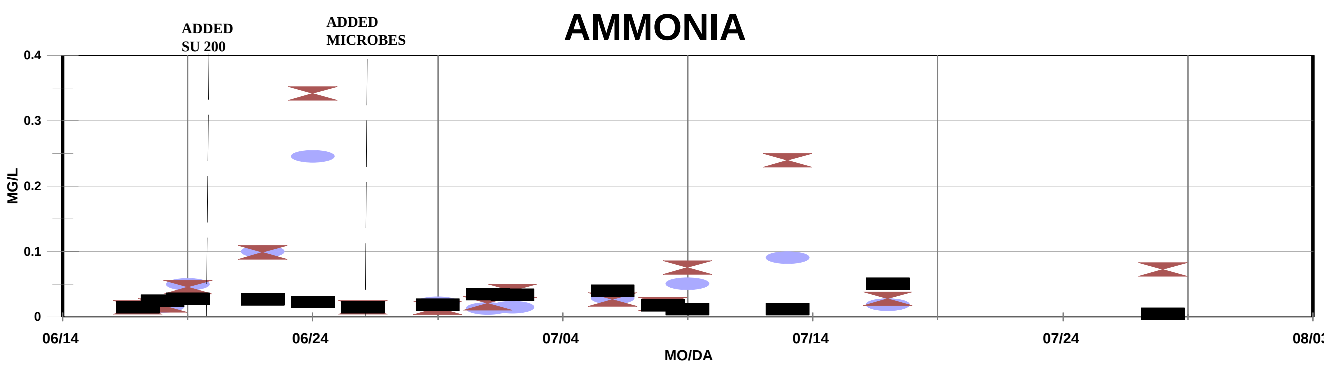
MG/L
MO/DA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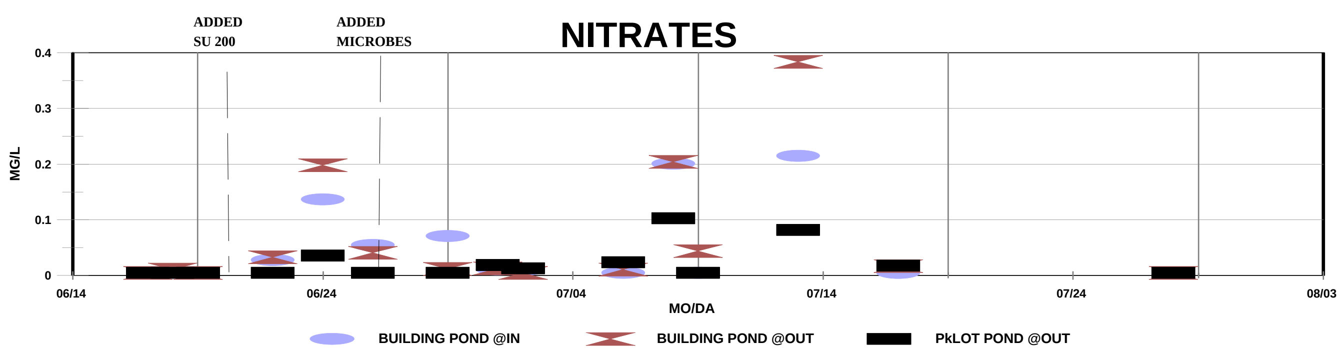
ADDED MICROBES
AMMONIA
MG/L
MO/DA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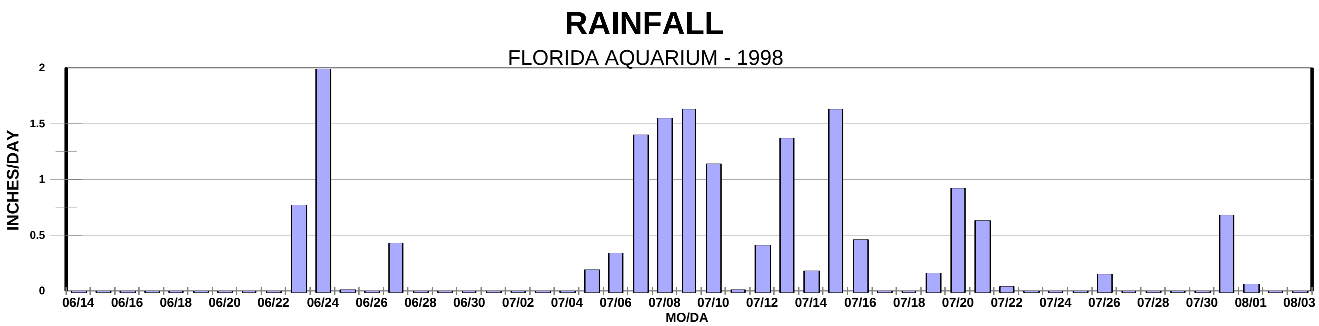
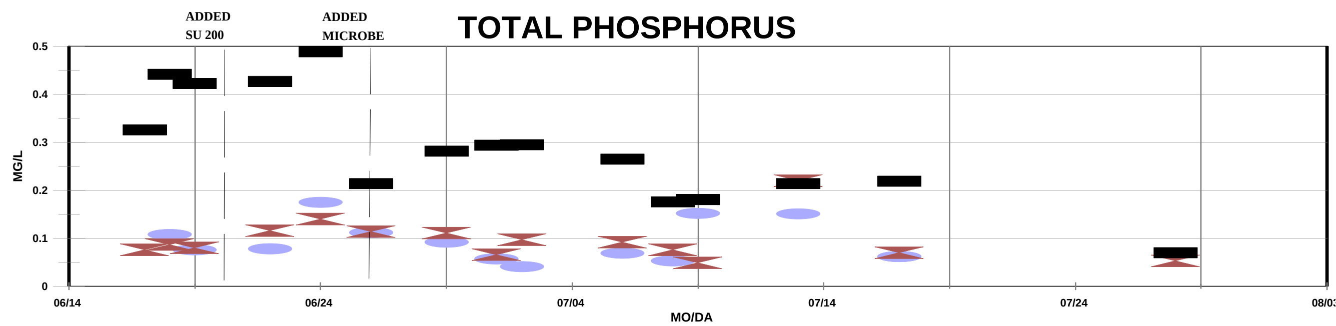
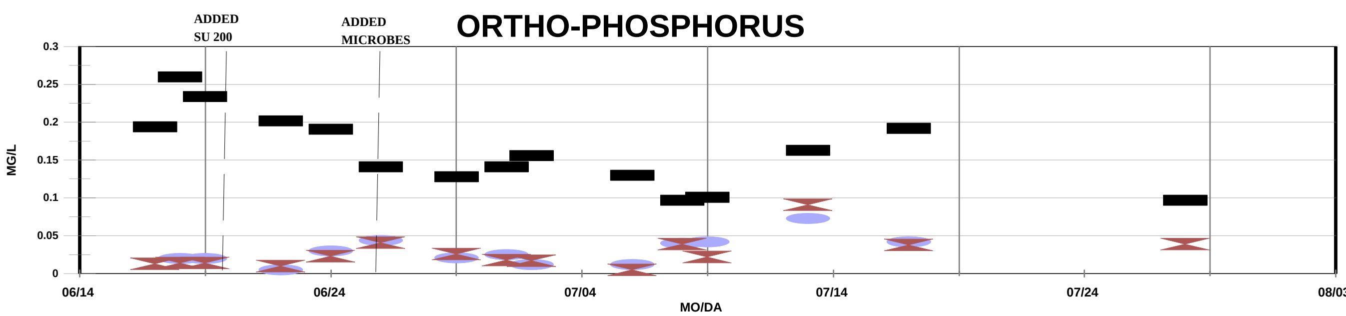
ADDED MICROBES
NITRATES
MG/L
MO/DA
BUILDING POND @IN
BUILDING POND @OUT
PkLOT POND @OUT



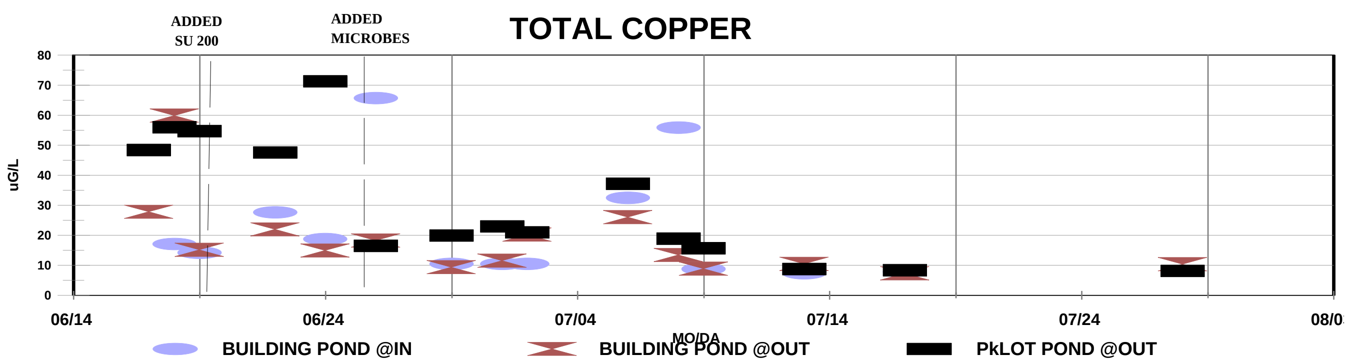
RAINFALL
FLORIDA AQUARIUM - 1998
INCHES/DAY
MO/DA



ADDED SU 200
ADDED MICROBE
TOTAL PHOSPHORUS
MG/L
MO/DA



ADDED SU 200
ADDED MICROBES
ORTHO-PHOSPHORUS
MG/L
MO/DA



ADDED SU 200
ADDED MICROBES
TOTAL COPPER
uG/L
MO/DA
BUILDING POND @IN
BUILDING POND @OUT
PkLOT POND @OUT

APPENDIX M

BIOCULTURES – "HEALTHY POND"

APPENDIX M "Healthy Pond"

Table M-1. Water quality concentrations measured before and after the introduction bioculture mixture

DATE	AMMONIA			NITRATE + NITRITE			TOTAL NITROGEN			ORGANIC NITROGEN			ORTHO- PHOSPHATE			TOTAL - PHOSPHATE		
	mg/L			mg/L			mg/L			mg/L			mg/L			mg/L		
L.O.Q**	0.01			0.01			0.07			0.07			0.01			0.01		
	Street			Street			Street			Street			Street			Street		
	Outflow 638	Pipe 1087	Inflow 1088	Outflo w 638	Pipe 1087	Inflow 1088	Outflo w 638	Pipe 1087	Inflow 1088	Outflo w 638	Pipe 1087	Inflow 1088	Outflo w 638	Pipe 1087	Inflow 1088	Outflow 638	Pipe 1087	Inflow 1088
4/7/03	0.006	0.021	0.214	0.005	0.005	0.005	0.637	0.655	0.835	0.626	0.629	0.616	0.015	0.011	0.084	0.034	0.049	0.207
4/14/03	0.022	0.014	0.095	0.011	0.011	0.012	0.636	0.706	0.540	0.603	0.681	0.433	0.005	0.005	0.074	0.044	0.026	0.134
5/12/03	0.032	0.02	0.227	0.005	0.005	0.016	0.559	0.663	0.842	0.522	0.638	0.599	0.005	0.005	0.164	0.038	0.043	0.225
7/21/03	0.035	0.027	0.052	0.005	0.005	0.048	0.447	0.587	0.571	0.407	0.555	0.471	0.005	0.005	0.019	0.025	0.037	0.052
8/4/03	0.016	0.019	0.113	0.019	0.035	0.118	0.585	0.473	0.454	0.550	0.419	0.223	0.022	0.02	0.069	0.047	0.04	0.091
8/11/03	0.01	0.035	0.089	0.001	0.017	0.08	0.842	0.265	0.371	0.831	0.213	0.202	0.021	0.017	0.079	0.029	0.037	0.09
8/18/03	0.031	0.022	0.096	0.001	0.001	0.001	0.807	0.248	0.474	0.775	0.225	0.377	0.016	0.005	0.152	0.039	0.023	0.199
9/2/03	0.028	0.036	0.146	0.011	0.018	0.006	0.635	0.491	0.486	0.596	0.437	0.334	0.01	0.012	0.145	0.081	0.05	0.197
9/15/03	0.023	0.045	0.253	0.008	0.017	0.013	0.497	0.490	0.824	0.466	0.428	0.558	0	0.012	0.424	0.035	0.039	0.511
09/29/03	0.03	0.02	0.065	0.006	0.008	0.096	0.537	0.432	0.551	0.501	0.404	0.390	0.014	0.029	0.094	0.044	0.07	0.145
10/13/03	0.1	0.014	0.331	0.013	0.005	0.007	2.740	0.635	0.950	2.627	0.616	0.612	0.011	0.018	0.207	0.282	0.092	0.27
10/27/03	0.016	0.563	0.096	0.006	0.02	0.01	0.789	1.110	2.950	0.767	0.527	2.844	*0.005*	0.235	*0.005*	0.061	0.287	0.268
12/2-3/03	0.152	0.083	0.29	0.006	0.005	0.124	3.200	2.630	0.780	3.042	2.542	0.367	0.014	0.002	0.209	0.208	0.018	0.412
Avg. before	0.020	0.023	0.132	0.008	0.013	0.047	0.618	0.558	0.602	0.590	0.523	0.424	0.012	0.011	0.082	0.036	0.039	0.133
Med before	0.019	0.021	0.104	0.005	0.008	0.032	0.611	0.621	0.556	0.577	0.592	0.452	0.010	0.008	0.077	0.036	0.039	0.113
Avg after	0.038	0.117	0.165	0.008	0.012	0.022	1.001	0.568	1.039	0.955	0.439	0.852	0.009	0.052	0.171	0.090	0.094	0.265
Med after	0.028	0.022	0.122	0.006	0.010	0.013	0.636	0.563	0.587	0.600	0.481	0.443	0.011	0.012	0.120	0.044	0.042	0.199

DATE	Chlorophyll A m			Chlorophyll A t			Chlorophyll B t			Chlorophyll C t			Pheaophytin m			SUSPENDED SOLIDS		
	ug/L			ug/L			ug/L			ug/L			ug/L			mg/L		
L.O.Q**										1						0.05		
	Street			Street			Street			Street			Street			Street		
	Outflow 638	Pipe 1087	Inflow 1088	Outflo w 638	Pipe 1087	Inflow 1088	Outflo w 638	Pipe 1087	Inflow 1088	Outflo w 638	Pipe 1087	Inflow 1088	Outflo w 638	Pipe 1087	Inflow 1088	Outflow 638	Pipe 1087	Inflow 1088
04/07/03	1.48	17.4	28.7	2.14	26.70	39.30	0.05	5.22	7.99	0.05	1.43	6.97	1.03	14.90	16.80	2.48	9.18	3.46
04/14/03	9.19	6.13	15.8	11.5	8.01	18.7	1.61	1.6	4.81	1.67	2.1	2.5	3.45	2.94	4.36	3.98	2.22	3.67
05/12/03	11.6	10.3	38	14.7	13.8	42.7	1.29	1.99	8.42	1.66	0.5	2.58	4.54	5.27	6.38	4.73	10.8	8.16
07/21/03	9.03	28.8	9.18	11.4	32.4	10.6	1.31	4.25	2.06	0.5	1.85	0.5	3.47	4.68	2.09	2.23	4.76	3.53
8/4/03	59.7	32.5	15.9	63.4	35.4	17.1	1.38	1.82	3.49	8.04	5.25	1.11	3.42	3.1	1.48			
8/11/03	142	9.89	0.5	151	11.9	1.21	3.86	1.46	0.5	17.6	1.14	0.5	7.58	2.91	0.5	9.34	1.46	2.4
8/18/03	94.2	6.72	5.33	104	8.84	6.2	0.5	0.5	0.5	13.5	0.5	0.5	10.5	3.14	1.22	6.67	1.35	5.33
9/2/03	41.7	24.2	8.75	50.5	28.9	10.4	0.5	2.16	1.52	6.44	3.12	1.52	12.1	6.56	2.3	6.66	2.49	3.76
9/15/03	27.4	50.1	4.32	33.4	56.6	5.25	3.16	0.259	1.4	2.18	4.99	0.335	8.59	7.71	1.44	11.91	3.69	4.63
09/29/03	42	18.6	4.56	48.6	21.3	5.3	4.52	1.53	1.43	3.71	2	*0.5*	8.85	3.51	1.14	3.64	2.8	5.09
10/13/03	105	56.9	19.7	133	72.3	22.5	8.5	10.4	6.1	10.4	5.2	1.4	41	23.1	4.2	92.3	14.5	5.27
10/27/03	75	14.8	83.4	99.2	17.5	115	19	4.3	10.3	5	*0.5*	7.3	37.6	4.2	47.6	18.9	3.82	58.9
12/2-3/03	313	437	6.3	515	716	10	38	35.2	2.1	20.5	16.7	2.3	316	435	6	134	395.4	15.72
Avg. before	38.83	17.50	18.01	42.36	21.37	21.60	1.58	2.72	4.55	4.92	2.05	2.36	3.92	5.63	5.27	4.55	5.68	4.24
Med before	10.40	13.85	15.85	13.10	20.25	17.90	1.35	1.91	4.15	1.67	1.64	1.81	3.46	3.89	3.23	3.98	4.76	3.53
Avg after	64.22	28.55	21.01	78.12	34.24	27.44	6.03	3.19	3.54	6.87	2.72	1.93	19.77	8.04	9.65	23.35	4.78	13.83
Med after	42.00	18.60	12.49	50.50	24.03	13.85	2.39	2.08	2.80	5.00	2.02	1.46	8.85	4.98	2.76	6.67	3.82	5.09

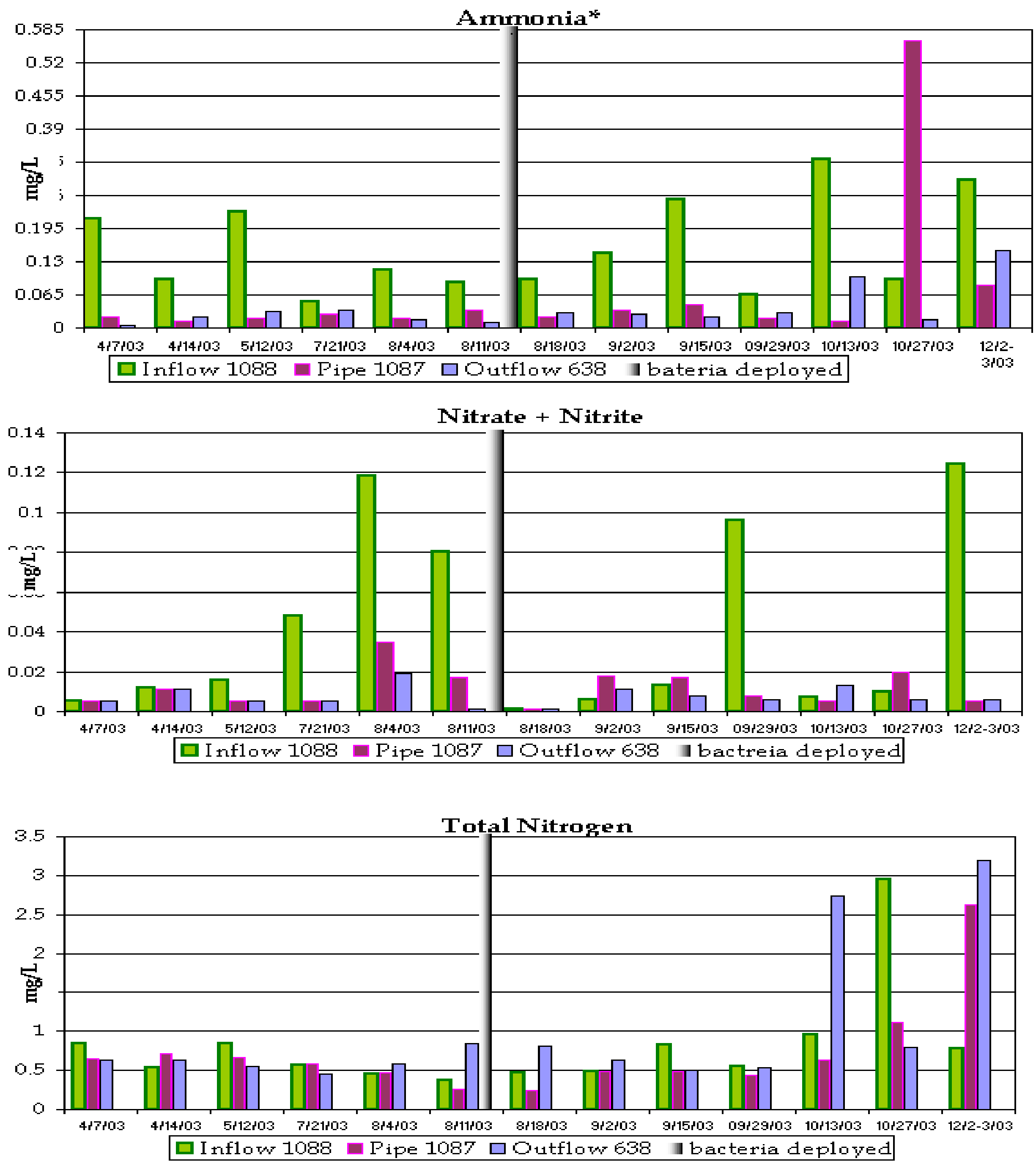


Figure M-1. Nutrient concentrations measured in pond water before and after introduction bioculture mixture.

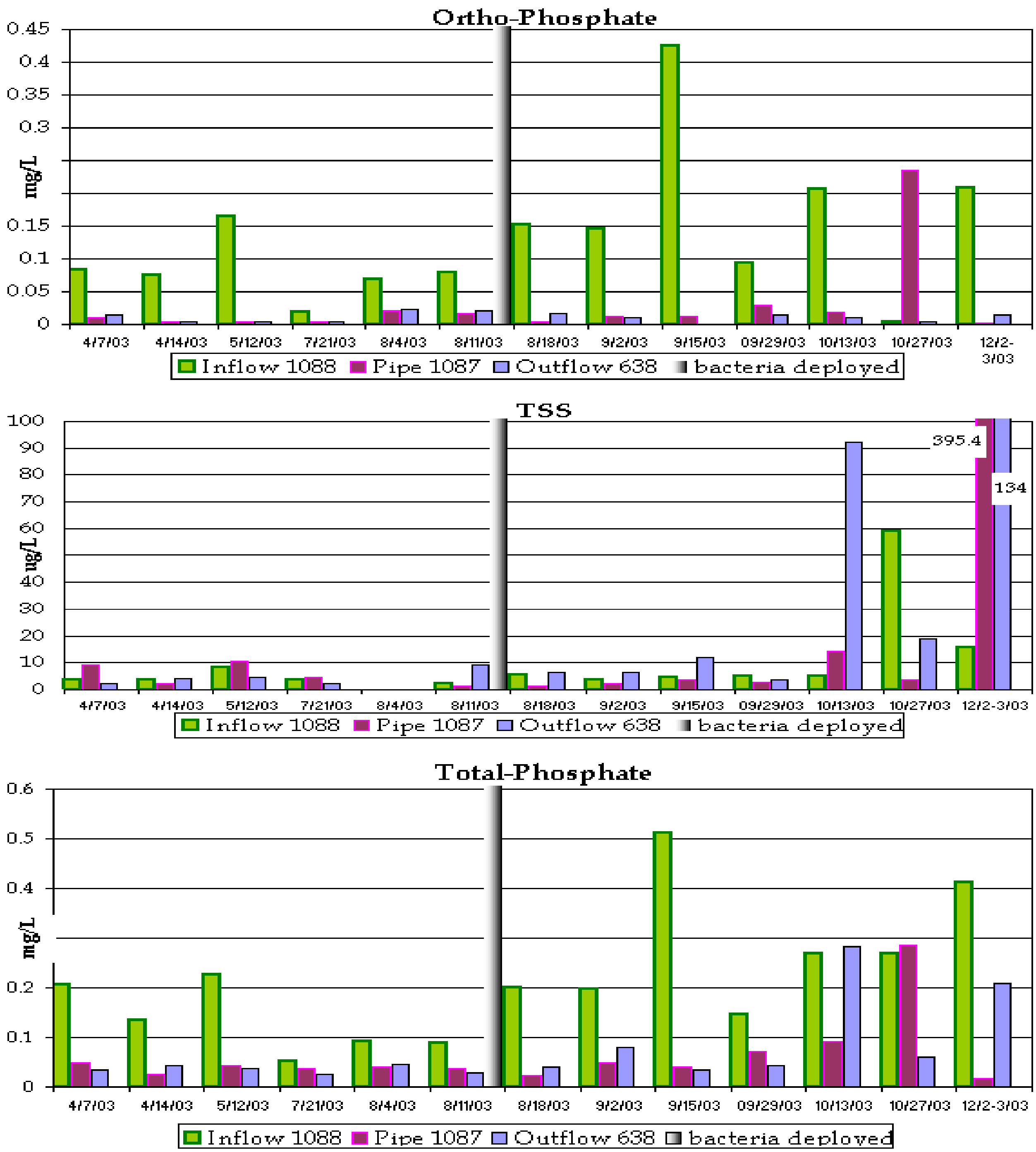


Figure M-2. Nutrient concentrations measured in pond water before and after introduction of bioculture mixture.

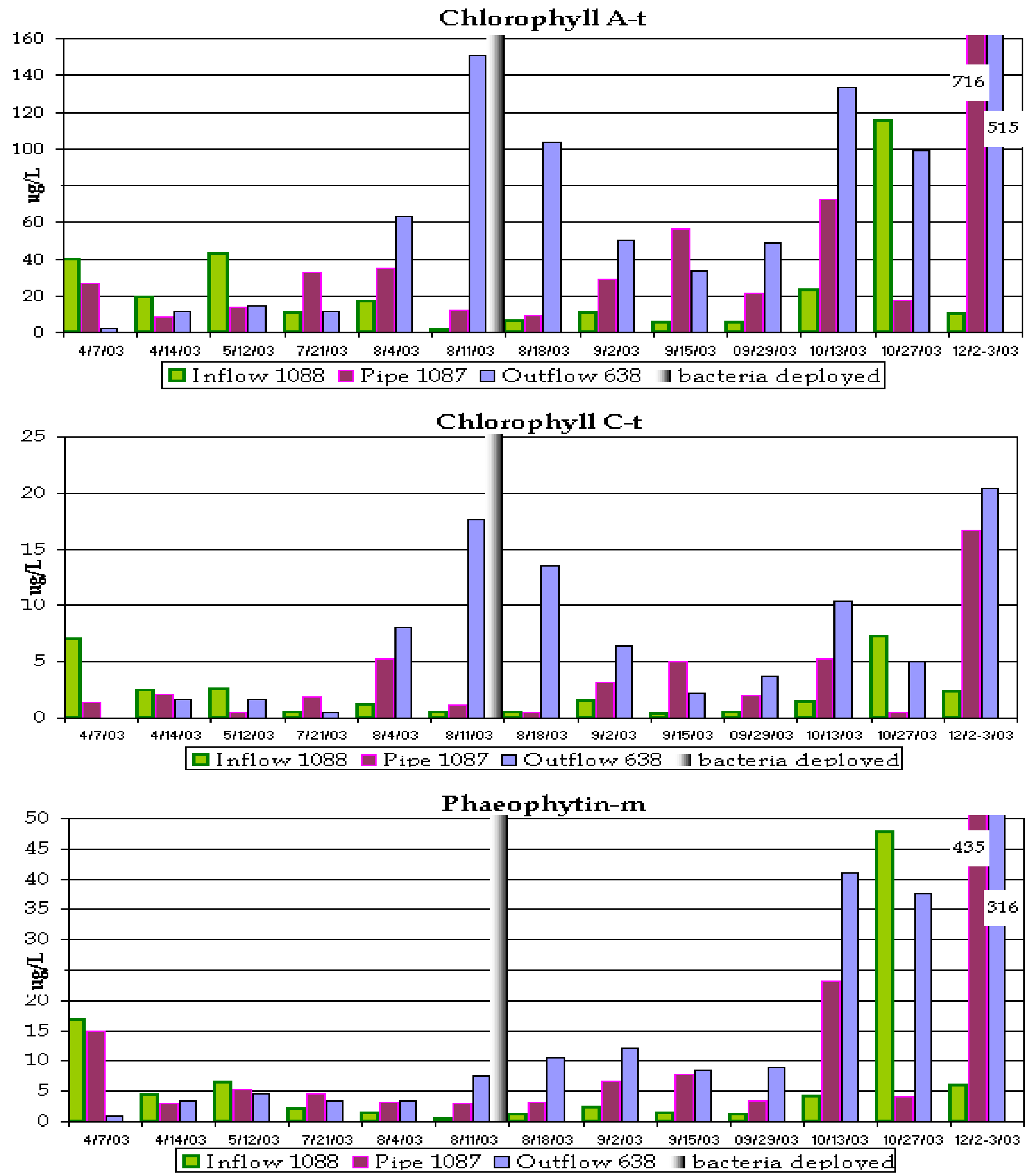
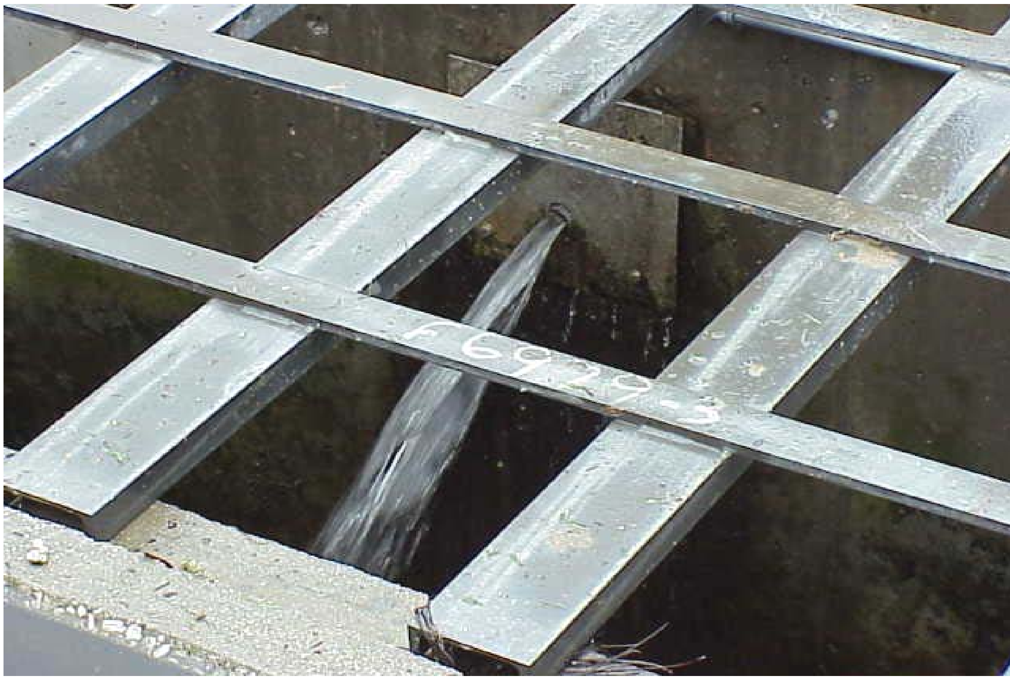


Figure M-3. Nutrient concentrations measured in pond water before and after introduction of bioculture mixture.

APPENDIX N

PICTURES OF THE SITE



BLEED DOWN FLOW AT BUILDING POND OUTFLOW WEIR

BUILDING POND DURING CRUISE SHIP TERMINAL ONSTRUCTION – COVERED IN DUCKWEED AND ASSOCIATED NUISANCE VEGETATION

STREET POND INFLOW INSTRUMENT SHELTER WITH PROJECT PERSONNEL COLLECTING STORM SAMPLES

INFLOW TO STREET POND DURING TROLLEY CONSTRUCTION SHOWING INSTRUMENT SHELTER AND SEDIMENTATION BASIN

SEDIMENTATION POND

FILTRATION POND WITH CRUISE SHIP TERMINAL CONSTRUC-TION IN BACK GROUND

SAMPLING EQUIPMENT FOR DETAILED STUDY SHOWING FLOW METERS AND SAMPLERS AT OUTFLOW

NORTH SIDE BANK FILTER COVERED TO KEEP FROM GETTING CLOGGED DURING CONSTRUC-TION

CLEAN OUT IN FOREGROUND

OUTFLOW WEIR BACKGROUND

UNDER DRAIN PIPE WITH THELMAR WEIR MEASURING DEVICE

PARKING LOT POND. FINAL TREATMENT FOR LOW IMPACT DESIGN PARKING LOT

SEDIMENT SAMPLING IN THE PARKING LOT POND