Winter Haven Chain-of-Lakes Sediment Removal Feasibility Study

Final Report

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SECTION 1

INTRODUCTION

1.1 General Description

The Winter Haven Chain-of-Lakes (Chain-of-Lakes) consists of a series of 21 interconnected lakes located near the City of Winter Haven in north-central Polk County, Florida. The Chain-of-Lakes is divided into two major hydrologic units, referred to as the "northern chain" and "southern chain". The northern chain consists of Lakes Haines, Rochelle, Conine, Smart, and Fannie, with a combined surface area of 2615 acres. The southern chain consists of 16 interconnected lakes, containing Lakes Mariana, Jessie, Hartridge, Idylwild, Blue, Spring, Mirror, Cannon, Howard, May, Shipp, Lulu, Roy, Summit, Eloise, and Winterset. The southern chain has a combined surface area of approximately 4892 acres and a watershed basin area of approximately 50,000 acres. Hydrologic characteristics and interconnections for lakes located in the southern chain are indicated on Figure 1-1.

During the early 1900s, lakes within the Winter Haven Chain-of-Lakes were primarily isolated waterbodies with well defined individual drainage basins. During the 1930s, a series of canals were excavated, creating hydrologic connections between many of the lakes which provide both navigation and flood control. This series of interconnecting canals effectively created the northern chain, which discharges from the east side of Lake Fannie into the Peace Creek Canal, and the southern chain which discharges from the southwest side of Lake Lulu, ultimately reaching the Peace Creek Canal.

All work efforts discussed in this report were conducted in Lakes May, Shipp, and Lulu which are located in the mid- to southern portion of the southern chain. Each of these three lakes is listed as "impaired" by the Florida Department of Environmental Protection and the entire southern chain is a SWIM priority waterbody. These lakes have been subjected to historical point and nonpoint sources of pollution which have resulted in poor water quality characteristics and the present sediment accumulations. Concern exists that release and resuspension of nutrients from the sediments as a result of diffusion, wind, storm events, and boating may create sufficient pollutant sources to mask benefits from previous water quality improvement projects within the drainage basins which have removed a number of point and nonpoint sources of pollution.

1.2 Previous Studies

A number of previous studies have been conducted on the Winter Haven Chain-of-Lakes as a whole, as well as selected individual lakes within the Chain. During 1980, Water and Air Research developed a comprehensive water and nutrient budget for Lake Howard based upon available existing data and generalized assumptions. The resulting report, titled "Lake Howard Restoration Study", provided the first assessment of pollutant loadings entering the Chain-of-Lakes and provided a discussion of potential load reduction strategies.

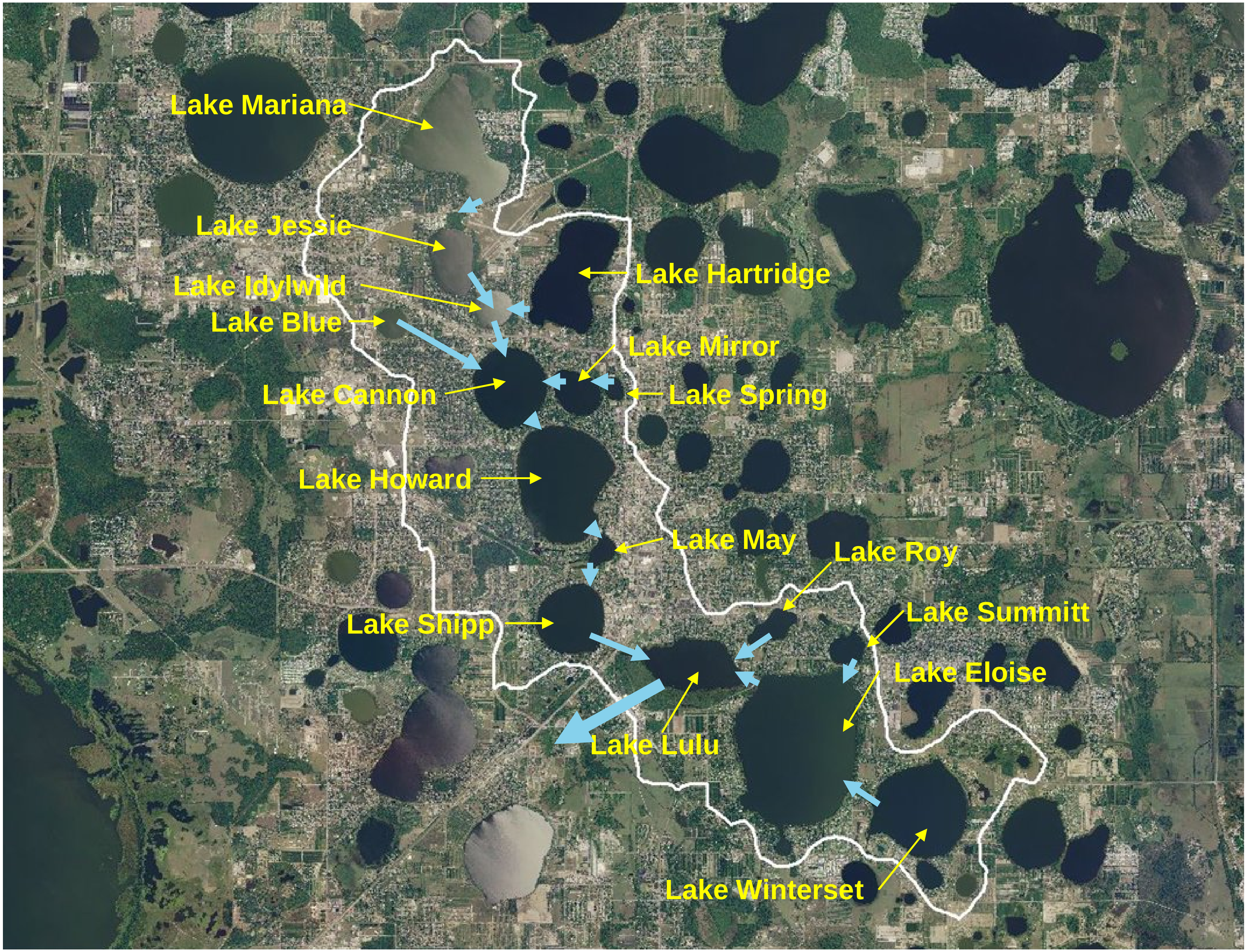

Figure 1-1. Hydrologic Characteristics for the Southern Chain of the Winter Haven Chain-of-Lakes.

During 1990, Dames & Moore conducted further evaluations on the extent of pollutant loadings entering the Chain-of-Lakes. The primary emphasis of this work effort was nonpoint source pollutant loadings which were estimated based upon stormwater monitoring data collected by Dames & Moore within the Chain-of-Lakes drainage basins. A summary report, titled "Winter Haven Lake Pollution Study", was developed which provided estimates of nonpoint source loadings to each of the lakes within the Chain. Although both the Water and Air Research and Dames & Moore studies estimated pollutant loadings into the lakes, neither of the studies evaluated the impacts of water discharges between the interconnected waterbodies.

During 2000, PBS&J developed detailed water and nutrient budgets for Lake Haines (located in the northern chain) and Lake Shipp (located in the southern chain). Development of the hydrologic budgets was assisted by installation of stage recorders and biweekly measurements of surface discharge between interconnected lakes. Estimates of groundwater inflow into the lakes were generated using the Darcy Flow Equation based on differences in piezometric elevations between the lake surface and adjacent groundwater table. Nutrient inputs were estimated for atmospheric deposition, surface water inflows, surface water outflows, groundwater inflows, and groundwater outflows. However, the impacts of sediment nutrient release and sediment resuspension on water quality within the lakes were not included as part of the nutrient budgets.

During the past decade, a number of water quality improvement projects have been constructed to control nonpoint source inputs entering the Winter Haven Chain-of-Lakes. These projects have included alum stormwater treatment systems, wetland treatment systems, and wet detention ponds. Recently, concern has arisen regarding the potential water quality impacts of the accumulated sediments within the lakes, along with the concern that continued nutrient release from the sediments may negate the potential water quality improvements which could be achieved by the constructed stormwater management projects.

The work efforts outlined in this report provide detailed hydrologic and nutrient budgets for Lakes May, Shipp, and Lulu which improve upon the previous hydrologic and nutrient budgets by providing direct measurements of discharges between interconnected waterbodies, volume and chemical characteristics of groundwater seepage, along with direct measurements of sediment nutrient release within each lake. Quantification of the depth and volume of organic sediments within each of the three lakes is also provided as part of this study. The specific objective of this study is to determine whether all or portions of the accumulated organic sediments in Lakes May, Shipp, and Lulu must be removed to achieve the desired water quality characteristics within these lakes.

1.3 Work Efforts Performed by ERD

1.3.1 Initial Field Monitoring Efforts

Field monitoring was conducted within Lakes May, Shipp, and Lulu by ERD from August 2005-June 2006. Detailed field surveys were conducted to develop water depth and organic muck contour maps for each of the three lakes. Sediment samples were collected throughout the lakes to evaluate the physical and chemical characteristics of the existing sediments. Groundwater seepage meters were installed and monitored to estimate the quantity and quality of seepage impacts on the three lakes. Field measurements of discharges between interconnected waterbodies were conducted on a biweekly basis for a period of seven months. Stormwater monitoring was conducted at four significant watershed sub-basin areas discharging into the three lakes to assist in development of runoff loadings into the lakes.

At the conclusion of the field monitoring efforts, hydrologic and nutrient budgets were developed over the period from October 2005-April 2006. These hydrologic and nutrient budgets are used to calibrate a water quality model for each of the three lakes to evaluate potential nutrient inputs and water quality impacts from sediment/water column interactions. Recommendations are provided regarding the significance of the existing sediments along with a discussion of the benefits of sediment removal. A Final Report, dated February 2007, was prepared by ERD which summarizes the results of the field monitoring efforts from October 2005-April 2006 and includes hydrologic and nutrient budgets, along with water quality management recommendations, for Lakes May, Shipp, and Lulu.

1.3.2 Supplemental Field Monitoring Efforts

During the review process for the February 2007 report, supplemental issues and concerns were raised which were outside of the original scope of services performed by ERD. One of the primary concerns is the lack of hydrologic data from the wet season months, particularly for groundwater inflows, since seepage monitoring was conducted from October 2005-May 2006, reflecting primarily dry season conditions. Extension of the seepage monitoring into the rainy season months was not possible due to time constraints contained in the original schedule for the project.

A supplemental work order was issued to ERD in July 2008 to conduct additional seepage monitoring over a 4-month period from July-October 2008 to provide information on groundwater inflows during rainy season conditions. This information is intended to supplement the original monitoring data to include both wet season and dry season conditions.

In addition, supplemental work efforts were also conducted to more directly address the issue of the impacts of existing sediments on water quality in Lakes May and Shipp. Large diameter limno corrals were installed in Lake May and Lake Shipp to evaluate changes in water quality characteristics over time in chambers with and without existing sediments. Water quality monitoring was conducted within the limno corrals from January-April 2009. At the completion of the limno corral study, concern was raised that the monitoring program for the limno corrals did not include warm water summer conditions. As a result, a second supplemental monitoring contract was issued to ERD to conduct additional limno corral monitoring during warm water summer conditions. This supplemental monitoring was conducted from July-October 2009.

The original February 2007 Final Report prepared by ERD titled “Winter Haven Chain-of-Lakes Sediment Removal Feasibility Study” forms the basis of this current document. Revisions and additions to the February 2007 report were made to include the results of the supplemental groundwater seepage monitoring and limno corral studies.

1.3.3 Report Organization

The work efforts discussed in this document have been divided into seven separate sections for presentation of data and results. Section 1 provides an introduction to the report, a history of previous studies performed on the Winter Haven Chain-of-Lakes, and an overview of work efforts performed by ERD. Section 2 provides a discussion of the existing characteristics of Lakes May, Shipp, and Lulu, including physical characteristics, historical water quality, existing ambient water quality characteristics, and sediment characteristics and volume. A discussion of the contributing watershed areas is given in Section 3. Hydrologic inputs to these three lakes are discussed in Section 4, and a hydrologic budget is developed for each lake. A discussion of pollutant inputs and estimated nutrient budgets for each lake is included in Section 5. Water quality models for the three lakes are summarized in Section 6. The results of the limno corral experiments and management recommendations for existing sediments are discussed in Section 7, and sediment management recommendations are given in Section 8. Appendices are also attached which contain raw data and other information used to support the results and conclusions provided in the main part of this report.

SECTION 2

CHARACTERISTICS OF LAKES MAY, SHIPP, AND LULU

This section provides a summary of the characteristics of Lakes May, Shipp, and Lulu, including physical characteristics, historical and current water quality, and sediment characteristics. A discussion of these issues is given in the following sections.

2.1 Physical Characteristics

Relatively current bathymetry or bathymetric characteristics for Lakes May, Shipp, and Lulu do not appear to be available. The most recent bathymetry for these lakes appears to be a study conducted by USGS during March 1977. The bathymetric contour information collected by USGS provides water depths only and does not attempt to quantify existing muck accumulations within the three lakes.

Revised bathymetric surveys of Lakes May, Shipp, and Lulu were conducted by ERD field personnel on November 16-17, 2005 to evaluate water column depth as well as thickness of unconsolidated sediments within each lake. Measurements of water depth and sediment thickness were collected at 167 individual locations in Lake May, 231 locations in Lake Shipp, and 199 locations in Lake Lulu. Each of the data collection sites was identified in the field by longitude and latitude coordinates which were recorded using a portable GPS device. Locations of bathymetric data collection sites in Lakes May, Shipp, and Lulu are indicated on Figure 2-1.

Water depth at each of the data collection sites was determined by lowering a 20 cm diameter Secchi disk, attached to a graduated line, until resistance from the surficial sediment layer was encountered. The depth on the graduated line was recorded in the field and is defined as the water depth at each site. Next, a 1.5-inch diameter graduated aluminum pole was lowered into the water column and forced into the sediments until a firm bottom material, typically sand or clay, was encountered. This depth is defined as the depth to the firm lake bottom. The difference between the depth to the firm lake bottom and the water depth is defined as the depth of unconsolidated sediments at each site. The final data was converted into a bathymetric contour map for each lake using Autodesk Land Desktop 2007.

A water depth contour map for Lake May, based upon field measurements conducted by ERD on November 17, 2005, is given in Figure 2-2. Water depth in Lake May appears to increase relatively quickly with increasing distance from the shoreline, reaching depths ranging from approximately 8-10 ft in central portions of the lake. Bathymetric relationships for Lake May are summarized in Table 2-1.

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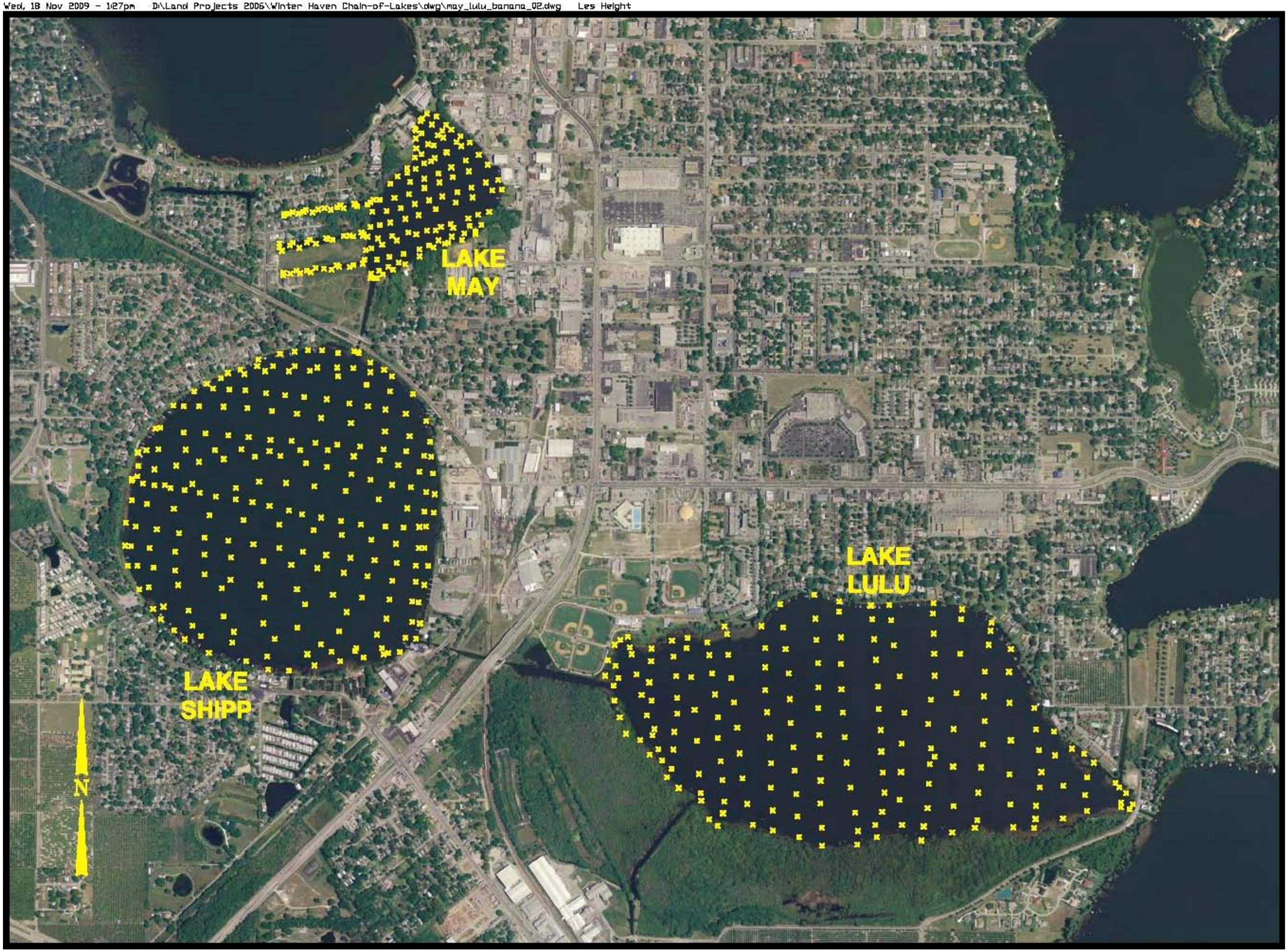

Figure 2-1. Locations of Bathymetric Data Collection Sites in Lakes May, Shipp, and Lulu.

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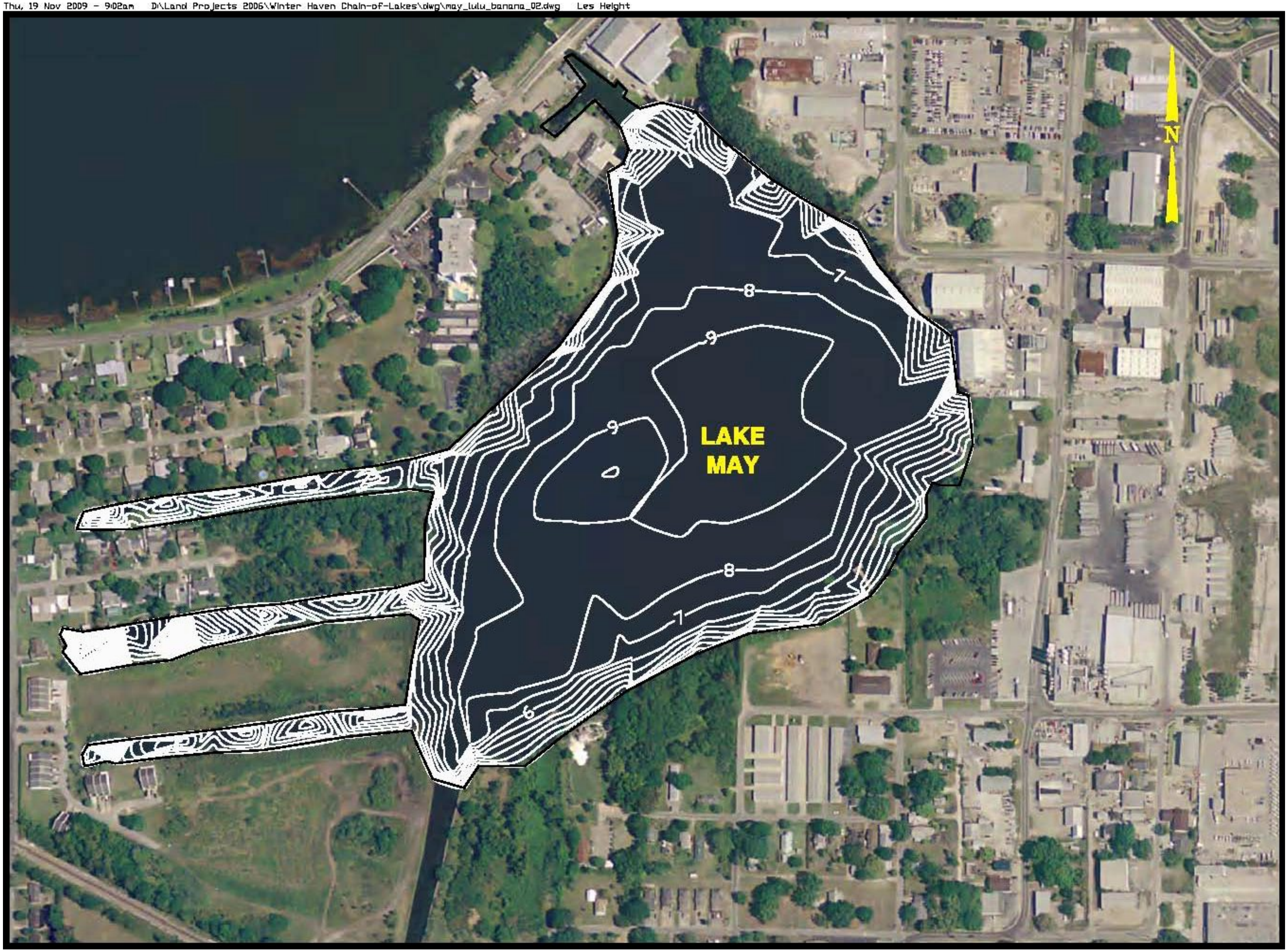

Figure 2-2. Water Depth Contours (ft) in Lake May (water surface elevation of 131.79 ft).

TABLE 2-1

BATHYMETRIC RELATIONSHIPS FOR LAKE MAY[1]

WATER DEPTH (ft)	SURFACE AREA (ac)	VOLUME (ac-ft)
0	50.54	316.0
1	43.62	239.0
2	42.16	226.1
3	40.34	184.8
4	38.35	145.5
5	36.08	108.3
6	33.32	73.6
7	29.08	42.4
8	20.27	17.7
9	7.56	3.8
10	0.02	--

1. Based on a water surface elevation of 131.79 ft

Water depth contours in Lake Shipp are illustrated on Figure 2-3 based upon a water surface elevation of 131.79 ft. Water depths in northern portions of Lake Shipp appear to increase rapidly, with a gradual increase in water depth in southern portions of the lake. Maximum water depth in Lake Shipp appears to be approximately 14 ft in several isolated pockets. Bathymetric relationships for Lake Shipp, based upon a water surface elevation of 131.79 ft, are given in Table 2-2.

TABLE 2-2

BATHYMETRIC RELATIONSHIPS FOR LAKE SHIPP[1]

WATER DEPTH (ft)	SURFACE AREA (ac)	VOLUME (ac-ft)
0	276.4	2589
1	271.6	2314
2	266.2	2046
3	260.0	1783
4	252.2	1526
5	241.8	1279
6	226.7	1045
7	208.5	827.6
8	185.4	630.7
9	159.4	458.3
10	136.7	310.3
11	115.9	184.0
12	88.2	81.9
13	36.6	19.5
14	2.51	--

1. Based on a water surface elevation of 131.79 ft

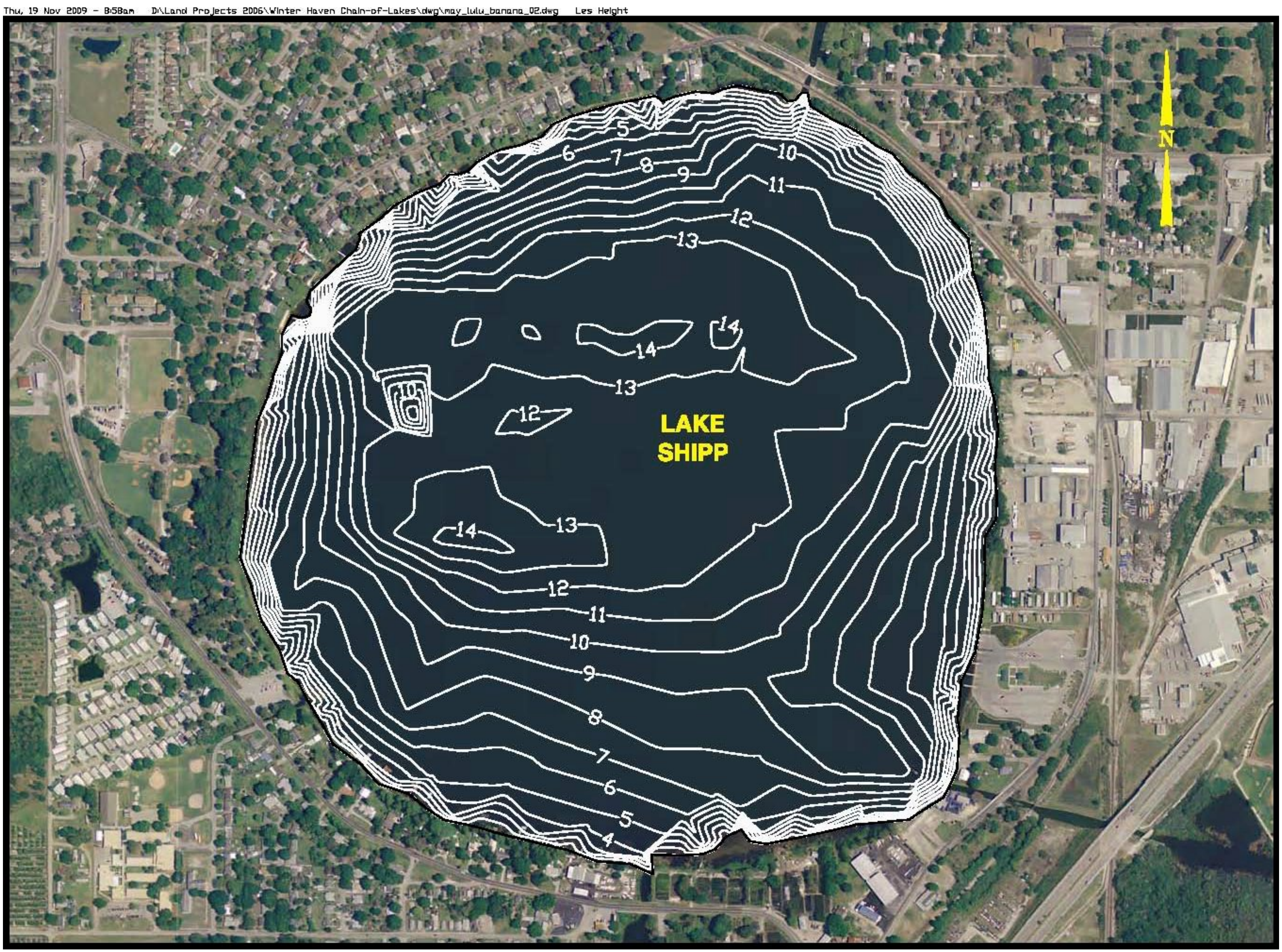

Figure 2-3. Water Depth Contours (ft) in Lake Shipp (water surface elevation of 131.79 ft).

Water depth contours in Lake Lulu are illustrated on Figure 2-4, based upon a water surface elevation of 131.79 ft. In general, water depth in Lake Lulu appears to increase quickly with increasing distance from shoreline areas. Most of the central portions of Lake Lulu exhibit water depths ranging from 8-13 ft. Bathymetric relationships for Lake Lulu are summarized in Table 2-3.

TABLE 2-3

BATHYMETRIC RELATIONSHIPS FOR LAKE LULU[1]

WATER DEPTH (ft)	SURFACE AREA (ac)	VOLUME (ac-ft)
0	307.0	2765
1	300.7	2461
2	293.3	2164
3	284.9	1875
4	274.7	1595
5	264.0	1326
6	251.5	1068
7	236.2	824.2
8	217.1	597.6
9	191.6	393.3
10	155.9	219.5
11	94.5	94.4
12	39.5	27.4
13	15.4	--

1. Based on a water surface elevation of 131.79 ft

A summary of physical characteristics of Lakes May, Shipp, and Lulu is given in Table 2-4 based upon a water surface elevation of 131.79 ft. Lake May has a calculated surface area of 50.54 ac, with a water volume of approximately 316 ac-ft, corresponding to a mean depth of 6.3 ft. Lake Shipp has a surface area of approximately 276.4 ac, with a water depth of 2589 ac-ft, corresponding to a mean depth of approximately 9.4 ft. Lake Lulu has a surface area of approximately 307.0 ac, a water volume of 2765 ac-ft, and a mean depth of approximately 9.0 ft.

TABLE 2-4

PHYSICAL CHARACTERISTICS OF LAKES MAY, SHIPP, AND LULU[1]

LAKE	SURFACE AREA (ac)	VOLUME (ac-ft)	MEAN DEPTH (ft)	MAXIMUM DEPTH (ft)
May	50.54	316.0	6.3	10
Shipp	276.4	2589	9.4	14
Lulu	307.0	2765	9.0	13

1. Based on a water surface elevation of 131.79 ft

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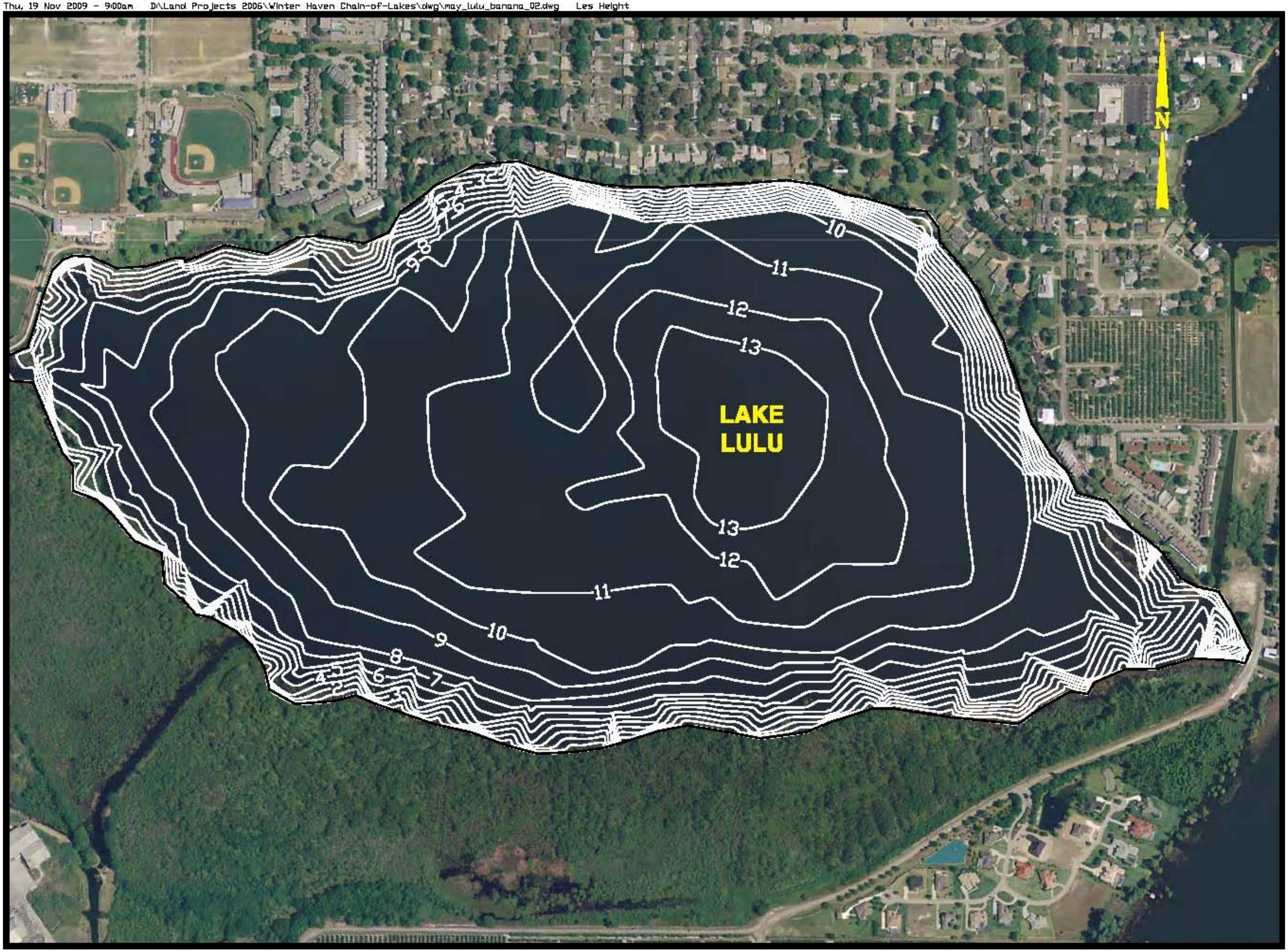

Figure 2-4. Water Depth Contours (ft) in Lake Lulu (water surface elevation of 131.79 ft).

2.2 Existing Water Quality Characteristics

2.2.1 Monitoring Activities

A surface water quality monitoring program was conducted in Lakes May, Shipp, and Lulu by ERD from October 2005-April 2006 at eight fixed monitoring locations within the three lakes. Approximate locations of the surface water monitoring sites in Lakes May, Shipp, and Lulu are indicated on Figure 2-5. The water quality monitoring sites were selected to evaluate potential water quality impacts from interconnected lake flows, as well as provide general information on ambient water quality characteristics. Water quality monitoring was conducted on approximately a biweekly basis, with a total of 17 monitoring events conducted during the 7-month monitoring program.

Sample collection procedures generally followed methods outlined in DEP-SOP-001/01 titled "Department of Environmental Protection Standard Operating Procedures for Field Activities" dated February 1, 2004. Surface water samples were collected using a battery-powered peristaltic pump constructed of plastic and stainless steel. Each sample was collected at a depth equal to 50% of the Secchi disk depth at the time of sample collection. Each of the collected samples was preserved as appropriate for the parameter to be analyzed, stored on ice, and returned to the ERD Laboratory for chemical analyses. A listing of laboratory measurements performed on the collected samples is given in Table 2-5, along with a summary of analytical methods and laboratory detection limits.

During each monitoring event, vertical profiles of pH, temperature, conductivity, dissolved oxygen, ORP, and turbidity were conducted at each site. Field measurements were collected at water depths of 0.25 m and at 0.5 m, and at 0.5 m intervals to the bottom at each site. All field measurements were performed using Hydrolab Data Sonde H20 and Data Sonde 4a units. A measurement of Secchi disk depth was also performed at each site.

Estimates of wave heights were also performed during each monitoring event. Wave height is defined as the distance from the bottom trough to the top crest of each wave. The pontoon boat used for sampling was turned perpendicular to the oncoming waves, and a ruler was extended to the mean bottom trough of each oncoming wave. The mean wave height is then read directly off the ruler.

Routine surface water monitoring events were conducted on approximately a biweekly basis to evaluate ambient water quality characteristics within the three lakes. Thirteen separate events were conducted during this program. In addition to the routine surface water monitoring, supplemental surface water monitoring events were conducted on four separate occasions during unusually windy conditions to evaluate potential water quality impacts from resuspension of bottom sediments into the water column by wind and wave action. These supplemental wind-based events were conducted on November 22, 2005, and January 3, March 10, and April 12, 2006. The results from all 17 monitoring events are used to define ambient water quality characteristics in the three lakes. A discussion of the differences between "normal" and "windy" water quality characteristics is given in a subsequent section.

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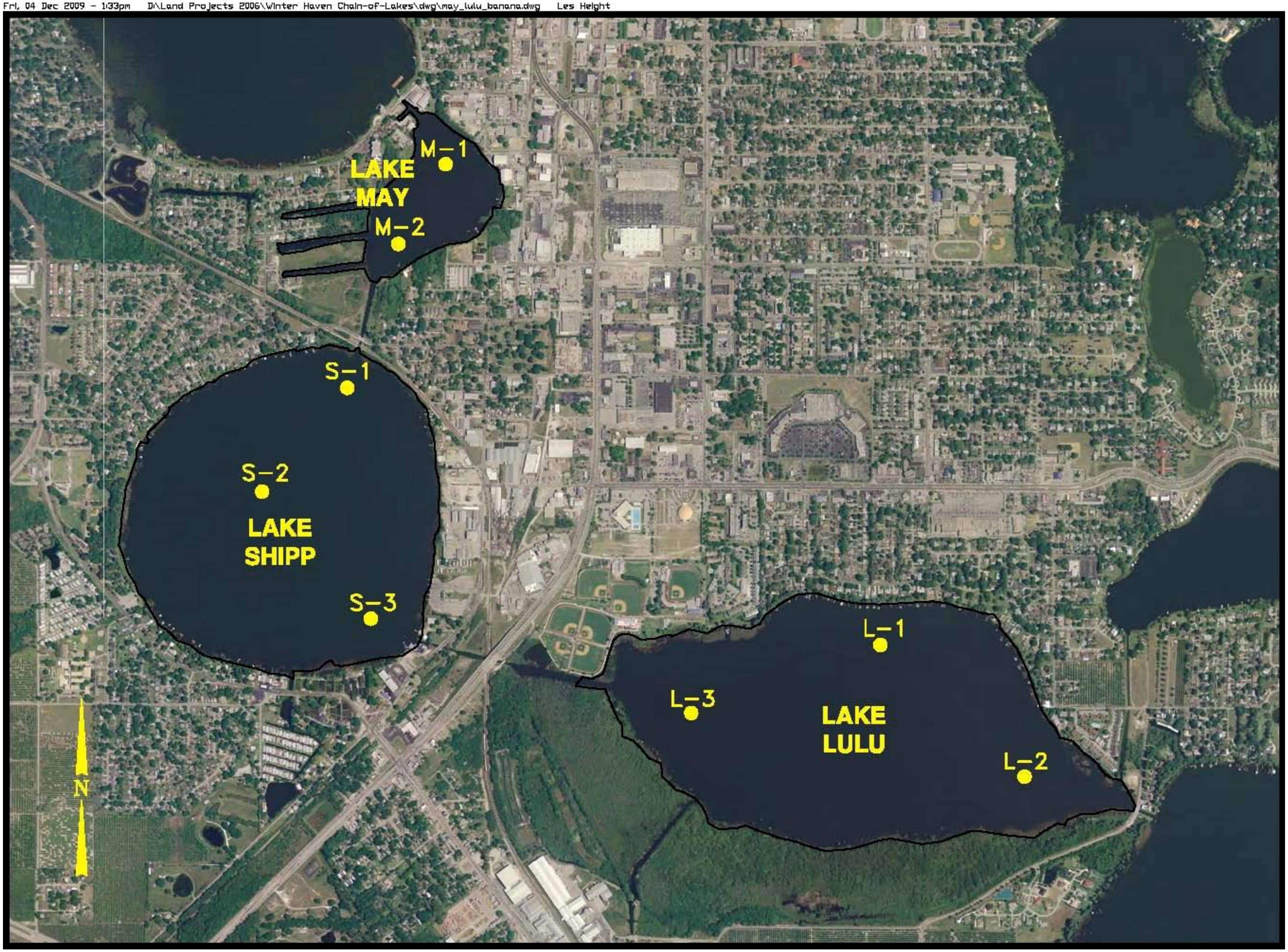

Figure 2-5. Surface Water Monitoring Sites in Lakes May, Shipp, and Lulu.

TABLE 2-5

ANALYTICAL METHODS AND DETECTION LIMITS FOR LABORATORY ANALYSES CONDUCTED BY ENVIRONMENTAL RESEARCH AND DESIGN, INC.

MEASUREMENT PARAMETER		METHOD	METHOD DETECTION LIMITS (MDLs)[1]
General Parameters	Hydrogen Ion (pH)	EPA-83[2], Sec. 150.1/Manf. Spec.[3]	N/A
	Alkalinity	EPA-83, Sec. 310.1	0.6 mg/l
	TSS	EPA-83, Sec. 160.2	0.7 mg/l
	Color	EPA-83, Sec. 110.3	1 Pt-Co Unit
	Specific Conductivity	EPA-83, Sec. 120.1/Manf. Spec.	0.3 μmho/cm
	Turbidity	EPA-83, Sec. 180.1	0.1 NTU
Nutrients	Ammonia-N (NH_3-N)	EPA-83, Sec. 350.1	0.005 mg/l
	Nitrate + Nitrite (NO_x-N)	EPA-83, Sec. 353.2	0.005 mg/l
	Organic Nitrogen	Alkaline Persulfate Digestion[4]	0.025 mg/l
	Orthophosphorus	EPA-83, Sec. 365.1	0.001 mg/l
	Total Phosphorus	Alkaline Persulfate Digestion[4]	0.001 mg/l
Biological Parameters	Chlorophyll-a	SM-19, Sec. 10200 H.3	0.08 mg/m^3

1. MDLs are calculated based on the EPA method of determining detection limits.
2. Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020, Revised March 1983.
3. Subject to manufacturer's specifications for test equipment used.
4. FDEP-approved method.

2.2.2 Existing Ambient Water Quality Characteristics

Existing ambient water quality characteristics in Lakes May, Shipp, and Lulu were evaluated during the routine surface water monitoring conducted from October 2005-April 2006, with a total of 17 separate monitoring events conducted during this period. A discussion of field profiles and laboratory analyses on the collected samples is given in the following sections.

A summary of wind speed and wave height conditions during the water quality monitoring events is given in Table 2-6. In general, wind speed during a majority of the monitoring events was equal to approximately 5-7 mph or less, with wave heights during these events ranging from approximately 1-6 inches. Wind speed during the wind-based monitoring events, conducted on November 22, 2005, and January 3, March 10, and April 12, 2006, range from approximately 15-20 mph with wave heights ranging from 12-24 inches between the three lakes.

TABLE 2-6

WIND SPEED AND WAVE HEIGHT CONDITIONS DURING AMBIENT MONITORING EVENTS

MONITORING DATE	WIND SPEED/ WAVE HEIGHT	MONITORING SITE							
		M-1	M-2	S-1	S-2	S-3	L-1	L-2	L-3
10/6/05	Wind (mph) Waves (inches)	4.2 2-4	0.6 2-4	0.5 2-4	0.5 2-4	0.6 2-4	0.8 2-4	0.4 2-4	7.8 4-6
10/20/05	Wind (mph) Waves (inches)	< 0.5 < 2	< 0.5 < 2	< 0.5 < 2	< 0.5 < 2	< 0.5 < 2	< 0.5 < 2	< 0.5 < 2	< 0.5 < 2
11/7/05	Wind (mph) Waves (inches)	7.4 3-6	7.6 3-6	7.1 3-6	7.2 3-6	7.3 3-6	2.9 3-6	4.2 3-6	6.1 3-6
11/22/05	Wind (mph)* Waves (inches)	12.4 12-14	16.7 12-14	15.4 24	17.6 24	18.9 24	15.4 24	20.2 24	21.4 24
11/29/05	Wind (mph) Waves (inches)	No Data							
12/14/05	Wind (mph) Waves (inches)	4.8 2-4	4.0 2-4	3.5 2-4	4.5 2-4	2.7 2-4	3.6 2-4	3.9 2-4	2.2 2-4
12/28/05	Wind (mph) Waves (inches)	4.9 4-6	4.4 4-6	3.9 4-6	5.4 4-6	5.9 4-6	11.3 4-6	5.5 4-6	3.0 4-6
1/3/06	Wind (mph) Waves (inches)	13.6 16	14.2 12	15.3 16	14.9 12	15.8 12	16.7 12	16.3 12	17.2 12
1/12/06	Wind (mph) Waves (inches)	3.3 2	4.5 1-2	5.0 2	3.2 2	4.2 2	4.5 2	5.0 2	4.1 2
1/23/06	Wind (mph) Waves (inches)	4.8 6	3.2 3-4	5.8 2-4	6.5 6	6.0 2-4	8.0 6	6.0 3	8.6 6
2/16/06	Wind (mph) Waves (inches)	5.3 2	4.6 2	6.2 2	4.2 2	4.8 2	4.5 1-2	4.5 1-2	6.6 2-3
3/2/06	Wind (mph) Waves (inches)	2.1 4	6.2 4	8.2 6	5.3 2	5.1 2	8.1 6	5.1 2	7.9 6
3/10/06	Wind (mph) Waves (inches)	14.4 12-14	16.9 12-14	17.7 12-14	17.5 12-14	17.7 12-14	19.6 22-26	17.1 12-14	21.4 24
3/13/06	Wind (mph) Waves (inches)	5.6 3	5.4 3	6.2 6	7.4 6	4.7 3	5.2 3	5.6 3	4.1 3
3/27/06	Wind (mph) Waves (inches)	4.3 1	3.9 1	1.4 1	1.1 2	1.2 1	1.4 1	0.6 1	1.7 1
4/12/06	Wind (mph) Waves (inches)	16.3 24	13.5 12	15.6 24	24.1 24	19.3 24	10.7 12	11.2 24	15.4 24
4/24/06	Wind (mph) Waves (inches)	0.7 Calm	0.4 Calm	1.7 1	1.1 1	0.5 Calm	0.4 Calm	0.6 Calm	0.3 Calm

*Indicates wind-based monitoring event

2.2.2.1 Field Profiles

A complete listing of field profiles collected in each of the three lakes from October 2005-April 2006 is given in Appendix A. A discussion of general field profiles observed at each of the three lakes is given in the following sections.

2.2.2.1.1 Lake May

A compilation of vertical depth profiles collected at Sites 1 and 2 in Lake May during the routine ambient monitoring program is given in Figures 2-6 and 2-7, respectively. The depth profiles summarized in these figures reflect a monthly average of all monitoring events conducted during the monitoring program from October 2005-April 2006. The number of monitoring events included in the monthly average profiles is indicated in parenthesis on the figure legend.

Measured water depths at the two sites in Lake May range from 2-2.5 m. Vertical profiles for temperature, pH, conductivity, and dissolved oxygen are virtually identical between the two sites. Relatively isograde temperature regimes were observed within Lake May during most monitoring events. No significant thermal stratification, defined as a temperature change of $1^{o}C$ or more over a water depth of 1 m, was observed in Lake May, although weak stratification was observed in lower layers of the water column at Site 1 during October, January, and February. However, the observed weak stratification during these events is probably related to seasonal temperature changes rather than the classic stratification which is observed during summer months.

In general, relatively isograde pH conditions were observed in Lake May to a water depth of approximately 1.5 m during most monitoring events, with relatively rapid decreases in pH observed at water depths in excess of 1.5 m. In general, water column pH appears to decrease approximately 0.5-1.0 units between top and bottom measurements. Surface measurements of pH ranged from approximately 7.2-8.2, with bottom measurements ranging from 6.5-7.2.

Relatively isograde conductivity measurements were observed at each of the two monitoring sites in Lake May to a water depth of approximately 1.5 m. However, below this depth, increases in conductivity were observed during virtually all monitoring events. The most consistent increases in conductivity were observed at Site 2, located in southern portions of Lake May. In general, conductivity increases of approximately 25-100% were observed near the water-sediment interface for most events.

Similar to the trends observed for conductivity and pH, relatively isograde dissolved oxygen conditions were observed in the upper 1.5 m of Lake May. However, below this depth, dissolved oxygen concentrations decreased rapidly, reaching anoxic conditions (indicated by dissolved oxygen levels less than 1 mg/l) at a water depth of approximately 2 m. The rapid decrease in dissolved oxygen near the lake bottom, combined with the large increases in specific conductivity, suggest that the bottom sediments within the lake are exerting a significant dissolved oxygen demand, and the anoxic conditions are causing release of ions (such as phosphorus and ammonia) from the bottom sediments. The observed increases in specific conductivity could also be caused by groundwater seepage, although, as discussed in Section 5, conductivity measurements in seepage were generally lower than the observed conductivity increases.

As seen on Figures 2-6 and 2-7, spikes appear to occur in the vertical depth profiles for temperature, pH, conductivity, and dissolved oxygen near the bottom of the lake. The profiles summarized on Figures 2-6 and 2-7 reflect the mean of all profiles collected during each individual month of the monitoring program. During most months, 2-4 separate water quality monitoring events were conducted, with the mean values for these profiles summarized on Figures 2-6 and 2-7. The apparent spikes which occur near the lake bottom are a result of this averaging process as well as variability in the water depth during each monitoring event. As a result, variability in vertical profiles near the lake bottom should be viewed in terms of the overall general trend of the data.

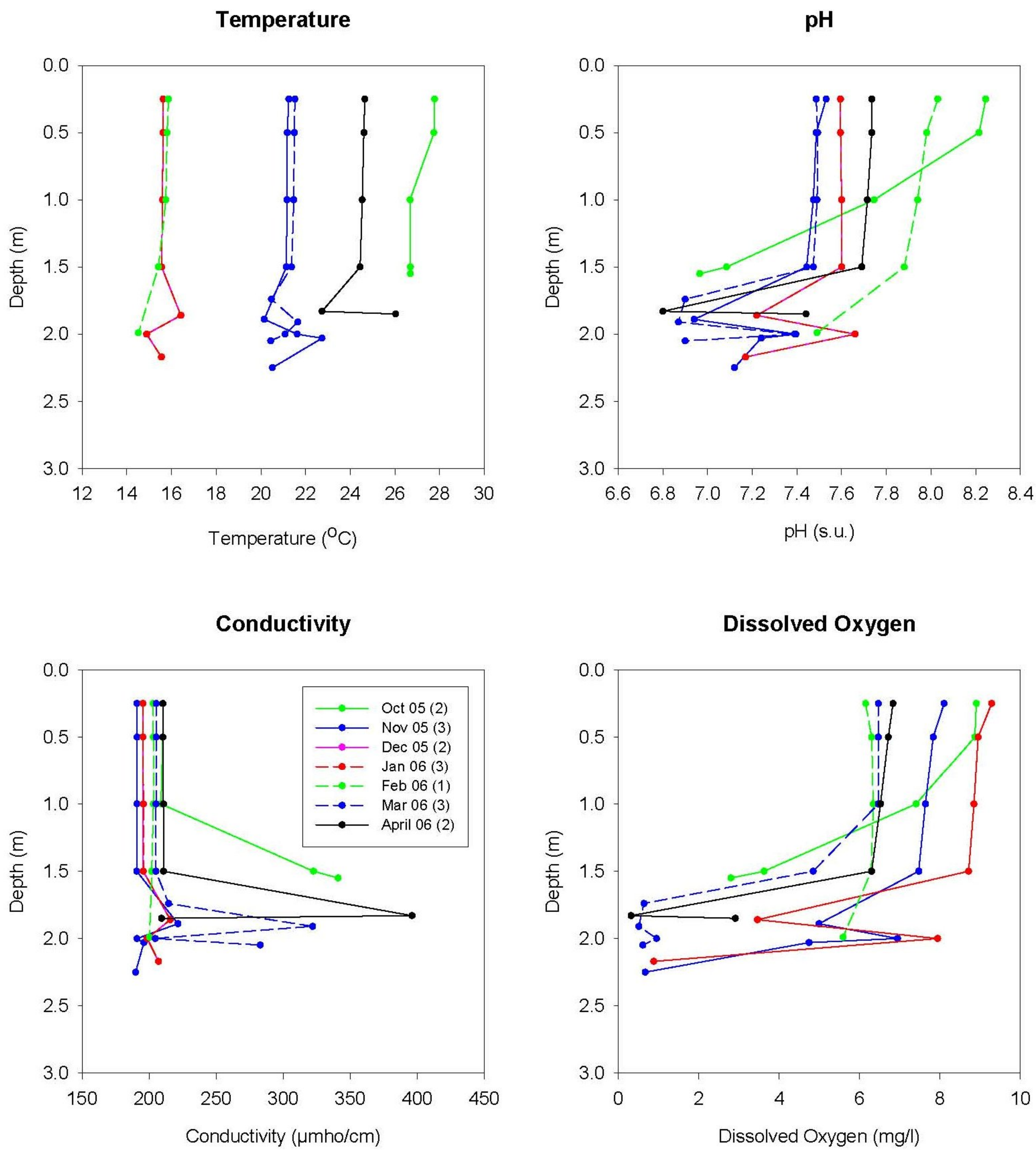

Figure 2-6. Compilation of Vertical Depth Profiles Collected at Site 1 in Lake May From October 2005-April 2006.

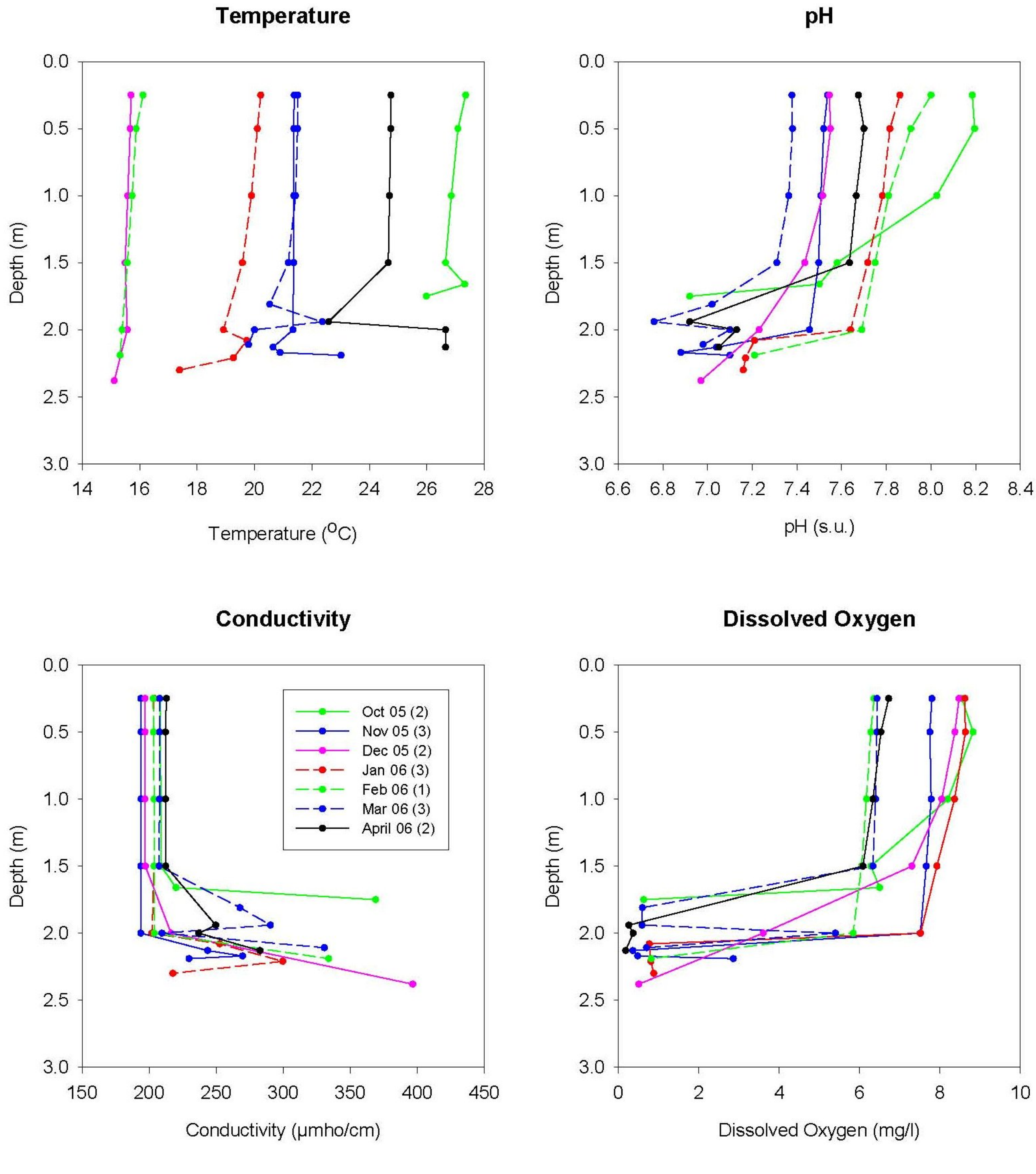

Figure 2-7. Compilation of Vertical Depth Profiles Collected at Site 2 in Lake May From October 2005-April 2006.

The field monitoring program conducted by ERD was performed during fall, winter, and spring conditions. In general, significant thermal and chemical stratification is not anticipated during these months. However, had the study extended into the summer months, it is likely that significant thermal stratification would have been observed during most monitoring events. This thermal stratification would have been accompanied by rapid decreases in pH in lower portions of the water column, along with increases in conductivity and anoxic conditions for dissolved oxygen.

2.2.2.1.2 Lake Shipp

A compilation of vertical depth profiles collected at Sites 1, 2, and 3 at Lake Shipp during routine ambient monitoring is given in Figures 2-8 through 2-10, respectively. Monitoring Site 1 is characterized by a water depth of approximately 3.5 m, with water depths of 4.5 m at Site 2 and 2.5-3.0 m at Site 3.

Relatively isograde temperature regimes were observed in Lake Shipp during virtually all of the ambient monitoring events. Temperature differences between top and bottom measurements were generally 1^{o}C or less. This suggests a relatively well mixed water column with little evidence of significant thermal stratification. Based upon the individual vertical field profiles presented in Appendix A, evidence of weak thermal stratification was observed in Lake Shipp at Site 1 during March and at Site 2 during January and March. However, this stratification appears to be related to seasonal variability in water temperature rather than classic thermal stratification which occurs during summer months.

Similar to the trends observed in Lake May, measured pH values in the top 1.5-2.0 m of Lake Shipp were found to be relatively isograde, with only a small trend of decreasing pH with increasing water depth. However, at water depths in excess of these values, a relatively rapid decrease in pH was observed during most events. Measured surface pH values ranged from approximately 7.7-9.0, with bottom measurements ranging from approximately 6.3-7.0.

Isograde conductivity measurements were observed in upper portions of the water column in Lake Shipp to a depth of approximately 1.5-2.5 m. However, below this depth, large increases in specific conductivity were observed during most monitoring events, particularly at Sites 1 and 2. Conductivity increases ranging from approximately 25-100% were common at these sites. A much lower impact on specific conductivity was observed at Site 3, with only a relatively slight increase in conductivity observed near the water-sediment interface on most dates.

In general, dissolved oxygen concentrations in excess of 5 mg/l were maintained within the water column of Lake Shipp to a depth of approximately 2-2.5 m during virtually all monitoring events. Below these depths, dissolved oxygen concentrations decreased rapidly, with anoxic conditions observed near the water-sediment interface at Sites 1 and 2. Anoxic conditions were observed at the water-sediment interface at Site 3 on only one of the ambient monitoring dates. The rapid decrease in dissolved oxygen observed in lower portions of the water column of Lake Shipp, combined with the rapid increase in specific conductivity, suggests significant water-sediment interactions which are impacting both dissolved oxygen and causing release of ions from the bottom sediments. Increases in specific conductivity near the water-sediment interface could also be caused by groundwater seepage, although, as discussed in Section 5, conductivity measurements in groundwater seepage entering Lake Ship are generally lower than the bottom conductivity measurements at monitoring Sites 1 and 2 where significant conductivity increases were observed.

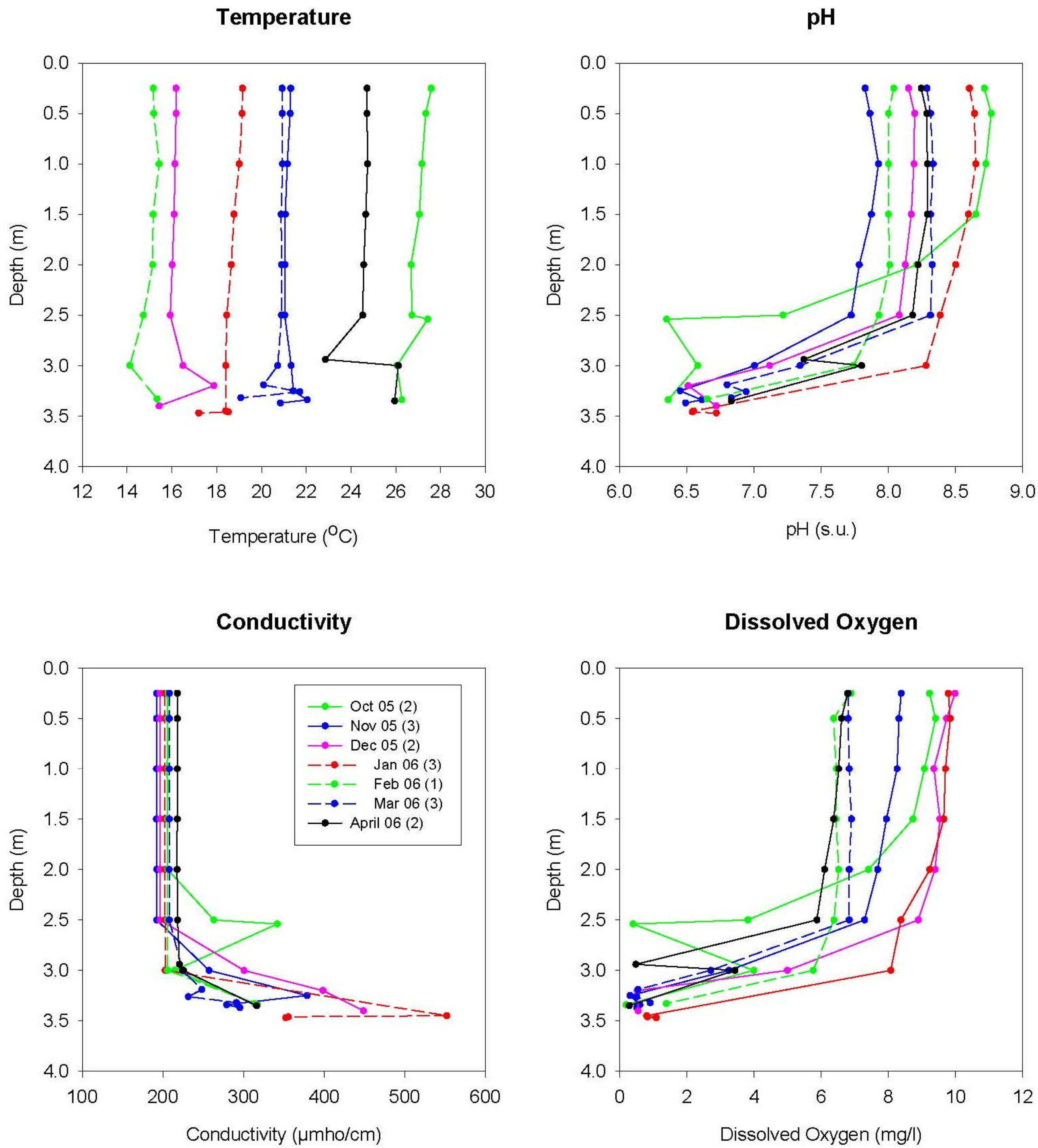

Figure 2-8. Compilation of Vertical Depth Profiles Collected at Site 1 in Lake Shipp From October 2005-April 2006.

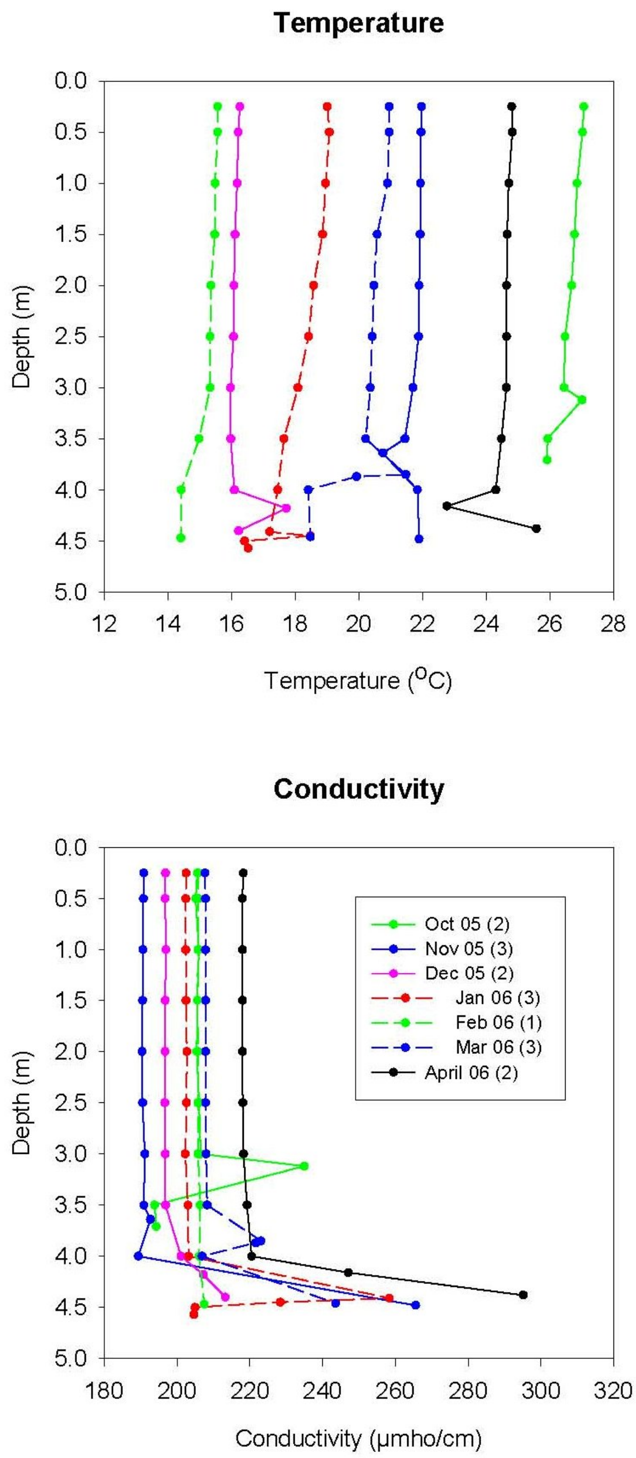

Figure 2-9. Compilation of Vertical Depth Profiles Collected at Site 2 in Lake Shipp From October 2005-April 2006.

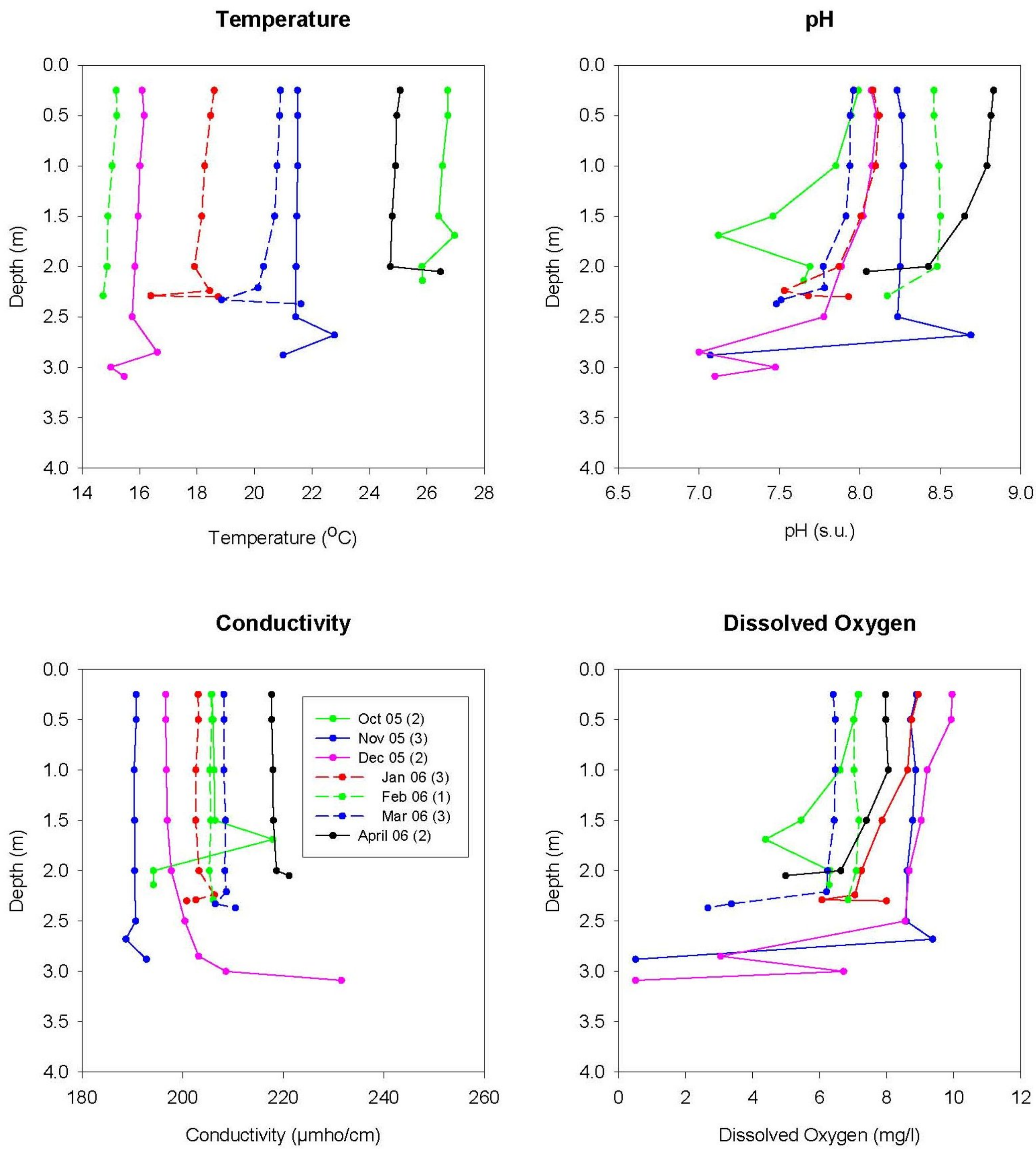

Figure 2-10. Compilation of Vertical Depth Profiles Collected at Site 3 in Lake Shipp From October 2005-April 2006.

The field monitoring program conducted by ERD was performed during fall, winter, and spring conditions. In general, significant thermal and chemical stratification is not anticipated during these months. However, had the study extended into the summer months, it is likely that significant thermal stratification would have been observed during most monitoring events. This thermal stratification would have been accompanied by rapid decreases in pH in lower portions of the water column, along with increases in conductivity and anoxic conditions for dissolved oxygen.

2.2.2.1.3 Lake Lulu

A compilation of vertical depth profiles collected at Sites 1, 2, and 3 in Lake Lulu during the routine ambient monitoring program is given in Figures 2-11 through 2-13, respectively. Water depths at Site 1 ranged from approximately 3-3.5 m, with a depth of approximately 3 m at Site 2 and 2.5-3 m at Site 3.

In general, relatively isograde temperature conditions were observed at each of the three sites in Lake Lulu during most monitoring events. Temperature differences of approximately 1-2^{o}C or less were observed between surface and bottom measurements. No trend of significant thermal stratification was observed during any monitoring event. Based upon the individual vertical field profiles presented in Appendix A, evidence of weak thermal stratification was observed in Lake Lulu at Site 1 during October and November and at Site 3 during January. However, this stratification appears to be a result of seasonal variability in water column temperature rather than classic thermal stratification which typically occurs during summer months.

Relatively isograde pH conditions were observed in upper portions of the water column, at water depths of approximately 2.0 m or less, during most monitoring events. Surface pH values within Lake Lulu ranged from approximately 7.5-8.5 during most events. However, below a water depth of 2.0 m, the pH appears to drop rapidly, with bottom pH measurements ranging from approximately 6.5-7.0.

Relatively isograde conductivity profiles were measured in Lake Lulu during most monitoring events. Significant increases in specific conductivity were observed during most events at water depths in excess of 2 m, although this phenomenon was less pronounced at Site 3 than at Sites 1 and 2. Conductivity increases of approximately 25-100% were common at the sediment-water interface at these two sites.

Dissolved oxygen concentrations in excess of 5 mg/l were maintained in Lake Lulu to water depths extending from 2-2.5 m. However, below these depths, dissolved oxygen concentrations decreased rapidly, with anoxic conditions observed at Sites 1 and 2 near the water-sediment interface. No apparent anoxic conditions were observed during any monitoring event at Site 3. The anoxic conditions observed near the water-sediment interface at Sites 1 and 2, combined with the measured substantial increases in conductivity, suggest that the sediments in Lake Lulu are creating a significant oxygen sink and are releasing dissolved ions into the overlying water column on a continuous basis. As discussed previously, increases in specific conductivity near the water-sediment interface may also be caused by influx of groundwater seepage, although, as discussed in Section 5, conductivity measurements in groundwater seepage entering Lake Lulu are generally lower than the observed conductivity values at the water-sediment interface, particularly at Sites 1 and 2.

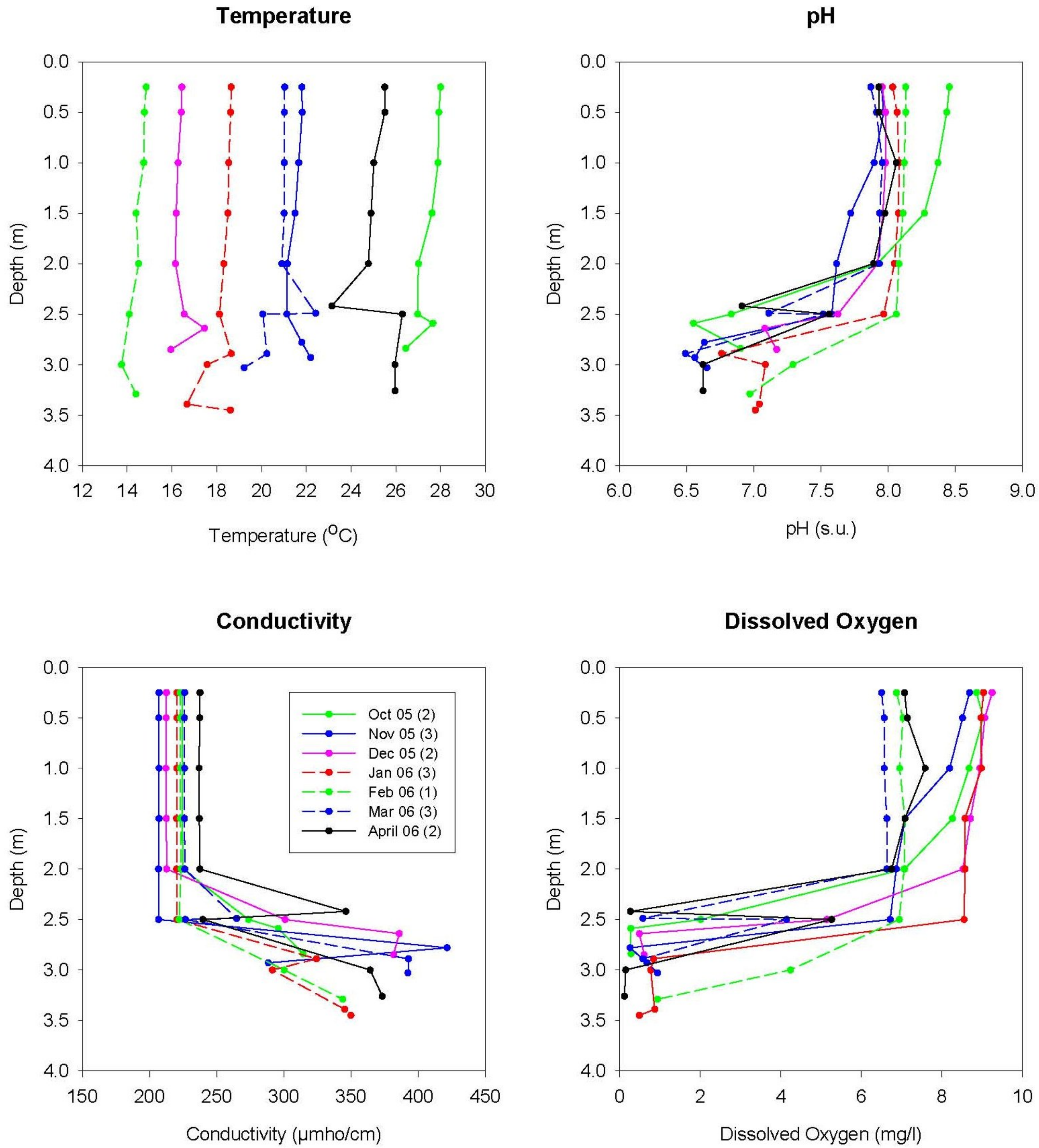

Figure 2-11. Compilation of Vertical Depth Profiles Collected at Site 1 in Lake Lulu From October 2005-April 2006.

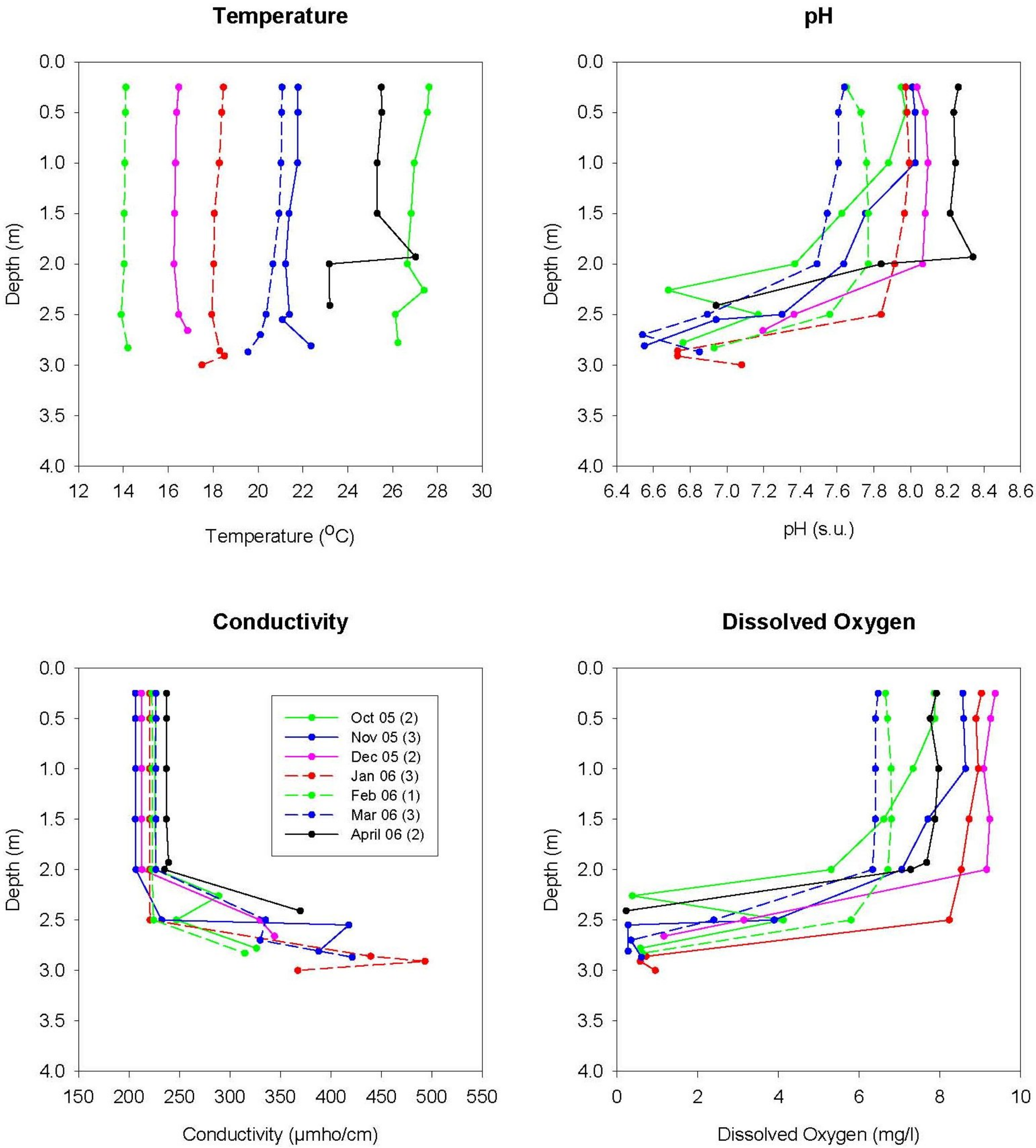

Figure 2-12. Compilation of Vertical Depth Profiles Collected at Site 2 in Lake Lulu From October 2005-April 2006.

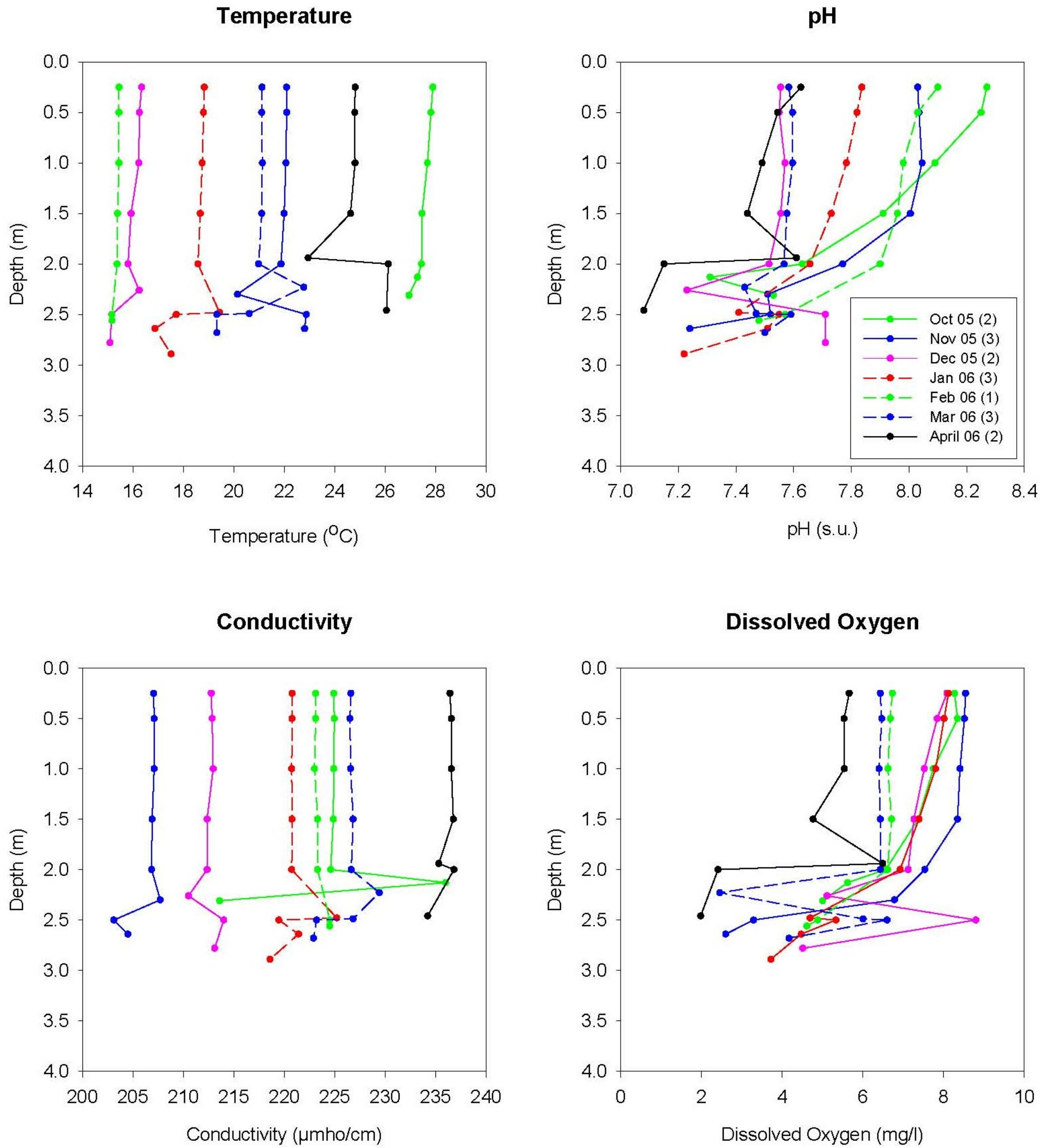

Figure 2-13. Compilation of Vertical Depth Profiles Collected at Site 3 in Lake Lulu From October 2005-April 2006.

The field monitoring program conducted by ERD was performed during fall, winter, and spring conditions. In general, significant thermal and chemical stratification is not anticipated during these months. However, had the study extended into the summer months, it is likely that significant thermal stratification would have been observed during most monitoring events. This thermal stratification would have been accompanied by rapid decreases in pH in lower portions of the water column, along with increases in conductivity and anoxic conditions for dissolved oxygen.

2.2.2.2 Laboratory Analyses

A complete listing of laboratory analyses conducted on surface water samples collected from Lakes May, Shipp, and Lulu from October 2005-April 2006 is given in Appendix B. A discussion of the results of these analyses is given in the following sections.

2.2.2.2.1 Lake May

A statistical summary of water quality samples collected in Lake May from October 2005-April 2006 is given in Table 2-7. Simple descriptive statistics, including mean values along with minimum and maximum values measured during the monitoring program, are provided for each of the monitoring sites in Lake May.

TABLE 2-7

SUMMARY OF WATER QUALITY SAMPLES COLLECTED IN LAKE MAY FROM OCTOBER 2005 TO APRIL 2006

PARAMETER	UNITS	SITE 1[1]			SITE 2[1]		
		mean	min	max	mean	min	max
pH	s.u.	7.30	7.08	8.04	7.32	7.07	8.17
Alkalinity	mg/l	50.6	47.2	56.2	51.2	47.0	55.2
NH_3	µg/l	210	<5	629	197	<5	636
NO_x	µg/l	14	<5	106	20	<5	166
Diss. Org. N	µg/l	306	35	642	249	24	434
Particulate N	µg/l	710	81	985	767	120	1174
Total N	µg/l	1240	801	1477	1232	727	1809
SRP	µg/l	0.9	<1	4.0	1.2	<1	8.0
Diss. Org P	µg/l	4	1	12	3	1	7
Particulate P	µg/l	57	14	81	59	25	99
Total P	µg/l	62	27	84	64	28	103
Turbidity	NTU	8.5	6.6	10.3	9.0	5.8	12.8
TSS	mg/l	14.8	8.8	21.3	15.5	6.6	27.0
Chlorophyll-a	mg/m^3	47.4	12.4	75.3	49.1	15.0	75.1

1. n = 17 samples

In general, the water column in Lake May was found to be neutral to slightly alkaline in pH, with measured values ranging from approximately 7.1-8.0. The water column was found to be moderately buffered, with mean alkalinities ranging from approximately 50-51 mg/l.

Measured total nitrogen concentrations in Lake May are typical of values commonly observed in urban lakes, with mean values ranging from 1232-1240 μg/l between the two sites. The dominant nitrogen species in Lake May appears to be particulate nitrogen which comprises approximately 57-62% of the nitrogen measured at each site. Dissolved organic nitrogen is the second most dominant nitrogen species, comprising 20-25% of the nitrogen measured at each site. Ammonia contributes approximately 16-17% of the total nitrogen, with minimal contributions of NO_x. Measured concentrations for nitrogen species were highly variable throughout the monitoring program, with several orders of magnitude observed between minimum and maximum values for most parameters.

Relatively elevated concentrations of total phosphorus were observed in Lake May, with mean total phosphorus concentrations ranging from 62-64 μg/l between the two sites. The most dominant phosphorus species is particulate phosphorus, comprising approximately 92% of the phosphorus measured at each site. Approximately 5-6% of the total phosphorus is comprised of dissolved organic phosphorus, with minimal amounts of SRP. A much smaller variability was observed in measured phosphorus concentrations, compared with the variability observed with nitrogen concentrations.

Relatively elevated levels of turbidity and TSS were measured in Lake May, with mean turbidity values ranging from 8.5-9.0 NTU and TSS concentrations ranging from 14.8-15.5 mg/l. Elevated levels of chlorophyll-a were also measured in Lake May, with mean values ranging from 47.4-49.1 mg/m^3. A relatively high degree of variability was exhibited by chlorophyll-a concentrations during the monitoring program, with approximately a 6-7 fold difference between minimum and maximum measured chlorophyll-a values.

Variability in trophic state indicators in Lake May from October 2005-April 2006 is illustrated on Figure 2-14. In general, measured concentrations of total nitrogen, total phosphorus, chlorophyll-a, and Secchi disk depth appear to be relatively similar between the two monitoring sites. The most elevated concentrations for chlorophyll-a were observed during the period from October-December 2005, with minimum concentrations observed during March 2006. Measured Secchi disk values were somewhat variable, ranging from approximately 0.45-0.65 m throughout the monitoring program.

2.2.2.2.2 Lake Shipp

A statistical summary of water quality samples collected in Lake Shipp from October 2005-April 2006 is given in Table 2-8. Measured pH values in Lake Shipp were found to be approximately neutral to moderately alkaline, with moderate levels of alkalinity. A relatively high degree of variability was observed in measured pH values, with only a small degree of variability observed in measured alkalinity values.

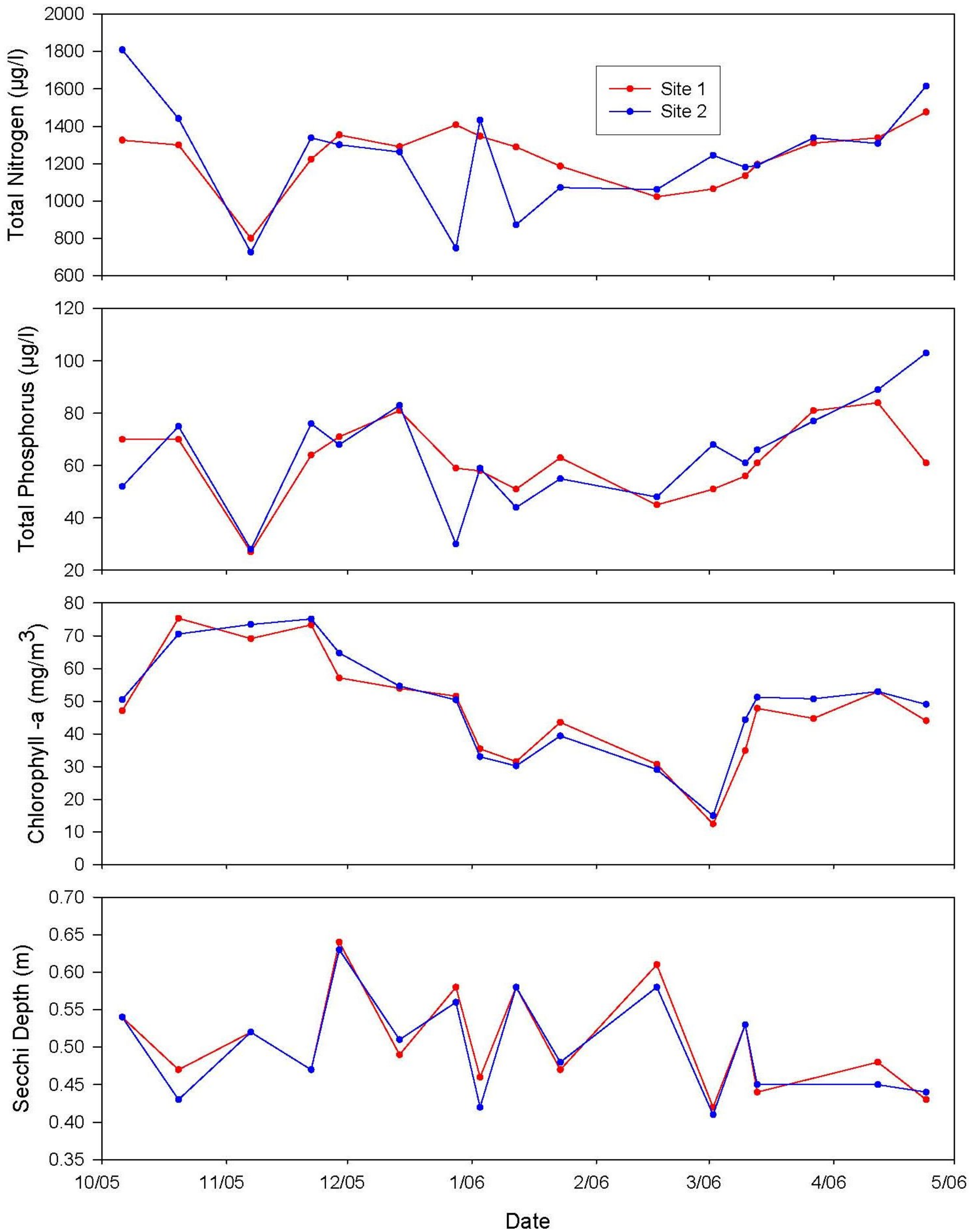

Figure 2-14. Variability in Trophic State Indicators in Lake May from October 2005-April 2006.

TABLE 2-8

SUMMARY OF WATER QUALITY SAMPLES COLLECTED IN LAKE SHIPP FROM OCTOBER 2005 TO APRIL 2006

PARAMETER	UNITS	SITE 1[1]			SITE 2[1]			SITE 3[1]		
		mean	min	max	mean	min	max	mean	min	max
pH	s.u.	7.55	7.11	8.75	7.59	7.06	8.91	7.55	7.04	9.01
Alkalinity	mg/l	51.7	47.4	57.2	56.9	47.6	143	51.7	46.4	58.2
NH_3	µg/l	257	3	1084	198	3	565	229	3	701
NO_x	µg/l	13	3	101	17	3	122	17	3	90
Diss. Org N	µg/l	335	56	715	300	88	458	354	26	1125
Particulate N	µg/l	972	363	1686	1126	797	1707	950	64	1608
Total N	µg/l	1578	875	2987	1640	1262	2172	1550	870	2111
SRP	µg/l	1	1	5	1	1	6	1	1	3
Diss. Org P	µg/l	4	1	10	5	1	18	4	1	8
Particulate P	µg/l	55	12	110	56	34	74	51	10	69
Total P	µg/l	60	14	114	62	37	87	56	15	77
Turbidity	NTU	10.5	7.1	13.1	10.5	7.3	13.4	10.9	7.1	15.8
TSS	mg/l	17.4	8.1	25.8	16.9	7.5	24.8	17.3	8.4	25.0
Chlorophyll-a	mg/m^3	78.0	54.6	127	78.3	50.5	124	77.3	54.5	115

1. n = 17 samples

Moderately elevated concentrations of total nitrogen were observed in Lake Shipp throughout the monitoring program. In general, a high degree of variability was observed in measured concentrations for virtually all nitrogen species, with several orders of magnitude observed between minimum and maximum values for certain parameters. Total nitrogen concentrations were somewhat elevated in Lake Shipp, with mean values ranging from 1550-1640 µg/l at the three sites. The most dominant nitrogen species present in Lake Shipp is particulate nitrogen which comprised 61-69% of the total nitrogen present. Dissolved organic nitrogen comprised approximately 18-23% of the total nitrogen, with 12-16% comprised of ammonia. Minimal contributions of NO_x were measured.

Relatively elevated levels of total phosphorus were observed in Lake Shipp during the monitoring program, with mean phosphorus concentrations ranging from 56-62 µg/l at the two sites. A relatively high degree of variability was observed in measured phosphorus concentrations within the lake, with approximately one order of magnitude between minimum and maximum values for most parameters. The most dominant phosphorus species is particulate phosphorus which comprises 90-92% of the total phosphorus measured. Approximately 7-8% of the total phosphorus consists of dissolved organic phosphorus, with 1-2% contributed by SRP.

Elevated levels of turbidity and TSS were observed in Lake Shipp, with mean turbidity values ranging from 10.5-10.9 NTU and TSS values ranging from 16.9-17.4 mg/l. Approximately a 2-3 fold difference in concentrations was observed for these parameters between minimum and maximum values.

Elevated levels of chlorophyll-a were observed in Lake Shipp, with mean concentrations ranging from 77.3-78.3 mg/m^3. Measured chlorophyll-a concentrations in Lake Shipp are approximately 50-75% greater than concentrations measured in Lake May. A relatively high degree of variability in chlorophyll-a concentrations was observed, with a 2-3 fold difference between minimum and maximum values. Maximum chlorophyll-a values measured in Lake Shipp exceeded 125 mg/m^3.

Variability in trophic state indicators in Lake Shipp from October 2005-April 2006 is illustrated on Figure 2-15. In general, measured concentrations of nutrients and chlorophyll-a appear to be relatively similar between the three monitoring sites. Maximum chlorophyll-a concentrations were observed in Lake Shipp during the period from November 2005-January 2006, with minimum levels observed during the period from January-March 2006. Measured Secchi disk values range from approximately 0.35-0.55 m during the monitoring program.

2.2.2.2.3 Lake Lulu

A statistical summary of water quality samples collected in Lake Lulu from October 2005-April 2006 is given in Table 2-9. The water column in Lake Lulu was found to be approximately neutral to slightly alkaline in pH and moderately well buffered, with mean alkalinities ranging from 51.1-51.7 mg/l.

TABLE 2-9

SUMMARY OF WATER QUALITY SAMPLES COLLECTED IN LAKE LULU FROM OCTOBER 2005 TO APRIL 2006

PARAMETER	UNITS	SITE 1[1]			SITE 2[1]			SITE 3[1]		
		mean	min	max	mean	min	max	mean	min	max
pH	s.u.	7.40	7.17	7.97	7.38	7.11	8.03	7.33	7.15	8.05
Alkalinity	mg/l	51.1	48.2	55.4	51.2	48.0	58.2	51.7	49.0	57.0
NH_3	µg/l	168	<5	559	168	<5	599	156	<5	623
NO_x	µg/l	14	<5	83	36	<5	309	16	<5	76
Diss. Org N	µg/l	315	22	678	263	16	532	314	17	507
Particulate N	µg/l	558	105	853	683	381	1034	598	228	870
Total N	µg/l	1055	679	1501	1149	736	1515	1083	705	1379
SRP	µg/l	0.7	<1	1.0	1.6	<1	11.0	1.2	<1	8.0
Diss. Org P	µg/l	5	1	20	3	1	8	6	2	10
Particulate P	µg/l	46	29	69	49	29	75	43	21	71
Total P	µg/l	52	32	71	54	34	77	51	25	78
Turbidity	NTU	6.8	4.4	10.6	7.1	3.8	10.1	7.0	4.4	9.7
TSS	mg/l	13.1	6.4	21.3	13.4	7.8	23.0	13.6	6.4	24.0
Chlorophyll-a	mg/m^3	36.7	18.9	69.8	36.5	19.1	62.6	33.6	20.4	52.9

1. n = 17 samples

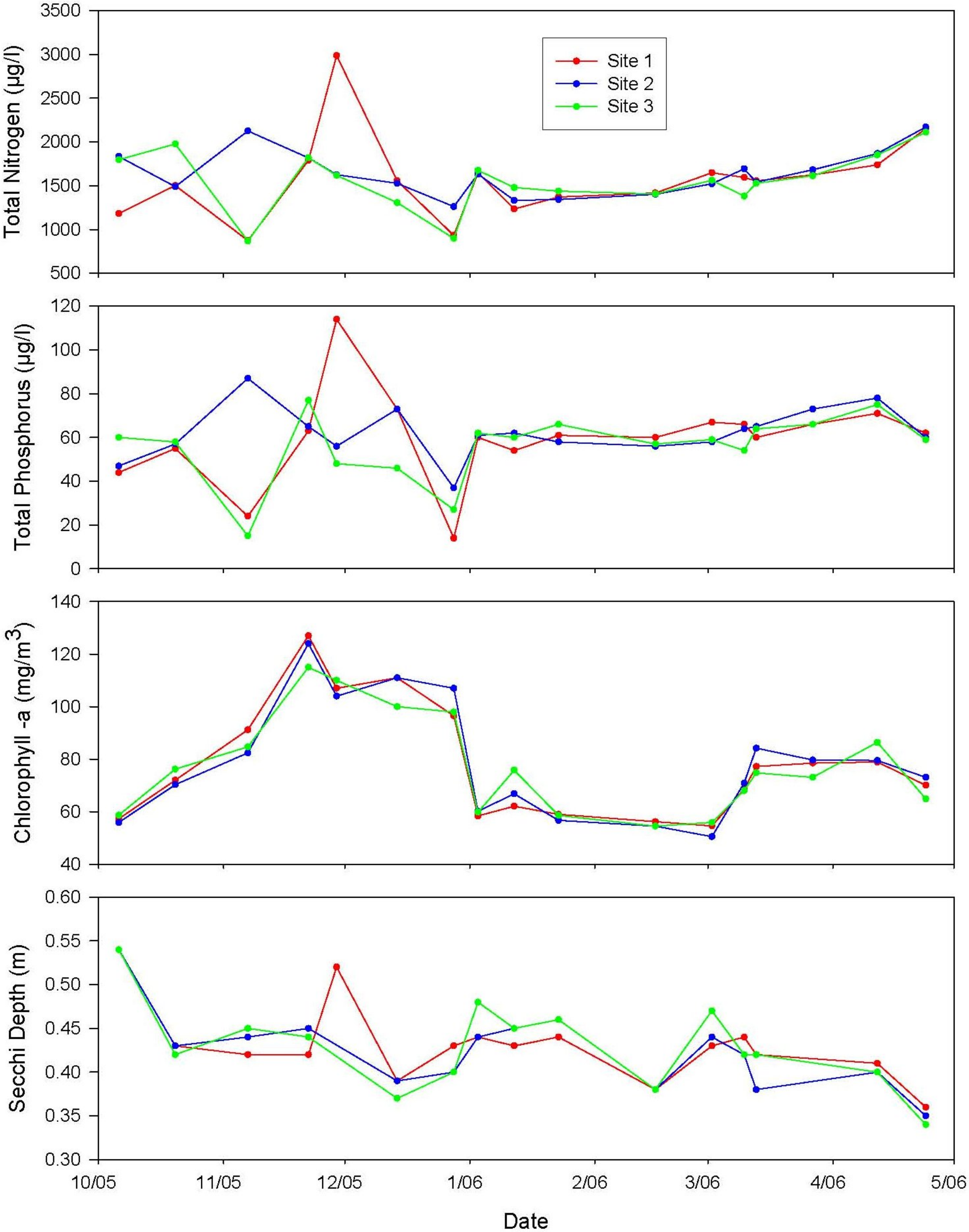

Figure 2-15. Variability in Trophic State Indicators in Lake Shipp from October 2005-April 2006.

Relatively low concentrations of total nitrogen were measured in Lake Lulu during the monitoring program, with mean total nitrogen concentrations ranging from 1055-1149 µg/l. A relatively high degree of variability was observed in measured concentrations for the various nitrogen species, with a difference of 2-3 orders of magnitude between minimum and maximum values for most parameters. The dominant nitrogen species present in Lake Lulu was particulate nitrogen, which comprises 53-59% of the total nitrogen present. Dissolved organic nitrogen contributes approximately 23-39%, with 14-16% contributed by ammonia. Nitrogen contributions from NO_x were found to be relatively minimal, contributing only 1-2% of the total nitrogen.

Moderate to high concentrations of total phosphorus were observed in Lake Lulu, with mean concentrations ranging from 51-54 µg/l between the three sites. A relatively high degree of variability was observed in measured phosphorus concentrations for most species, although the variability between phosphorus species appeared to be substantially less than that exhibited by nitrogen species. The dominant phosphorus species present was particulate phosphorus, which comprises 84-91% of the total phosphorus at each site. Approximately 6-12% of the total phosphorus consists of dissolved organic phosphorus, with minimal contributions from SRP.

Moderate concentrations of turbidity and TSS were observed in Lake Lulu, with mean turbidity values ranging from 6.8-7.1 NTU and mean TSS concentrations ranging from 13.1-13.6 mg/l. These values are somewhat lower than concentrations measured in either Lake Shipp or Lake May.

Moderate levels of chlorophyll-a were also observed in Lake Lulu, with mean concentrations ranging from 33.6-36.7 mg/m^3. Mean chlorophyll-a concentrations in Lake Lulu are somewhat lower than values measured in either Lake May or Lake Shipp.

Variability in trophic state indicators in Lake Lulu from October 2005-April 2006 is illustrated on Figure 2-16. In general, measured concentrations for nutrients and chlorophyll-a appear to be relatively similar between the three monitoring sites. Maximum concentrations for nitrogen, phosphorus, and chlorophyll-a were observed from October-November 2005, with minimum values for these parameters occurring during the period from January-March 2006. Measured Secchi disk values in Lake Lulu ranged from approximately 0.45-0.65 m during the monitoring program.

2.2.2.2.4 Seasonal Variability

As seen in Figures 2-14, 2-15, and 2-16, a significant seasonal variability was observed in water quality characteristics within Lakes May, Shipp, and Lulu during the monitoring program conducted from October 2005-April 2006. In general, minimum concentrations of total nitrogen, total phosphorus, and chlorophyll-a were observed in most lakes during the period from January-March 2006, with more elevated concentrations for these parameters observed before and after this period. There are several potential explanations for this phenomenon. The most obvious explanation may be related to rainfall patterns at the three lakes. As discussed in Section 4, substantially higher than normal rainfall was observed during October 2005, with approximately "normal" rainfall observed during November. However, substantially below "normal" rainfall was observed in the Winter Haven area during December 2005, January 2006, and March-April

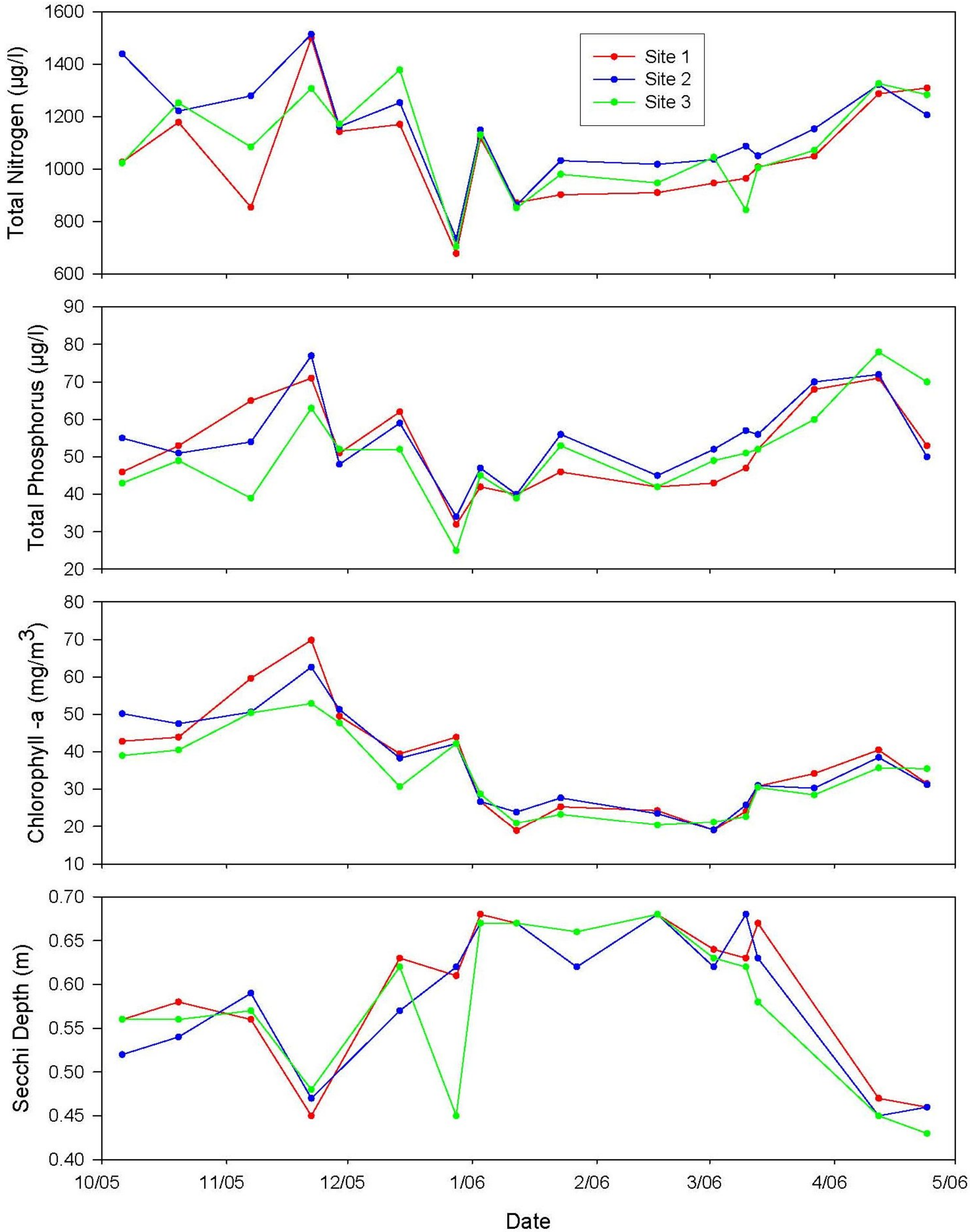

Figure 2-16. Variability in Trophic State Indicators in Lake Lulu from October 2005-April 2006.

2006. The reduction in phosphorus concentrations observed within the three lakes during the period from January-March may be related to the lack of rainfall and lowered runoff loadings during this period. The relatively consistent water quality characteristics observed within the three lakes from January-March 2006 for total nitrogen, total phosphorus, and chlorophyll-a may reflect near-equilibrium water quality characteristics within the lakes in the absence of significant runoff inputs. During this period, the most significant loadings into the three lakes would occur as a result of internal recycling and resuspension of bottom sediments during windy conditions. Therefore, water quality characteristics measured during this time appear to reflect primarily internal loadings, while water quality characteristics measured during other times of the year reflect a combination of external and internal loadings.

Another possible explanation for the observed seasonal differences in water quality characteristics is changes in water temperature within the lakes. Since the rate of chemical and biological processes is impacted by temperature, lowered water temperatures during the period from January-March would correspond with reductions in algal productivity as well as reductions in the rate of internal recycling due to changes in metabolism and diffusion rates within the sediments. It is interesting to note that the variability in water quality characteristics between monitoring stations is virtually eliminated during periods of low rainfall when the lake appears to be uniformly impacted by internal processes. However, a much higher degree of horizontal variability is apparent in water quality characteristics during periods of elevated rainfall due to the disproportionate impacts of runoff inputs on various areas within the lake.

An increase in measured values for total nitrogen, total phosphorus, and chlorophyll-a was observed during March-April 2006 which were the final two months of the monitoring program. As discussed in Section 4, rainfall during these months was substantially below "normal", so the observed increases are not likely related to runoff inputs. As discussed in Section 4, water level elevations within the lakes were dropping rapidly during the final two months of the monitoring program, with water levels approximately one foot lower than occurred at the start of the monitoring program. This lowered water surface elevation made the three lakes more susceptible to resuspension during wind events as a result of the more shallow water depth. Based upon the relative impacts affecting the lakes during the final two months of the monitoring program, the observed increases in concentrations are probably most impacted by the shallow water depth and resulting increased resuspension opportunity.

Based on the preceding discussion, it appears that the variability in water quality characteristics indicated on Figures 2-14, 2-15, and 2-16 can be divided into three separate time frames with respect to significant processes impacting the lakes. During the first period from October-December 2005, rainfall conditions were either above or near "normal", and water quality was impacted by a combination of runoff and internal recycling. During the period from January-March 2006, rainfall appears to have a relatively minimal impact, with concentrations primarily a result of internal processes. During the period from March-April 2006, the impacts of lowered water surface elevations and increased opportunity for resuspension appear to result in increases in constituent concentrations in spite of below "normal" rainfall conditions.

2.2.3 Changes in Water Quality Characteristics During Windy Conditions

Four separate monitoring events were conducted under unusually high windy conditions to evaluate potential water quality impacts from wave and wind action. Monitoring during windy conditions was conducted on November 22, 2005 and January 3, March 10, and March 12, 2006. A summary of monitoring dates and wind conditions for the supplemental monitoring events was given previously in Table 2-6. In general, normal monitoring events were characterized by wind speeds of approximately 5-7 mph or less and wave heights ranging from 2-6 inches. The wind-based monitoring events were characterized by wind speeds ranging from 15-25 mph and wave heights ranging from 12-24 inches.

A comparison of mean water quality characteristics in Lakes May, Shipp, and Lulu under "normal" and "windy" conditions is given in Table 2-10. In general, water column pH under windy conditions was found to be slightly lower than non-windy conditions in each of the three lakes. This decrease in pH is likely related to circulation of the lower portions of the water column which typically exhibit lower pH values. A slight increase in alkalinity was also observed under windy conditions.

TABLE 2-10

COMPARISON OF MEAN WATER QUALITY IN LAKES MAY, SHIPP, AND LULU UNDER "NORMAL" AND "WINDY" CONDITIONS

PARAMETER	UNITS	LAKE MAY		LAKE SHIPP		LAKE LULU	
		NORMAL	WINDY	NORMAL	WINDY	NORMAL	WINDY
pH	s.u.	7.38	7.18	7.60	7.43	7.41	7.27
Alkalinity	mg/l	50.7	51.2	51.5	52.2	51.0	51.9
NH_3	µg/l	240	65	278	69	193	52
NO_x	µg/l	20	5	17	11	25	6
Diss. Org N	µg/l	321	389	307	404	298	440
Particulate N	µg/l	721	830	951	1227	561	716
Total N	µg/l	1190	1280	1552	1710	1077	1213
SRP	µg/l	< 1	< 1	1	1	1	1
Diss. Org P	µg/l	3	3	4	5	5	4
Particulate P	µg/l	57	65	52	60	43	56
Total P	µg/l	62	69	57	66	50	60
Turbidity	NTU	8.6	9.4	10.2	12.0	6.6	8.1
TSS	mg/l	13.7	18.7	16.0	21.2	11.7	17.9
Chlorophyll-a	mg/m^3	48.0	50.2	76.3	83.1	36.8	37.9

Windy conditions appear to decrease water column concentrations of both ammonia and NO_x compared with monitoring conducted under normal conditions. However, windy conditions appear to increase water column concentrations of dissolved organic nitrogen, particulate nitrogen, and total nitrogen compared with non-windy conditions.

Windy conditions appear to have no impact on measured concentrations of either SRP or dissolved organic phosphorus within the three lakes. However, windy conditions resulted in measurable increases in both particulate phosphorus and total phosphorus within the three lakes. Under windy conditions, total phosphorus increased approximately 11% in Lake May, 16% in Lake Shipp, and 20% in Lake Lulu.

Windy conditions also resulted in measurable increases in turbidity and TSS in each of the three lakes. Windy conditions caused an increase in turbidity of approximately 9% in Lake May, 18% in Lake Shipp, and 23% in Lake Lulu. Similarly, windy conditions caused an increase in TSS of approximately 37% in Lake May, 33% in Lake Shipp, and 53% in Lake Lulu.

Measured chlorophyll-a concentrations were also increased within the three lakes during windy conditions. Chlorophyll-a concentrations in Lake May increased approximately 5% during windy conditions, with an increase of approximately 9% in Lake Shipp, and 3% in Lake Lulu.

In general, windy conditions resulted in measurable increases in particulate species of both nitrogen and phosphorus as well as turbidity, TSS, and chlorophyll-a. The most significant increases in water column characteristics occurred in Lake Lulu under windy conditions. The measurable increases in water column concentrations appear to suggest that portions of the sediment are resuspending during windy activities, causing water column increases of particulate matter, nutrients, and chlorophyll-a. Based upon this limited data collection activity, it appears that the sediments in each of the three lakes can resuspend and cause measurable changes in water column characteristics under windy conditions.

2.2.4 **Trophic Status**

Florida Trophic State Index (TSI) values were calculated for each monitoring event in the three lakes over the period from October 2005-April 2006. TSI is a summary statistic which incorporates measured concentrations of significant parameters in lake systems, including total phosphorus, total nitrogen, Secchi disk depth, and chlorophyll-a. Since this index summarizes information obtained from several separate measured parameters, it is often considered the best overall indicator of the health of a lake system. Calculated TSI values less than 50 indicate oligotrophic conditions, representing lakes with low nutrient loadings and good to excellent water quality characteristics. Calculated TSI values from 50-60 indicate mesotrophic or fair water quality characteristics. Calculated TSI values between 60-70 indicate eutrophic or poor water quality characteristics, with hypereutrophic conditions indicated by TSI values in excess of 70.

The trophic state index was developed by Carlson (1977) as a relative measure of the degree of algal productivity in lakes. The TSI concept incorporates forcing functions such as nutrient supplies, light availability, seasonality, and other factors. Since the TSI value is intended to reflect algal productivity, the best estimator for algal productivity is chlorophyll-a. Therefore, TSI calculations are conducted for Lakes May, Lulu, and Shipp using measured concentrations of chlorophyll-a only according to the following relationship:

$$\text{TSI (chl-a)} = 16.8 + 14.4 \ln \text{chl-a (mg/m}^3\text{)}$$

Variability in calculated TSI values in Lakes May, Shipp, and Lulu from October 2005-April 2006 is illustrated on Figure 2-17. Lake May exhibited primarily eutrophic and hypereutrophic conditions during the study period. In general, TSI values in Lake May appear to be lowest during winter conditions, with more elevated hypereutrophic TSI values during fall and spring conditions.

A combination of eutrophic and hypereutrophic conditions was also observed in Lake Lulu, although the majority of events performed by ERD indicated eutrophic characteristics. TSI values in Lake Lulu also appear to be lowest during winter and early spring conditions, with hypereutrophic and near-hypereutrophic conditions exhibited during fall and late spring. In contrast, hypereutrophic conditions were observed in Lake Shipp throughout the entire monitoring program. Although the trend is less significant than observed in Lake Lulu, TSI values appear to be lowest in Lake Shipp during winter and early spring, with higher TSI values measured during winter and late spring conditions.

2.2.5 Nutrient Limitation

Nutrient limitation is typically evaluated using the total nitrogen/total phosphorus (TN/TP) ratio The calculated TN/TP ratio is a numerical ratio of the measured concentrations of total nitrogen and total phosphorus and is useful in evaluating the relative significance of nitrogen and phosphorus species in the overall lake system. Measured TN/TP ratios less than 10 are considered to indicate nitrogen-limited conditions, suggesting that nitrogen is the element which regulates the growth of algae and aquatic species within the lake system. Calculated TN/TP ratios between 10-30 indicate nutrient-balanced conditions, with both nitrogen and phosphorus considered important for limiting aquatic growth. Some researchers suggest that nutrient balanced conditions are more appropriately represented by ratios between 10-20. Calculated TN/TP ratios in excess of 30 (sometimes 20) indicate phosphorus-limited conditions, which is the typical situation observed in many lakes in the Central Florida area. This condition indicates that inputs of phosphorus into the lake system should be controlled to regulate the growth of algal biomass within the lake.

Variability in calculated TN/TP ratios in Lakes May, Shipp, and Lulu from October 2005-April 2006 is illustrated in Figure 2-18. In general, TN/TP ratios within Lake May ranged from approximately 16-28 during the monitoring program from October 2005-April 2006, with TN/TP ratios in excess of 30 observed in Lakes Shipp and Lulu on virtually all monitoring dates. Each of the lakes exhibited either phosphorus-limiting or nutrient-balanced conditions during the field monitoring program. As indicated in Tables 2-7 through 2-9, each of the three lakes appears to have adequate supplies of inorganic nitrogen, with most measurements for dissolved phosphorus below detectable limits. As a result, algal production within each of the three lakes appears to be regulated by concentrations of phosphorus rather than nitrogen, and algal productivity can best be controlled by limiting inputs of phosphorus into the lakes.

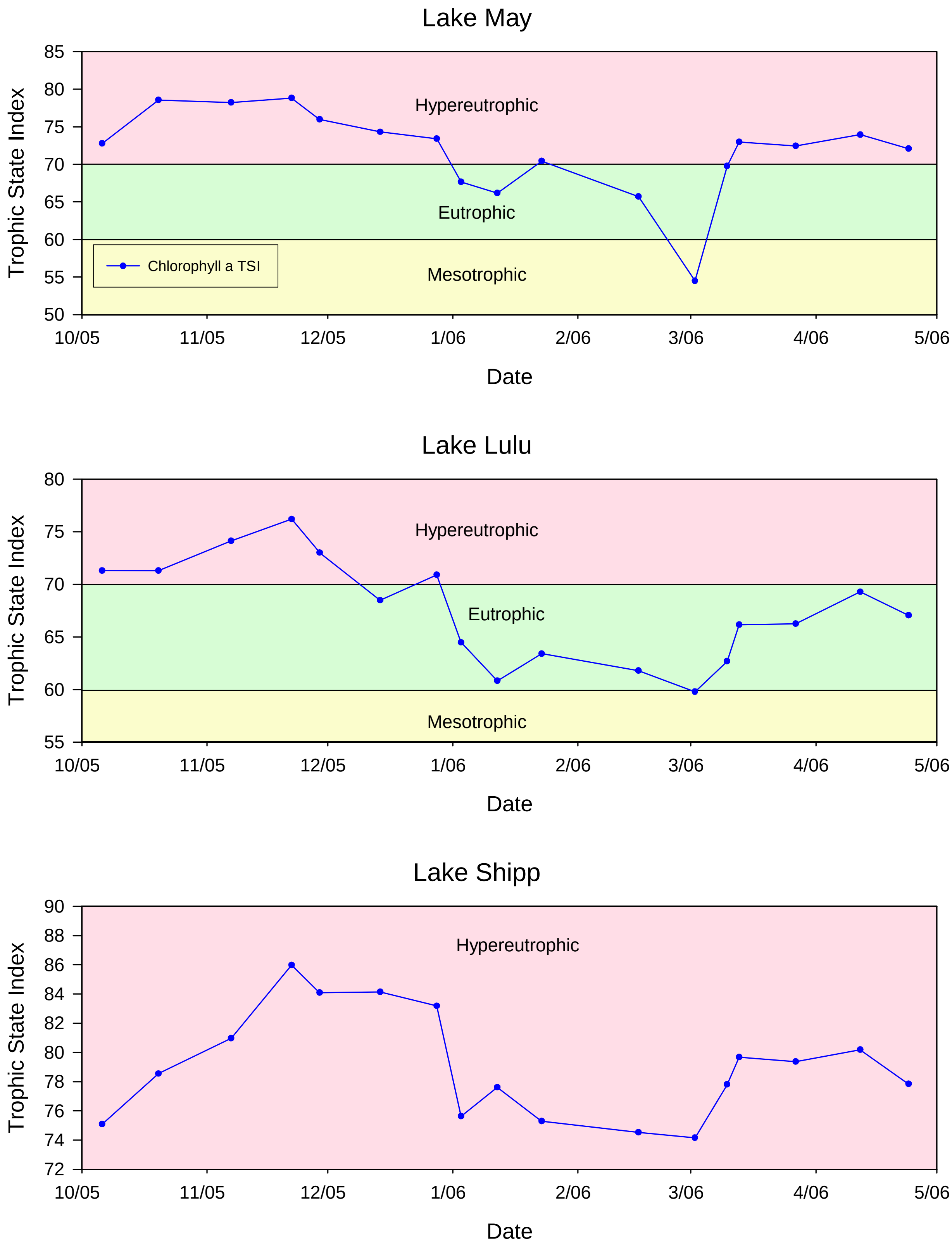

Figure 2-17. Variability in Calculated TSI Values in Lakes May, Shipp, and Lulu from October 2005-April 2006.

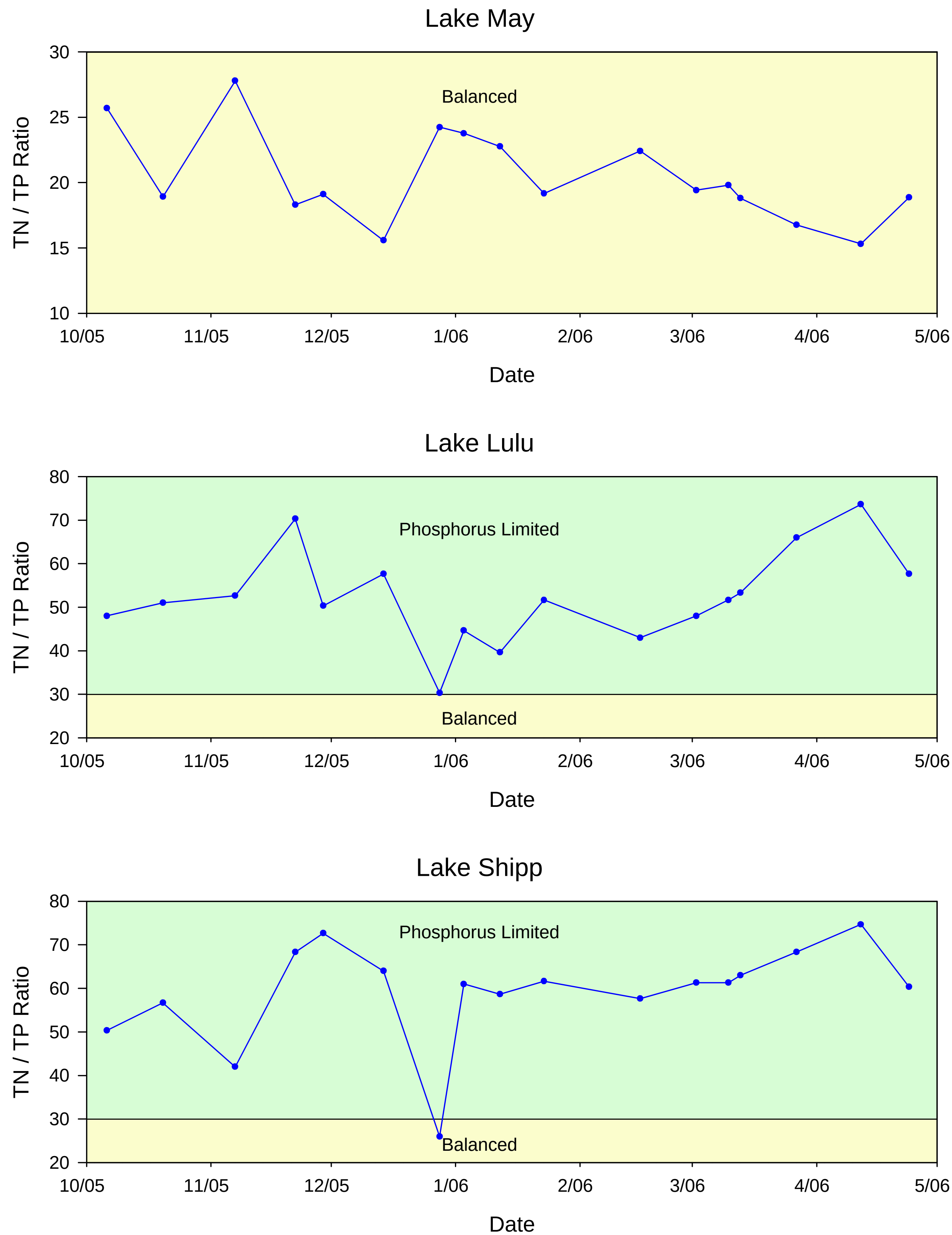

Figure 2-18. Variability in Calculated TN/TP Ratios in Lakes May, Shipp, and Lulu from October 2005-April 2006.

2.3 Sediment Characteristics

2.3.1 Quantification of Accumulated Sediments

As discussed in Section 2.1, bathymetric surveys of Lakes May, Shipp, and Lulu were conducted by ERD field personnel on November 16-17, 2005. These surveys were conducted to evaluate water column depth as well as thickness of unconsolidated sediments within each lake. A discussion of water depth contours in Lakes May, Shipp, and Lulu was given in Section 2.1. Estimates of quantities of accumulated organic sediments within the three lakes are provided in this section.

A bathymetric contour map of the depth of unconsolidated organic sediments in Lake May is given in Figure 2-19. In general, the depth of organic muck sediments within Lake May ranges from approximately 6-10 ft throughout most portions of the lake. However, muck depths extend as deep as 18 ft in an isolated pocket along the northwest side of the lake adjacent to the inflow from Lake Howard. Muck depths within the residential canals, located along the west side of Lake May, range from approximately 1-4 ft.

Estimated accumulation of organic muck sediments in Lake May are summarized on Table 2-11. Overall, Lake May contains approximately 302.4 ac-ft (487,872 yd^3) of organic sediments above the firm lake bottom. Approximately 50% of the lake bottom has organic muck depths of 7 ft or more. Based upon a lake surface area of 50.54 ac, the average depth of organic muck sediments in Lake May, if distributed evenly across the entire lake bottom, would be approximately 5.98 ft.

TABLE 2-11

ESTIMATED ACCUMULATION OF ORGANIC MUCK SEDIMENTS IN LAKE MAY

MUCK DEPTH (ft)	CONTOUR AREA (ac)	PERCENT OF LAKE AREA	MUCK VOLUME (ac-ft)
> 18	0.04	< 1	--
17-18	0.13	< 1	0.085
16-17	0.27	1	0.28
15-16	0.46	1	0.65
14-15	0.69	1	1.22
13-14	0.87	2	2.00
12-13	1.16	2	3.01
11-12	1.51	3	4.35
10-11	3.79	7	7.00
9-10	8.98	18	13.39
8-9	16.90	33	26.33
7-8	23.97	47	46.77
6-7	29.79	59	73.65
5-6	33.03	65	105.1
4-5	35.54	70	139.3
3-4	37.87	75	176.0
2-3	40.06	79	215.0
1-2	42.04	83	256.1
0-1	50.54	100	302.4

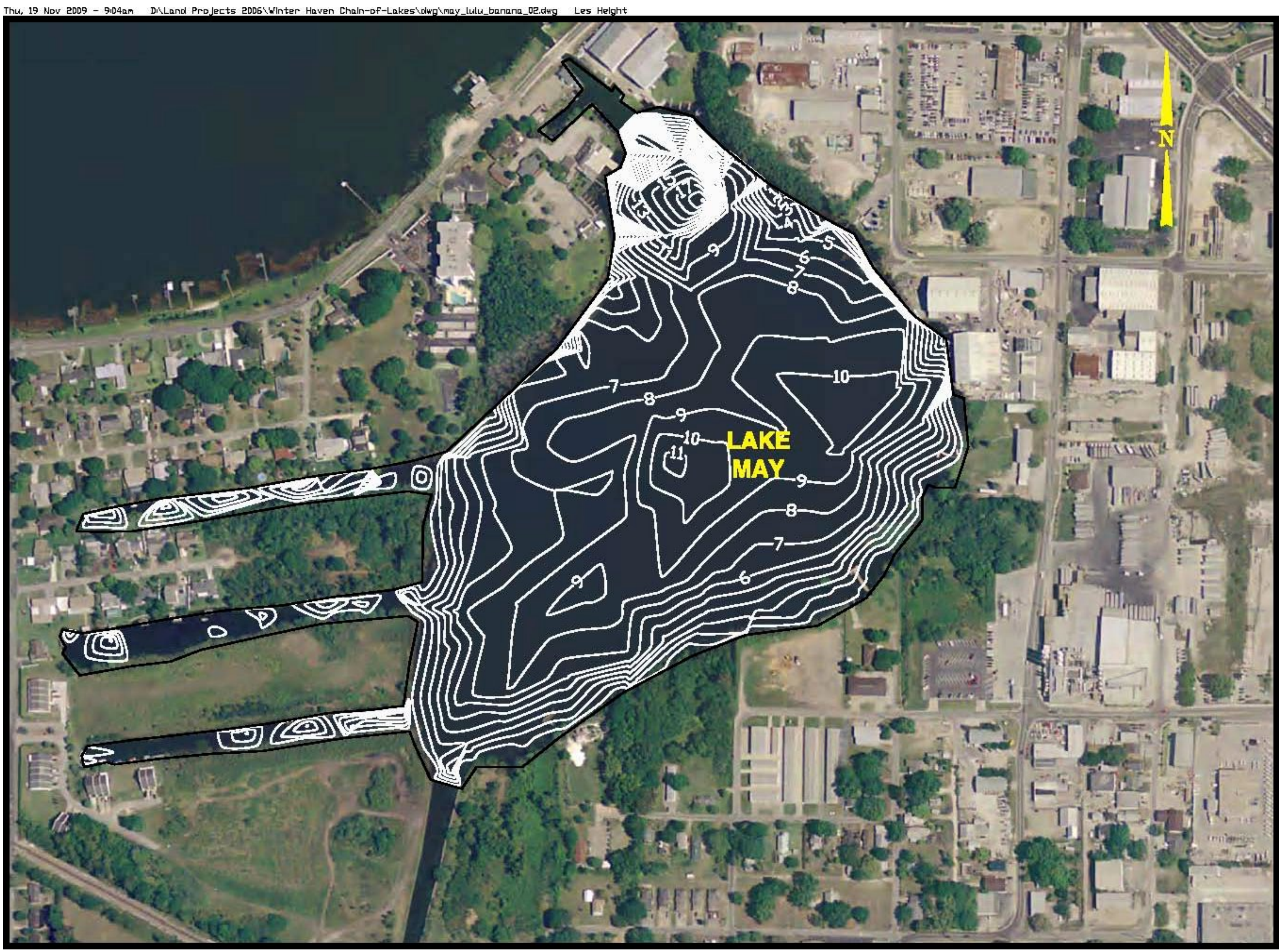

Figure 2-19. Isopleths of Organic Sediment (Muck) Depths in Lake May.

Isopleths of organic muck depths in Lake Shipp are illustrated on Figure 2-20. Muck accumulation in Lake Shipp is concentrated primarily in the northern half of the lake where muck depths exceed 15 ft in two isolated pockets. Muck depths in the remaining portions of the northern half of Lake Shipp range from approximately 3-5 ft. In contrast, muck depth in southern portions of Lake Shipp is typically less than 1 ft deep.

A summary of estimated accumulation of organic muck sediments in Lake Shipp is given in Table 2-12. Overall, approximately 621 ac-ft (1,001,880 yd^3) of organic muck sediments current exist in Lake Shipp. This muck volume is sufficient to cover the entire 276.4 ac surface of the lake to a depth of approximately 2.25 ft.

TABLE 2-12

ESTIMATED ACCUMULATION OF ORGANIC MUCK SEDIMENTS IN LAKE SHIPP

MUCK DEPTH (ft)	CONTOUR AREA (ac)	PERCENT OF LAKE AREA	MUCK VOLUME (ac-ft)
15	0.26	< 1	--
14	1.07	< 1	0.67
13	2.19	1	2.30
12	3.57	1	5.18
11	5.18	2	9.55
10	7.02	3	15.65
9	9.11	3	23.72
8	11.44	4	34.00
7	25.29	9	52.35
6	26.55	10	78.27
5	43.69	16	113.4
4	61.55	22	166.0
3	75.56	27	234.6
2	90.76	33	317.7
1	119.6	43	422.9
0	276.4	100	621.0

Isopleths of organic muck depths in Lake Lulu are illustrated on Figure 2-21. The southern half of Lake Lulu appears to have muck depth accumulations ranging from approximately 1-2 ft in most areas. However, the northern half of the lake has muck accumulations extending to a depth of approximately 12 ft, with much of the northern half of the lake covered by muck depths ranging from 5-10 ft.

Estimates of the accumulation of organic muck sediments in Lake Lulu are summarized in Table 2-13. Overall, Lake Lulu contains approximately 846.6 ac-ft (1,365,848 yd^3) of muck sediments above the firm lake bottom. This muck depth is sufficient to cover the entire surface area of Lake Lulu to a depth of approximately 2.76 ft.

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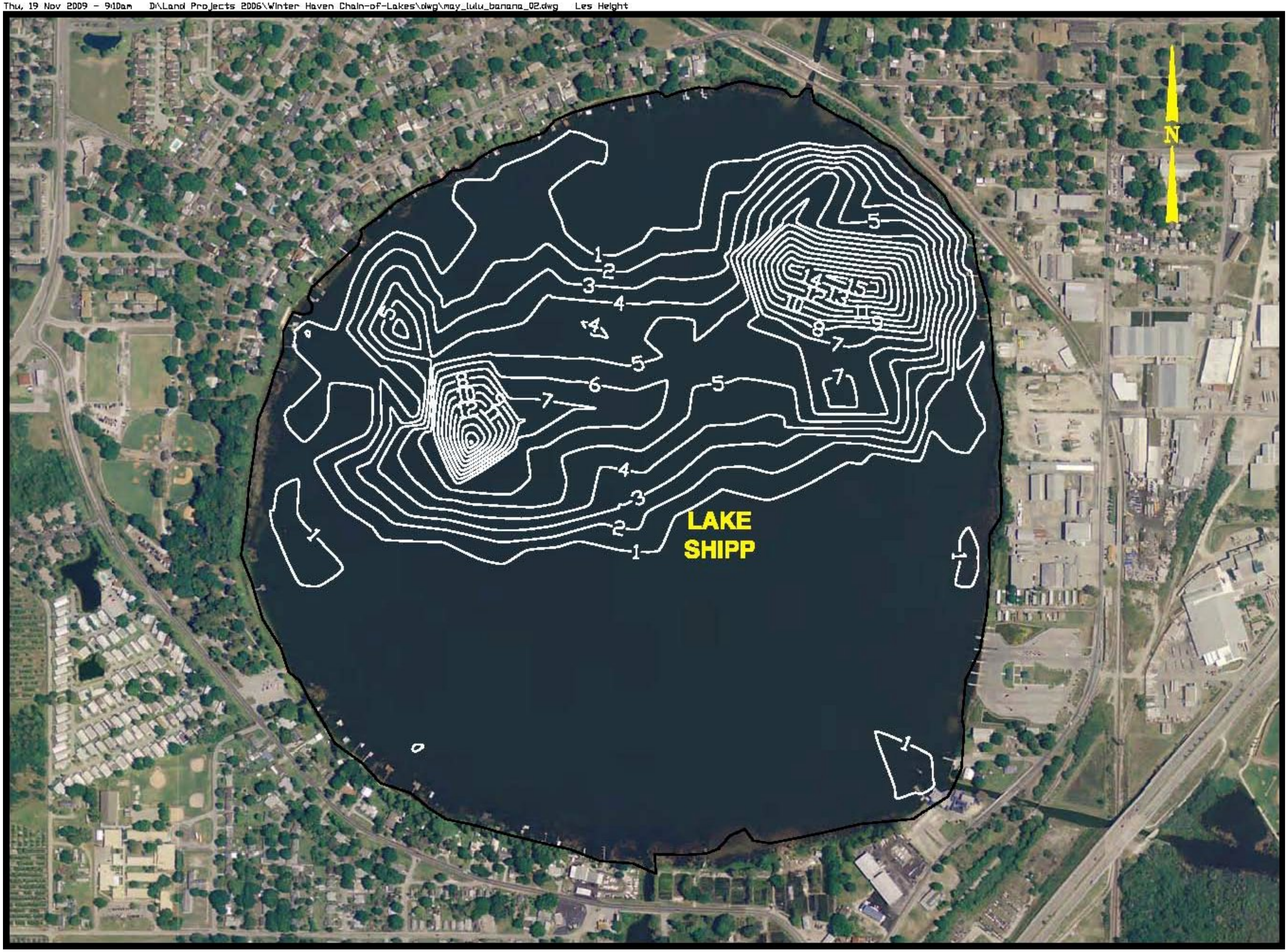

Figure 2-20. Isopleths of Organic Sediment (Muck) Depths in Lake Shipp.

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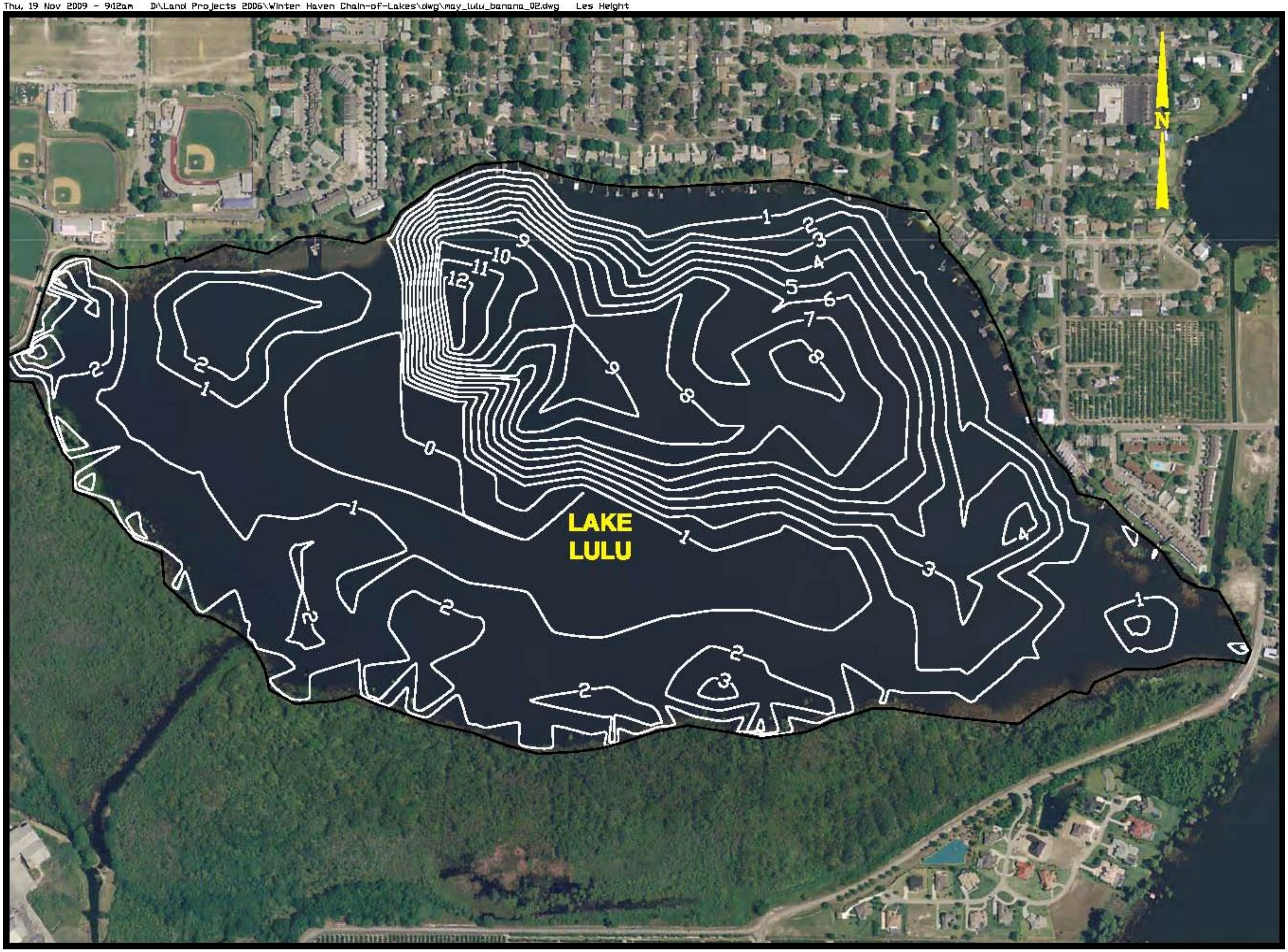

Figure 2-21. Isopleths of Organic Sediment (Muck) Depths in Lake Lulu.

TABLE 2-13

ESTIMATED ACCUMULATION OF ORGANIC MUCK SEDIMENTS IN LAKE LULU

MUCK DEPTH (ft)	CONTOUR AREA (ac)	PERCENT OF LAKE AREA	MUCK VOLUME (ac-ft)
> 12	0.78	< 1	--
11-12	2.60	1	1.69
10-11	5.07	2	5.53
9-10	10.89	4	13.50
8-9	23.20	8	30.54
7-8	40.31	13	62.30
6-7	54.05	18	109.5
5-6	63.37	21	168.2
4-5	73.42	24	236.6
3-4	89.03	29	317.8
2-3	126.7	41	425.6
1-2	203.9	66	590.9
0-1	307.0	100	846.6

2.3.2 General Sediment Characteristics

2.3.2.1 Evaluation Methodology

Sediment core samples were collected throughout Lakes May, Shipp, and Lulu to quantify general sediment characteristics and to evaluate the significance of sediments for impacting water quality within the lakes. Sediment core samples were collected at a total of 50 separate locations within the three lakes. The geographic coordinates of the sediment sample sites were recorded in the field as latitude and longitude using a portable GPS device. Locations of sediment sampling sites in Lakes May, Shipp, and Lulu are indicated on Figure 2-22.

Sediment monitoring in Lake Shipp was conducted on January 31, 2006 as part of this project. Sediment monitoring in Lakes May and Lulu was conducted by ERD on January 19, 2002 as part of the Lake May and Lake Lulu Stormwater Treatment Project for the City of Winter Haven at the 10 locations in Lake May and 20 locations in Lake Lulu indicated on Figure 2-22. These samples were analyzed for a wide variety of parameters, including physical characteristics, nutrients, and sediment phosphorus speciation. Since the samples collected in Lake May and Lake Lulu during 2002 are relatively recent, and were analyzed for the same parameters included as part of this current study, it was decided to use the 2002 sediment characterization data for Lakes May and Lulu rather than collect new additional data in these lakes. Therefore, sediment characteristics for Lake Shipp reflect the January 2006 monitoring event, while sediment characteristics presented for Lakes May and Lulu reflect the January 2002 monitoring data.

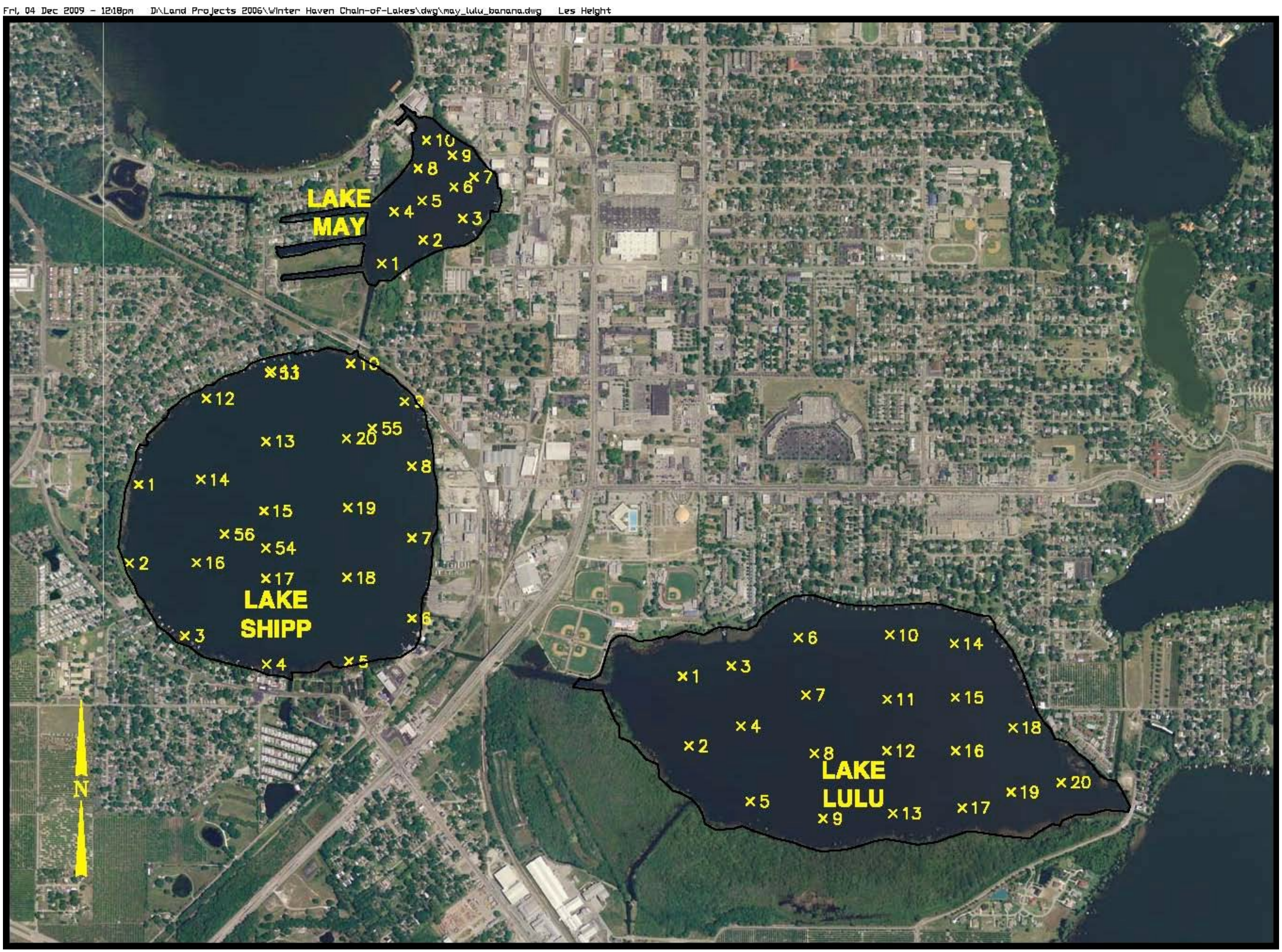

Figure 2-22. Sediment Monitoring Sites in Lakes May, Shipp, and Lulu.

Sediment samples were collected at each of the 50 monitoring sites using a stainless steel split-spoon core device, which was penetrated into the sediments at each location to a minimum distance of approximately 0.5 m. After retrieval of the sediment sample, any overlying water was carefully decanted before the split-spoon device was opened to expose the collected sample. Visual characteristics of each sediment core sample were recorded, and the 0-10 cm layer was carefully sectioned off and placed into a polyethylene container for transport to the ERD laboratory. Previous research has indicated that water quality impacts from sediments are limited to processes within the top 10 cm. Therefore, sediment characteristics in this layer are used to evaluate potential sediment-water column interactions.

Duplicate core samples were collected at each site, and the 0-10 cm layers were combined together to form a single composite sample for each of the 50 monitoring sites. The polyethylene containers utilized for storage of the collected samples were filled completely so no air space was present in the storage container above the composite sediment sample. The collected samples were stored on ice and returned to the ERD laboratory for physical and chemical characterization.

Each of the 50 collected sediment core samples was analyzed for a variety of physical characteristics (including moisture content, organic content, and sediment density), and nutrients (including total nitrogen and total phosphorus). Methodologies utilized for preparation and analysis of the sediment samples for these parameters are outlined in Table 2-14.

TABLE 2-14

ANALYTICAL METHODS FOR SEDIMENT ANALYSES

MEASUREMENT PARAMETER	SAMPLE PREPARATION	ANALYSIS REFERENCE	REFERENCES FOR PREPARATION AND ANALYSIS	METHOD DETECTION LIMITS (MDLs)
pH	EPA 9045	EPA 9045	3, 3	0.01 pH units
Moisture Content	p. 3-54	p. 3-58	1, 1	0.1%
Organic Content (Volatile Solids)	p. 3-52	pp. 3-52 to 3-53	1, 1	0.1%
Total Phosphorus	pp. 3-227 to 3-228 (Method C)	EPA 365.4	1, 2	0.005 mg/kg
Total Nitrogen	p. 3-201	pp. 3-201 to 3-204	1, 1	0.010 mg/kg
Specific Gravity (Density)	p. 3-61	pp. 3-61 to 3-62	1, 1	NA

REFERENCES:

1. Procedures for Handling and Chemical Analysis of Sediments and Water Samples, EPA/Corps of Engineers, EPA/CE-81-1, 1981.

2. Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020, Revised March 1983.

3. Test Methods for Evaluating Solid Wastes, Physical-Chemical Methods, Third Edition, EPA-SW-846, Updated November 1990.

2.3.2.2 Physical/Chemical Characteristics

A summary of physical and chemical characteristics of sediment core samples collected in Lake May on January 19, 2002 are summarized in Table 2-15. Sediment characteristics at monitoring sites 1-5 and 8-10 appear to be similar. Sediments in these areas are characterized by moisture contents of approximately 90% or more and elevated organic contents of approximately 40% or more. Due to the high moisture content, these samples also exhibit a low wet density. In contrast, sediment core samples collected at Sites 6 and 7 indicate a mixture of sand and organic muck, and are characterized by lower measured values for moisture content and organic content as well as a higher wet density.

TABLE 2-15

PHYSICAL-CHEMICAL CHARACTERISTICS OF SEDIMENT CORE SAMPLES COLLECTED IN LAKE MAY ON JANUARY 19, 2002

SITE	WET DENSITY (g/cm^3)	MOISTURE CONTENT (%)	ORGANIC CONTENT (%)	NUTRIENTS ($\mu g/cm^3$ wet weight)	
				TOTAL N	TOTAL P
1	1.04	92.2	66.4	19,082	1,796
2	1.06	92.2	52.6	21,008	3,800
3	1.07	90.5	48.4	20,670	3,545
4	1.05	91.4	58.9	21,588	3,035
5	1.07	91.3	47.1	19,903	3,083
6	1.16	84.5	30.8	17,938	3,330
7	1.46	65.6	11.8	13,634	2,298
8	1.05	92.7	52.5	20,441	2,759
9	1.19	81.8	32.2	23,004	4,236
10	1.07	88.4	62.4	22,618	667
Mean Value	**1.12**	**87.1**	**46.3**	**19,989**	**2,855**

Sediment samples collected in Lake May are characterized by elevated concentrations of both total nitrogen and total phosphorus. Measured concentrations of total phosphorus in the sediments of Lake May range from 667-4236 $\mu g/cm^3$ (wet weight basis). These values are similar to sediment phosphorus concentrations measured by ERD in Banana Lake during November 2005.

A summary of chemical and physical characteristics of sediment core samples collected in Lake Shipp on January 31, 2006 is given in Table 2-16. In general, sediment characteristics in Lake Shipp appear to be divided between areas dominated primarily by sandy sediments with a low organic content and muck-type sediments with elevated values for both moisture content and organic content. Primarily sandy type sediments were observed at monitoring sites 1-4, 6-7, 10-13, 16-17, and 19-20. Sites designated as 5, 8, 9, 14, 15, and 18 reflect primarily organic muck-type sediments. Areas where the soils appear to be primarily sandy are characterized by moisture contents ranging from approximately 20-35% and organic contents of approximately 4% or less. Sediment density values at these sites typically exceed 2.0. In contrast, areas consisting of muck-type sediments are characterized by moisture contents of approximately 85% or more, with organic contents of approximately 25-45%. Sediment densities at these sites range from approximately 1.07-1.15.

TABLE 2-16

PHYSICAL-CHEMICAL CHARACTERISTICS OF SEDIMENT CORE SAMPLES COLLECTED IN LAKE SHIPP ON JANUARY 31, 2006

SITE	WET DENSITY (g/cm^3)	MOISTURE CONTENT (%)	ORGANIC CONTENT (%)	pH (s.u.)	NUTRIENTS ($\mu g/cm^3$ wet weight)	
					TOTAL N	TOTAL P
1	2.09	26.2	1.8	6.36	7,704	1,136
2	2.12	25.0	0.7	6.86	7,018	724
3	2.07	28.1	0.8	6.82	4,587	434
4	2.16	22.2	1.0	7.14	5,675	619
5	1.07	92.5	38.5	6.45	20,130	1,763
6	2.05	27.8	3.2	6.69	19,387	2,176
7	2.15	22.6	1.1	7.02	5,552	598
8	1.05	94.0	46.7	6.33	18,539	1,682
9	1.11	89.8	30.5	6.43	19,379	2,373
10	2.08	26.9	1.3	6.91	6,678	440
11	2.07	25.7	4.4	5.93	15,170	2,449
12	1.91	37.8	2.4	6.60	7,998	719
13	2.16	22.3	0.4	6.92	6,120	527
14	1.14	87.8	22.8	6.57	18,767	2,160
15	1.06	92.9	43.3	6.41	20,037	2,013
16	2.17	21.3	0.6	7.02	3,520	407
17	2.11	25.5	0.8	6.95	778	817
18	2.08	27.1	1.1	7.06	6,204	605
19	2.13	22.3	2.6	6.95	4,215	436
20	1.06	92.8	47.8	6.31	20,641	1,861
Mean Value	**1.79**	**45.5**	**12.6**	**6.69**	**10,905**	**1,197**

Sediment pH values in Lake Shipp appear to be approximately neutral, with the majority of measured values ranging from approximately 6.3-7.1. The overall mean pH value measured within the lake is approximately 6.69.

Sediment samples collected from Lake Shipp are characterized by elevated concentrations of both total nitrogen and total phosphorus, particularly for samples which reflect organic muck-type characteristics. Concentrations of total nitrogen and total phosphorus in Lake Shipp at the muck-type sites are similar to sediment concentrations measured at the organic muck sites in Lake May. Measured sediment nitrogen concentrations range from 778-20,130 $\mu g/cm^3$, with sediment phosphorus concentrations ranging from 407-2449 $\mu g/cm^3$.

Physical-chemical characteristics of sediment core samples collected in Lake Lulu on January 19, 2002 are given in Table 2-17. Similar to the trends observed in Lake Shipp, Lake Lulu appears to have areas which are occupied by both sandy as well as muck-type sediments. Monitoring sites with a low moisture content, low organic content, and elevated wet density indicate primarily sand type sediments. These characteristics were observed at sites 3, 4, and 8. An apparent mixture of sand and muck-type sediments occurs at sites 1, 2, 5, and 9, which appear to exhibit physical characteristics for moisture content, organic content, and wet density which are mid-way between sandy and muck-type characteristics. The remaining sites all appear to have primarily muck-type sediments based upon the physical characteristics summarized in Table 2-17.

A high degree of variability was observed in sediment nitrogen concentrations in Lake Lulu. The majority of sediments within the lake exhibited sediment nitrogen concentrations of approximately 20,000 $\mu g/cm^3$ or more. However, substantially lower numbers were observed at most of the sites previously described as exhibiting sandy or combination sand/muck soils. Nitrogen concentrations in these soils range from approximately 1,661-15,192 $\mu g/cm^3$. Overall, the mean sediment nitrogen concentration in Lake Lulu is similar to the mean concentration observed in Lake May.

A high degree of variability is also apparent in measured phosphorus concentrations in sediments collected within Lake Lulu. In general, sites which exhibit primarily muck-type sediments appear to have sediment phosphorus concentrations of approximately 1500 $\mu g/cm^3$ or more, with substantially lower phosphorus concentrations observed in areas characterized by sandy or sand/muck sediments. In general, sediment phosphorus concentrations in Lake Lulu appear to be elevated, compared with concentrations commonly observed in urban lakes. The overall mean sediment phosphorus concentration in Lake Lulu of 1370 $\mu g/cm^3$ is similar to the mean sediment phosphorus concentration of 1197 $\mu g/cm^3$ measured in Lake Shipp.

Isopleths of sediment moisture contents in Lakes May, Shipp, and Lulu are illustrated on Figure 2-23. Sediment moisture content in Lake May appears to be lowest along the northeast side of the lake, with sediment moisture contents ranging from approximately 60-70%. Sediment moisture content appears to increase in a southwesterly direction, with much of the central and southern portions of Lake May exhibiting sediment moisture contents in excess of 90%. Areas of elevated sediment moisture content in Lake Shipp are apparent along the northeast shore and in central portions of the lake. The majority of the remaining portions of the lake exhibit sediment moisture contents ranging from approximately 30-40%. Sediment moisture content in Lake Lulu appears to be greatest in the eastern portion of the lake and southwestern perimeter areas. The lowest levels of sediment moisture content in Lake Lulu occur in the northwestern portion of the lake.

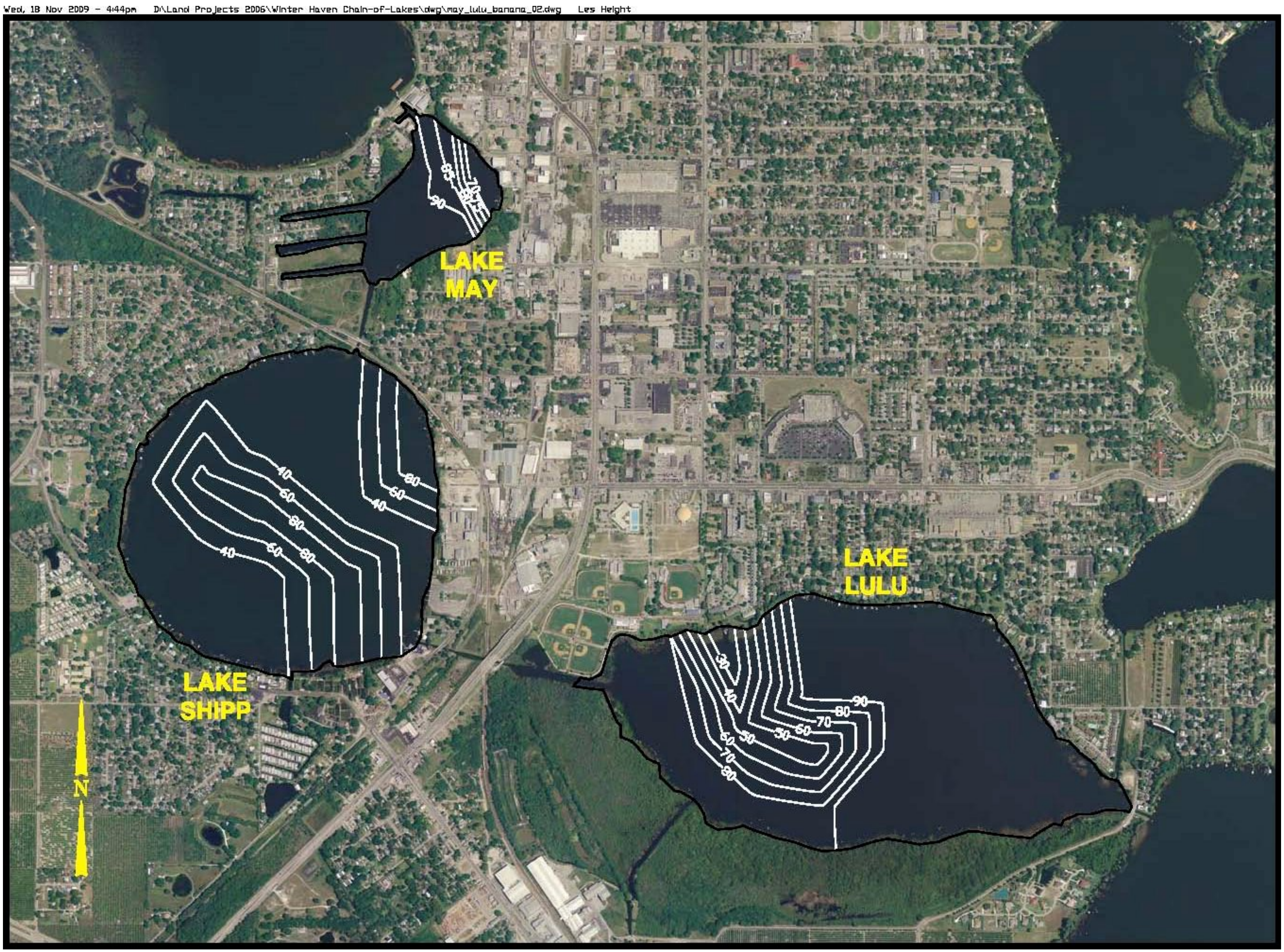

Figure 2-23. Isopleths of Sediment Moisture Content (%) in Lakes May, Shipp, and Lulu.

TABLE 2-17

PHYSICAL-CHEMICAL CHARACTERISTICS OF SEDIMENT CORE SAMPLES COLLECTED IN LAKE LULU ON JANUARY 19, 2002

SITE	WET DENSITY (g/cm^3)	MOISTURE CONTENT (%)	ORGANIC CONTENT (%)	NUTRIENTS ($\mu g/cm^3$ wet weight)	
				TOTAL N	TOTAL P
1	1.27	77.1	21.4	15,192	319
2	1.16	85.4	28.3	18,894	364
3	2.15	22.9	0.4	1,661	128
4	1.80	44.8	3.5	9,492	641
5	1.16	84.3	30.9	14,693	805
6	1.02	94.5	73.8	27,946	2,030
7	1.02	94.5	72.2	27,025	1,878
8	1.86	41.4	2.2	6,439	411
9	1.10	89.3	39.4	20,532	467
10	1.03	94.6	65.3	25,768	2,086
11	1.02	94.9	73.5	25,898	3,217
12	1.04	93.6	60.9	26,177	1,907
13	1.02	93.9	80.6	20,242	157
14	1.03	94.0	62.4	27,034	2,152
15	1.02	95.7	76.1	23,992	1,689
16	1.02	95.1	75.3	26,334	1,723
17	1.06	92.7	45.3	23,383	2,242
18	1.02	94.9	73.9	24,077	1,605
19	1.05	93.2	51.1	21,682	1,912
20	1.02	94.3	74.8	26,643	1,663
Mean Value	**1.19**	**78.8**	**50.6**	**20,655**	**1,370**

Isopleths of sediment organic contents in Lakes May, Shipp, and Lulu are illustrated on Figure 2-24. Similar to the trends observed for moisture content, organic content in Lake May sediments appears to be lowest along the northeastern shoreline, where organic contents range from approximately 10-20%. Organic content appears to increase in a southwesterly direction, with most of the central and southern portions of Lake May exhibiting organic contents ranging from 50-70%. Sediment organic content in Lake Shipp follows the patterns exhibited for sediment moisture content. Elevated levels of organic content, with values exceeding 40%, were found in the northeastern and central portions of Lake Shipp. Much of the remaining portions of Lake Shipp exhibit organic contents of approximately 20% or less. Organic content in Lake Lulu appears to be greatest in northeastern and eastern portions of the lake, with lower values in western portions of the lake.

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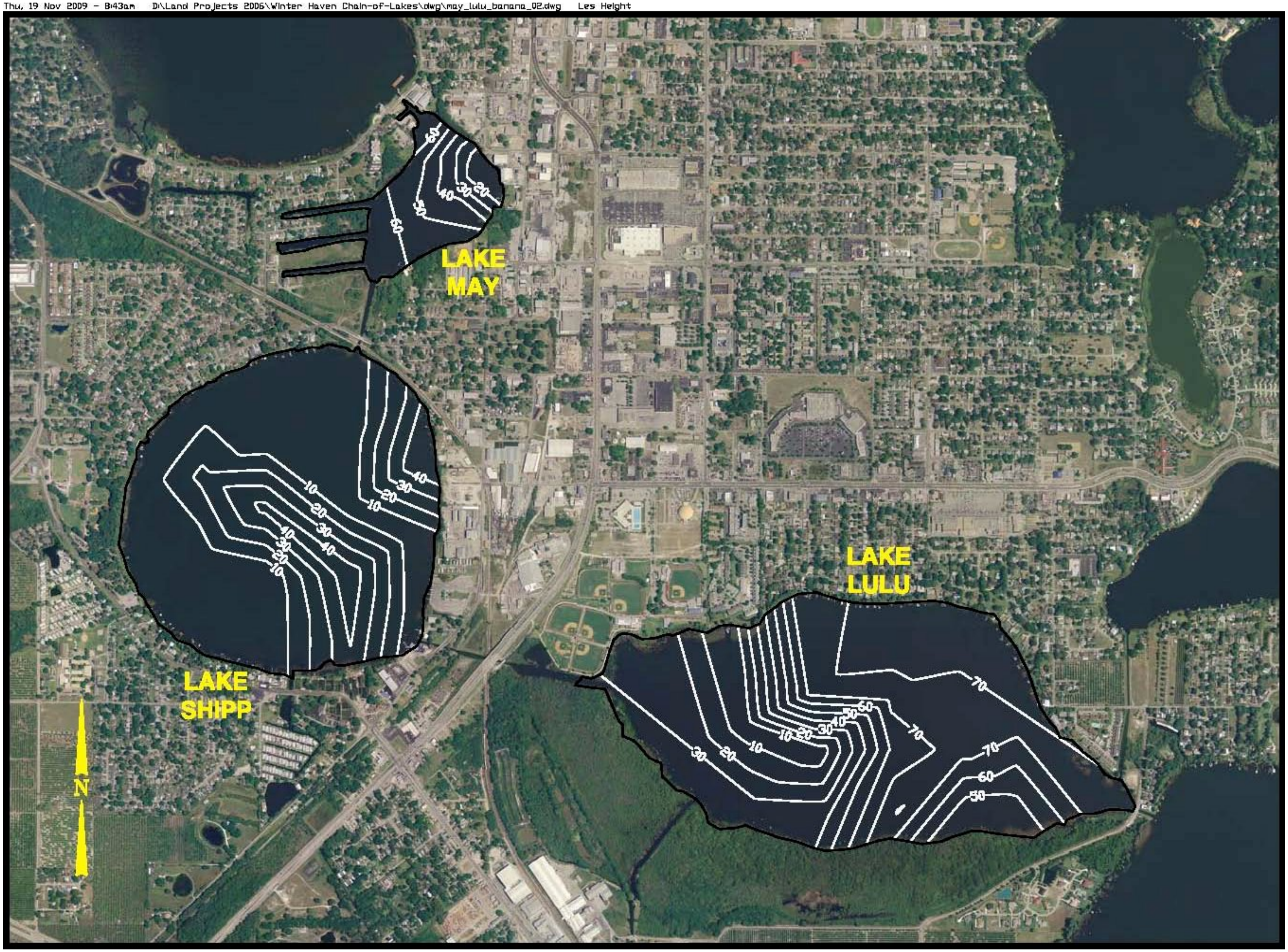


Figure 2-24. Isopleths of Sediment Organic Content (%) in Lakes May, Shipp, and Lulu.

Isopleths of sediment density, in units of g/cm^3 (wet weight basis), for Lakes May, Shipp, and Lulu are given in Figure 2-25. Sediment densities indicate primarily muck-type sediments in Lake May, with an increasing mixture of sand and muck sediments along the northeast shoreline. Primarily muck-type sediments in Lake Shipp appear to occur along the northeastern shoreline and central portions of the lake, with measured density values ranging from 1.0-1.2 g/cm^3. Sediment density appears to increase in other portions of Lake Shipp, indicating a mixture of muck and sandy soils. Predominantly sandy sediments (indicated by sediment density values in excess of 2.0 g/cm^3) appear to occur in the northern and southwestern portions of the lake. Muck-type sediments appear to be predominant in the eastern and southwestern perimeter areas of Lake Lulu. An area of increasingly sandy sediment characteristics is apparent along the northwestern portion of the lake.

Isopleths of sediment nitrogen concentrations, in terms of $\mu g/cm^3$ (wet weight basis), in Lakes May, Shipp, and Lulu are illustrated on Figure 2-26. Sediment nitrogen concentrations in Lake May appear to be lowest along the northeastern shoreline of the lake, with increasing nitrogen concentrations during movement in a southwesterly direction through the lake. Elevated sediment nitrogen concentrations are also apparent near the inflow from Lake Howard. A wide range of sediment nitrogen concentrations was observed in Lake Shipp. Measured concentrations range from approximately 2,000-20,000 $\mu g/cm^3$, reflecting a 10-fold difference between minimum and maximum concentrations. Areas of elevated sediment nitrogen concentrations are apparent along the northeastern and central portions of the lake, with substantially lower concentrations observed along the southwestern and northwestern portions of the lake. A high degree of variability was also observed in sediment nitrogen concentrations in Lake Lulu, with measured concentrations ranging from approximately 2,000-26,000 $\mu g/cm^3$, reflecting more than a 10-fold difference between minimum and maximum values. The most elevated sediment nitrogen concentrations were observed in central, eastern, and southwest perimeter areas of Lake Lulu. Areas of lower sediment nitrogen concentrations were observed within the relatively sandy sediments along the northwest portion of the lake.

Isopleths of sediment phosphorus concentrations, in units of $\mu g/cm^3$ (wet weight basis), in Lakes May, Shipp, and Lulu are given in Figure 2-27. In contrast to the trends exhibited by nitrogen, phosphorus within the sediments of Lake May appears to be fairly uniformly distributed, with concentrations ranging from approximately 2,000-3,500 $\mu g/cm^3$ (wet weight basis) in most portions of the lake. Phosphorus concentrations in this range are relatively high compared with values commonly observed in urban lakes, and is a reflection of the significant accumulations of organic sediment material within Lake May. A higher degree of variability is apparent in sediment phosphorus concentrations in Lake Shipp, where measured concentrations range from approximately 500-2,000 $\mu g/cm^3$. Areas of elevated sediment phosphorus concentrations were observed along the northeastern and central portions of the lake, with lower concentrations observed along the southwest shoreline. Sediment phosphorus concentrations in Lake Lulu appear to be greatest in central and eastern portions of the lake, with the lowest phosphorus concentrations in western portions of the lake.

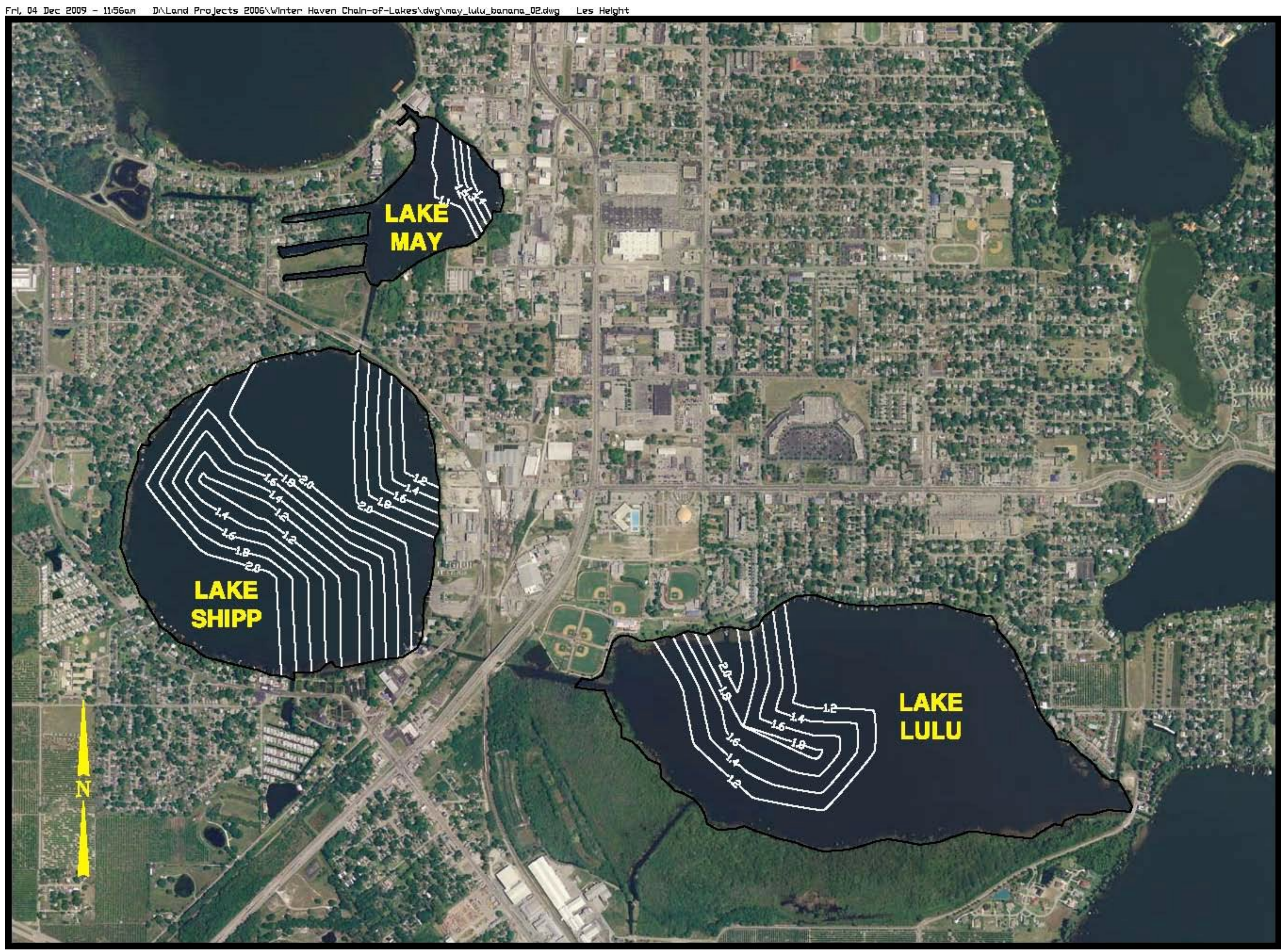


Figure 2-25. Isopleths of Sediment Density (g/cm^3, wet weight basis) in Lakes May, Shipp, and Lulu.

Figure 2-26. Isopleths of Sediment Nitrogen Concentrations (μg/cm^3, wet weight basis) in Lakes May, Shipp, and Lulu.

Figure 2-27. Isopleths of Sediment Phosphorus Concentrations (μg/cm^3, wet weight basis) in Lakes May, Shipp, and Lulu.

2.3.3 Sediment Phosphorus Speciation

2.3.3.1 Evaluation Methodology

In addition to general sediment characterization, a fractionation procedure for inorganic soil phosphorus was conducted on each of the 50 collected sediment samples. The modified Chang and Jackson Procedure, as proposed by Peterson and Corey (1966), was used for phosphorus fractionation. The Chang and Jackson Procedure allows the speciation of sediment phosphorus into saloid-bound phosphorus (defined as the sum of soluble plus easily exchangeable sediment phosphorus), iron-bound phosphorus, and aluminum-bound phosphorus. Although not used in this project, subsequent extractions of the Chang and Jackson procedure also provide calcium-bound and residual organic fractions.

Saloid-bound phosphorus is considered to be available under all conditions at all times. Iron-bound phosphorus is relatively stable under aerobic environments, generally characterized by redox potentials greater than 200 mv (E_h), while unstable under anoxic conditions, characterized by redox potential less than 200 mv. Aluminum-bound phosphorus is considered to be stable under all conditions of redox potential and natural pH conditions. A schematic of the Chang and Jackson Speciation Procedure for evaluating soil phosphorus bounding is given in Figure 2-28.

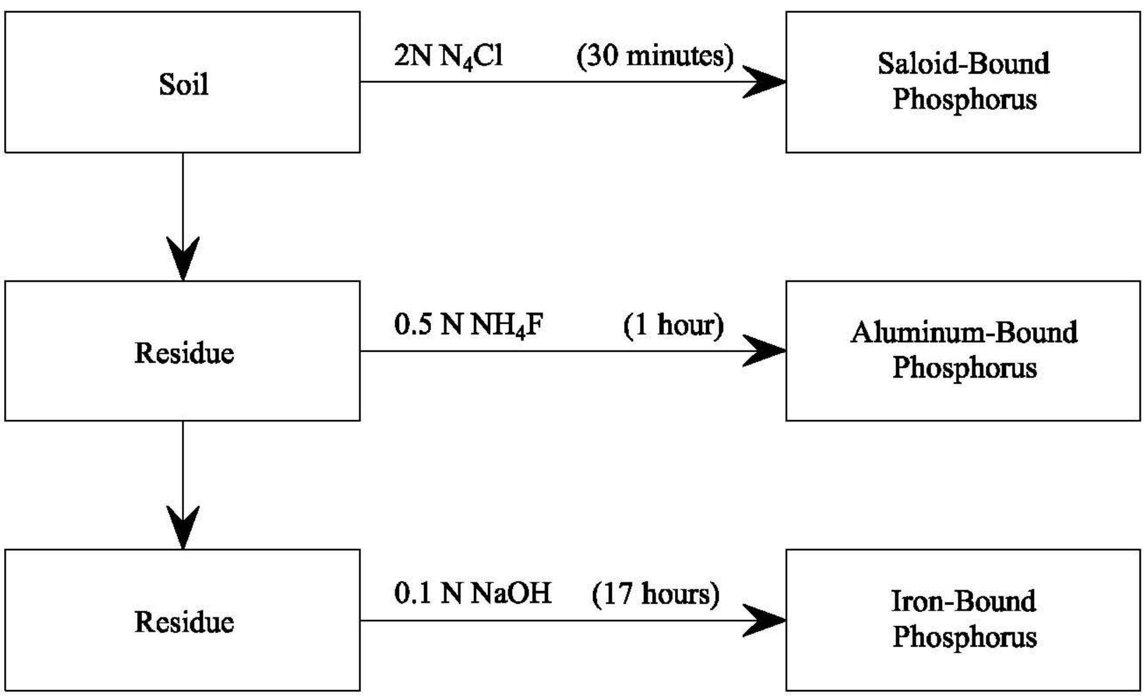


Figure 2-28. Schematic of Chang and Jackson Speciation Procedure for Evaluating Soil Phosphorus Bonding.

For purposes of evaluating release potential, ERD typically assumes that potentially available inorganic phosphorus in soils/sediments, particularly those which exhibit a significant potential to develop highly reduced conditions below the sediment-water interface, is represented by the sum of the soluble inorganic phosphorus and easily exchangeable phosphorus fractions (collectively termed saloid-bound phosphorus), plus iron-bound phosphorus, which can become solubilized under reduced conditions. Aluminum-bound phosphorus is generally considered to be unavailable in the pH range of approximately 5.5-7.5 under a wide range of redox conditions.

Measured values for each of the physical and chemical parameters were entered into a database along with the geographic coordinates for each collected sediment core sample. Isopleth maps were then developed for sediment characteristics in each of the three waterbodies using Autodesk Land Desktop Version 2007. These isopleth maps are used to discuss general sediment characteristics within the three lakes.

2.3.3.2 Phosphorus Speciation

A summary of measured sediment phosphorus speciation in core samples collected from Lake May on January 19, 2002 is given in Table 2-18. In general, a high degree of variability is apparent in measured saloid-bound phosphorus concentrations in Lake May, with measured values ranging from 2-71 $\mu g/cm^3$ and an overall average of 33 $\mu g/cm^3$. These values are typical of saloid-bound phosphorus concentrations commonly observed in urban lakes. In contrast, elevated levels of iron-bound phosphorus were observed in Lake May, with measured concentrations ranging from 55-1059 $\mu g/cm^3$ and an overall mean of 642 $\mu g/cm^3$.

TABLE 2-18

SEDIMENT PHOSPHORUS SPECIATION IN SEDIMENT CORE SAMPLES COLLECTED FROM LAKE MAY ON JANUARY 19, 2002

SITE	SALOID-BOUND P ($\mu g/cm^3$)	IRON-BOUND P ($\mu g/cm^3$)	TOTAL AVAILABLE P ($\mu g/cm^3$)	PERCENT OF TOTAL[1] (%)	Al-BOUND P ($\mu g/cm^3$)	PERCENT OF TOTAL[2] (%)
1	34	188	222	18	198	16
2	71	732	803	30	393	15
3	47	904	951	38	754	30
4	71	701	772	36	531	25
5	27	703	730	34	423	20
6	2	722	724	31	661	28
7	19	755	774	48	716	45
8	45	602	647	34	328	17
9	13	1059	1072	36	1120	38
10	2	55	57	12	100	21
Average	**33**	**642**	**675**	**32**	**522**	**26**

1. Percent of total sediment phosphorus present as available phosphorus
2. Percent of total sediment phosphorus present as Al-bound phosphorus

Total available phosphorus, representing the sum of the saloid-bound and iron-bound phosphorus fractions, ranges from 57-1072 μg/cm^3, with an overall mean of 675 μg/cm^3. These values appear to be elevated compared with values commonly observed by ERD in urban lakes which typically range from 100-300 μg/cm^3. Overall, approximately 32% of the existing sediment phosphorus is potentially available for release into the overlying water column as either saloid-bound or iron-bound fractions. Aluminum-bound phosphorus, which represents an unavailable form of phosphorus within the sediments, comprises 22% of the total sediment phosphorus concentration.

A summary of sediment phosphorus speciation in sediment core samples collected from Lake Shipp on January 31, 2006 is given in Table 2-19. In general, a high degree of variability was observed in saloid-bound phosphorus concentrations in Lake Shipp, with measured values ranging from 9-427 μg/cm^3 and an overall mean of 114 μg/cm^3. These concentrations appear to be extremely elevated compared with saloid-bound phosphorus concentrations commonly observed in urban lakes. Elevated levels of iron-bound phosphorus are also apparent in Lake Shipp, with measured concentrations ranging from 29-849 μg/cm^3 and an overall mean of 274 μg/cm^3.

TABLE 2-19

SEDIMENT PHOSPHORUS SPECIATION IN SEDIMENT CORE SAMPLES COLLECTED FROM LAKE SHIPP ON JANUARY 31, 2006

SITE	SALOID-BOUND P (μg/cm^3)	IRON-BOUND P (μg/cm^3)	TOTAL AVAILABLE P (μg/cm^3)	PERCENT OF TOTAL[1] (%)	Al-BOUND P (μg/cm^3)	PERCENT OF TOTAL[2] (%)
1	13	272	285	52	252	46
2	26	76	102	30	56	16
3	32	66	98	47	58	28
4	14	171	185	64	93	32
5	273	345	618	37	711	43
6	23	812	835	79	211	20
7	27	186	213	77	56	20
8	427	386	813	51	736	46
9	284	626	910	42	1201	56
10	17	97	114	54	36	17
11	9	849	858	72	299	25
12	179	63	242	64	112	30
13	16	51	67	27	30	12
14	190	478	668	35	1126	59
15	357	326	683	36	1173	62
16	22	84	106	57	56	30
17	34	112	146	38	58	15
18	284	365	649	37	1026	58
19	20	89	109	53	43	21
20	38	29	67	23	50	17
Average	**114**	**274**	**388**	**49**	**369**	**33**

1. Percent of total sediment phosphorus present as available phosphorus
2. Percent of total sediment phosphorus present as Al-bound phosphorus

Total available phosphorus, representing the sum of the saloid-bound and iron-bound phosphorus fractions, ranges from approximately 67-910 $\mu g/cm^3$, with an overall mean of 388 $\mu g/cm^3$. These values appear to be elevated compared with values commonly observed by ERD in urban lakes which typically range from 100-300 $\mu g/cm^3$. Overall, approximately 49% of the existing sediment phosphorus is potentially available for release into the overlying water column as either saloid-bound or iron-bound fractions.

Aluminum-bound phosphorus represents a potentially unavailable phosphorus source within the sediments. Measured aluminum-bound phosphorus in the sediments of Lake Shipp range from 30-1201 $\mu g/cm^3$, with an overall mean of 369 $\mu g/cm^3$. On an average basis, approximately 33% of the existing sediment phosphorus is considered to be unavailable for release into the overlying water column due to significant existing bonding mechanisms with aluminum.

A summary of sediment phosphorus speciation in sediment core samples collected from Lake Lulu on January 19, 2002 is given in Table 2-20. In general, a high degree of variability was observed in saloid-bound phosphorus concentrations in Lake Lulu, with measured values ranging from <1-521 $\mu g/cm^3$, and an overall mean of 107 $\mu g/cm^3$. Many of these concentrations appear to be extremely elevated compared with saloid-bound phosphorus concentrations commonly observed in urban lakes. In contrast, iron-bound phosphorus concentrations appear to be moderate in value, ranging from 5-244 $\mu g/cm^3$, with an overall mean of 139 $\mu g/cm^3$.

Total available phosphorus, representing the sum of the saloid-bound and iron-bound phosphorus fractions, ranges from 6-765 $\mu g/cm^3$, with an overall mean of 246 $\mu g/cm^3$. This value is approximately one-third of the total available phosphorus concentration measured in Lake May. Overall, approximately 22% of the existing sediment phosphorus is potentially available for release into the overlying water column in Lake Lulu as either saloid-bound or iron-bound fractions.

Aluminum-bound phosphorus represents a potentially unavailable phosphorus source within the sediments. Measured aluminum-bound phosphorus in the sediments of Lake Lulu range from 5-770 $\mu g/cm^3$, with an overall mean of 196 $\mu g/cm^3$. On an average basis, approximately 19% of the existing sediment phosphorus is considered to be unavailable for release into the overlying water column due to significant existing bonding mechanisms with aluminum.

Isopleths of saloid-bound phosphorus in the top 10 cm of sediments in Lakes May, Shipp, and Lulu are given in Figure 2-29. The isopleth lines on Figure 2-29 range from 100-500 $\mu g/cm^3$ in increments of 100. No isopleths are present in Lake May since all measured values for saloid-bound phosphorus in Lake May are less than 100 $\mu g/cm^3$. Elevated sediment concentrations of saloid-bound phosphorus are present in central and northeastern portions of Lake Shipp, along with central and southeastern portions of Lake Lulu.

Isopleths of iron-bound phosphorus in the top 10 cm of sediments in Lakes May, Shipp, and Lulu are illustrated on Figure 2-30. Isopleths for iron-bound phosphorus range from 100-1000 $\mu g/cm^3$ in 100-unit increments. Substantially elevated levels of iron-bound phosphorus are apparent along the eastern and central portions of Lake May and northern and southwestern portions of Lake Shipp. Iron-bound phosphorus associations in Lake Lulu appear to be relatively minimal compared with the values measured in Lake May and Lake Shipp.

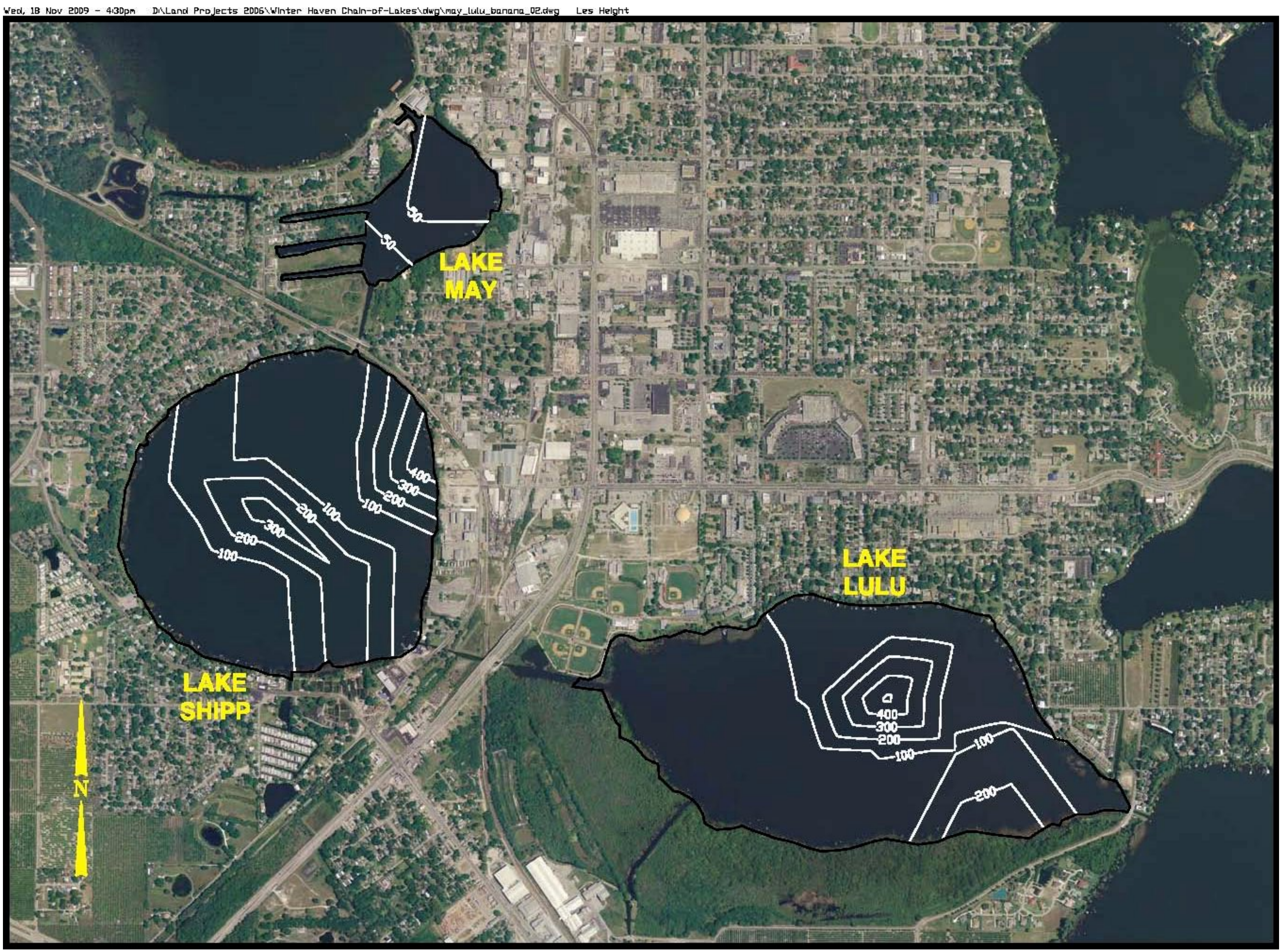


Figure 2-29. Isopleths of Saloid-Bound P ($\mu g/cm^3$ wet wt.) in the Top 10 cm of Sediments in Lakes May, Shipp, and Lulu.

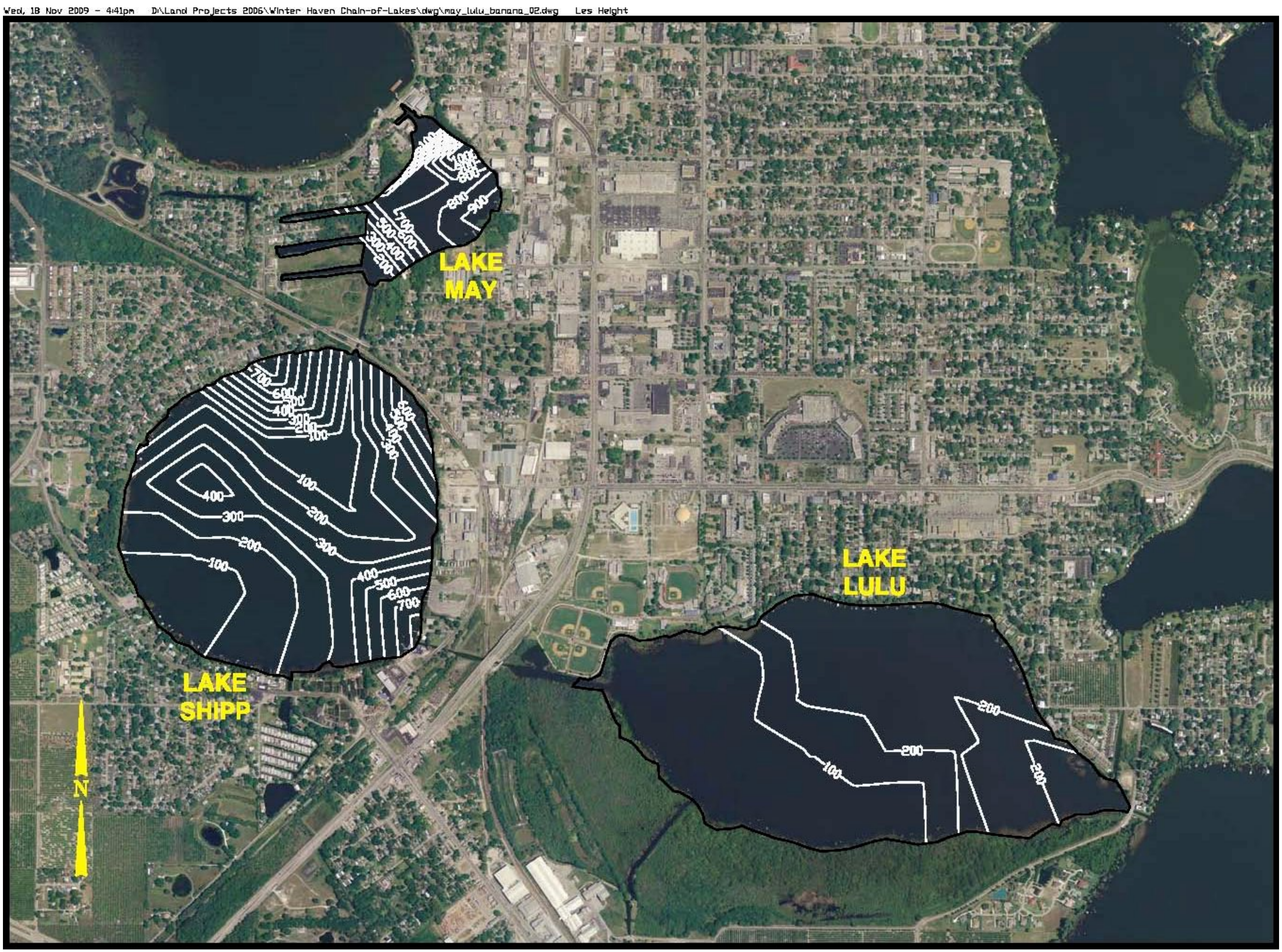


Figure 2-30. Isopleths of Iron-Bound P (μg/cm^3 wet wt.) in the Top 10 cm of Sediments in Lakes May, Shipp, and Lulu.

TABLE 2-20

SEDIMENT PHOSPHORUS SPECIATION IN SEDIMENT CORE SAMPLES COLLECTED FROM LAKE LULU ON JANUARY 19, 2002

SITE	SALOID-BOUND P ($\mu g/cm^3$)	IRON-BOUND P ($\mu g/cm^3$)	TOTAL AVAILABLE P ($\mu g/cm^3$)	PERCENT OF TOTAL[1] (%)	Al-BOUND P ($\mu g/cm^3$)	PERCENT OF TOTAL[2] (%)
1	2	6	8	3	33	15
2	4	6	10	4	6	2
3	14	7	21	23	33	37
4	13	65	79	18	64	14
5	6	20	26	5	27	5
6	121	224	345	24	288	20
7	114	223	337	26	208	16
8	51	106	157	55	128	44
9	2	5	7	2	5	2
10	184	243	426	29	437	30
11	521	244	765	34	770	34
12	113	202	315	24	237	18
13	< 1	5	6	4	13	12
14	189	231	420	28	321	21
15	115	200	315	27	180	15
16	93	204	297	25	181	15
17	209	215	424	27	393	25
18	97	194	291	26	160	14
19	214	169	383	29	301	22
20	81	217	298	26	137	12
Average	**107**	**139**	**246**	**22**	**196**	**19**

1. Percent of total sediment phosphorus present as available phosphorus
2. Percent of total sediment phosphorus present as Al-bound phosphorus

Isopleths of total available phosphorus, defined as the sum of saloid-bound and iron-bound phosphorus associations, in the top 10 cm of sediments in Lakes May, Shipp, and Lulu is given in Figure 2-31. Available phosphorus isopleths range from 100-1000 $\mu g/cm^3$ in 100-unit increments. Areas of elevated total available phosphorus are present in central and northeastern portions of Lake May, northern and central portions of Lake Shipp, and central portions of Lake Lulu. The isopleths summarized on Figure 2-31 represent the sediment phosphorus concentrations which can potentially become available for release into the overlying water column, particularly under anoxic conditions.

Isopleths of aluminum-bound phosphorus in the top 10 cm of sediments in Lakes May, Shipp, and Lulu are illustrated on Figure 2-32. Aluminum-bound phosphorus is generally considered to be unavailable for release into the overlying water column. Isopleths summarized on Figure 2-31 range from 100-1100 $\mu g/cm^3$ in 100-unit increments. Areas of elevated aluminum-bound phosphorus are present along the northeast lobe of Lake May, central and northeastern portions of Lake Shipp, and central portions of Lake Lulu. The isopleths summarized on Figure 2-32 indicate phosphorus which is generally considered to be unavailable with respect to water quality impacts.

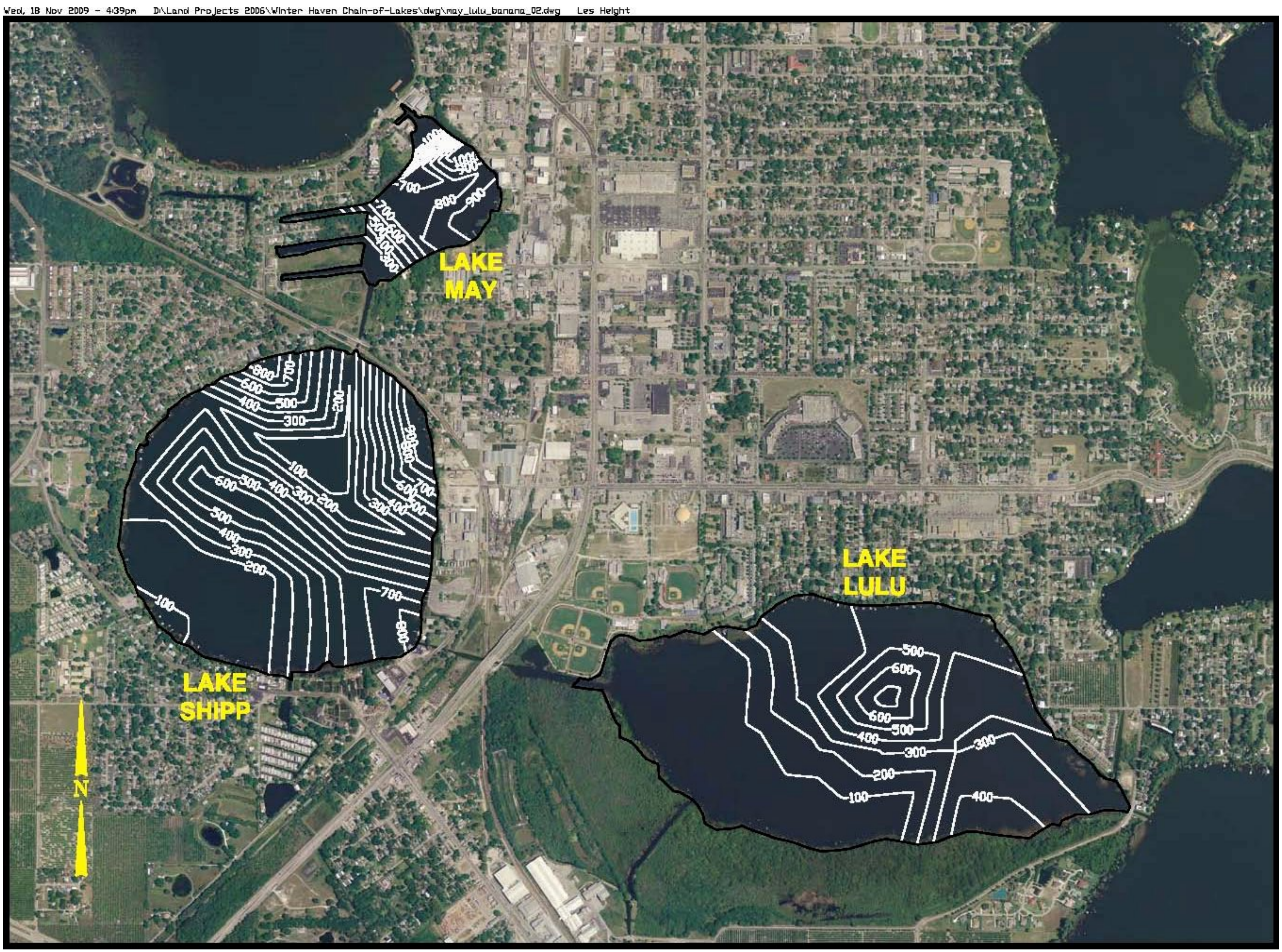


Figure 2-31. Isopleths of Total Available P ($\mu g/cm^3$ wet wt.) in the Top 10 cm of Sediments in Lakes May, Shipp, and Lulu.

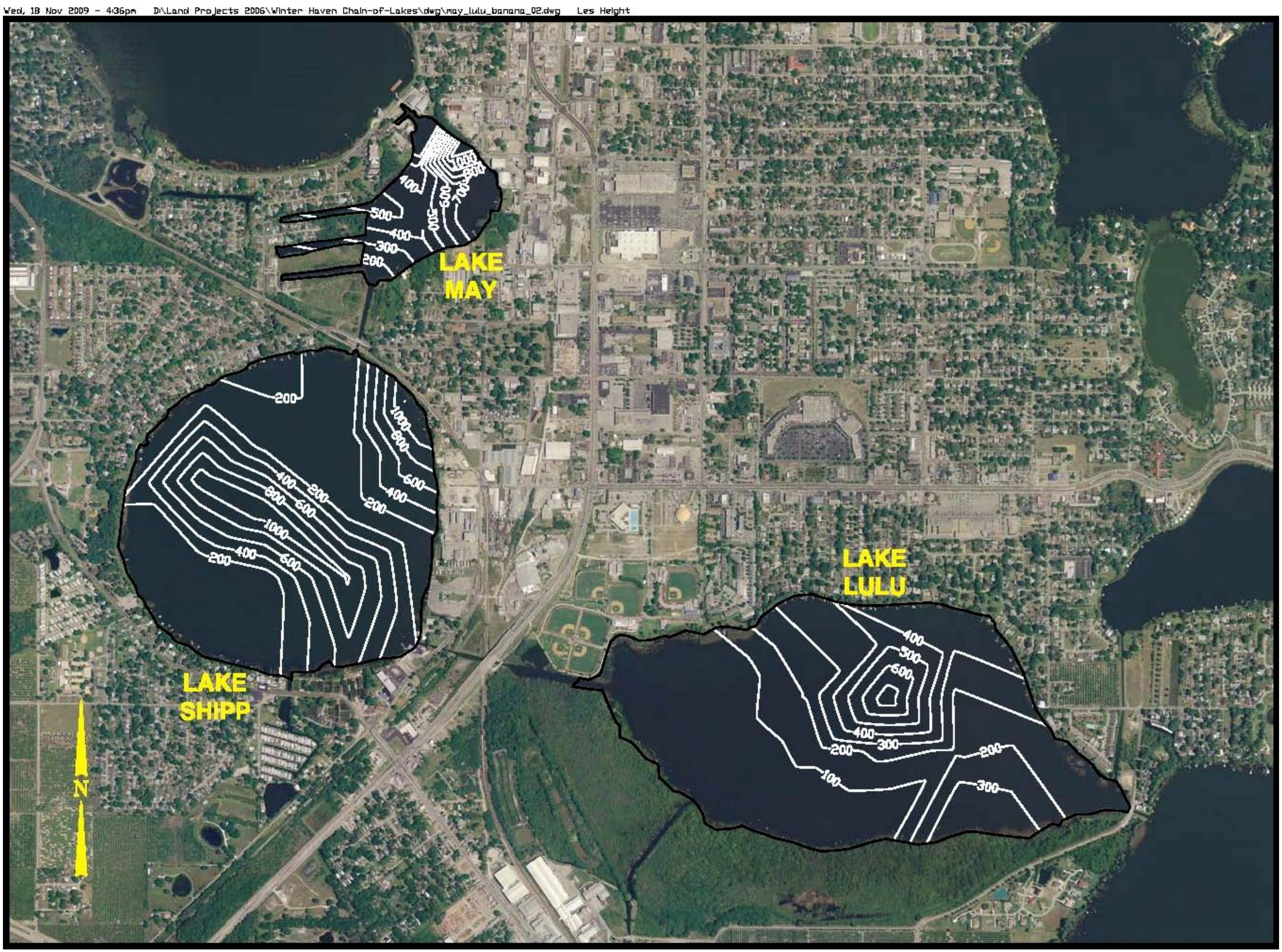


Figure 2-32. Isopleths of Aluminum-Bound P ($\mu g/cm^3$ wet wt.) in the Top 10 cm of Sediments in Lakes May, Shipp, and Lulu.

2.4 Water Surface Elevations

A long-term water level monitoring site has been maintained in Lake Shipp by SWFWMD beginning in 1984. This site, identified as STA-392, is located in Lake Shipp north of the Lake Shipp-Lake Lulu Canal. The approximate location of this water level monitoring site is given on Figure 2-33. Water level data were collected at this site on a daily basis from March 7, 1984-September 30, 1989. No measurements were recorded during 1990, and only one measurement was conducted during 1991. Routine monitoring was initiated again at this site during March 1994 and has been conducted on approximately a monthly basis through 2006. A complete listing of water level data collected at this site is given in Appendix C.

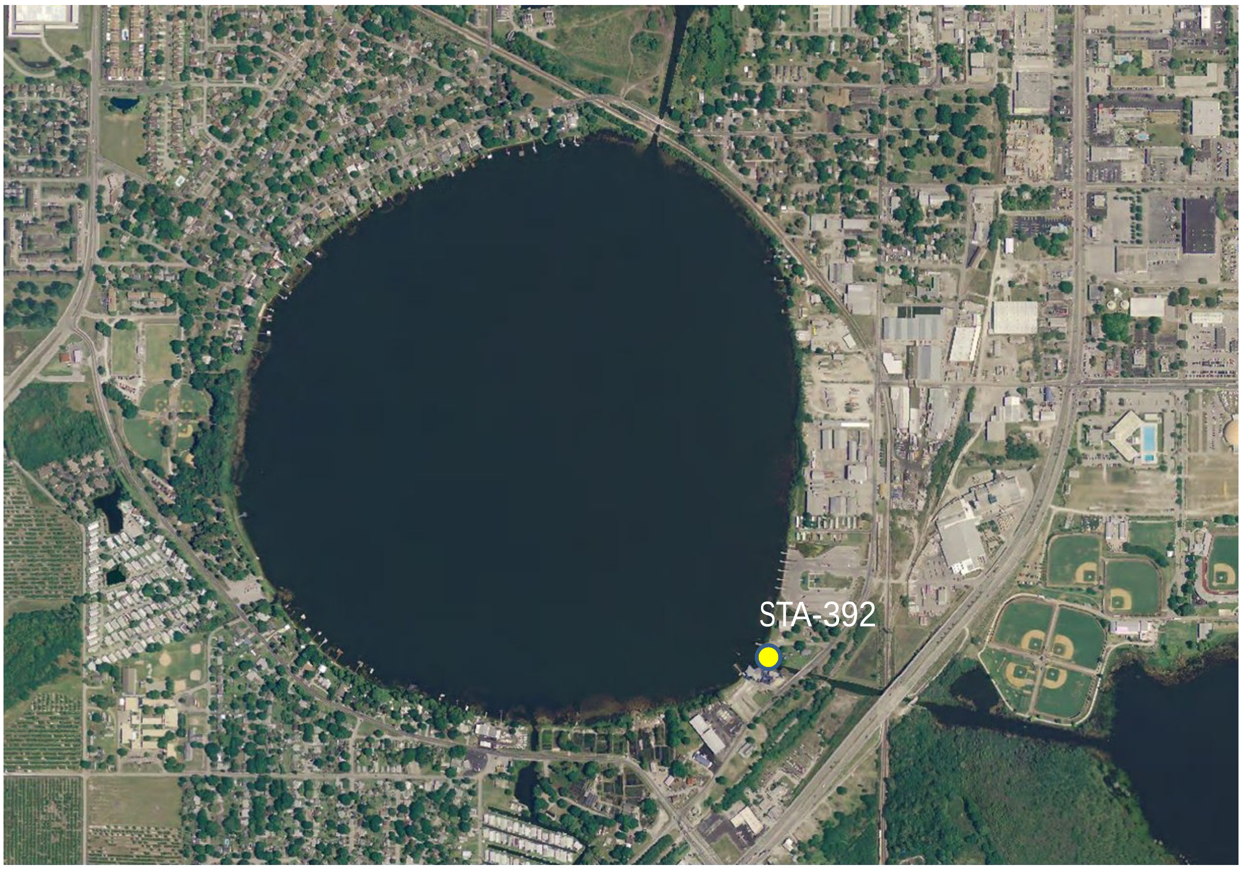


Figure 2-33. SWFWMD Water Level Monitoring Site in Lake Shipp.

A graphical summary of water level data in Lake Shipp from 1984-2006 is given in Figure 2-34. Water levels within Lake Shipp appear to vary from approximately El. 128 ft to El. 133 ft. Water levels within the Winter Haven Chain-of-Lakes are regulated by the Canal Commission which operates the outfall control structure on Lake Lulu. Based on information provided by the Canal Commission, the control elevation of the outfall structure is set at approximately 131.2 ft. However, the Canal Commission routinely allows water elevations to stage above El. 131.2 ft. As a result, discharges from the Chain-of-Lakes occur relatively infrequently, with no discharge occurring during the period from 1998-2003.

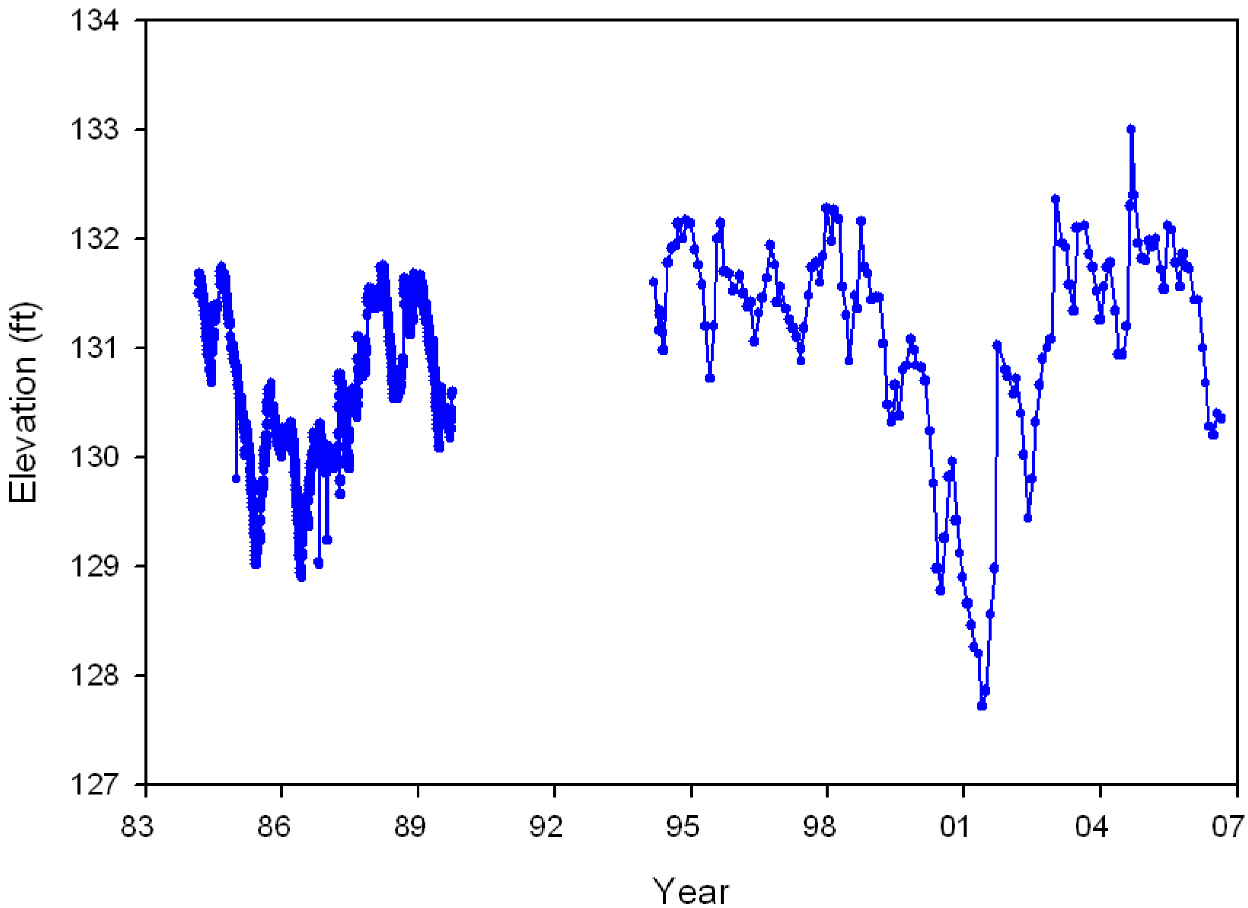


Figure 2-34. Summary of Water Level Data in Lake Shipp from 1984-2006.

SECTION 3

DRAINAGE BASIN CHARACTERISTICS

Characteristics of the drainage basin areas for Lakes May, Shipp, and Lulu are summarized in this section, including information on basin delineations, land use characteristics, impervious surfaces, stormwater treatment, and soil types. A discussion of these elements is given in the following sections.

3.1 Watershed Basin Characteristics

A delineation of contributing watershed areas for Lakes May, Shipp, and Lulu was conducted by ERD as part of this project. Preliminary drainage basin boundaries were established by reviewing USGS 5-ft contour quad maps, along with available City of Winter Haven stormsewer drainage maps. Additional information related to the Lake Shipp drainage basin was obtained from the PBS&J (2000) report.

After development of preliminary drainage basin boundaries, refinements to the basin delineations were made using a combination of field reconnaissance and observation of drainage patterns during significant storm events. This process resulted in the final drainage basin delineations for Lakes May, Shipp, and Lulu indicated on Figure 3-1. A summary of general drainage basin characteristics for Lakes May, Shipp, and Lulu is given in Table 3-1. The drainage basin for Lake May is estimated to be approximately 353.4 acres, with a 671.0-acre drainage basin for Lake Shipp and 629.3-acre drainage basin for Lake Lulu.

Calculated drainage basin/lake area ratios are also provided in the final column of Table 3-1. Drainage basin/lake area ratios are often useful in evaluating the potential for runoff inputs to be a significant contributor to water quality within a waterbody. Some researchers have suggested that drainage basin/lake area ratios substantially less than 7 indicate lakes where nonpoint source pollution should have minimal impacts on lake water quality, while drainage basin/lake area ratios substantially in excess of 7 indicate waterbodies where nonpoint source runoff may have a significant impact on water quality. Based upon these ratios, Lake Shipp and Lake Lulu would be expected to exhibit minimal water quality impacts from nonpoint source inputs, with a more significant impact from nonpoint source inputs for Lake May.

In addition to the overall drainage basin boundary delineations, ERD also delineated sub-basin boundaries for areas within the drainage basin boundary which discharge into each of the evaluated waterbodies through a unique conveyance mechanism. Approximate sub-basin delineations were developed utilizing the USGS quad maps and the City of Winter Haven stormsewer maps. Sub-basin delineations were modified, as necessary, based upon an extensive review of aerial photography, field reconnaissance, and visual observations during storm events.

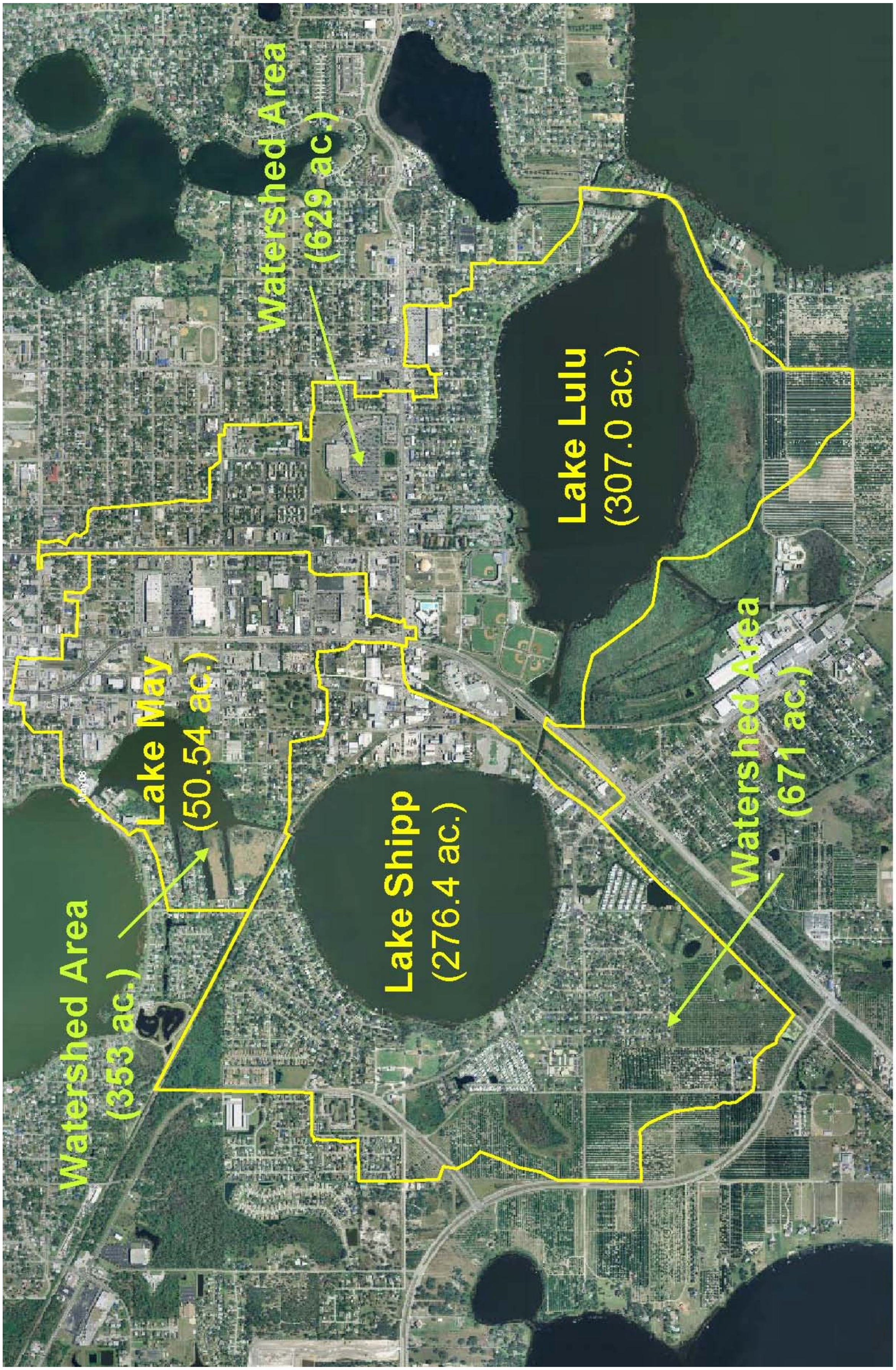


Figure 3-1. Drainage Basin Delineations for Lakes May, Shipp, and Lulu.

TABLE 3-1

GENERAL DRAINAGE BASIN CHARACTERISTICS FOR LAKES MAY, SHIPP, AND LULU

LAKE	DRAINAGE BASIN (acres)	LAKE AREA (acres)	DRAINAGE BASIN / LAKE AREA RATIO
May	353.4	50.54	7.0
Shipp	671.0	276.4	2.4
Lulu	629.3	307.0	2.1

A delineation of sub-basin areas within the Lake May drainage basin is given in Figure 3-2. Eleven separate sub-basin areas were identified which discharge directly into Lake May. Estimates of volumetric and pollutant inputs to Lake May from these sub-basin areas are given in subsequent sections.

A delineation of sub-basin areas within the Lake Shipp drainage basin is given in Figure 3-3. Twenty-three separate sub-basin areas were identified which discharge directly into Lake Shipp. Estimates of annual runoff volumes and mass loadings generated within each of these sub-basin areas are provided in subsequent sections.

A delineation of sub-basin areas within the Lake Lulu drainage basin is given in Figure 3-4. Nineteen separate sub-basin areas were identified which discharge directly into Lake Lulu. Volumetric and pollutant loadings associated with each of these sub-basin areas are discussed in subsequent sections.

A summary of areas associated with each of the identified sub-basin areas in the Lakes May, Shipp, and Lulu drainage basins is given in Table 3-2. Individual sub-basin areas discharging into Lake May range from approximately 1.8-149 acres. Sub-basin areas discharging into Lake Shipp range from 1.2-126.4 acres, with sub-basin areas discharging into Lake Lulu ranging from 3.2-144.0 acres.

Figure 3-2. Sub-basin Areas Within the Lake May Drainage Basin.

Figure 3-3. Sub-basin Areas Within the Lake Shipp Drainage Basin.

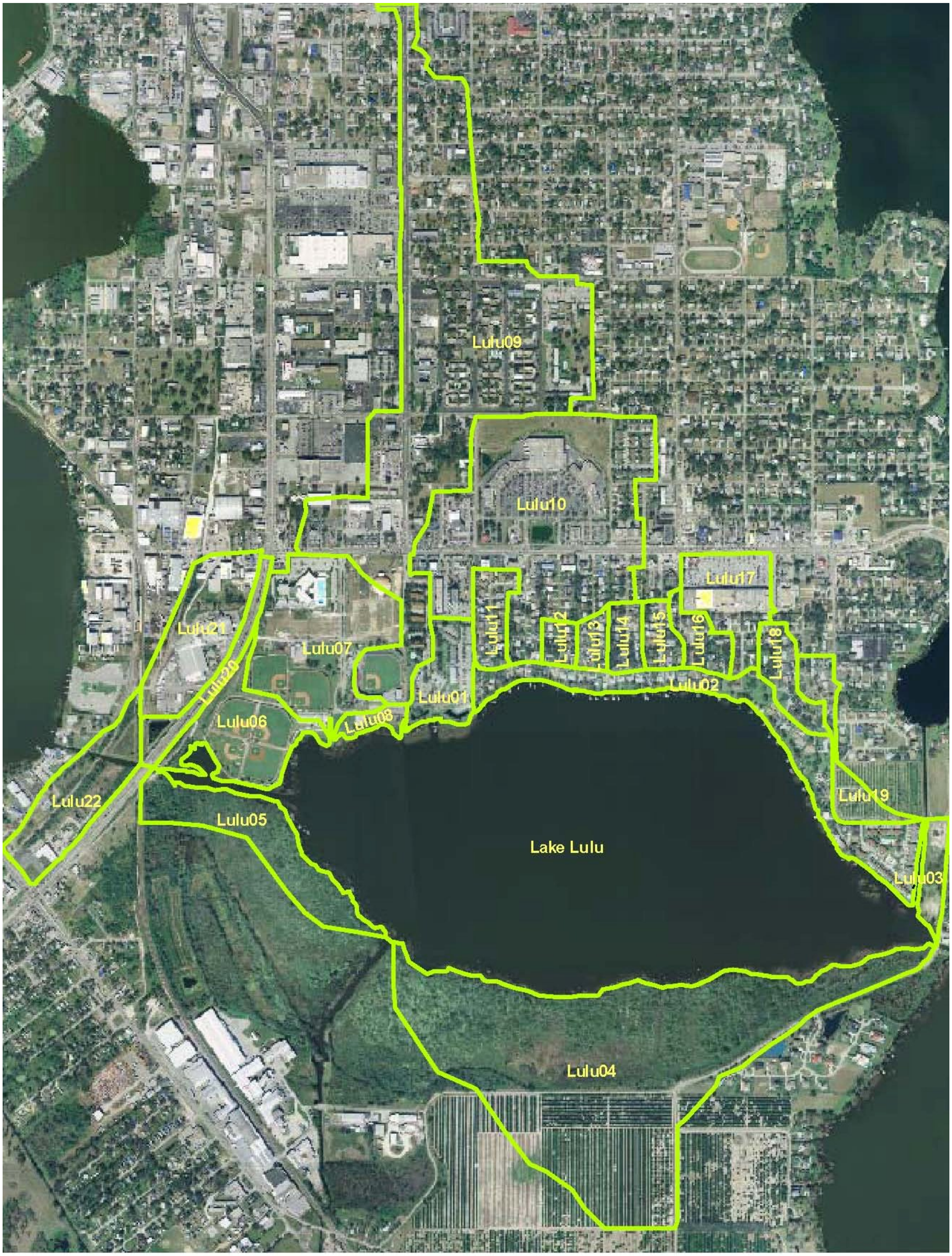


Figure 3-4. Sub-basin Areas Within the Lake Lulu Drainage Basin.

TABLE 3-2

IDENTIFIED SUB-BASIN AREAS IN THE LAKES MAY, SHIPP, AND LULU DRAINAGE BASINS

LAKE MAY			LAKE SHIPP			LAKE LULU		
Sub-Basin	Area (ac)	Percent of Total (%)	Sub-Basin	Area (ac)	Percent of Total (%)	Sub-Basin	Area (ac)	Percent of Total (%)
1	10.2	2.9	1	4.8	0.7	1	12.2	1.9
2	25.5	7.2	2	32.3	4.8	2	32.9	5.2
3	1.8	0.5	3	12.8	1.9	3	5.4	0.9
4	2.6	0.7	4	7.0	1.0	4	137.8	21.9
5	11.3	3.2	5	18.4	2.7	5	24.1	3.8
6	18.1	5.1	6	18.2	2.7	6	21.6	3.4
7	49.6	14.0	7	43.9	6.5	7	40.4	6.4
8	2.7	0.8	8	8.3	1.2	8	3.2	0.5
9	5.5	1.6	9	47.4	7.1	9	144.0	22.9
10	81.1	22.9	10	52.3	7.8	10	87.9	14.0
11	145.0	41.0	11	40.6	6.1	11	7.8	1.2
Total:	**353.4**	**100.0**	12	126.4	18.8	12	3.3	0.5
			13	35.4	5.3	13	3.7	0.6
			14	91.9	13.7	14	5.3	0.8
			15	15.0	2.2	15	5.1	0.8
			16	8.5	1.3	16	6.4	1.0
			17	12.1	1.8	17	16.5	2.6
			18	4.8	0.7	18	8.1	1.3
			19	2.5	0.4	19	10.0	1.6
			20	19.4	2.9	20	8.6	1.4
			21	27.5	4.1	21	23.7	3.8
			22	40.3	6.0	22	21.4	3.4
			23	1.2	0.2	**Total:**	**629.3**	**100.0**
			Total:	**671.0**	**100.0**			

3.2 Land Use

Land use information for the Lakes May, Shipp, and Lulu drainage basin areas was initially obtained from the 1999 Land Use Inventory conducted by the Florida Department of Environmental Protection (FDEP). This information was utilized by ERD as a baseline, and changes to the land use characterization data were identified using a combination of aerial photography and field reconnaissance. The land use data were allocated to 12 different general land use categories for which runoff characterization data is typically available. The resulting land use summary developed by ERD reflects conditions which currently exist within the drainage basin.

An overview of general land use characteristics in the Lakes May, Shipp, and Lulu drainage basins is given in Figure 3-5. The dominant land uses within the drainage basins appear to be commercial, industrial, and medium-density residential. A few areas of agricultural land use still exist in southern portions of the Lake Lulu drainage basin and southwestern portions of the Lake Shipp drainage basin.

A summary of land use characteristics in the Lakes May, Shipp, and Lulu drainage basins is given in Table 3-3. The land use summaries provided in this table do not include the surface area of the individual lakes. The category identified as "water" consists of ponds and other small waterbodies which are not part of the primary lake system.

TABLE 3-3

SUMMARY OF LAND USE CHARACTERISTICS IN THE LAKES MAY, SHIPP, AND LULU DRAINAGE BASINS

LAND USE	LAKE MAY		LAKE SHIPP		LAKE LULU		OVERALL	
	AREA (acres)	PERCENT (%)	AREA (acres)	PERCENT (%)	AREA (acres)	PERCENT (%)	AREA (acres)	PERCENT (%)
Agriculture	0.0	0.0	136.8	20.4	49.1	7.8	185.9	11.2
Commercial	125.2	35.4	19.9	3.0	146.9	23.3	292.0	17.7
High-Density Residential	7.6	2.1	17.1	2.5	68.7	10.9	93.4	5.6
Industrial	84.3	23.8	63.3	9.4	18.3	2.9	165.9	10.0
Institutional	7.1	2.0	12.5	1.9	0.0	0.0	19.6	1.2
Low-Density Residential	0.0	0.0	12.6	1.9	8.2	1.3	20.8	1.3
Medium-Density Residential	46.7	13.2	256.0	38.1	109.8	17.5	412.5	24.9
Open Space	69.0	19.5	78.2	11.7	51.8	8.2	199.0	12.0
Recreational	0.0	0.0	36.0	5.4	45.7	7.3	81.7	4.9
Transportation	12.1	3.4	20.5	3.1	14.3	2.3	46.9	2.8
Water	0.0	0.0	17.9	2.7	4.0	0.6	21.9	1.3
Wetlands	1.5	0.4	0.3	0.0	112.7	17.9	114.5	6.9
Total	**353.4**	**100.0**	**671.0**	**100.0**	**629.3**	**100.0**	**1653.7**	**100.0**

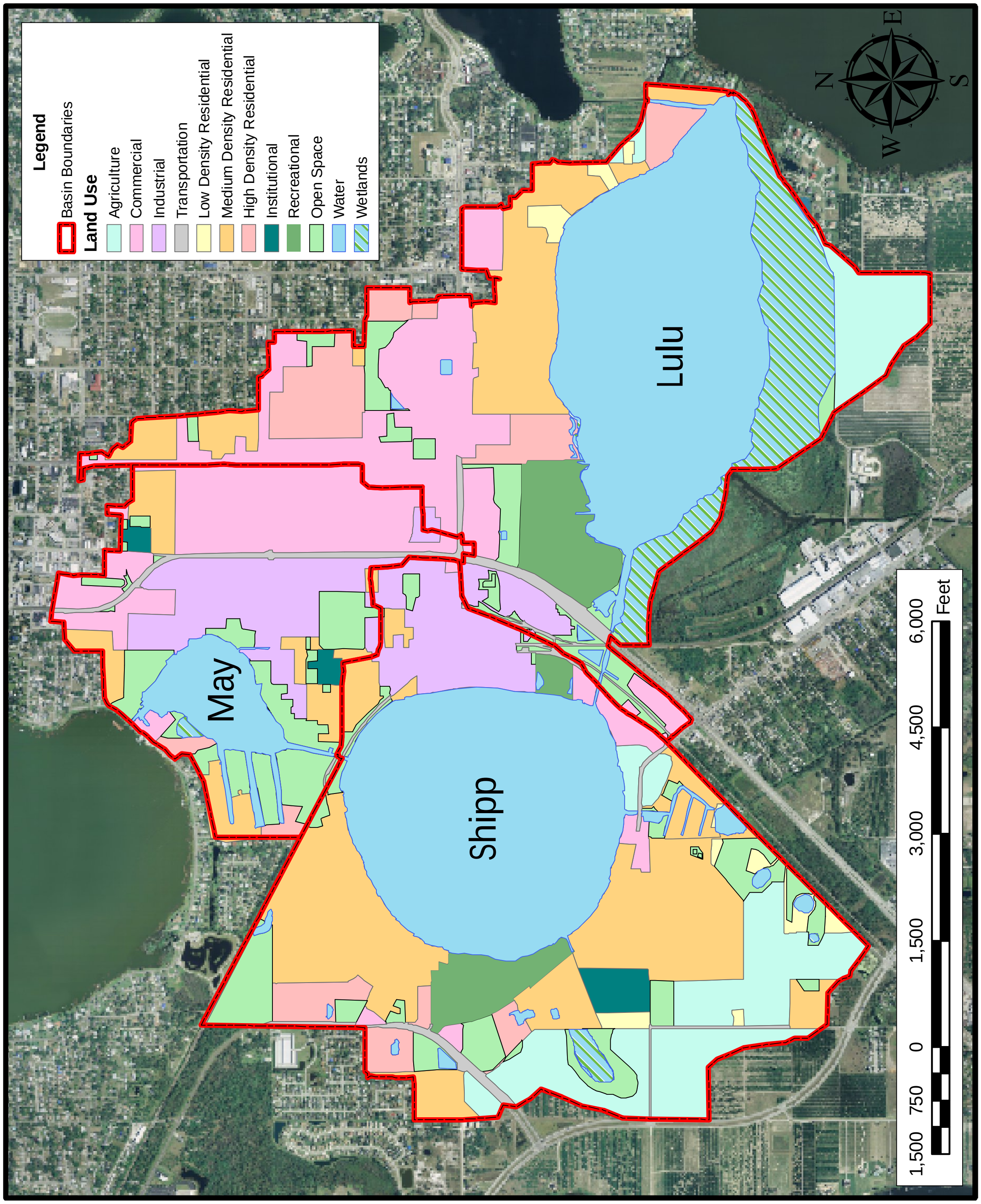


Figure 3-5. Land Use Characteristics in the Lakes May, Shipp, and Lulu Drainage Basins.

The largest land use category in sub-basin areas discharging to Lakes May, Shipp, and Lulu is medium-density residential which comprises approximately 24.9% of the total combined basin areas. An additional 17.7% of the combined basin area is covered with commercial land use, with 12% of the basins in open space, 11.2% in agriculture, and 10.0% in industrial land use. Each of the remaining land use categories comprises approximately 7% or less of the sub-basin areas.

3.3 Soil Characteristics

Information on soil types within the Lakes May, Shipp, and Lulu drainage basins was obtained from the Southwest Florida Water Management District GIS database. Soil information was extracted in the form of Hydrologic Soil Groups (HSG) which classifies soil types with respect to runoff-producing characteristics. Soil groups within the Lakes May, Shipp, and Lulu drainage basins were divided into five separate categories for evaluation and modeling purposes. A summary of the characteristics of each hydrologic soil group is given in Table 3-4. The chief consideration in each of the soil group types is the inherent capacity of bare soil to permit infiltration.

TABLE 3-4

CHARACTERISTICS OF SCS HYDROLOGIC SOIL GROUP CLASSIFICATIONS

SOIL GROUP	DESCRIPTION	RUNOFF POTENTIAL	INFILTRATION RATE
A	Deep sandy soils	very low	High
B / D	Shallow sandy soils over low permeability layer	1. high in undeveloped condition 2. low in developed condition	1. low in undeveloped condition 2. moderate in developed condition
C	Sandy soil with high clay or organic content	Medium to high	Low
D	Clayey soils	very high	low to none
W	Wetland or hydric soils	--	--

A graphical depiction of hydrologic soil groups in drainage basin areas for Lakes May, Shipp, and Lulu is given in Figure 3-6. The vast majority of soils within the drainage basins appear to be classified in Hydrologic Soil Group (HSG) A, which includes deep sandy soils with a very low runoff potential, and in HSG C, which includes sandy soil with clay or organic content with a moderate to high runoff potential. Pockets of HSG B and D soils are scattered throughout the drainage basins. The soils indicated as HSG D primarily represent wetland and hydric areas within the basins.

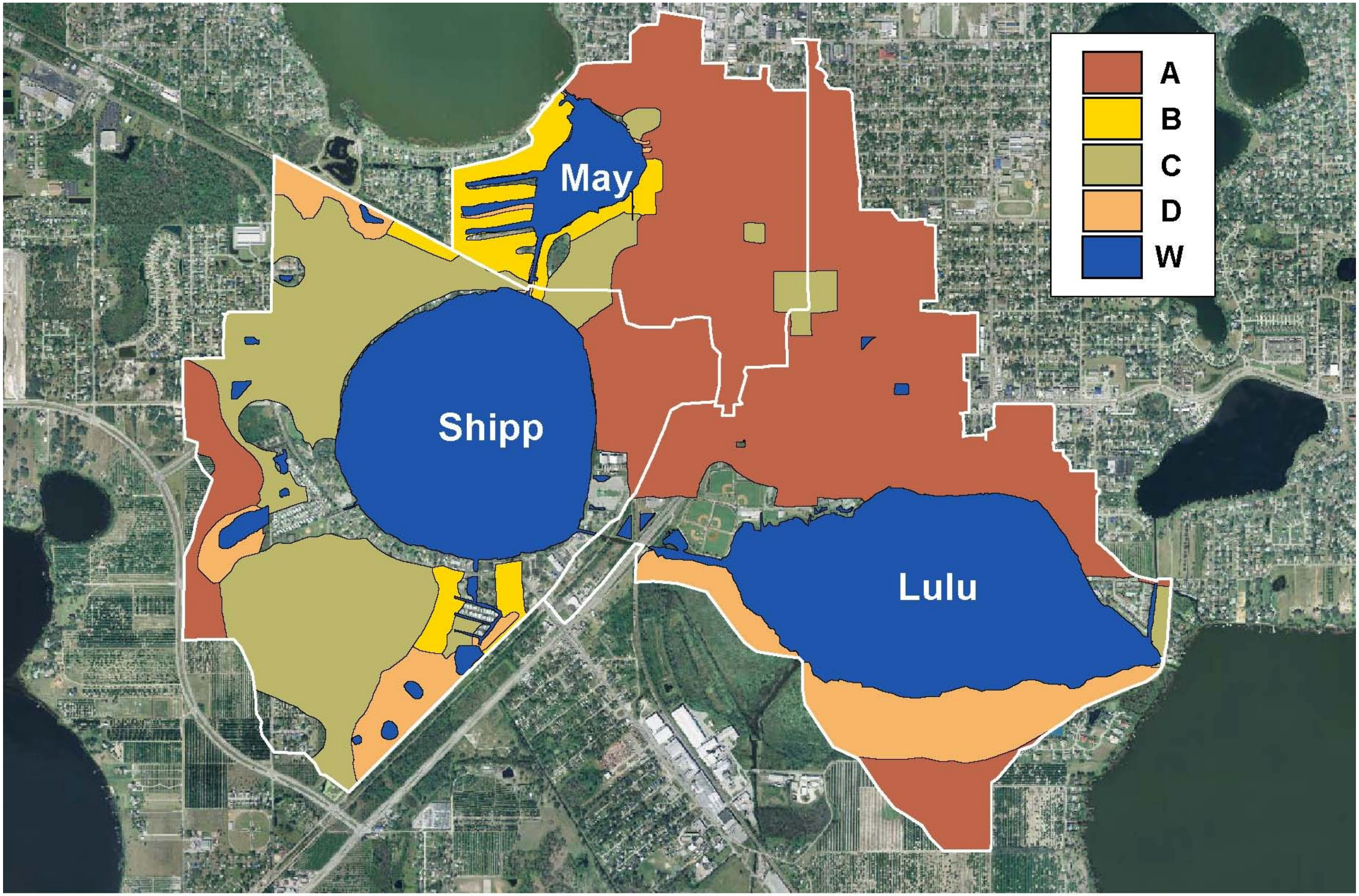


Figure 3-6. Hydrologic Soil Groups in the Lakes May, Shipp, and Lulu Drainage Basins.

A summary of hydrologic soil groups in watershed areas discharging to Lakes May, Shipp, and Lulu is given in Table 3-5. Approximately 48.9% of the combined drainage basins is covered with HSG A soils, indicating a low runoff potential and a high infiltration rate. These types of soil characteristics minimize the amount of runoff generated within these areas. Approximately 28.0% of the soils within the basins are classified as HSG C, which represents areas with a moderate to high runoff potential. In general, soils within the drainage basin areas for Lakes May, Shipp, and Lulu consist of a combination of well drained sandy soils and lower lying, relatively impermeable soils with a high runoff potential.

TABLE 3-5

HYDROLOGIC SOIL GROUPS IN THE LAKES MAY, SHIPP, AND LULU DRAINAGE BASINS

HYDROLOGIC SOIL GROUP	LAKE MAY		LAKE SHIPP		LAKE LULU		OVERALL	
	Area (acres)	Percent (%)	Area (acres)	Percent (%)	Area (acres)	Percent (%)	Area (acres)	Percent (%)
A	251.9	71.3	137.9	20.5	419.1	66.6	808.9	48.9
B	57.2	16.2	53.6	8.0	18.9	3.0	129.7	7.8
C	33.8	9.6	361.3	53.8	68.7	10.9	463.8	28.0
D	10.5	3.0	100.3	14.9	118.7	18.9	229.5	13.9
W	0.0	0.0	17.9	2.7	4.0	0.6	21.9	1.3
Total	**353.4**	**100.0**	**671.0**	**100.0**	**629.3**	**100.0**	**1653.7**	**100.0**

3.4 Hydrologic Characteristics

In addition to land use characteristics, information on hydrologic characteristics of the drainage sub-basin areas was developed by ERD for use in modeling inputs of stormwater runoff into the three lakes. The initial step in evaluating hydrologic characteristics involves delineating the pervious and non-pervious areas within the drainage basin. Aerial photography of the drainage basin areas, dated 2002, was obtained from the Polk County GIS site. All impervious areas within the drainage basin boundaries were digitally outlined using GIS. The remaining land areas are assumed to be either pervious areas or water.

A summary of hydrologic characteristics of drainage basin areas discharging to Lakes May, Shipp, and Lulu, is given in Figure 3-7. All impervious areas within the drainage basins are divided into directly connected impervious areas (DCIA) or non-DCIA areas. An area is considered to be directly connected if the drainage from the area discharges directly into the primary stormsewer system for the basin. In non-directly connected areas, the runoff from the impervious surface first migrates over a pervious area prior to entering the stormsewer system. This pervious area provides additional opportunities for soil infiltration of the runoff prior to reaching the receiving waterbody. The DCIA and non-DCIA areas are modeled separately when performing estimates of runoff inputs from modeled storm events. As seen in Figure 3-7, much of the impervious area within the basin is centered around the commercial corridor adjacent to U.S. 17. Single-family residential areas with limited impervious surfaces are present along the northern side of Lake Lulu and western side of Lake Shipp.

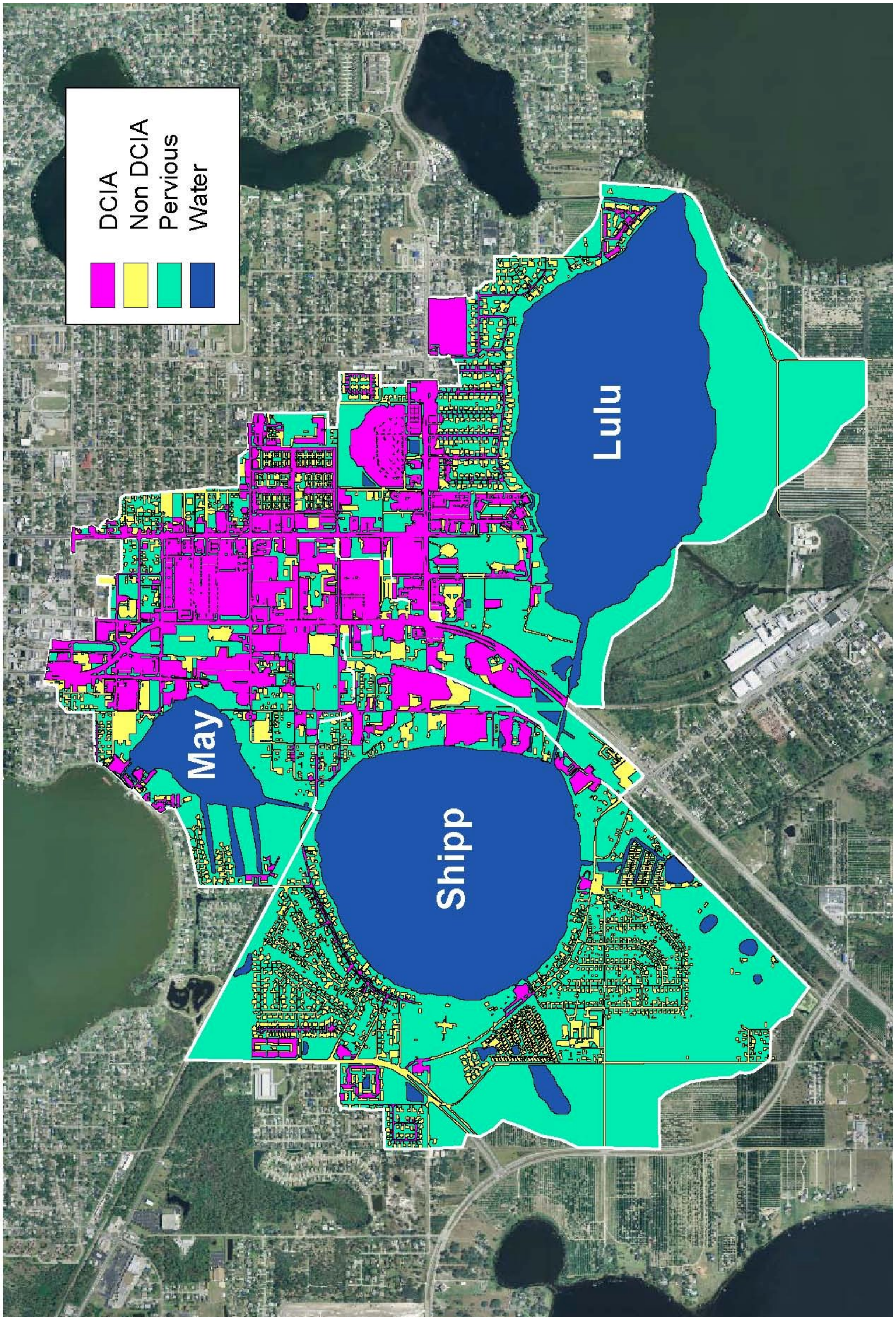


Figure 3-7. Hydrologic Characteristics of Drainage Basin Areas Discharging to Lakes May, Shipp, and Lulu.

Pervious areas within the watersheds consist of open land, landscaped areas, grassed areas, and wetlands. Each of the pervious areas indicated on Figure 3-7 is associated with a specific soil group type which is used to estimate runoff volumes generated in these areas.

A summary of hydrologic characteristics for the Lakes May, Shipp, and Lulu drainage basins is given in Table 3-6. Values summarized in this table reflect the overall characteristics of the drainage basin for each lake. Information is provided in Table 3-6 for pervious area, impervious area, percentage of impervious, DCIA area, and percent DCIA. This information was also generated for each of the individual sub-basin areas discharging into the three lakes and is used for estimation of runoff volumes from the sub-basin areas.

TABLE 3-6

HYDROLOGIC CHARACTERISTICS FOR THE LAKES MAY, SHIPP, AND LULU DRAINAGE BASINS

HYDROLOGIC PARAMETER	LAKE MAY	LAKE SHIPP	LAKE LULU
Pervious (acres)	153.7	495.8	391.8
Impervious (acres)	199.7	175.2	237.5
Percent Impervious (%)	56.5	26.1	37.7
DCIA (acres)	148.5	51.1	160.1
Percent DCIA (%)	42.0	7.6	25.4

3.5 Stormwater Treatment

Watershed areas which currently receive stormwater treatment were identified by ERD within each of the three drainage basin areas using a combination of aerial photography and field reconnaissance. A summary of the results of these evaluations is given on Figure 3-8. Stormwater treatment within the Lakes May, Shipp, and Lulu drainage basins primarily consists of dry retention and wet detention. Developed areas which receive stormwater treatment by one of these two common mechanisms are indicated on Figure 3-8. Some of the drainage basin areas in the Lake Shipp drainage basin discharge to existing natural or man-made ponds which are not considered to be formal stormwater treatment systems. These areas are included under the "pond" category on Figure 3-8 and are assumed to receive stormwater treatment equivalent to wet detention, although the treatment does not occur in a permitted stormwater management facility.

In addition to the stormwater treatment discussed previously, several areas in the Lakes Shipp and Lulu drainage basins appear to receive treatment in wetlands prior to discharging into each of the lakes. A residential area located on the western side of Lake Shipp appears to discharge into a hardwood wetland area before ultimately reaching Lake Shipp. Areas discharging to this wetland area assumed to receive stormwater treatment equivalent to wetland treatment. An agricultural area on the south side of Lake Lulu also discharges through a wetland area prior to entering Lake Lulu. Runoff loadings from this area are assumed to receive wetland treatment prior to reaching Lake Lulu.

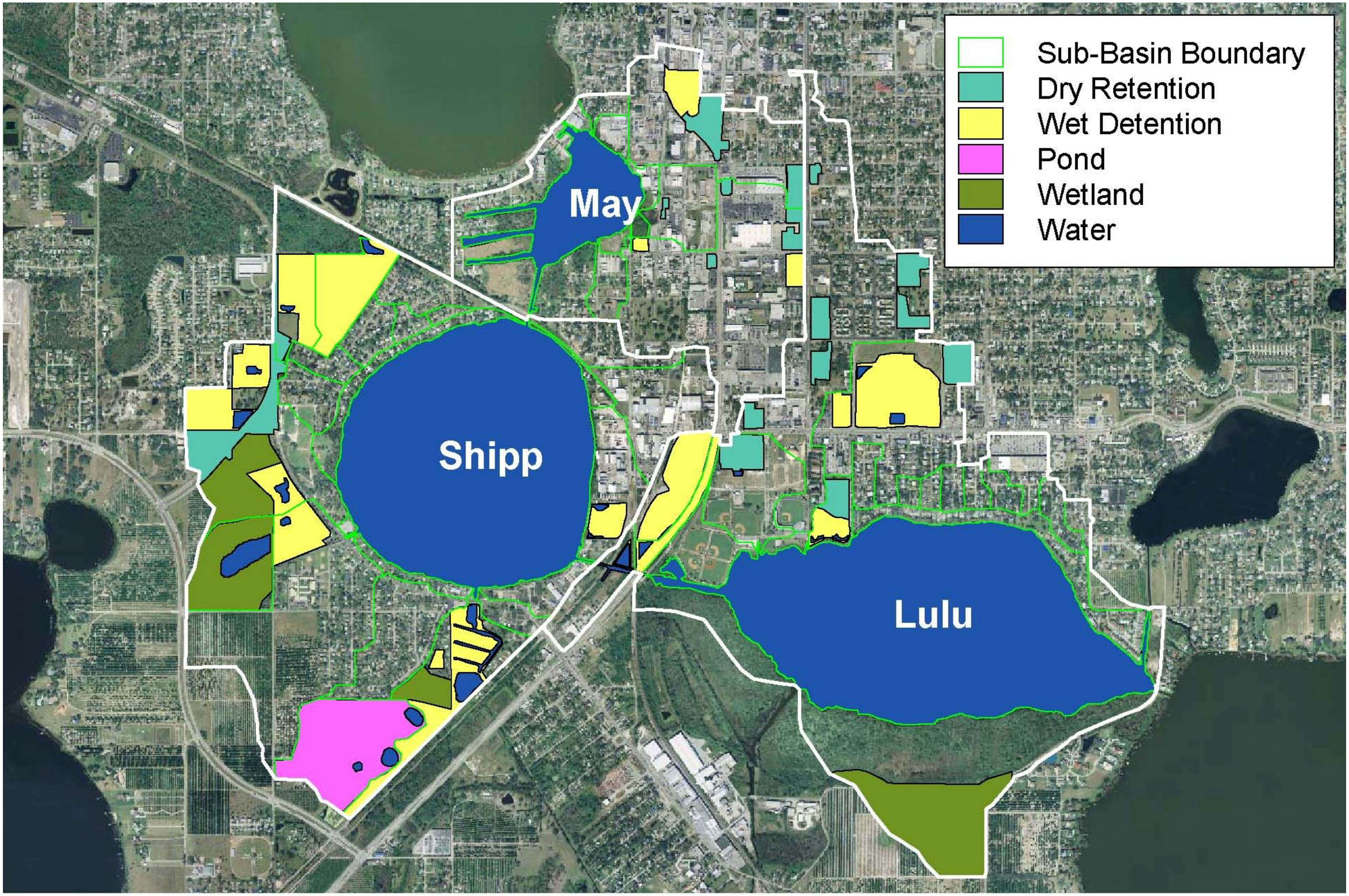


Figure 3-8. Stormwater Treatment in the Lakes May, Shipp, and Lulu Drainage Basins.

A summary of identified stormwater treatment in the Lakes May, Shipp, and Lulu drainage basins is given in Table 3-7 for each of the sub-basin areas discharging into the three lakes. Information is provided on the total sub-basin area, the total developed area, and the developed area with stormwater treatment. Stormwater treatment within each sub-basin is broken down into areas treated by dry retention, wet detention, depressional areas and ponds, and wetlands. The information summarized in Table 3-7 is utilized in Section 4 and Section 5 for estimation of hydrologic inputs and mass loadings from stormwater runoff entering the three lakes.

In addition to the stormwater treatment systems discussed in the previous paragraphs, the City of Winter Haven has also constructed retrofit projects which provide stormwater treatment using alum for three significant drainage basin areas discharging into Lake May and two significant drainage sub-basin areas discharging into Lake Lulu. Each of these treatment systems injects liquid alum into the stormwater flow on a flow-proportioned basis and provides full treatment for all runoff generated by rain events up to the 1.75-inch design storm for each basin. Locations of watershed areas which receive stormwater treatment using alum are indicated on Figure 3-9. Alum stormwater treatment is extremely effective for reducing concentrations of total phosphorus and TSS. Watershed areas which are treated with alum have a combined area of 483.5 acres or approximately 29% of the total drainage basin area for the three lakes.

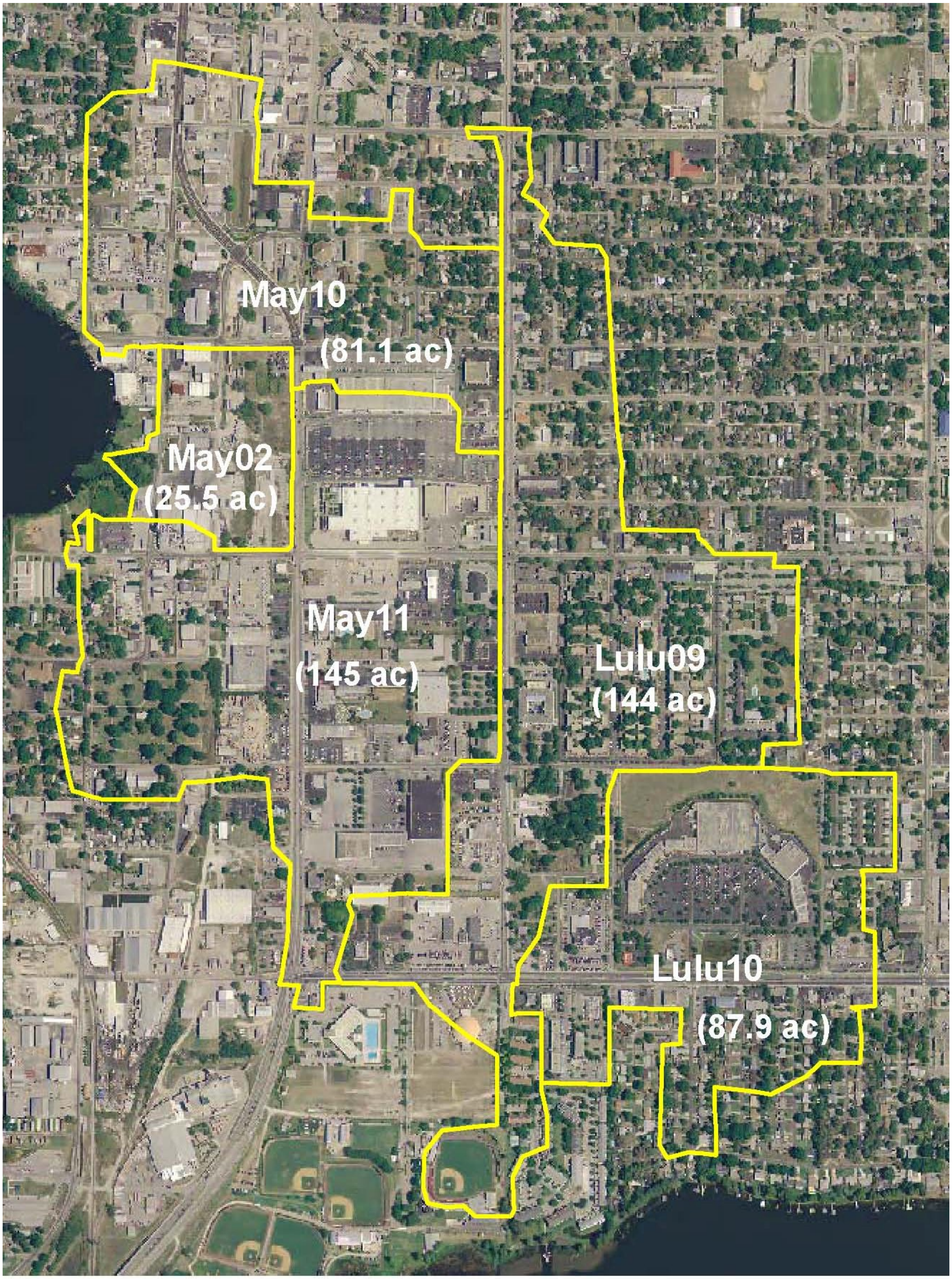


Figure 3-9. Watershed Areas Which Receive Stormwater Treatment Using Alum.

TABLE 3-7

SUMMARY OF STORMWATER TREATMENT IN THE LAKES MAY, SHIPP, AND LULU DRAINAGE BASINS

LAKE	SUB-BASIN	TOTAL SUB-BASIN AREA (ac)	AREAS DISCHARGING TO DRY RETENTION PONDS (ac)	AREAS DISCHARGING TO WET DETENTION PONDS (ac)	AREAS DISCHARGING TO DEPRESSIONS AND PONDS (ac)	AREAS DISCHARGING TO WETLANDS (ac)	TOTAL DEVELOPED AREA (ac)	TOTAL AREA WITH TREATMENT (ac)
May	1	10.20	0.00	0.00	0.00	0.00	3.60	0.00
	2	25.46	0.57	0.00	0.00	0.00	24.32	0.57
	3	1.80	0.00	0.00	0.00	0.00	0.00	0.00
	4	2.63	0.00	0.00	0.00	0.00	0.94	0.00
	5	11.34	0.00	0.00	0.00	0.00	9.34	0.00
	6	18.07	0.00	0.00	0.00	0.00	8.95	0.00
	7	49.61	0.00	0.00	0.00	0.00	22.26	0.00
	8	2.66	0.00	0.00	0.00	0.00	0.03	0.00
	9	5.52	0.00	0.00	0.00	0.00	4.74	0.00
	10	81.10	12.16	7.24	0.00	0.00	76.76	19.40
	11	145.00	5.48	4.10	0.00	0.00	132.05	9.58
Shipp	1	4.80	0.00	0.00	0.00	0.00	3.96	0.00
	2	32.33	0.00	6.13	0.00	0.00	30.01	6.13
	3	12.83	0.00	0.00	0.00	0.00	7.55	0.00
	4	7.01	0.00	0.00	0.00	0.00	7.01	0.00
	5	18.37	0.00	0.00	0.00	0.00	17.63	0.00
	6	18.23	0.00	0.00	0.00	0.00	16.31	0.00
	7	43.86	0.00	0.00	0.00	0.00	41.49	0.00
	8	8.28	0.00	0.00	0.00	0.00	2.81	0.00
	9	47.36	0.00	28.60	0.00	7.64	21.98	36.24
	10	52.26	0.00	0.00	51.98	0.00	6.18	51.98
	11	40.63	0.00	0.00	0.00	0.00	40.63	0.00
	12	126.45	0.00	12.13	0.00	0.00	64.94	12.13
	13	35.36	0.00	0.00	0.00	34.23	0.57	34.23
	14	91.90	17.52	26.65	0.00	22.33	57.35	66.50
	15	14.96	0.00	0.00	0.00	0.00	14.42	0.00
	16	8.48	0.00	0.00	0.00	0.00	8.46	0.00
	17	12.12	0.00	0.00	0.00	0.00	12.12	0.00

TABLE 3-7 -- CONTINUED

SUMMARY OF STORMWATER TREATMENT IN THE LAKES MAY, SHIPP, AND LULU DRAINAGE BASINS

LAKE	SUB-BASIN	TOTAL SUB-BASIN AREA (ac)	AREAS DISCHARGING TO DRY RETENTION PONDS (ac)	AREAS DISCHARGING TO WET DETENTION PONDS (ac)	AREAS DISCHARGING TO DEPRESSIONS AND PONDS (ac)	AREAS DISCHARGING TO WETLANDS (ac)	TOTAL DEVELOPED AREA (ac)	TOTAL AREA WITH TREATMENT (ac)
Shipp	18	4.84	0.00	0.00	0.00	0.00	4.84	0.00
	19	2.50	0.00	0.00	0.00	0.00	2.50	0.00
	20	19.42	0.00	0.00	0.00	0.00	17.49	0.00
	21	27.54	0.00	27.54	0.00	0.00	26.40	27.54
	22	40.28	3.54	14.30	0.00	0.00	19.42	17.84
	23	1.17	0.00	0.00	0.00	0.00	1.17	0.00
Lulu	1	12.16	4.71	5.29	0.00	0.00	11.19	10.00
	2	32.93	0.00	0.00	0.00	0.00	27.75	0.00
	3	5.44	0.00	0.00	0.00	0.00	5.44	0.00
	4	137.77	0.00	0.00	0.00	50.09	0.00	50.09
	5	24.13	0.00	0.00	0.00	0.00	0.09	0.00
	6	21.55	0.00	0.00	0.00	0.00	19.52	0.00
	7	40.38	7.50	0.00	0.00	0.00	29.73	7.50
	8	3.19	0.00	0.00	0.00	0.00	3.11	0.00
	9	143.97	18.83	0.00	0.00	0.00	134.97	18.83
	10	87.86	5.99	31.47	0.00	0.00	77.31	37.46
	11	7.84	0.00	0.00	0.00	0.00	7.84	0.00
	12	3.34	0.00	0.00	0.00	0.00	3.34	0.00
	13	3.68	0.00	0.00	0.00	0.00	3.68	0.00
	14	5.29	0.00	0.00	0.00	0.00	5.29	0.00
	15	5.07	0.00	0.00	0.00	0.00	5.07	0.00
	16	6.42	0.00	0.00	0.00	0.00	6.41	0.00
	17	16.46	0.00	0.00	0.00	0.00	15.72	0.00
	18	8.09	0.00	0.00	0.00	0.00	7.03	0.00
	19	10.01	0.00	0.00	0.00	0.00	5.53	0.00
	20	8.61	0.00	8.20	0.00	0.00	6.92	8.20
	21	23.72	0.00	19.09	0.00	0.00	18.27	19.09
	22	21.40	0.00	1.44	0.00	0.00	9.42	1.44
Total:		**1653.70**	**76.29**	**192.19**	**51.98**	**114.29**	**76.29**	**434.75**

SECTION 4

HYDROLOGIC INPUTS AND LOSSES

Hydrologic budgets were developed for Lakes May, Shipp, and Lulu on an average annual basis. The hydrologic budgets include inputs from direct precipitation, stormwater runoff, dry weather baseflow, groundwater seepage, and flow between interconnected lakes. Hydrologic losses are estimated for evaporation, flow between interconnected lakes, deep recharge, and outfall discharges into the Peace River Canal. A discussion of identified hydrologic inputs and losses to Lakes May, Shipp, and Lulu is given in the following sections.

4.1 Hydrologic Inputs

4.1.1 Direct Precipitation

4.1.1.1 Rainfall Characteristics

Hydrologic inputs from direct rainfall on Lakes May, Shipp, and Lulu were calculated based upon historical precipitation data for the Winter Haven area. Estimates of mean monthly precipitation were generated by ERD based upon historical monthly rainfall at the Winter Haven meteorological station (Site No. 089707), obtained from the Southeast Regional Climate Center (SRCC), over the period from 1941-2008.

A summary of mean monthly rainfall at the Winter Haven meteorological station is given in Table 4-1. Mean monthly rainfall depths range from a low of 2.05 inches during November to a high of 8.41 inches in July. The average annual total rainfall at this site is approximately 50.77 inches.

TABLE 4-1

SUMMARY OF MEAN MONTHLY RAINFALL IN THE WINTER HAVEN AREA FROM 1941-2008

MONTH	RAINFALL DEPTH (inches)	MONTH	RAINFALL DEPTH (inches)
January	2.32	July	8.41
February	2.71	August	7.07
March	3.56	September	6.53
April	2.38	October	2.88
May	3.53	November	2.05
June	7.27	December	2.06
		TOTAL:	**50.77**

4.1.1.2 Hydrologic Inputs

Estimated monthly hydrologic inputs from direct precipitation into Lakes May, Shipp and Lulu were calculated by multiplying the mean monthly rainfall during the period from 1941-2008 (as summarized in Table 4-1) times the assumed surface area of each of the three lakes (summarized in Table 2-4). A summary of estimated average monthly hydrologic inputs to Lakes May, Shipp, and Lulu from direct precipitation is given in Table 4-2. On an annual average basis, direct precipitation contributes approximately 213.8 ac-ft to Lake May, 1169 ac-ft to Lake Shipp, and 1299 ac-ft to Lake Lulu.

TABLE 4-2

ESTIMATED MEAN MONTHLY HYDROLOGIC INPUTS TO LAKES MAY, SHIPP, AND LULU FROM DIRECT PRECIPITATION

MONTH	MONTHLY RAINFALL (inches)	HYDROLOGIC INPUTS (ac-ft)		
		LAKE MAY[1]	LAKE SHIPP[2]	LAKE LULU[3]
January	2.32	9.77	53.44	59.35
February	2.71	11.41	62.42	69.33
March	3.56	14.99	82.00	91.08
April	2.38	10.02	54.82	60.89
May	3.53	14.87	81.31	90.31
June	7.27	30.62	167.5	186.0
July	8.41	35.42	193.7	215.2
August	7.07	29.78	162.9	180.9
September	6.53	27.50	150.4	167.1
October	2.88	12.13	66.34	73.68
November	2.05	8.63	47.22	52.45
December	2.06	8.68	47.45	52.70
TOTALS:	**50.77**	**213.8**	**1169**	**1299**

1. Based on a lake surface area of 50.54 acres
2. Based on a lake surface area of 276.4 acres
3. Based on a lake surface area of 307.0 acres

4.1.2 Stormwater Runoff

Estimates of annual hydrologic inputs to Lakes May, Shipp, and Lulu from stormwater runoff were calculated for each identified sub-basin area based upon the historical rainfall record from 1941-2008. Individual estimates of runoff inputs were generated for each sub-basin area and utilized for development of both hydrologic and nutrient budgets for the three lakes. Details of evaluation methods and results of the runoff modeling efforts are given in the following sections.

4.1.2.1 Computational Methods

Estimates of volumetric inputs from direct stormwater runoff were generated by ERD for each of the identified sub-basin areas discharging into Lakes May, Shipp, and Lulu. The estimated runoff volumes were calculated for average annual rainfall conditions based upon a statistical distribution of historical rainfall events. A probability distribution of individual rain events during the period of record for the Winter Haven meteorological site was developed by evaluating common rain events which occurred at the monitoring site. Hourly meteorological data was obtained from the Southeast Regional Climate Center for the Winter Haven meteorological site, and the continuous hourly rainfall record was scanned to determine the total rainfall depth for individual rain events which occurred at the monitoring site over the period of record from 1941-2008. Only National Climatic Data Center (NCDC) valid rainfall years, defined as a year with valid data for all 12 months, were used in this analysis. Yearly periods which were missing one or more months of rainfall data were excluded from the data set.

For purposes of this analysis, a rain event is defined as a period of continuous rainfall. The US EPA typically uses a 6-hour separation for defining individual rain events. Using this criterion, rain episodes separated by less than six hours of dry conditions are considered to be one continuous event, while rain events separated by six hours or more of dry conditions are assumed to be separate events. The six-hour separation period is thought to be the minimum period of no rainfall required to restore the hydrologic characteristics of the site to pre-rain event conditions.

Although this definition may work well in the temperate climates present throughout much of the U.S., it fails to consider the small convective events which occur frequently within the State of Florida, particularly during the summer months. For rain events in the range of 0.25 inches or more, an inter-event separation period of approximately six hours seems adequate to restore hydrologic characteristics for a Florida watershed. However, for events less than 0.25 inches, hydrologic characteristics can be restored rapidly, often within several hours. Therefore, for purposes of this evaluation, a variable inter-event dry period is utilized. When the cumulative hourly rainfall is equal to 0.25 inches or more, an inter-event dry period of six hours is required to initiate the start of a new rain event. Rainfall which occurs less than six hours from the termination of the previous rainfall is assumed to be part of the original rainfall event. However, for rain events less than 0.25 inches, an inter-event dry period of three hours is used to indicate the start of a new independent runoff event.

The available data set for the Winter Haven meteorological site was scanned and divided into individual rain events based upon the criteria outlined previously. Individual rainfall events at the monitoring site were divided into 19 rainfall event ranges which include 0.00-0.10 inches, 0.11-0.20 inches, 0.21-0.30 inches, 0.31-0.40 inches, 0.41-0.50 inches, 0.51-1.00 inch, 1.01-1.50 inches, 1.51-2.00 inches, 2.01-2.50 inches, 2.51-3.00 inches, 3.01-3.50 inches, 3.51-4.00 inches, 4.01-4.50 inches, 4.51-5.00 inches, 5.01-6.00 inches, 6.01-7.00 inches, 7.01-8.00 inches, 8.01-9.00 inches, and greater than 9 inches. For each rainfall event range, the median depth of rain events within the interval was calculated, along with the average number of rain events.

A frequency distribution of typical rain events in the Winter Haven area from 1941-2008 is given in Table 4-3. During an average rainfall year, the Winter Haven area receives approximately 121 independent rain events. Approximately 44% of these events contribute approximately 0.1 inch of rainfall or less, with 57% contributing 0.2 inches or less and 76% contributing 0.5 inches or less.

TABLE 4-3

FREQUENCY DISTRIBUTION OF RAIN EVENTS IN THE WINTER HAVEN AREA FROM 1941-2008

RAINFALL EVENT RANGE (inches)	NUMBER OF ANNUAL EVENTS IN RANGE	MEDIAN INTERVAL RAINFALL DEPTH (inches)	RAINFALL EVENT RANGE (inches)	NUMBER OF ANNUAL EVENTS IN RANGE	MEDIAN INTERVAL RAINFALL DEPTH (inches)
0.00-0.10	53.66	0.054	3.01-3.50	0.38	3.261
0.11-0.20	15.72	0.165	3.51-4.00	0.28	3.757
0.21-0.30	9.91	0.265	4.01-4.50	0.08	4.235
0.31-0.40	7.00	0.368	4.51-5.00	0.08	4.745
0.41-0.50	6.04	0.466	5.01-6.00	0.15	5.303
0.51-1.00	14.75	0.733	6.01-7.00	0.06	6.140
1.01-1.50	6.66	1.247	7.01-8.00	0.02	7.380
1.51-2.00	3.55	1.760	8.01-9.00	0.02	8.370
2.01-2.50	1.66	2.232	>9.00	0.02	10.800
2.51-3.00	1.00	2.729			

A hydrologic model was developed for the Lakes May, Shipp, and Lulu sub-basin areas, and the statistical distribution of historical rain events summarized in Table 4-3 was used as the precipitation input data. This model provides an estimate of runoff inputs to Lakes May, Shipp, and Lulu from direct runoff sub-basins during average annual rainfall conditions. A modified version of the SCS curve number methodology was used to provide estimates of the runoff volumes generated within each delineated drainage sub-basin areas for the rainfall events listed in Table 4-3. The modified SCS methodology utilizes the hydrologic characteristics of the drainage basin, including impervious area, directly connected impervious area, and soil curve numbers to estimate runoff volumes for modeled storm events. Hydrologic characteristics of the sub-basin areas were determined by ERD based upon aerial photography and field reconnaissance of the watershed areas. This information was discussed previously in Section 3.5.

After estimating the hydrologic characteristics of the basin area, the runoff volume for each rainfall event is calculated by adding the rainfall excess from the non-directly connected impervious area (non-DCIA) portion to the rainfall excess created from the DCIA portion for the basin. Rainfall excess from the non-DCIA areas is calculated using the following set of equations:

$$Soil\ Storage,\ S = \left(\frac{1000}{nDCIA\ CN} - 10 \right)$$

$$nDCIA\ CN = \frac{[CN * (100 - IMP)] + [98\ (IMP - DCIA)]}{(100 - DCIA)}$$

$$Q_{nDCIA_i} = \frac{(P_i - 0.2S)^2}{(P_i + 0.8S)}$$

where:

CN	=	curve number for pervious area
IMP	=	percent impervious area
DCIA	=	percent directly connected impervious area
nDCIA CN	=	curve number for non-DCIA area
P_i	=	rainfall event depth (inches)
Q_{nDCIAi}	=	rainfall excess for non-DCIA for rainfall event (inches)

For the DCIA portion, rainfall excess is calculated using the following equation:

$$Q_{DCIA_i} = (P_i - 0.1)$$

When P_i is less than 0.1, Q_{DCIAi} is equal to zero. This methodology is used to estimate the generated runoff volume within each of the delineated sub-basin areas for each of the rainfall events listed in Table 4-3. The sum of runoff generated by each of the modeled events is equivalent to the estimated annual runoff volume. This methodology was developed by ERD for FDEP for use in the Statewide Stormwater Rule.

The methodology outlined above provides an estimate of the "generated" runoff volume for each sub-basin area. However, significant portions of the generated runoff volume may be attenuated during migration through stormwater management systems within each sub-basin area. If the stormwater management system provides dry retention treatment, a large portion of the runoff volume may infiltrate into the ground and not reach the receiving water as a surface flow. If the stormwater system provides wet detention treatment, a portion of the generated runoff volume may be lost due to evaporation within the pond or infiltration through the pond bottom. The watershed model includes information of the types of stormwater management systems utilized within each sub-basin area and the amount of developed area treated by each stormwater management type. Estimates of the amount of generated runoff volume attenuated by each type of stormwater management system are calculated by the model, and the attenuated volume is subtracted from the generated volume within each sub-basin. The result is an estimate of the runoff volume which actually discharges into the three receiving waterbodies from each sub-basin area.

A summary of estimated volumetric removal efficiencies for stormwater management systems in the Lakes May, Shipp, and Lulu drainage basins is given in Table 4-4. These volumetric removals are based on previous research performed by ERD on the performance efficiencies of stormwater management systems used in the State of Florida. Developed areas treated by dry retention are assumed to have a volumetric loss of approximately 80% for runoff inputs due to infiltration and evaporation within the pond. Wet detention ponds are assumed to have a volumetric loss of approximately 20%, due primarily to evaporation and infiltration through the pond bottom. Depressional areas and low-lying ponds are assumed to retain approximately 95% of the runoff inflow, and a 25% volumetric loss is assumed for runoff inputs into wetlands. The information summarized in Table 4-4 is combined with information on stormwater management systems (summarized in Table 3-7) to assist in calculation of estimated runoff inflow from sub-basin areas into each of the three lakes.

TABLE 4-4

ESTIMATED VOLUMETRIC REMOVAL EFFICIENCIES FOR STORMWATER MANAGEMENT SYSTEMS IN THE LAKES MAY, SHIPP, AND LULU DRAINAGE BASINS

SYSTEM TYPE	VOLUME REDUCTION (%)
Dry Retention Pond	80
Wet Detention Pond	20
Depressional Area	95
Wetland	25

A summary of estimated runoff volumes which discharge from sub-basin areas into Lake May during average annual rainfall conditions is given in Table 4-5. Approximately 80% of the runoff inputs to Lake May originate from sub-basins 10 and 11, with inputs from the remaining sub-basin areas contributing approximately 6% or less of the inflow to Lake May. Calculated runoff coefficients for sub-basin areas range from a low of 0.039 in sub-basin 3 to a high of 0.500 in sub-basin 11. The overall weighted average annual runoff coefficient for sub-basins discharging to Lake May is approximately 0.359, indicating that approximately 35.9% of the annual rainfall enters the lake as stormwater runoff.

TABLE 4-5

CALCULATED AVERAGE ANNUAL RUNOFF INPUTS FROM SUB-BASIN AREAS TO LAKE MAY

SUB-BASIN	AREA (acres)	INFLOW (ac-ft)	PERCENT OF TOTAL INFLOW (%)	RUNOFF "C" VALUE
1	10.20	10.7	2.0	0.248
2	25.46	36.2	6.7	0.336
3	1.80	0.3	0.1	0.039
4	2.63	1.0	0.2	0.090
5	11.34	13.2	2.5	0.275
6	18.07	10.8	2.0	0.141
7	49.61	27.4	5.1	0.131
8	2.66	4.3	0.8	0.382
9	5.52	1.7	0.3	0.073
10	81.10	124.7	23.2	0.363
11	145.00	306.9	57.1	0.500
TOTALS:	**353.4**	**537.2**	**100.0**	**0.359**[1]

1. Weighted basin average

A summary of estimated runoff volumes discharging from sub-basin areas directly into Lake Shipp is given in Table 4-6. The values summarized in this table reflect the annual output from the watershed model for Lake Shipp. On an annual average basis, stormwater runoff contributes approximately 505.8 ac-ft to Lake Shipp. With the exceptions of sub-basins 7, 12, and 14, runoff inputs appear to be distributed relatively evenly between the identified sub-basin areas, with 20 of the 23 sub-basins contributing 10% or less of the annual runoff inflow.

Calculated runoff coefficients are provided in the final column of Table 4-6. Runoff coefficients for sub-basin areas range from a low of 0.034 in sub-basin 1 to a high of 0.566 in sub-basin 23. Overall, the weighted runoff coefficient for sub-basin areas discharging to Lake Shipp is 0.178, indicating that on an annual average basis, approximately 17.8% of the rainfall volume on the watershed areas enters the lake as stormwater runoff.

TABLE 4-6

CALCULATED ANNUAL AVERAGE RUNOFF INPUTS FROM SUB-BASIN AREAS TO LAKE SHIPP

SUB-BASIN	AREA (acres)	INFLOW (ac-ft)	PERCENT OF TOTAL INFLOW (%)	RUNOFF "C" VALUE
1	4.80	0.7	0.1	0.034
2	32.33	47.8	9.5	0.349
3	12.83	16.3	3.2	0.300
4	7.01	7.6	1.5	0.256
5	18.37	13.3	2.6	0.171
6	18.23	17.3	3.4	0.224
7	43.86	64.7	12.8	0.349
8	8.28	4.6	0.9	0.131
9	47.36	41.9	8.3	0.209
10	52.26	1.6	0.3	0.007
11	40.63	32.0	6.3	0.186
12	126.45	69.8	13.8	0.130
13	35.36	28.2	5.6	0.188
14	91.90	55.0	10.9	0.141
15	14.96	11.5	2.3	0.182
16	8.48	7.2	1.4	0.201
17	12.12	10.8	2.1	0.211
18	4.84	5.2	1.0	0.254
19	2.50	3.3	0.7	0.312
20	19.42	11.1	2.2	0.135
21	27.54	20.0	4.0	0.172
22	40.28	33.1	6.5	0.194
23	1.17	2.8	0.6	0.566
TOTALS:	**671.0**	**505.8**	**100.0**	**0.178**[1]

1. Weighted basin average

A summary of estimated mean annual runoff volumes discharging from sub-basin areas directly into Lake Lulu is given in Table 4-7. The values summarized in this table reflect the output from the watershed model. Overall, a total of 621.5 ac-ft of runoff discharges into Lake Lulu on an annual average basis. Approximately 64% of the total annual inflow to Lake Lulu originates in sub-basins 4, 9, and 10. Percentage contributions from the remaining sub-basin areas are equal to approximately 5% or less.

A high degree of variability was observed in calculated runoff coefficients for the evaluated sub-basin areas. Calculated runoff "C" values range from a low of 0.064 for sub-basin 19 to a high of 0.491 for sub-basin 20. Overall, the weighted runoff "C" value for the combined Lake Lulu drainage basin is approximately 0.233, suggesting that, on an average annual basis, approximately 23.3% of the annual rainfall volume on the watershed areas enters the lake as stormwater runoff.

TABLE 4-7

CALCULATED ANNUAL AVERAGE RUNOFF INPUTS FROM SUB-BASIN AREAS TO LAKE LULU

SUB-BASIN	AREA (acres)	INFLOW (ac-ft)	PERCENT OF TOTAL INFLOW (%)	RUNOFF "C" VALUE
1	12.16	11.6	1.9	0.225
2	32.93	16.2	2.6	0.116
3	5.44	2.4	0.4	0.104
4	137.77	57.0	9.2	0.098
5	24.13	14.4	2.3	0.141
6	21.55	9.3	1.5	0.102
7	40.38	29.4	4.7	0.172
8	3.19	2.3	0.4	0.170
9	143.97	199.4	32.1	0.327
10	87.86	141.7	22.8	0.381
11	7.84	6.1	1.0	0.184
12	3.34	2.3	0.4	0.163
13	3.68	2.6	0.4	0.167
14	5.29	3.8	0.6	0.170
15	5.07	3.7	0.6	0.172
16	6.42	3.9	0.6	0.144
17	16.46	40.6	6.5	0.583
18	8.09	4.4	0.7	0.129
19	10.01	2.7	0.4	0.064
20	8.61	17.9	2.9	0.491
21	23.72	31.7	5.1	0.316
22	21.40	18.1	2.9	0.200
TOTALS:	**629.3**	**621.5**	**100.0**	**0.233**[1]

1. Weighted basin average

4.1.3 Dry Weather Baseflow

ERD field personnel performed ongoing visual observations of the various sub-basin areas discharging to Lakes May, Shipp, and Lulu during the monitoring program to identify areas where significant dry weather baseflow inputs may occur into the evaluated lakes. During these observations, measurable baseflow inputs were observed at only one of the identified inflows entering the lakes. This dry weather baseflow occurred through an earthen, partially vegetated canal which discharges into Lake Shipp along the southeast side of Lake Shipp Park. This canal receives drainage from Lake Shipp sub-basin 12, which has a combined area of 126.4 acres, and is the largest single sub-basin area discharging into Lake Shipp. The dry weather baseflow observed at this site appears to be primarily groundwater inflow which occurs into the canal and associated drainage system between storm events.

A stormwater monitoring program was conducted by ERD as part of this project which included a flow monitoring and sample collection site within the canal for sub-basin 12 upstream from the point of inflow into Lake Shipp. Specific details of these monitoring activities are given in Section 5. A continuous record of flow discharges at this site was maintained by ERD over the period from October 2005-April 2006. A graphical summary of measured mean daily flow rates at this site from October 2005-April 2006 is given in Figure 4-1. Peaks in the discharge rates are obvious for significant storm events which occurred within the basin. However, between storm events, a measurable low level baseflow was observed discharging through the canal. During the period from October 2005-April 2006, this baseflow averaged approximately 0.04 cfs in the absence of rain events. As seen in Figure 4-1, the baseflow is relatively constant under dry season conditions as well as during October which typically reflects maximum wet season hydrologic conditions. Since baseflow appears to be relatively constant throughout the year, the observed baseflow of 0.04 cfs is assumed to reflect mean annual conditions.

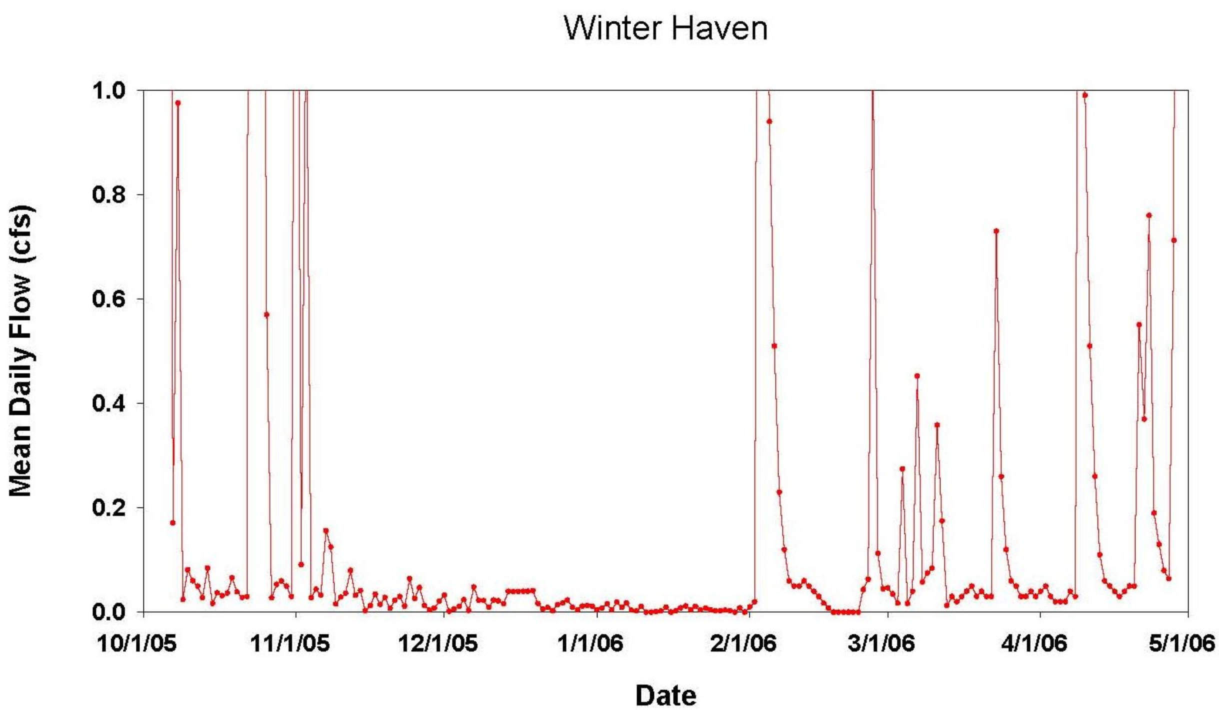


Figure 4-1. Measured Flow Rates from Lake Shipp Sub-basin 12 from October 2005-April 2006.

An estimate of the total inflow into Lake Shipp from dry weather baseflow on an average annual basis was generated by multiplying the mean average baseflow rate of 0.04 cfs times 365 days. Based upon this analysis, baseflow inputs from Lake Shipp sub-basin 12 contributed approximately 28.96 ac-ft of water into Lake Shipp. No other significant baseflow inputs are assumed to occur within the Lakes May, Shipp, or Lulu drainage basins.

4.1.4 Flow Between Interconnected Lakes

4.1.4.1 Measurement Techniques

Lakes within the southern Winter Haven Chain-of-Lakes are interconnected through a series of navigable channels, which provide a mechanism for stabilizing water levels within the chain, a means for discharging excess water, and navigational access between the interconnected waterbodies. A field monitoring program was conducted by ERD from October 2005-April 2006 to quantify water exchange into and out of Lakes May, Shipp, and Lulu. Locations used for monitoring interconnected lake flow are indicated on Figure 4-2. Flow monitoring was conducted at a total of five separate locations, including the Lake Howard-Lake May canal, the Lake May-Lake Shipp canal, Lake Shipp-Lake Lulu canal, Lake Eloise-Lake Lulu canal, and the outfall structure from Lake Lulu. Field monitoring of discharge rates was conducted by ERD personnel on approximately a biweekly basis at each of the five channels indicated on Figure 4-2. Four of these sites are located in navigable channels, ranging in width from 25-35 ft, where the flow regime is confined between two well-defined walls. Water depths at these sites were typically 3-5 ft. In contrast, the canal leading to the outfall structure from Lake Lulu is a poorly defined earthen channel with variable physical characteristics.

ERD personnel performed biweekly field measurements of flow rates at each of the five monitoring sites using the velocity/cross-sectional area method. Velocity measurements were performed at known distances across each channel cross-section using a Sontek Acoustic Doppler Velocity (ADV) meter. In general, the distance between measurements ranged from 2-3 ft. The spacing between the velocity measurements was determined in the field such that not more than 10% of the total flow is represented by any one vertical cross-section. The depth at each section was also simultaneously measured using a graduated metal rod. A graduated tape was stretched across each channel so that reference locations could be determined for each simultaneous measurement of velocity and water depth. The Sontek ADV meter used by ERD for this project reflects state-of-the-art instrumentation for velocity measurements in open channels. The minimum reliable detection limit for this instrument is approximately 0.01-0.02 ft/sec compared with a minimum detection limit of approximately 0.1-0.2 ft/sec for most other types of instruments.

If the water depth was less than 2.5 ft at a measurement point, the velocity was measured at 60% of the total water depth. If the water column depth exceeded 2.5 ft at a measurement point, velocity measurements were performed at 20% and 80% of the total water depth, with the mean section velocity determined by taking the average of the two measurements. The velocities were then integrated over each of the cross-sectional areas to determine the total discharge through the section on each monitoring date.

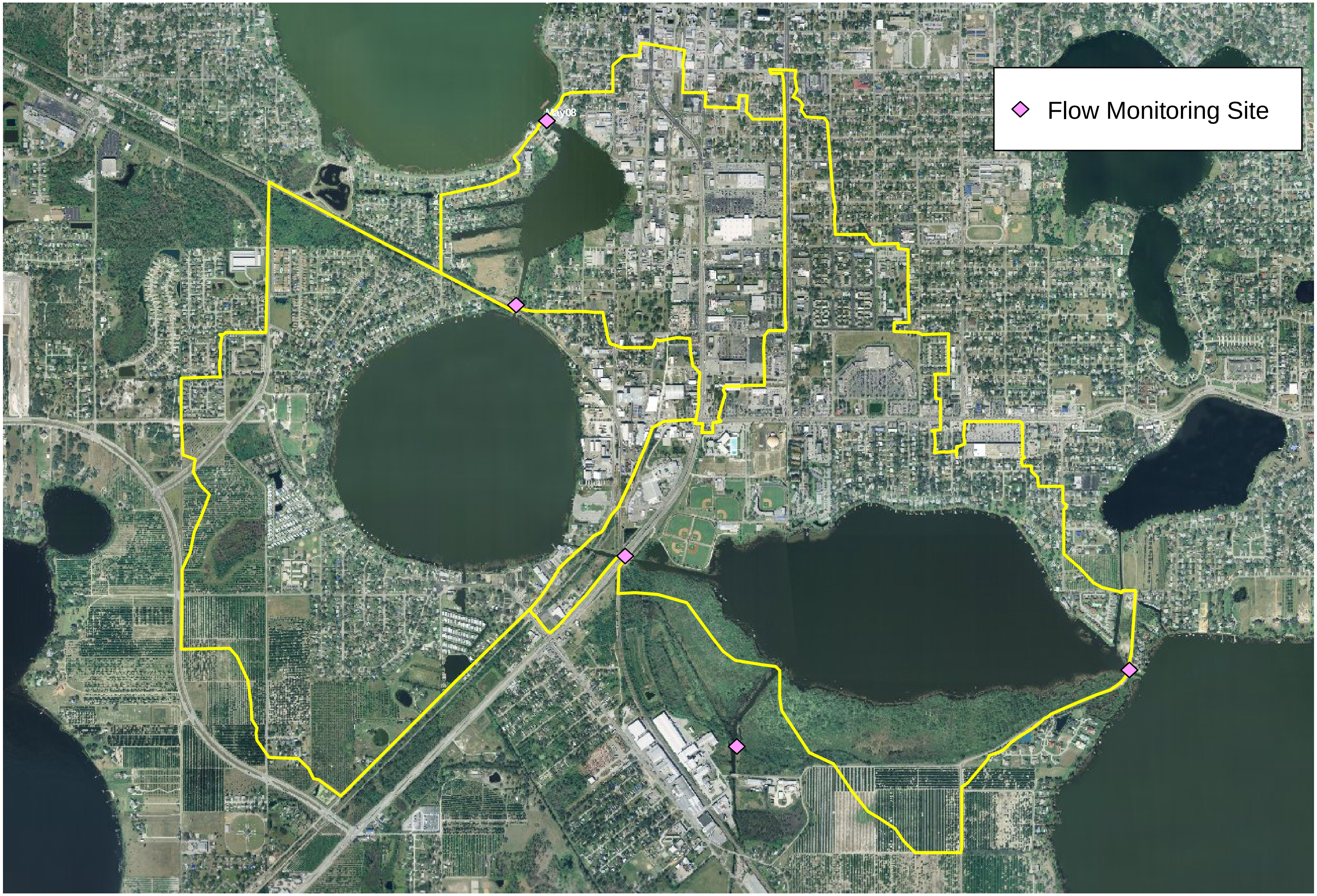


Figure 4-2. Flow Monitoring Sites Used by ERD from October 2005-April 2006.

4.1.4.2 Discharge Characteristics

A summary of field measured discharges at the five monitoring sites from October 2005-April 2006 is given in Table 4-8. Flow monitoring was conducted during 14 separate events performed at approximately two-week intervals. In general, measured discharge rates between the interconnected channels were highly variable, ranging from approximately -40 to +60 cfs at the individual sites. All flow measurements listed in Table 4-8 are referenced with respect to the outfall for the southern Chain-of-Lakes, located on the south side of Lake Lulu. Measurements which indicate a flow pattern in the direction of Lake Lulu are assigned positive values, while flow measurements indicating discharges away from Lake Lulu are assigned negative values. For example, flow measurements conducted on December 28, 2005 indicate negative values for the Howard-May canal, May-Shipp canal, and Eloise-Lulu canals. The negative signs associated with these values indicate that water movement on these dates was from Lake May to Lake Howard, Lake Shipp to Lake May, and from Lake Lulu to Lake Eloise. A positive discharge was measured within the Shipp-Lulu canal, indicating a positive discharge from Lake Shipp into Lake Lulu.

TABLE 4-8

FIELD MEASURED DISCHARGE RATES AT THE CANAL MONITORING SITES

DATE	MEASURED FLOW RATE (cfs)					WIND SPEED (mph)	WIND DIRECTION (degrees and compass)
	Howard-May Canal	May-Shipp Canal	Shipp-Lulu Canal	Eloise-Lulu Canal	Lulu Outfall		
9/30/05	-11.54	-6.84	4.66	7.29	< 1.8[1]	3.4	67 ENE
10/13/05	7.08	7.40	14.37	1.31	< 1.8[1]	3.8	1 N
11/7/05	16.41	23.92	22.52	20.38	< 1.8[1]	4.7	102 ESE
11/22/05	--	44.97	41.56	--	< 1.8[1]	8.8	255 WSW
12/15/05	2.48	-38.53	-43.41	--	< 1.8[1]	10.5	175 S
12/28/05	-19.47	-23.10	11.28	-5.70	< 1.8[1]	5.0	183 S
1/3/06	59.43	60.97	49.40	-63.98	< 1.8[1]	5.3	304 WNW
1/12/06	-7.15	-10.34	-10.98	6.09	< 1.8[1]	4.3	156 SSE
1/23/06	-21.10	-21.75	-37.22	8.32	< 1.8[1]	5.9	188 S
2/16/06	-1.66	-21.71	-1.14	-6.72	< 1.8[1]	5.1	139 SE
3/2/06	12.12	10.27	-18.24	2.88	< 1.8[1]	4.7	208 SSW
3/13/06	-39.61	-19.96	9.67	-16.36	< 1.8[1]	6.8	218 SW
3/27/06	-3.44	-0.45	-7.53	4.46	< 1.8[1]	4.2	245 WSW
4/24/06	27.88	29.31	25.34	-14.16	< 1.8[1]	3.9	223 SW

1. Discharge consisting of leaks through outfall structure, no direct discharge

Flow measurements into the Lake Lulu outfall canal were conducted approximately 50 ft upstream from the outfall structure. Photographs of the outfall structure are given in Figure 4-3. The canal width at the monitoring location was approximately 30-35 ft, with a water depth ranging from 3-5 ft. Assuming a canal width of 30 ft and a water depth of 4 ft, the cross-sectional area perpendicular to the direction of flow is approximately 120 ft^2. Velocity measurements performed at this location by ERD personnel from October 2005-April 2006 indicated velocities less than the minimum detectable velocity of 0.01-0.02 ft/sec during all monitoring events. If the minimum useable velocity measurement is assumed to be 0.015 ft/sec, the average of 0.01 and 0.02 ft/sec, the minimum detectable flow rate at this site would be approximately 1.8 cfs. Therefore, even though flow could not be detected at this site by ERD, the actual flow rate at this site could be as high as 1.8 cfs.

The outfall structure consists of a bottom discharging sluice gate which can be raised to discharge water from the Chain. No direct discharges from this structure were observed by ERD during the monitoring program. However, continuous leakage was present through the sluice gate structure, although the flow rate created by this leakage could not be directly measured by ERD. Two 24-inch RCPs are also present at the outfall structure which are used to convey low flow discharges into the downstream creek. Visual flow through this RCP was observed only during August 2005, with a water depth of approximately 1-2 inches within the pipe. This flow level was too shallow to be directly measured in the field. After October 2005, the water level within the canal dropped below the invert of the RCPs and no further discharges occurred through this conveyance, although leakage was still present through the outfall structure.

As seen in Table 4-8, field measured discharge rates at the remaining canal monitoring sites were highly variable, with both negative and positive flow measurements observed throughout the monitoring program. A high level of confidence is present in the flow measurements summarized in Table 4-8 due to the well defined conveyance channels, relatively shallow water depth (3-5 ft), and accuracy of the velocity monitoring equipment. However, the magnitude of the observed flow rates is clearly too high for the relatively dry conditions observed throughout the monitoring program.

Further evaluations were performed on the discharge data summarized in Table 4-8 to evaluate the impact of wind speed and wind direction on measured discharge rates. Wind speed and direction were measured by ERD at each monitoring site during all flow measurement events. The wind speed values summarized in Table 4-8 reflect the overall mean value for the four interconnected lake monitoring sites on each measurement date. The listed wind direction (in degrees) also reflects the average of wind direction at the four sites. A general compass direction is also included for each measurement.

Various plots of flow rates vs. wind speed and wind direction were generated by ERD. A good correlation was observed between measured flow rates and both wind speed and wind direction. When the wind direction originated from the south or southeast, negative discharge rates were measured at many of the monitoring sites. These values suggest that, under these conditions, water is migrating away from Lake Lulu into upper reaches of the southern Chain. When the wind direction is from the north and east, most of the measured flow rates appear to be positive. This behavior suggests that the flow rates measured by ERD were primarily wind-induced currents and not necessarily an indication of net water movement. It is likely that, for the events which recorded negative discharge rates, a flow reversal to a positive direction occurred during the calmer night-time conditions with little or no net water movement. Since water was not significantly discharging from the outfall structure on Lake Lulu, water movement between the interconnected waterbodies should be relatively minimal, although a slight net migration toward Lake Lulu must occur to replace the constant low flow leakage from the outfall structure.

a. Primary Weir Structure

b. Supplemental 24-inch RCP Outfalls

Figure 4-3. Outfall Control Structure for the Southern Chain-of-Lakes.

4.1.5 Shallow Groundwater Seepage

Field investigations were performed by ERD to evaluate the quantity and quality of shallow groundwater seepage entering Lakes May, Shipp, and Lulu. Groundwater seepage was quantified using a series of underwater seepage meters installed at locations throughout each of the three lakes. Seepage meters provide a mechanism for direct measurement of groundwater inflow into a lake by isolating a portion of the lake bottom so that groundwater seeping up through the bottom sediments into the lake can be collected and characterized. Use of the direct seepage meter measurement technique avoids errors, assumptions, and extensive input data required when indirect techniques are used, such as the Gross Water Budget or Subtraction Method, as well as computer modeling and flow net analyses.

With installation of adequate numbers of seepage meters and proper placement, seepage meters can be a very effective tool to estimate groundwater-surface water interactions. Seepage inflow is generally greatest along the perimeter of a waterbody, and the majority of seepage meters are placed in shallow shoreline areas. Seepage inflow decreases with distance from the shoreline, and fewer seepage meters are placed in central portions of a lake. Placement of seepage meters should also consider variability in upland land uses, topography, and sewage disposal techniques to properly characterize groundwater inflows to a lake. The seepage meter technique has been recommended by the U.S. Environmental Protection Agency (EPA) and has been established as an accurate and reliable technique in field and tank test studies (Lee, 1977; Erickson, 1981; Cherkauer and McBride, 1988; Belanger and Montgomery, 1992). One distinct advantage of seepage meters is that seepage meters can provide estimates of both water quantity and quality entering a lake system, whereas estimated methods can only provide information on water quantity.

4.1.5.1 Seepage Meter Construction and Locations

A schematic of a typical seepage meter installation used in Lakes May, Shipp, and Lulu is given in Figure 4-4. Seepage meters were constructed from a 2-ft diameter aluminum container with a closed top and open bottom. Each seepage meter isolated a sediment area of approximately 3.14 ft^2. Seepage meters were inserted into the lake sediments to a depth of approximately 6-9 inches, isolating a portion of the lake bottom. Approximately 3 inches of water was trapped inside the seepage meter above the lake bottom.

A 0.75-inch PVC fitting was threaded into the top of each aluminum container. The 0.75-inch PVC fitting was attached to a female quick-disconnect PVC camlock fitting. A flexible polyethylene bag, with an approximate volume of 40 gallons, was attached to the seepage meters using a quick-disconnect PVC male camlock fitting with a terminal ball valve. Each of the collection bags was constructed of black polyethylene to prevent light penetration into the bag. Light could potentially stimulate photosynthetic activity within the sample prior to collection and result in an undesirable alteration of the chemical characteristics of the sample.

Prior to attachment to the seepage meter, all air was removed from inside the polyethylene collection bag, and the PVC ball valve was closed so that lake water would not enter the collection container prior to attachment to the seepage meter. A diver then connected the collection bag to the seepage meter using the PVC camlock fitting. After attaching the collection bag to the seepage meter, the PVC ball valve was then opened. As groundwater influx occurs into the open bottom of the seepage meter, it is collected inside the flexible polyethylene bag.

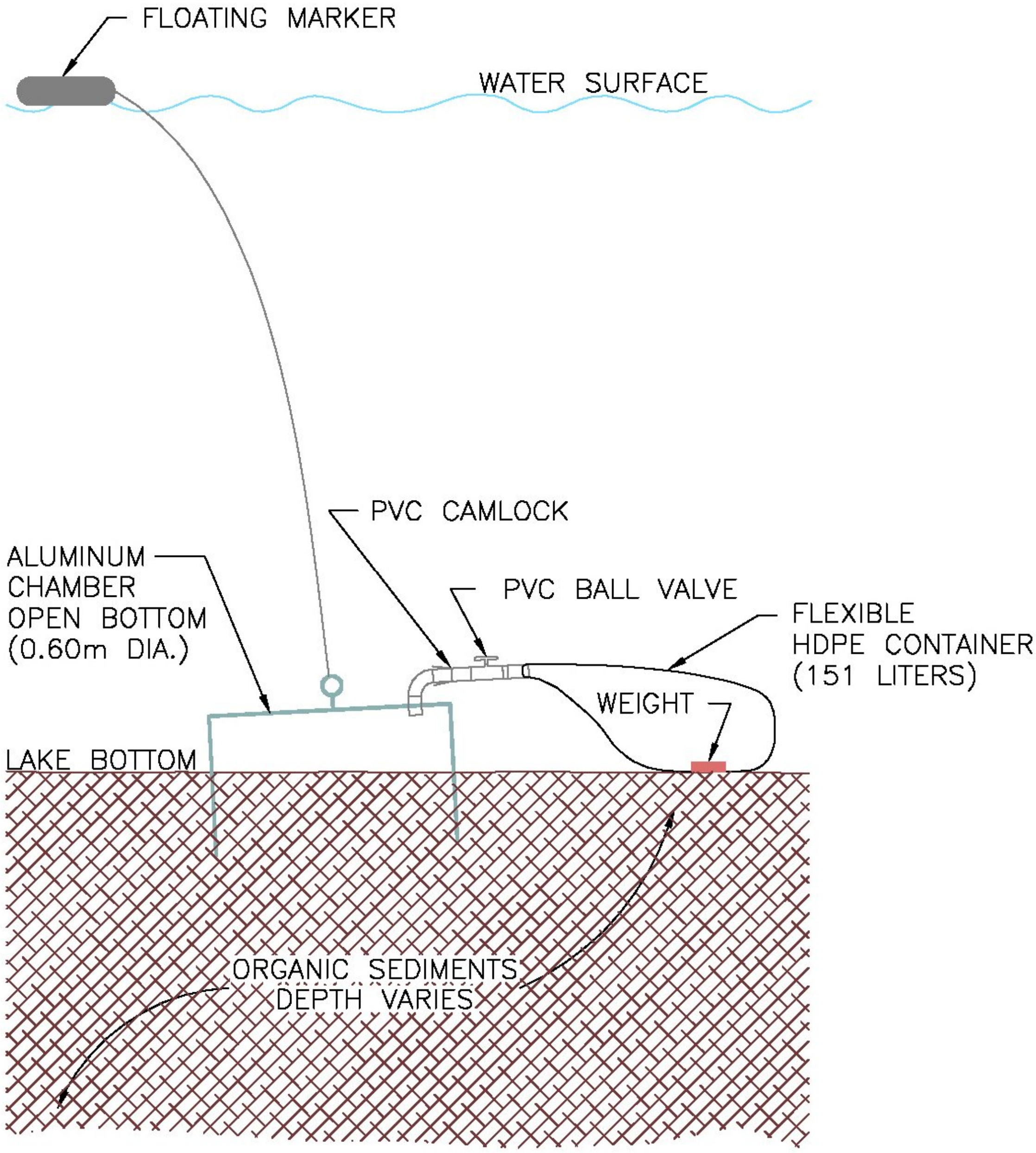


Figure 4-4. Typical Seepage Meter Installation.

Each seepage meter was installed with a slight tilt toward the outlet point so that any gases which may be generated inside the seepage meter would exit into the collection container. A plastic-coated fishing weight was placed inside each of the collection bags to prevent the bags from floating up towards the water surface as a result of trapped gases. The location of each seepage meter was indicated by a floating marker in the lake which was attached to the seepage meter using a coated wire cable.

Twenty-six (26) seepage meters were installed in Lakes May, Shipp, and Lulu during September 2005. Five seepage meters were installed in Lake May, with 10 seepage meters in Lake Shipp and 11 seepage meters in Lake Lulu. Locations for the seepage meters are indicated on Figure 4-5. Since seepage inflow is often most variable around the perimeter of a lake, the majority of the seepage meters were installed around the perimeter of the lakes at a uniform water depth of approximately 5 ft. Seepage meters were also installed in the central portions of each lake in areas of maximum water depth.

Each of the 26 seepage meters was allowed to equilibrate from September-October 2005. During October, collection bags were installed on each of the seepage meters, and the monitoring program was initiated. Each of the 26 seepage meters was monitored on approximately a monthly basis from October 2005-April 2006. Seven (7) separate seepage monitoring events were conducted for evaluation of quantity and quality at each of the monitoring sites, with a total of 155 samples collected between the 26 sites. Each of the seepage meters was removed at the end of the monitoring program.

A supplemental groundwater seepage monitoring program was initiated during July 2008. Seepage meters were reinstalled at each of the 26 seepage monitoring sites indicated on Figure 4-5. Each of the 26 seepage meters was allowed to equilibrate from July-August 2008, when collection bags were installed on each of the seepage meters and the supplemental monitoring program was initiated. The seepage meters were monitored on approximately a monthly basis from August-December 2008 to provide estimates of seepage inputs during peak wet season conditions. A total of five separate seepage monitoring events was conducted for evaluation of quantity and quality of each of the monitoring sites, with a total of 86 samples collected between the 26 sites.

4.1.5.2 Seepage Meter Sampling Procedures

After the initial installation of collection bags, site visits were performed at monthly intervals to collect the seepage samples. During the collection process, a diver was used to close the PVC ball valve and remove the collection bag from the seepage meter using the quick-disconnect camlock fitting. The collection bag was placed onto the boat and the contents were emptied into a polyethylene container. The volume of seepage collected in the container was measured using either a 4-liter graduated cylinder or a 20-liter graduated polyethylene bucket, depending on the collected volume.

Following the initial purging, seepage meter samples were collected for return to the laboratory for chemical analysis. On many occasions, seepage meter samples were found to contain turbidity or particles originating from the sediments isolated within the seepage meter. Since these contaminants are not part of the seepage flow, all seepage meter samples collected for chemical analyses were field-filtered using a 0.45 micron disposable glass fiber filter typically used for filtration of groundwater samples. A new filter was used for each seepage sample. Seepage samples were filtered immediately following collection using a battery operated peristaltic pump at a flow rate of approximately 0.25 liter/minute. The filtered seepage sample was placed on ice for return to the ERD laboratory for further chemical analyses.

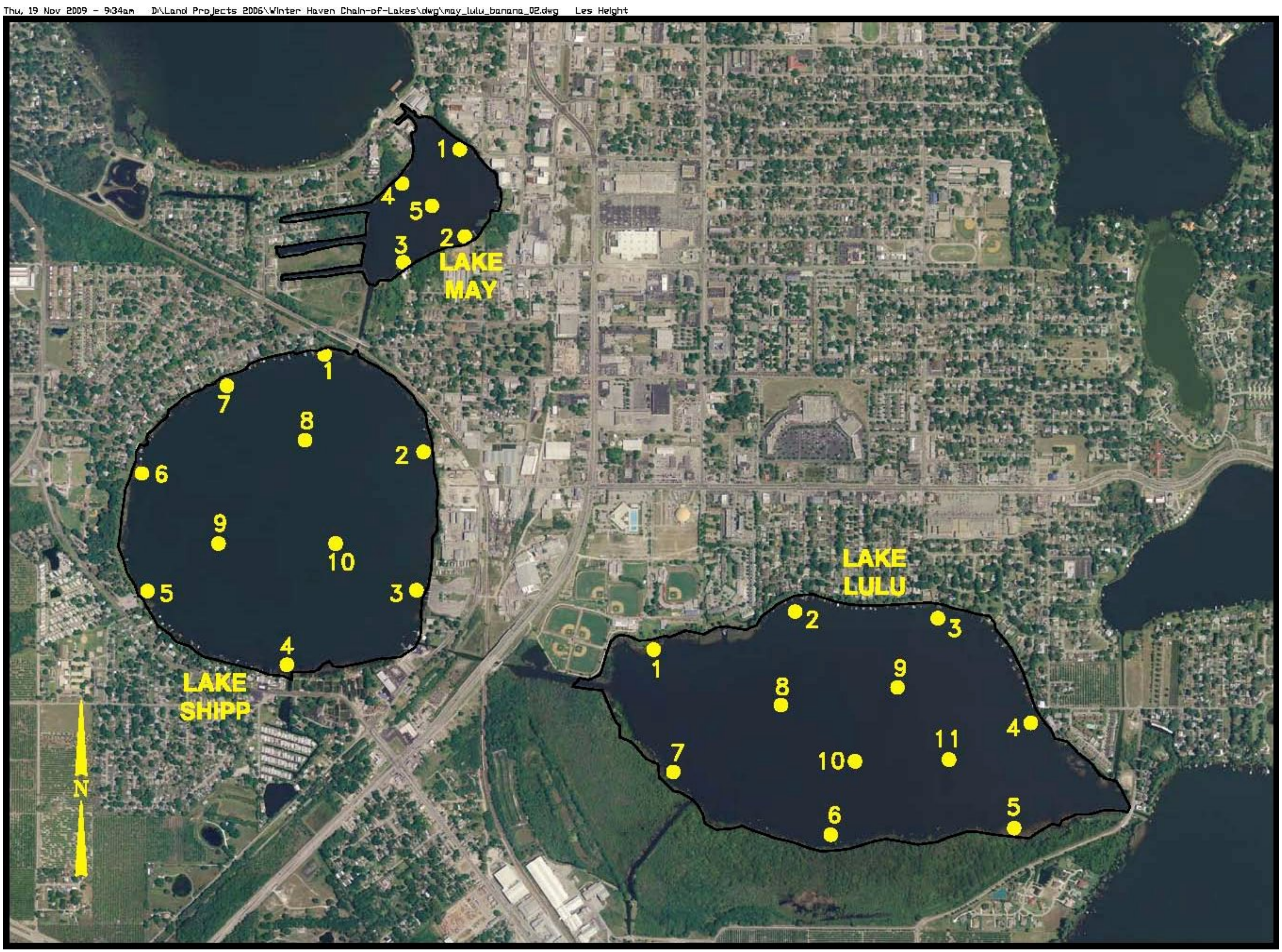


Figure 4-5. Groundwater Seepage Monitoring Sites in Lakes May, Shipp, and Lulu.

A summary of field measurements of seepage inflow over the original monitoring period from October 2005-April 2006 is given in Appendix E.1, with field measurements collected during the supplemental monitoring program from August-December 2008 given in Appendix E.2. During collection of the seepage samples, information was recorded on the time of sample collection, the total volume of seepage collected at each site, and general observations regarding the condition of the seepage collection bags and replacement/repair details. The seepage flow rate at each location is calculated by dividing the total collected seepage volume (liters) by the area of the seepage meter (0.27 m^2) and the time (days) over which the seepage sample was collected.

As seen in Appendix E, a number of seepage meter sites contain missing data for one or more events during both the original and supplemental monitoring programs as a result of missing or damaged collection bags and seepage meters. A large portion of the lost data occurred from seepage meters located in central portions of the lakes where the floats were most visible. Loss of seepage meters was particularly a problem in Lake Lulu, where the centrally located seepage meters appeared to be deliberately damaged or removed. Each of the four centrally located seepage meters in Lake Lulu were replaced by ERD on at least 3-4 separate occasions, but in most cases, the newly installed seepage meters were missing by the time of the next monthly monitoring event. As a result, only 1-2 useable samples were actually collected at the centrally located seepage meter sites in Lake Lulu during the monitoring program. A similar situation was observed with the centrally located seepage meter in Lake May, which was also replaced numerous times. Two useable seepage samples were collected at this site.

4.1.5.3 Seepage Inflow

A summary of mean seepage inflow measurements during both the original and supplemental monitoring programs is given in Table 4-9. Mean seepage inflow for a given site is calculated as the total seepage volume collected over the monitoring period divided by the cumulative time over which the measurements were taken.

Mean seepage values measured at the monitoring sites during the original monitoring period (October 2005-June 2006) range from 0.46-6.91 liters/m^2-day, with the majority of mean values ranging from approximately 1-2 liters/m^2-day. Mean seepage values measured during the supplemental monitoring period (July-December 2008) range from approximately 0.40-4.28 liters/m^2-day. However, virtually all of the mean values are approximately 1 liter/m^2-day or less.

The mean seepage values summarized on Table 4-9 were combined with the geographic coordinates for each site to generate an isopleth contour map for mean seepage inflow into the three lakes using the Autodesk Land Desktop 2007 Module for AutoCAD. Separate seepage isopleths were developed for both the original and supplemental monitoring programs. Isopleths of mean seepage inflow into Lakes May, Shipp, and Lulu during the original monitoring program from October 2005-April 2006 are given in Figure 4-6. The range of seepage values indicated on this figure is from <1 to >6 liters/m^2-day. However, much of the area within the Chain-of-Lakes appears to exhibit relatively low seepage inflow, with large portions of the lake areas indicating seepage of approximately 1-2 liter/m^2-day or less.

TABLE 4-9

STATISTICAL SUMMARY OF SEEPAGE INFLOW MEASUREMENTS DURING THE ORIGINAL AND SUPPLEMENTAL MONITORING PROGRAMS

LAKE	SITE	ORIGINAL MONITORING (OCT. 2005-APRIL 2006)		SUPPLEMENTAL MONITORING (JULY-DEC. 2008)	
		MEAN VALUE (liters/m^2-day)	NUMBER OF SAMPLES	MEAN VALUE (liters/m^2-day)	NUMBER OF SAMPLES
May	1	6.91	6	0.54	3
	2	0.77	5	1.01	3
	3	4.96	7	0.40	3
	4	2.84	6	0.92	3
	5	0.63	3	--	0
	Mean	3.22		0.72	
Lulu	1	1.28	6	0.82	3
	2	5.00	6	2.53	3
	3	1.69	7	0.93	3
	4	0.97	6	0.70	2
	5	0.85	6	0.41	2
	6	1.02	4	0.60	2
	7	0.89	5	0.71	2
	8	4.44	2	0.78	1
	9	1.02	3	0.75	3
	10	0.46	2	0.57	3
	11	2.46	2	0.93	1
	Mean	1.83		0.88	
Shipp	1	0.71	7	1.13	3
	2	3.78	6	3.02	3
	3	1.82	6	0.60	3
	4	1.68	6	1.33	3
	5	1.93	5	1.05	2
	6	3.86	6	4.28	3
	7	1.90	7	0.69	3
	8	1.36	5	0.48	3
	9	0.94	3	0.91	3
	10	0.98	4	1.42	2
	Mean	1.90		1.49	

Elevated seepage inflow rates were observed along the northwest and southwest portions of Lake May, west and northeast portions of Lake Shipp, and northwest portions of Lake Lulu. Most of the areas with elevated seepage inflow are located adjacent to sub-basin areas with permeable soils and a relatively steep topography which enhances the potential for migration of groundwater into the adjacent receiving waterbodies. However, in contrast, areas on the east side of Lake May and the southern side of Lake Lulu contain less permeable soils and are relatively low in topography, resulting in lower seepage inflow from these areas.

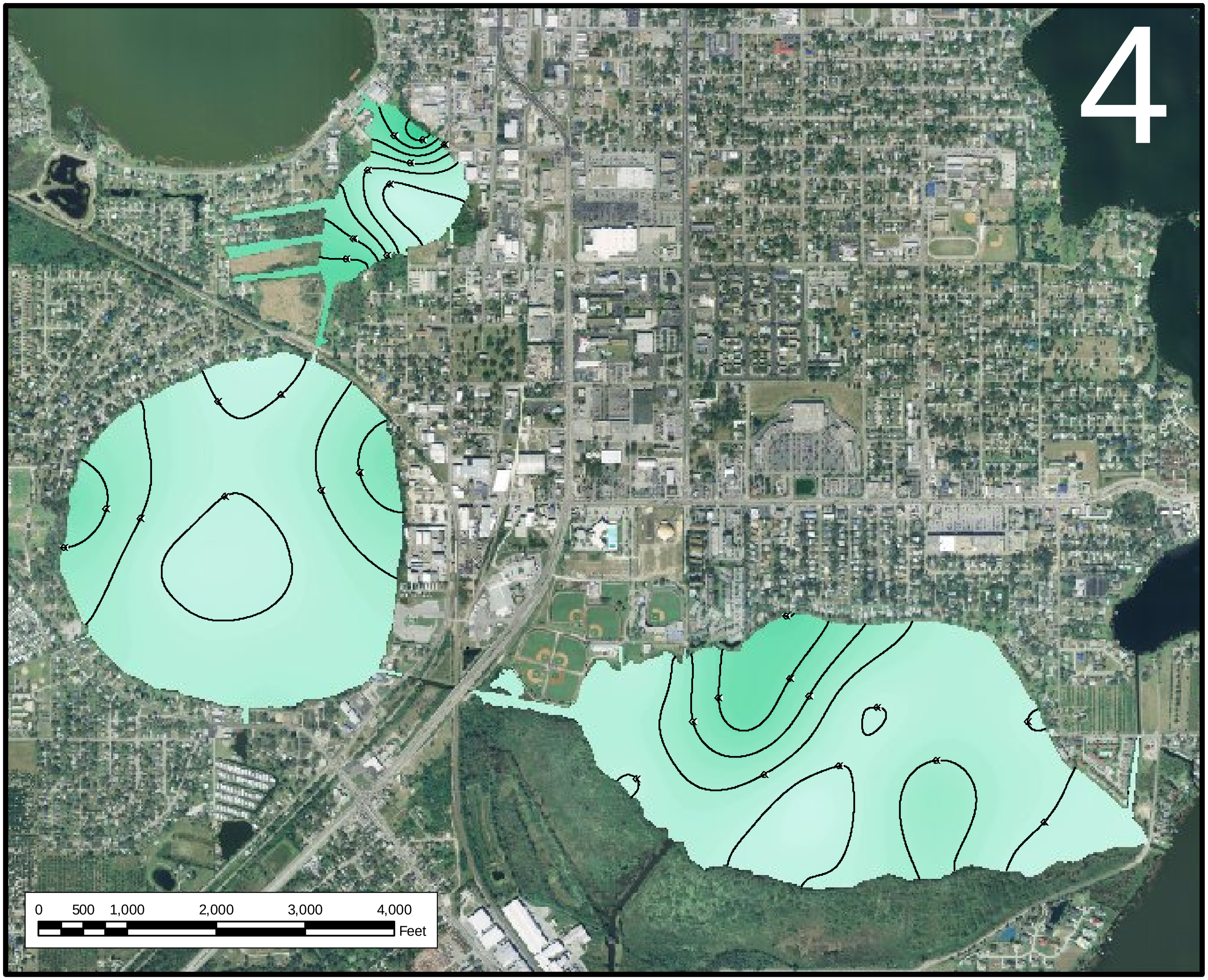


Figure 4-6. Isopleths of Mean Seepage Inflow (liters/m^2-day) to Lakes May, Shipp, and Lulu from October 2005-June 2006.

Isopleths of mean seepage inflow into Lakes May, Shipp, and Lulu from July-November 2008 are given on Figure 4-7. The range of seepage values on this figure is from 0.5-4.0 liters/m^2-day. Much of the areas within the three lakes exhibited relatively low seepage inflow during this period, with large portions of the lake areas indicating seepage of approximately 1 liter/m^2-day or less.

As seen in Table 4-9, mean seepage inflow was substantially lower during the supplemental monitoring program from July-December 2008 than measured during the original monitoring program conducted from October 2005-June 2006. These results were initially surprising since seepage measurements are expected to be greater during wet season conditions than during dry season conditions. However, after reviewing hydrologic conditions which occurred in the three lakes and surrounding watersheds during the two monitoring periods, the differences in seepage rates between the two periods may be explained by differences in long-term rainfall and resulting lake surface elevations.

A comparison of recorded and average monthly rainfall during the original and supplemental monitoring periods is given on Figure 4-8. Information on historical rainfall characteristics in the Winter Haven area was obtained from the National Climatic Data Center (NCDC) for the long-term Winter Haven meteorological station. Rainfall records at this site are available over the period from 1941-2008. These data are used to reflect mean monthly and annual rainfall in the Winter Haven area. A significant rainfall surplus was observed during the initial month for both the original and supplemental monitoring periods. However, substantial deficits in rainfall were observed during five of the next eight months included in the original monitoring program, and during each of the subsequent months included in the supplemental monitoring program.

The total rainfall depth which occurred during the original monitoring program, conducted from October 2005-June 2006, was approximately 23.36 inches compared with mean annual rainfall for this period of 28.77 inches. Overall, total rainfall occurring during the original monitoring program was approximately 19% less than normal. The total rainfall which occurred during the supplemental monitoring program, conducted from August-December 2008, was approximately 16.23 inches, compared with mean average rainfall of approximately 20.60 inches during this period. The cumulative rainfall during the supplemental monitoring program was approximately 21% less than normal. It appears that each of the two monitoring programs was conducted during periods of below-normal rainfall depths. Since groundwater seepage originates from rainfall, the reduced rainfall during the two monitoring periods may cause seepage values to be underestimated compared with values that may be observed during average rainfall conditions.

A summary of annual rainfall in the Winter Haven area from 2005-2008 is given on Table 4-10. Significantly below-normal rainfall was observed during the period from 2005-2007, with near-normal rainfall observed during 2008. Overall, a rainfall deficit of approximately 33.49 inches occurred in the Winter Haven area during the period from 2005-2008. If the rainfall patterns are examined on a monthly basis, a rainfall deficit of approximately 20-25 inches occurred between the end of the original monitoring period and initiation of the supplemental monitoring period. The effects of this rainfall deficit can be observed in Figure 4-9 which provides a comparison of water surface elevations in Lake Shipp during the original and supplemental monitoring programs. Periods of time during which actual field monitoring was conducted during the original and supplemental monitoring programs are indicated by the **red lines** on the figure. In general, water surface elevations in Lake Shipp were approximately 1-2 ft higher during the original monitoring program compared with lake level elevations during the supplemental monitoring program. The observed reductions in lake level elevations are a direct result of the reduction in hydrologic inputs from direct rainfall, runoff, and groundwater seepage between the two monitoring periods.

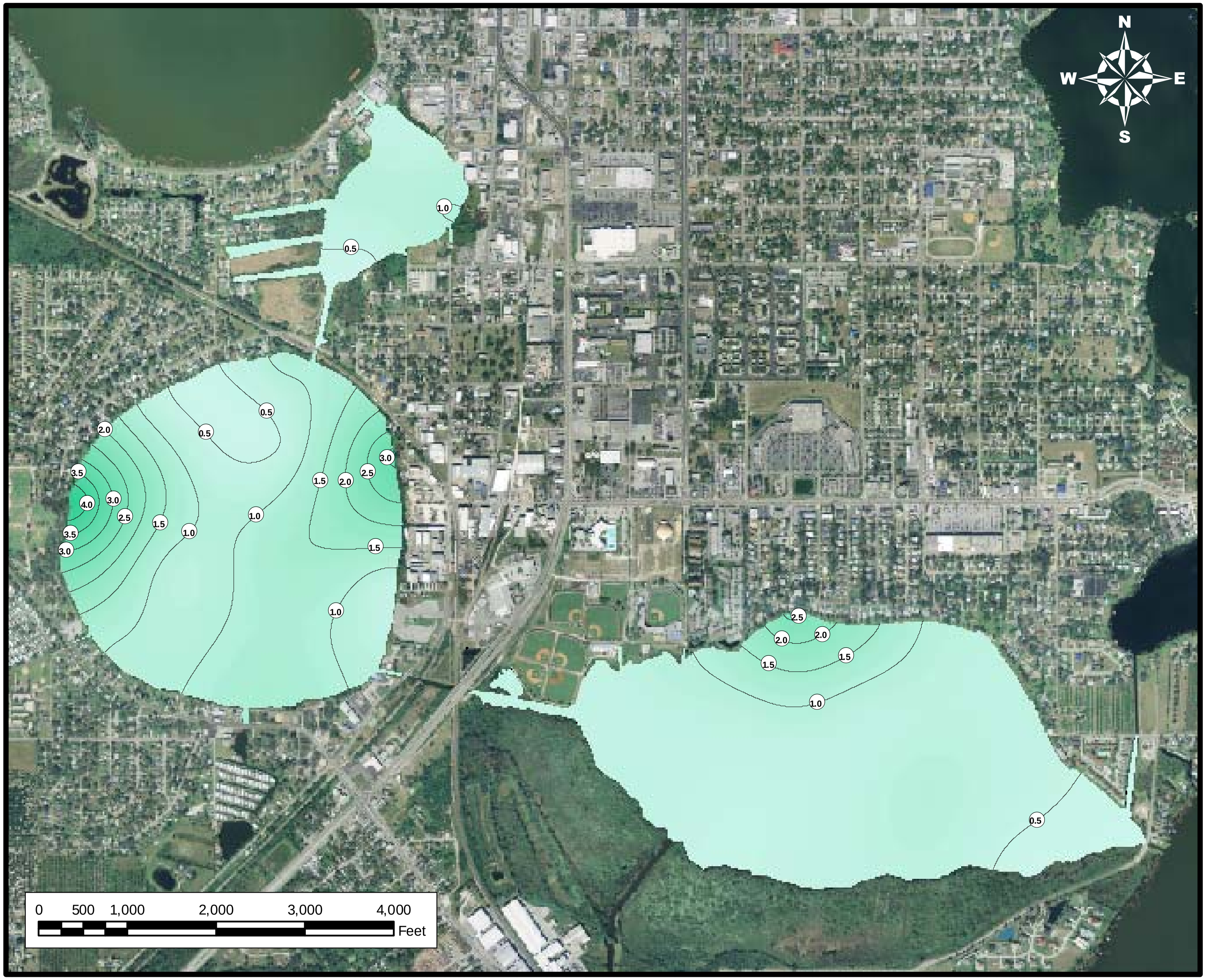
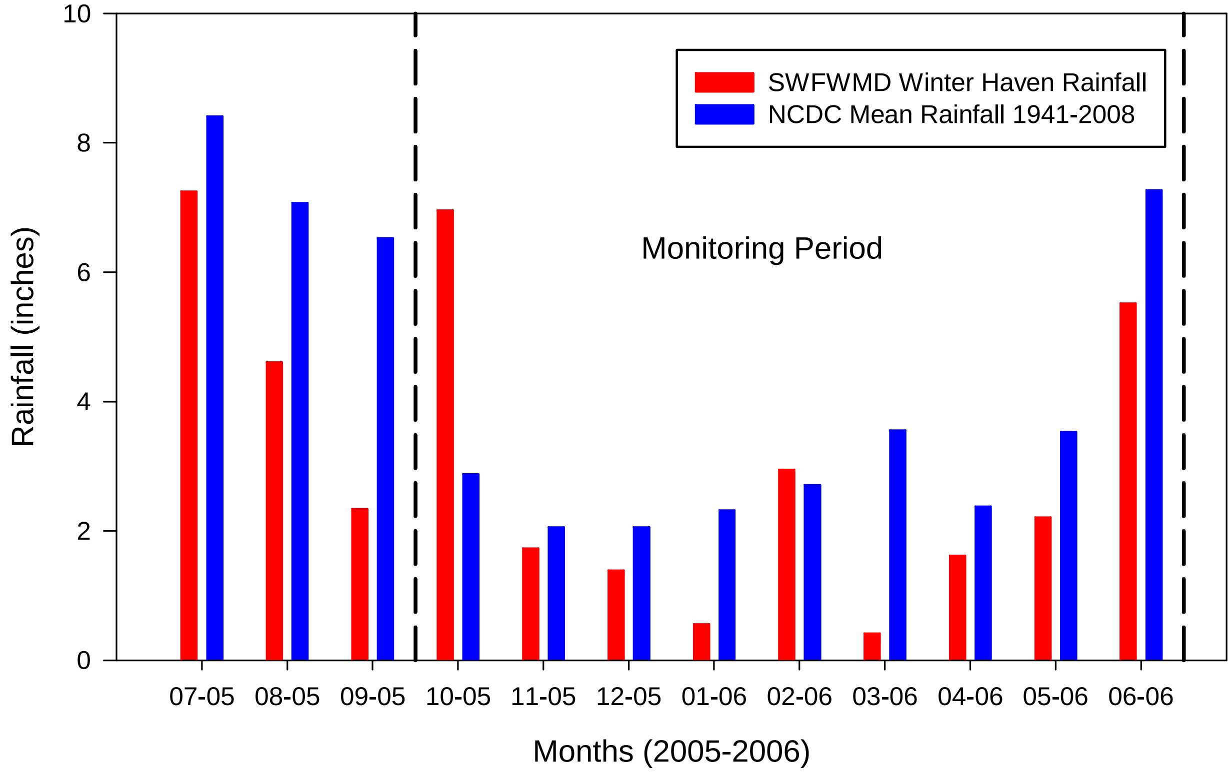


Figure 4-7. Isopleths of Mean Seepage Inflow (liters/m^2-day) to Lakes May, Shipp, and Lulu from August-November 2008.



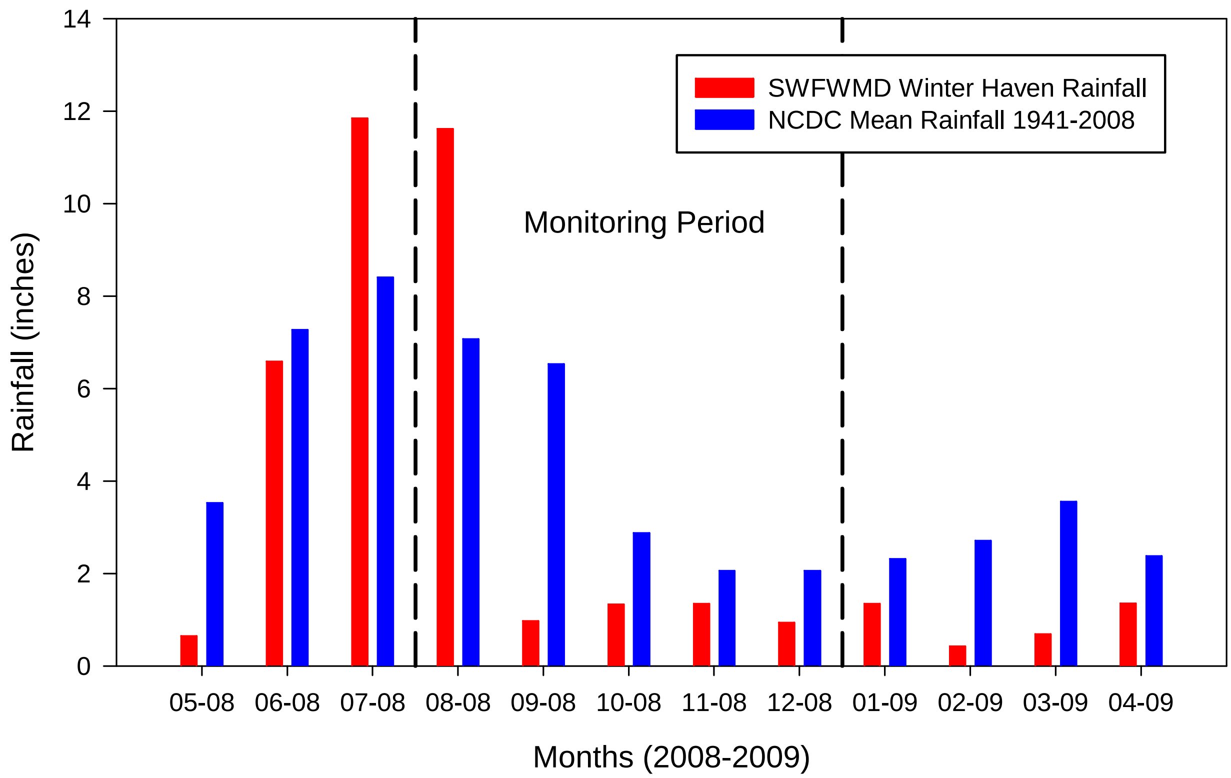
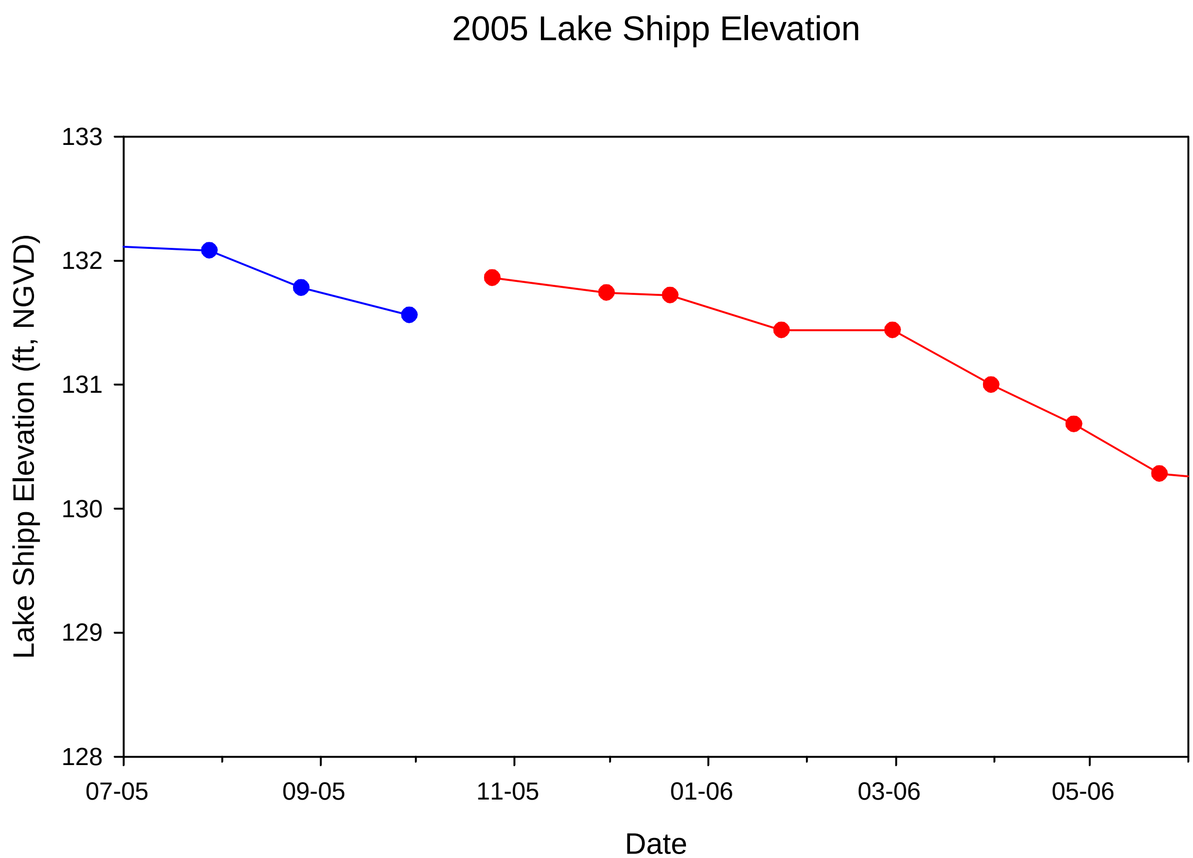


Figure 4-8. Comparison of Measured and Average Monthly Rainfall During the Original and Supplemental Monitoring Periods.



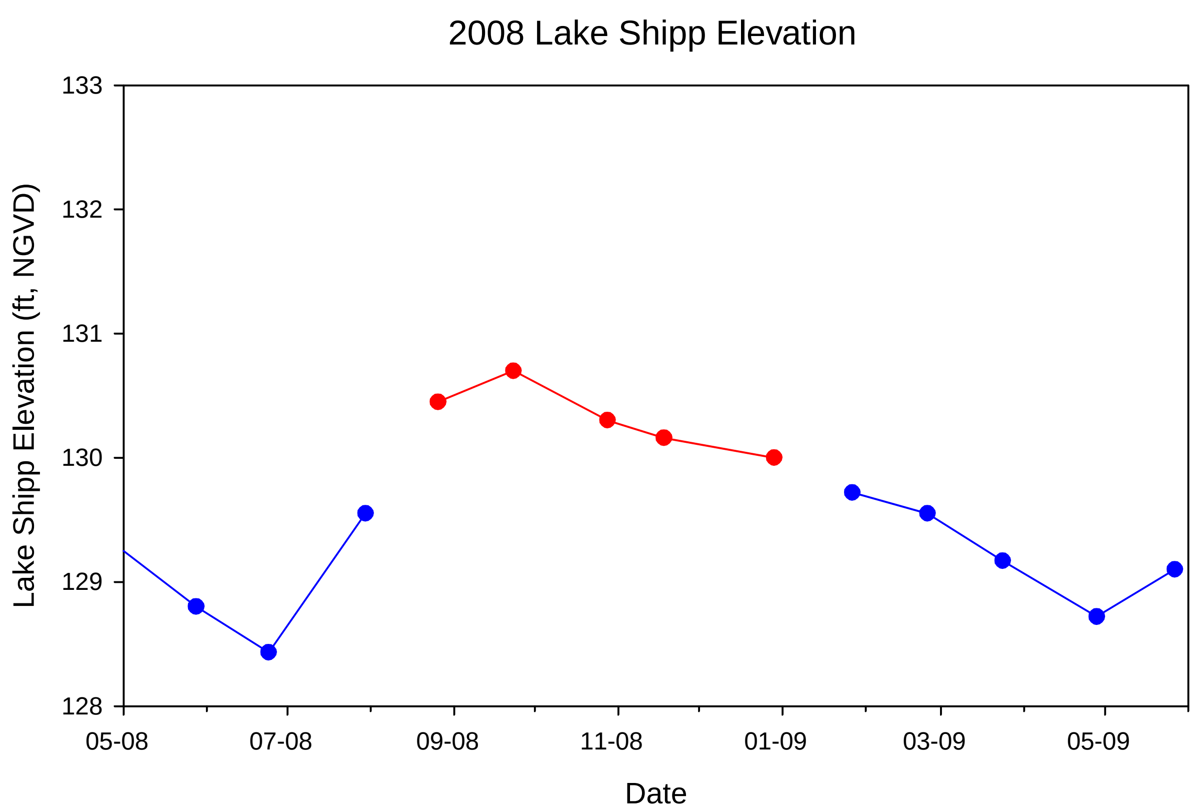


Figure 4-9. Comparison of Water Surface Elevations in Lake Shipp During the Original and Supplemental Monitoring Programs.

TABLE 4-10

MEAN ANNUAL RAINFALL IN THE WINTER HAVEN AREA FROM 2005-2008

YEAR	ANNUAL RAINFALL (inches)	RAINFALL DEFICIT (inches)
2005	43.79	- 6.98
2006	36.40	- 14.37
2007	37.26	- 13.51
2008	52.14	+ 1.37
	TOTAL:	**- 33.49**

A large amount of consideration was given concerning the most appropriate method of merging the isopleths conducted during the original (Figure 4-6) and supplemental (Figure 4-7) monitoring periods. The original intent of the supplemental monitoring was to provide additional seepage inflow data during wet season conditions. Unfortunately, these data are compromised due to the extended period of rainfall deficit which occurred between the two monitoring programs. However, since both the original and supplemental monitoring programs provide information on actual seepage inflows into the lakes, a decision was made to merge the two data sets and generate a mean seepage inflow value for each site in each lake from the two data sources. However, it is likely that the estimated seepage inflow indicated by this analysis will underestimate seepage inputs during normal rainfall conditions.

A summary of the combined estimated annual seepage isopleths for Lakes May, Shipp, and Lulu is given on Figure 4-10. These isopleths were obtained using the numerical average of the seepage inflow rates measured during the original and supplemental monitoring programs. For purposes of this evaluation, the isopleths summarized in Figure 4-10 are assumed to reflect annual seepage inflow to each of the three lakes.

The seepage isopleths indicated on Figure 4-10 were graphically integrated to obtain estimates of mean daily seepage influx into each of the three lakes. This mean value was converted into an estimated annual seepage volume by multiplying the mean daily values by the 365 days. A summary of estimated annual seepage inputs into each of the evaluated lakes is given in Table 4-11. Annual seepage inputs range from 120 ac-ft in Lake May to 401 ac-ft in Lake Shipp.

Calculated seepage/surface area ratios for each lake are provided in the final column of Table 4-11. These values provide an estimate of seepage inflow in terms of a water depth over the entire lake surface and provides a method for comparing relative seepage inflow between the lakes without consideration of lake area. The overall average seepage/surface area ratio for the three lakes is 1.70. Higher than average seepage inflow was observed in Lake May, while lower than average seepage was observed in Lake Shipp and Lake Lulu. The seepage inflows listed on Table 4-11 are utilized in subsequent sections for development of an overall hydrologic budget for the three lakes.

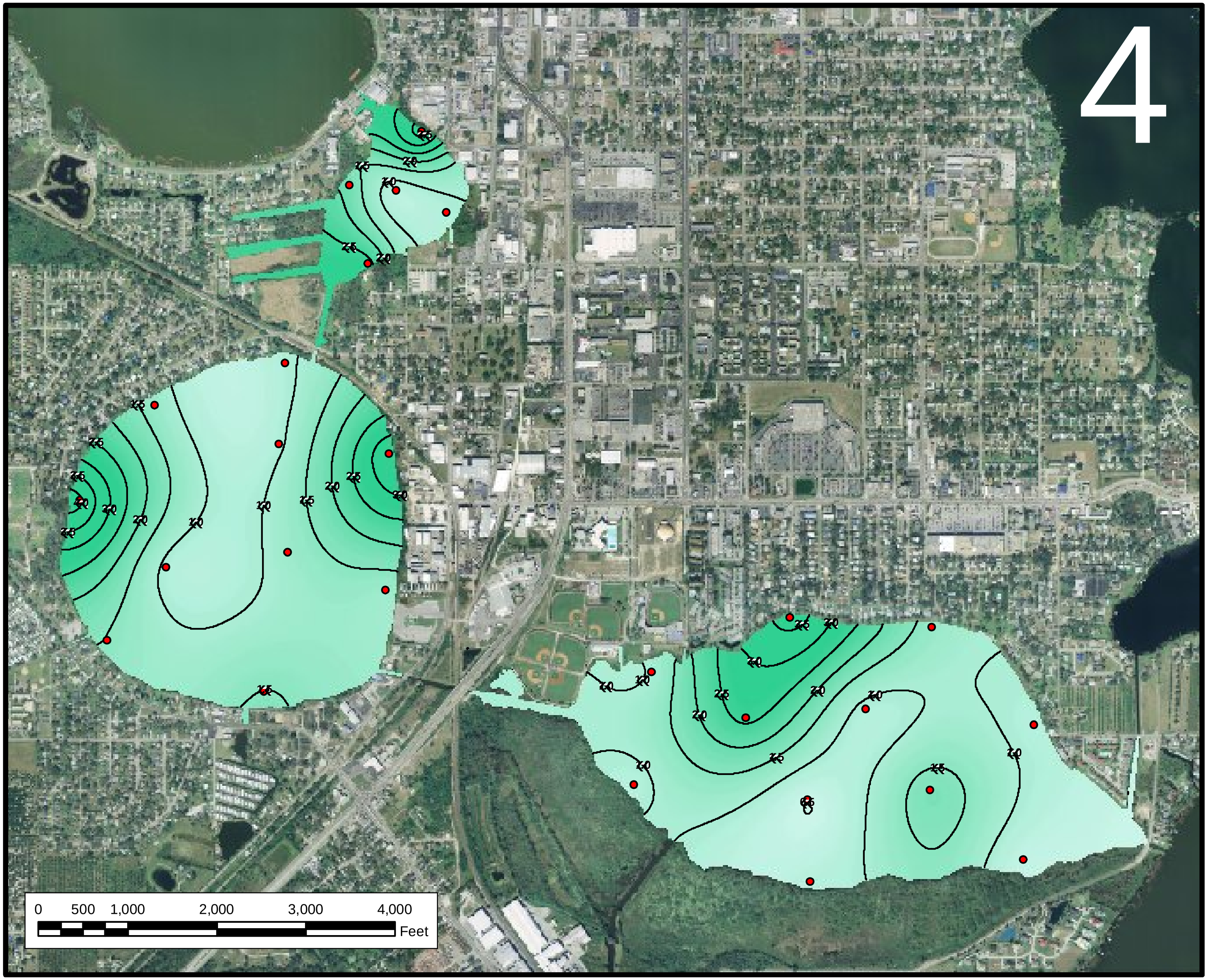


Figure 4-10. Combined Estimated Annual Seepage Isopleths for Lakes May, Shipp, and Lulu.

TABLE 4-11

ESTIMATED ANNUAL SEEPAGE INFLOW TO LAKES MAY, SHIPP, AND LULU FROM OCTOBER 2005-APRIL 2006

LAKE	SURFACE AREA (acres)	SEEPAGE INFLOW (ac-ft/yr)	SEEPAGE / SURFACE AREA RATIO (ft)
May	50.54	120	2.37
Shipp	276.4	401	1.45
Lulu	307.0	393	1.28
		MEAN:	**1.70**

4.2 Hydrologic Losses

Hydrologic losses were estimated for each of the three lakes resulting from evaporation, deep groundwater recharge, and discharges to downstream waterbodies. Estimated losses from these sources are summarized in the following sections.

4.2.1 Evaporation Losses

4.2.1.1 Methodology

A Class A pan evaporimeter was installed by ERD during September 2005 at the hydrologic monitoring site adjacent to the Chain-of-Lakes baseball complex, approximately 100 ft south of the Lake Lulu alum injection equipment building. The pan evaporimeter was equipped with a sensitive water level recorder which kept a continuous record of changes in water surface elevations within the pan. Daily pan evaporation was calculated as the change in water surface elevation after correcting for rainfall inputs, if any. Lake evaporation was calculated as 70% of the pan evaporation which is the commonly assumed factor for this conversion.

A summary of monthly pan and lake evaporation measured at the Chain-of-Lakes complex monitoring site from October 2005-April 2006 is given in Table 4-12. Calculated lake evaporation rates range from a low of 2.45 inches during December to a high of 5.92 inches during April. The total lake evaporation at the monitoring site from October 2005-April 2006 is 26.94 inches. A summary of mean monthly long-term lake evaporation measured at the Lake Alfred experimental station from 1980-1998 is provided in the final column of Table 4-12. Monthly lake evaporation measured by ERD at the Chain-of-Lakes complex appears to be similar to long-term lake evaporation data measured at the Lake Alfred experimental station.

In view of the relatively close agreement between the measured and mean evaporation rates summarized in Table 4-12, it was decided to utilize the historical Lake Alfred monitoring data for lake evaporation estimates over an annual cycle. A summary of historical mean monthly lake evaporation data measured at the Lake Alfred monitoring station from 1980-1998 is given in Table 4-13. The total annual lake evaporation is assumed to be 52.40 inches. For the purposes of this analysis, monthly and annual lake evaporation is assumed to be reflected by the values summarized in Table 4-13.

TABLE 4-12

MONTHLY PAN AND LAKE EVAPORATION MEASURED AT THE CHAIN-OF-LAKES MONITORING COMPLEX SITE FROM OCTOBER 2005-APRIL 2006

MONTH	PAN EVAPORATION (inches)	LAKE EVAPORATION (inches)	LAKE EVAPORATION AT THE LAKE ALFRED EXPERIMENTAL STATION (1980-1998)
Oct. 2005	5.05	3.79	4.12
Nov. 2005	4.25	3.19	2.94
Dec. 2005	3.27	2.45	2.39
Jan. 2006	4.20	3.15	2.60
Feb. 2006	4.12	3.09	3.33
March 2006	7.13	5.35	4.56
April 2006	7.89	5.92	5.46
TOTAL:	**35.91**	**26.94**	**25.40**

TABLE 4-13

HISTORICAL LAKE EVAPORATION DATA MEASURED AT THE LAKE ALFRED MONITORING SITE FROM 1980-1998

MONTH	MEAN PAN EVAPORATION (inches)	LAKE EVAPORATION[1] (inches)
January	3.72	2.60
February	4.76	3.33
March	6.51	4.56
April	7.80	5.46
May	8.99	6.29
June	8.10	5.67
July	7.75	5.43
August	7.13	4.99
September	6.60	4.62
October	5.89	4.12
November	4.20	2.94
December	3.41	2.39
TOTALS:	**74.86**	**52.40**

1. Estimated as 70% of the pan evaporation

4.2.1.2 Hydrologic Losses

A summary of estimated evaporation losses for Lakes May, Shipp, and Lulu from October 2005-April 2006 is given in Table 4-14. The values summarized in this table were obtained by multiplying the lake surface areas summarized in Table 2-4 times the mean monthly historical lake evaporation summarized in Table 4-13. This information is utilized for estimation of hydrologic budgets for each of the evaluated lakes. On an annual basis, evaporation losses removed 2769 ac-ft of water from Lakes May, Shipp, and Lulu.

TABLE 4-14

ESTIMATED MEAN MONTHLY EVAPORATION LOSSES FROM LAKES MAY, SHIPP, AND LULU

MONTH	MONTHLY LAKE EVAPORATION (inches)	HYDROLOGIC LOSSES (ac-ft)		
		LAKE MAY[1]	LAKE SHIPP[2]	LAKE LULU[3]
January	2.60	10.95	59.89	66.52
February	3.33	14.02	76.70	85.19
March	4.56	19.21	105.0	116.7
April	5.46	23.00	125.8	140.0
May	6.29	26.49	144.9	160.9
June	5.67	23.88	130.6	145.1
July	5.43	22.87	125.1	138.9
August	4.99	21.02	114.9	127.7
September	4.62	19.46	106.4	118.2
October	4.12	17.35	94.90	105.4
November	2.94	12.38	67.72	75.21
December	2.39	10.07	55.05	61.14
TOTALS:	**52.40**	**220.7**	**1207.0**	**1341.0**

1. Based on a lake surface area of 50.54 acres
2. Based on a lake surface area of 276.4 acres
3. Based on a lake surface area of 307.0 acres

4.2.2 Deep Recharge

4.2.2.1 Methodology

Hydrologic losses from deep recharge occur as a result of continuous seepage of water through the bottom of the lake into deeper groundwater aquifers. This recharge typically occurs in the deepest portions of the lake which have the lowest hydraulic head between the lake bottom and the deep aquifer. This process occurs simultaneously with seepage inflow which primarily represents movement of shallow groundwater into the lake above the initial confining layer.

The magnitude of the deep recharge component was estimated using the recharge information obtained from the SWFWMD GIS database. This database provides estimates of annual deep recharge for all portions of Polk County. The data are provided in the form of rectangular polygons, with a range of annual deep recharge rates for all lakes located within each individual polygon. All of Lake May is included in a single polygon area, and the mean annual recharge is assumed to be the median of the listed recharge range. Lakes Shipp and Lulu overlap two different polygon areas, and a weighted recharge value was calculated for each lake based upon the percentage of lake area contained within each different polygon and the median recharge value for the polygon area.

4.2.2.2 Hydrologic Losses

A summary of estimated annual hydrologic losses from deep recharge in Lakes May, Shipp, and Lulu is given in Table 4-15. On an average annual basis, approximately 38 ac-ft/yr of water is lost from Lake May due to deep recharge, with 224 ac-ft/yr lost from Lake Shipp and 252 ac-ft/yr lost from Lake Lulu. The estimated hydrologic losses summarized in Table 4-14 should be viewed as rough estimates only due to the relatively coarse nature of the recharge maps.

TABLE 4-15

CALCULATED ANNUAL HYDROLOGIC LOSSES FROM DEEP RECHARGE IN LAKES MAY, SHIPP, AND LULU

LAKE	LAKE AREA (acres)	RECHARGE LOSS		
		in/yr	ft/yr	ac-ft/yr
May	50.54	8.92	0.74	38
Shipp	276.4	9.76	0.81	224
Lulu	307.0	9.84	0.82	252

4.3 Hydrologic Model

A mean annual hydrologic model was developed for Lakes May, Shipp, and Lulu based upon the hydrologic inputs and losses summarized in previous sections. Hydrologic inputs and losses were evaluated for each of the three lakes as well as the system as a whole. Since the model is intended to reflect mean annual conditions, change in storage is not considered.

A schematic of the revised annual hydrologic model for Lakes May, Shipp, and Lulu is given in Figure 4-11. The information summarized on this figure is utilized in a subsequent section to develop individual hydrologic budgets for each lake. The hydrologic budgets include inputs from direct rainfall, stormwater runoff, groundwater seepage, and baseflow (if applicable) to each lake. Losses are assumed to occur as a result of evaporation from the lake surface and estimates of deep recharge. If the volume of the inputs exceeds the estimated losses, the difference in water volume is assumed to be discharged to the downstream waterbodies.

Although bidirectional water flows were observed on occasion between Lake Howard and Lake May, as well as between Lake Lulu and Lake Eloise, the hydrologic budget assumes that net water movement between these lakes is negligible under current hydrologic conditions within the lakes. However, significant flows from Lake Howard to Lake May and from Lake Eloise to Lake Lulu are possible during extended rainfall periods and elevated water levels when water begins discharging from the Lake Lulu outfall structure. However, direct discharge from this structure is assumed to occur only rarely and significant outfall discharges are not considered as part of this hydrologic model.

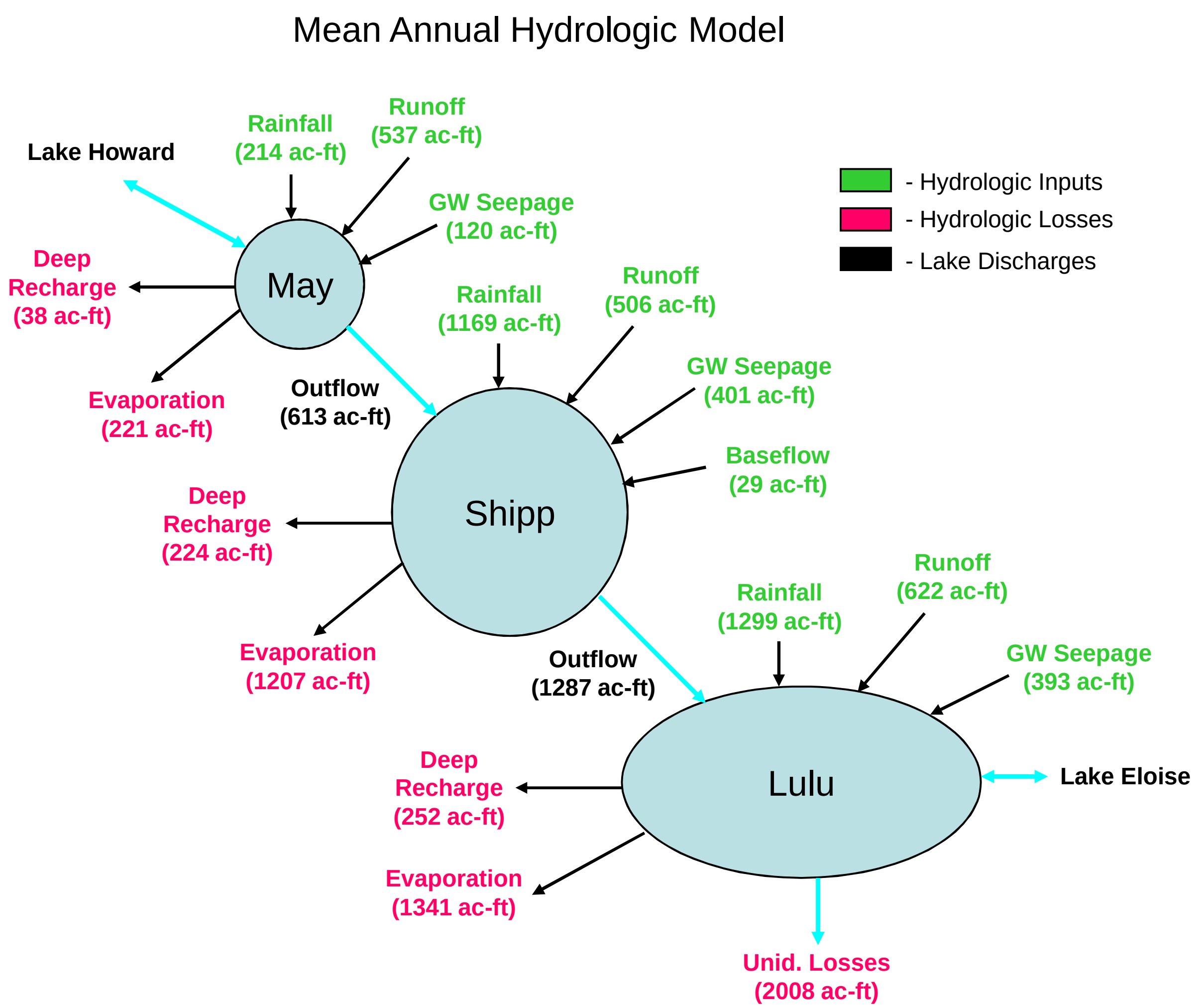


Figure 4-11. Mean Annual Hydrologic Model Components for Lakes May, Shipp, and Lulu. (NOTE: Hydrologic inputs are indicated in **green**, losses are indicated in **red**, and interconnected lake flow is indicated in **black**)

After accounting for inputs and losses for Lake May and Lake Shipp, an excess water volume of approximately 2008 ac-ft/yr must be discharged from Lake Lulu to balance the hydrologic budget. Potential sources for these losses include evapotranspiration from the large wetland area along the south shore of Lake Lulu, water losses to a perimeter ditch system along the southwest side of Lake Lulu, and leakage through the Lake Lulu outfall canal structure. On an average annual basis, the unidentified loss of 2008 ac-ft/yr is equivalent to a constant loss of approximately 2.8 cfs or approximately 0.2 inches/day over the surface of Lake Lulu.

4.4 Hydrologic Budgets

A summary of estimated mean annual hydrologic inputs to Lakes May, Shipp, and Lulu is given in Table 4-16, and a summary of hydrologic losses to the three lakes is given in Table 4-17. A comparison of mean annual hydrologic inputs and losses to Lake May is illustrated on Figure 4-12. On an average annual basis, stormwater runoff represents the largest hydrologic input into Lake May, contributing 62% of the total inflow. Approximately 24% of the annual inflow is contributed by direct rainfall, with 14% by groundwater seepage. Hydrologic losses from Lake May occur primarily as a result of outflow to Lake Shipp which accounts for approximately 71% of the annual losses. Approximately 25% of the annual losses occur through evaporation, with deep recharge contributing approximately 4% of the annual hydrologic losses.

Hydrologic inputs and losses to Lake Shipp are summarized on Figure 4-13. On an annual basis, direct rainfall is the largest single contributor of water to Lake Shipp (43%), followed by inflow from Lake May (22%), stormwater runoff (19%), and groundwater seepage (15%). The remaining 1% is contributed by dry weather baseflow. Hydrologic losses from Lake Shipp occur as a result of evaporation (45%), outflow to Lake Lulu (47%), and deep recharge (8%).

Hydrologic inputs and losses to Lake Lulu on an average annual basis are summarized on Figure 4-14. On an average annual basis, the largest contributors of hydrologic inputs to Lake Lulu are direct rainfall (36%) and inflow from Lake Shipp (36%). Approximately 17% of the annual hydrologic inputs are contributed by stormwater runoff, with 11% by groundwater seepage. Hydrologic losses from Lake Lulu occur primarily as a result of evaporation (37%), with 7% lost by deep recharge. Approximately 56% of the hydrologic losses discharge through unidentified mechanisms, such as evapotranspiration, discharges to a perimeter canal on the southwest side of Lake Lulu, and leakage through the outfall structure.

TABLE 4-16

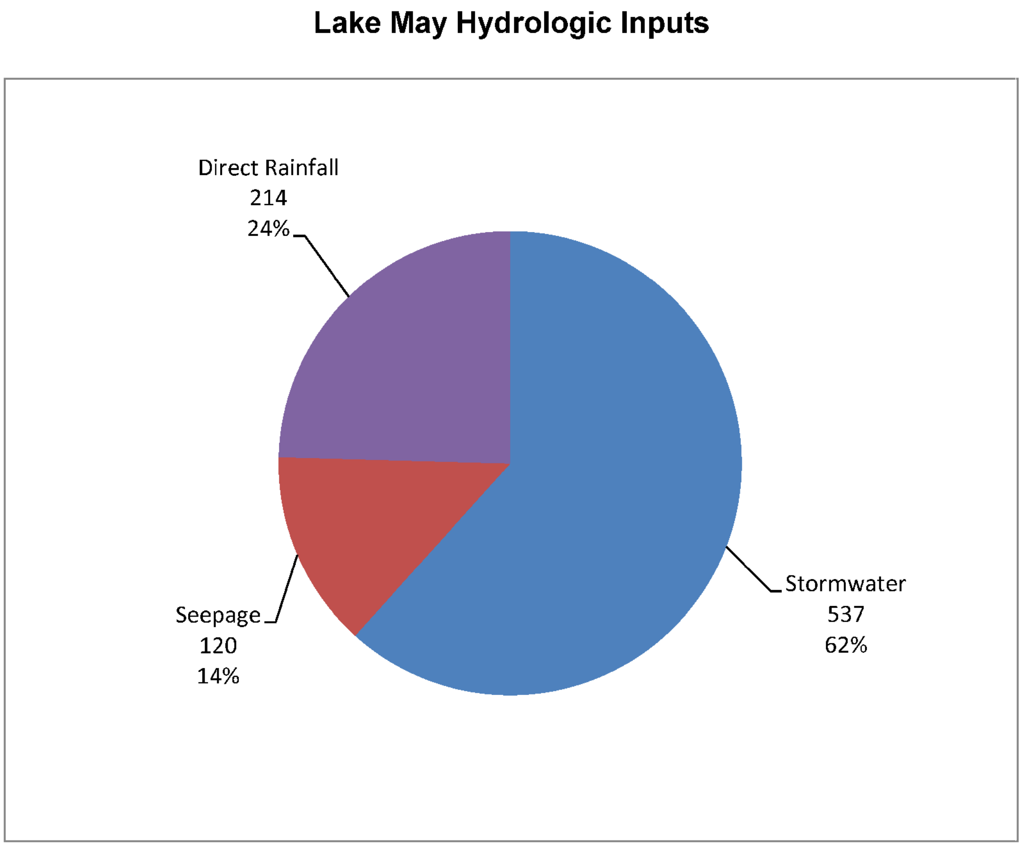
ESTIMATED AVERAGE ANNUAL NET HYDROLOGIC INPUTS TO LAKES MAY, SHIPP, AND LULU

LAKE	PARAMETER	VOLUME (ac-ft/yr)	PERCENT OF TOTAL
May	Stormwater	537	62
	Groundwater Seepage	120	14
	Direct Rainfall	214	24
	Total:	871	100
Shipp	Stormwater	506	19
	Groundwater Seepage	401	15
	Direct Rainfall	1169	43
	Inflow from Lake May	613	22
	Baseflow	29	1
	Total:	2718	100
Lulu	Stormwater	622	17
	Groundwater Seepage	393	11
	Direct Rainfall	1299	36
	Inflow from Lake Shipp	1287	36
	Total:	3601	100

TABLE 4-17

ESTIMATED AVERAGE ANNUAL NET HYDROLOGIC LOSSES TO LAKES MAY, SHIPP, AND LULU

LAKE	PARAMETER	VOLUME (ac-ft/yr)	PERCENT OF TOTAL
May	Evaporation	221	26
	Deep Recharge	37	4
	Outflow to Lake Shipp	613	70
	Total:	871	100
Shipp	Evaporation	1207	45
	Deep Recharge	224	8
	Outflow to Lake Lulu	1287	47
	Total:	2718	100
Lulu	Evaporation	1341	37
	Deep Recharge	252	7
	Unidentified Losses	2008	56
	Total:	3601	100



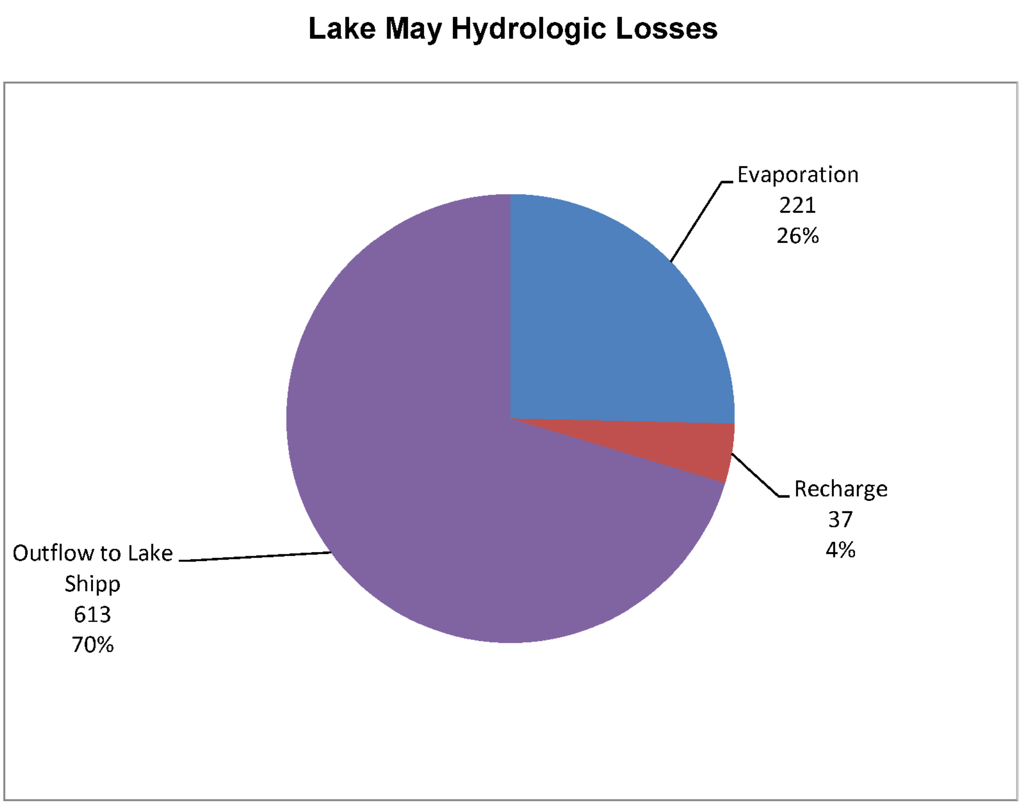
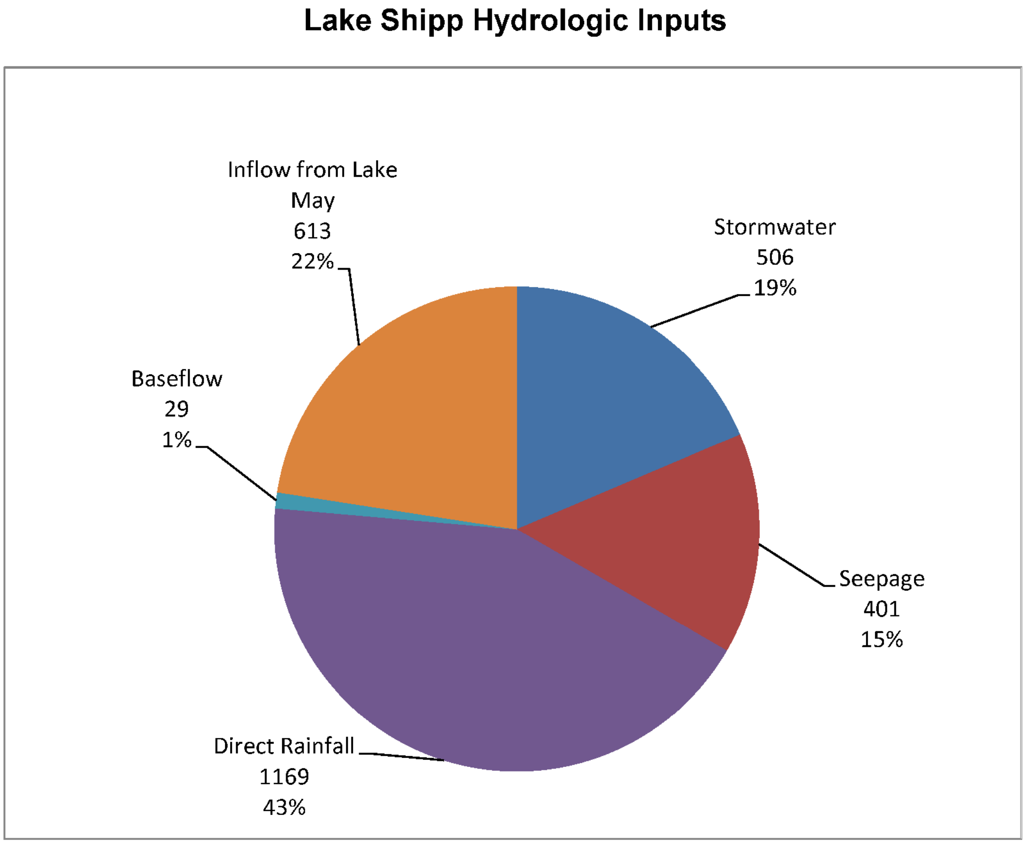


Figure 4-12. Summary of Average Annual Hydrologic Inputs and Losses to Lake May.



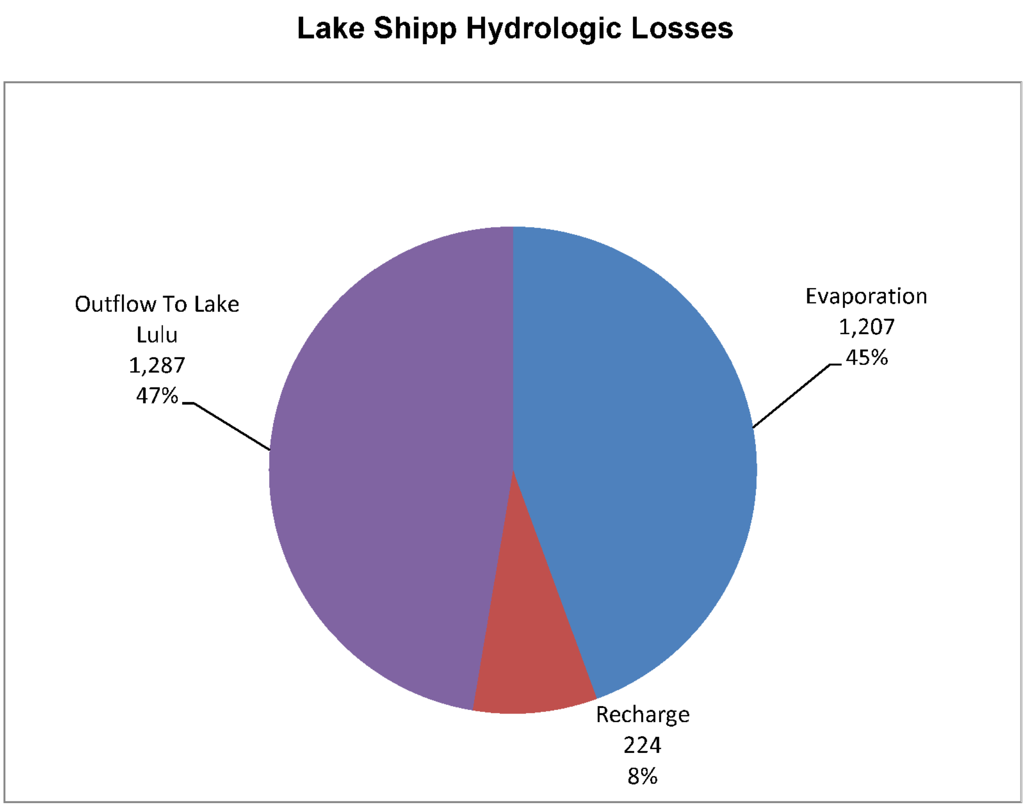
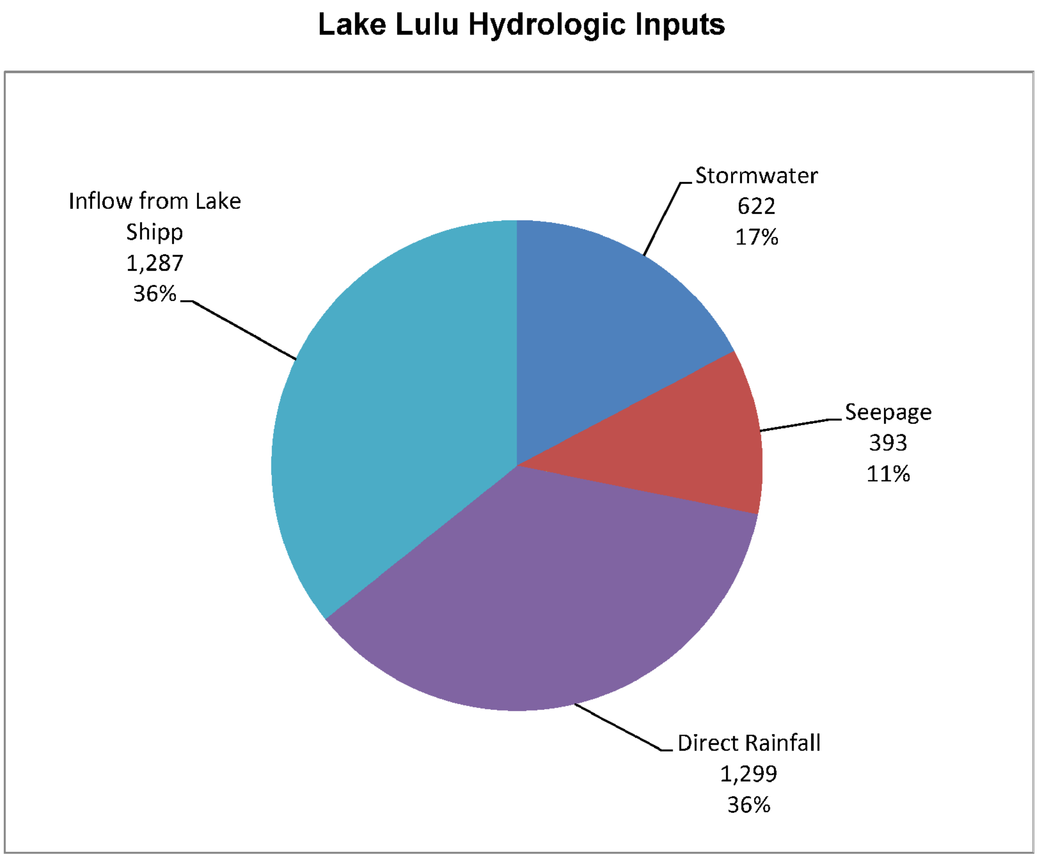


Figure 4-13. Summary of Average Annual Hydrologic Inputs and Losses to Lake Shipp.



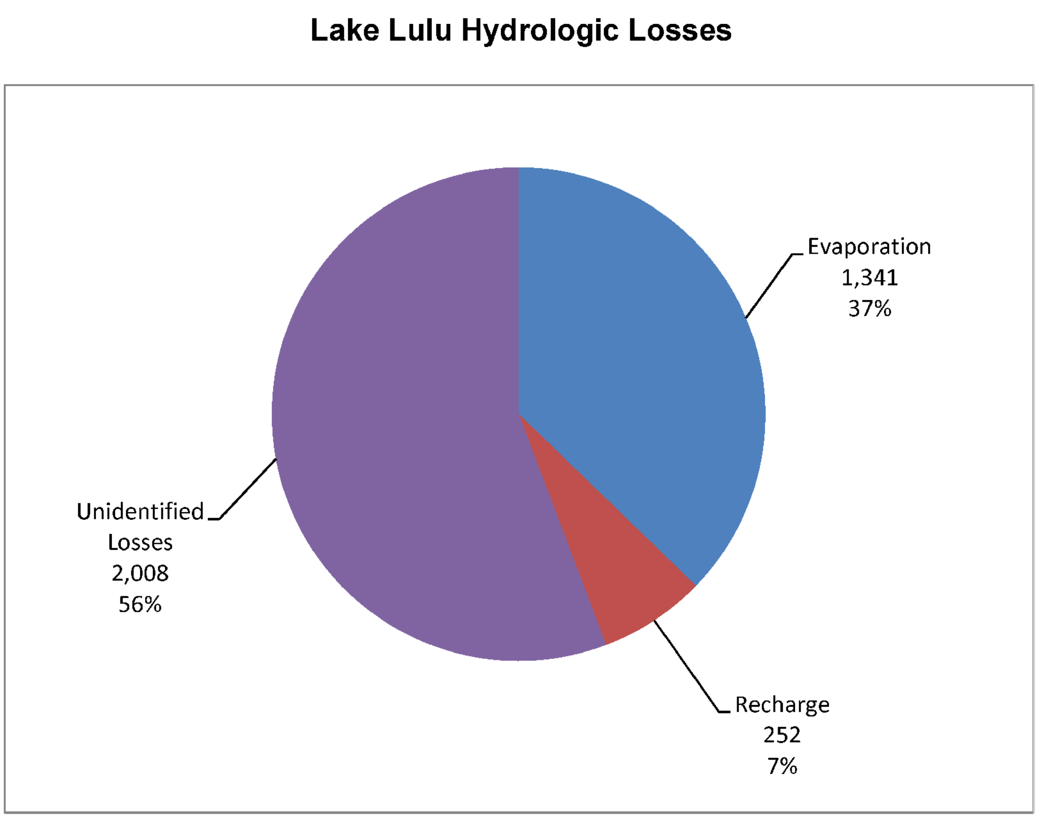


Figure 4-14. Summary of Average Annual Hydrologic Inputs and Losses to Lake Lulu.

4.5 Water Residence Times

Water residence times were calculated for Lakes May, Shipp, and Lulu on an average annual basis by dividing the estimated water volume for each lake (summarized in Table 2-4) by the calculated total annual hydrologic inputs (summarized in Table 4-16). A summary of calculated residence times for Lakes May, Shipp, and Lulu is given in Table 4-18.

TABLE 4-18

CALCULATED ANNUAL RESIDENCE TIMES IN LAKES MAY, SHIPP, AND LULU

LAKE	VOLUME (ac-ft)	HYDROLOGIC INPUTS (ac-ft/yr)	RESIDENCE TIME	
			YEARS	DAYS
May	316	871	0.36	132
Shipp	2589	2718	0.95	348
Lulu	2765	3601	0.77	280

Annual residence times in Lakes May, Shipp, and Lulu are highly variable, ranging from approximately 348 days in Lake Shipp to 132 days in Lake May. Values in this range are typical of residence times commonly observed in urban lakes.

SECTION 5

NUTRIENT INPUTS AND LOSSES

Lakes May, Shipp, and Lulu receive nutrient inputs from a variety of sources which include bulk precipitation, flow between interconnected lakes, stormwater runoff, dry weather baseflow, and shallow groundwater seepage. Chemical characteristics of each of these inputs were measured directly by ERD during the period from October 2005-April 2006. A discussion of these inputs, along with estimated annual mass loadings, is given in the following sections. This information is used to generate nutrient budgets for total phosphorus and total nitrogen for each of the evaluated lakes.

5.1 Characteristics of Nutrient Inputs

5.1.1 Bulk Precipitation

5.1.1.1 Chemical Characteristics

Bulk precipitation samples were collected on a continuous basis from October 2005-April 2006 at the hydrologic monitoring site located adjacent to the Chain-of-Lakes baseball complex. Bulk precipitation samples were collected using a 12-inch diameter polyethylene collection funnel. The discharge from the funnel was attached to a length of tygon tubing which was inserted into a 4-liter sample container inside an ice-filled cooler. Combined wet and dry fallout was collected and stored inside the sample container. The collected bulk precipitation samples were retrieved on approximately a weekly basis, depending on antecedent rainfall conditions, with the sample collection container replaced with a new pre-cleaned bottle during each weekly visit.

Twelve bulk precipitation samples were collected at the monitoring site from October 2005-April 2006, although the final sample was actually collected in May. Each of the retrieved bulk precipitation samples was returned to the ERD Laboratory and analyzed for general parameters, nutrients, and TSS. A complete listing of the laboratory measurements performed on bulk precipitation samples is given in Appendix F.

A summary of the characteristics of the bulk precipitation samples collected at the Chain-of-Lakes complex monitoring site is given in Table 5-1. In general, bulk precipitation samples were found to be slightly acidic, with an overall mean pH of 6.89 and measured pH values ranging from 5.07-8.11. The bulk precipitation samples were found to have highly variable specific conductivity values, with an overall mean of 116 μmho/cm, and moderate alkalinity, with a mean of 50.1 mg/l. A relatively wide range of values was measured for each of these parameters during the monitoring program.

TABLE 5-1

CHARACTERISTICS OF BULK PRECIPITATION SAMPLES COLLECTED AT THE CHAIN-OF-LAKES COMPLEX MONITORING SITE

PARAMETER	UNITS	MEAN VALUE[1]	RANGE OF VALUES
pH	s.u.	6.89	5.07 – 8.11
Conductivity	μmho/cm	116	36 – 307
Alkalinity	mg/l	50.1	7.4 – 124
NH_3	μg/l	254	18 – 566
NO_x	μg/l	468	137 – 1322
Organic N	μg/l	735	152 – 2826
Total N	μg/l	1457	608 – 3366
SRP	μg/l	20	< 1 – 50
Total P	μg/l	56	20 – 94
TSS	mg/l	21.3	2.5 – 84.0

1. n = 12 samples

In general, the bulk precipitation samples were found to have low to elevated concentrations of ammonia, with an overall mean of 254 μg/l and measured values ranging from 18-566 μg/l. Somewhat more elevated concentrations were observed for NO_x, with an overall mean of 468 μg/l. The dominant nitrogen species present in the bulk precipitation samples was organic nitrogen, with an overall mean of 735 μg/l. The overall mean total nitrogen concentration of 1457 μg/l is similar to nitrogen concentrations measured in surface waters within the Chain-of-Lakes. The dominant nitrogen species in bulk precipitation is organic nitrogen which comprises approximately 50% of the nitrogen species measured. Approximately 32% is contributed by NO_x, with 18% contributed by ammonia.

Bulk precipitation samples were characterized by relatively elevated concentrations for SRP and organic phosphorus. The mean SRP concentration of 20 μg/l is substantially higher than concentrations for this parameter measured in the water column of the lakes. The mean total phosphorus concentration of 56 μg/l is similar to values measured within the Chain-of-Lakes.

Relatively elevated levels of TSS were also observed in bulk precipitation collected at the site, with an overall mean of 21.3 mg/l. This value is approximately 25-50% greater than TSS concentrations commonly measured within the surface waters of the Chain-of-Lakes.

A statistical summary of measured values for pH, conductivity, alkalinity, and TSS in bulk precipitation samples is given in Figure 5-1. A graphical summary of laboratory data is presented in the form of Tukey box plots, also often called "box and whisker plots". The bottom of the box portion of each plot represents the lower quartile, with 25% of the data points falling below this value. The upper line of the box represents the 75% upper quartile, with 25% of the data falling above this value. The horizontal line within the box represents the median value, with 50% of the data falling both above and below this value. The vertical lines, also known as "whiskers", represent the 5 and 95 percentiles for the data sets. Individual values which fall outside of the 5-95 percentile range are indicated as **red dots**.

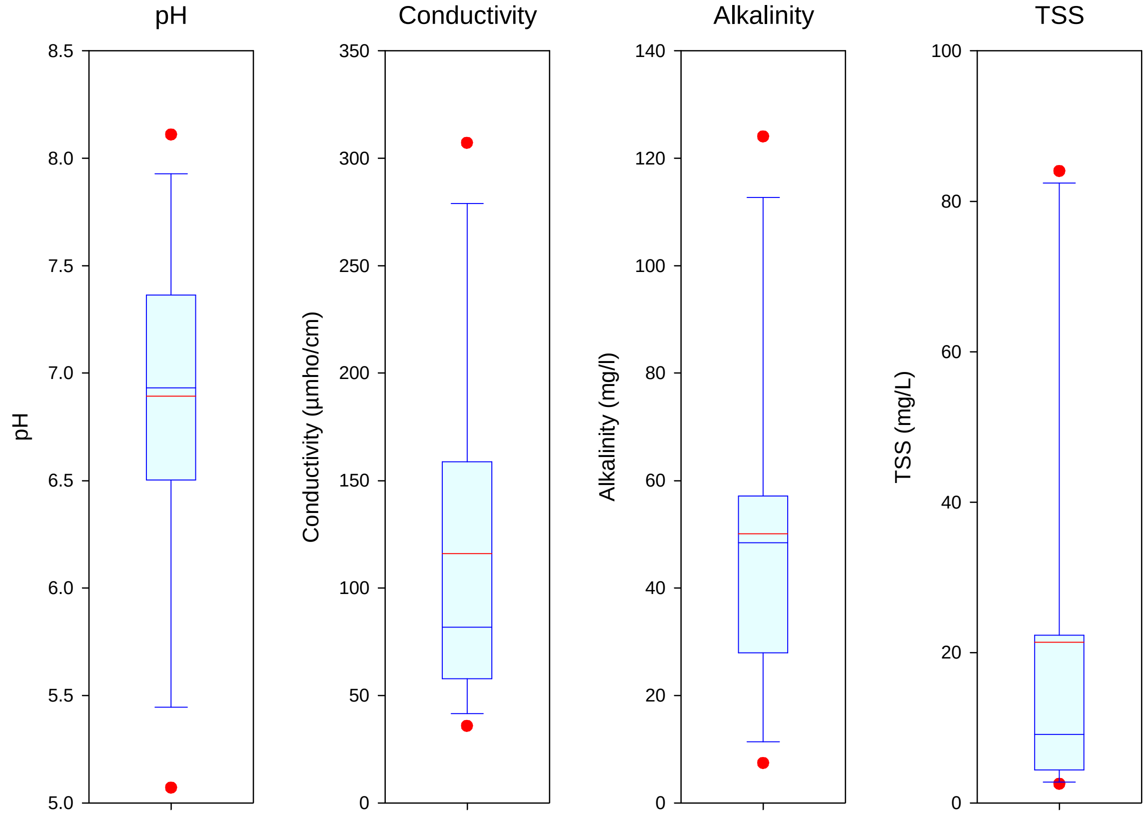
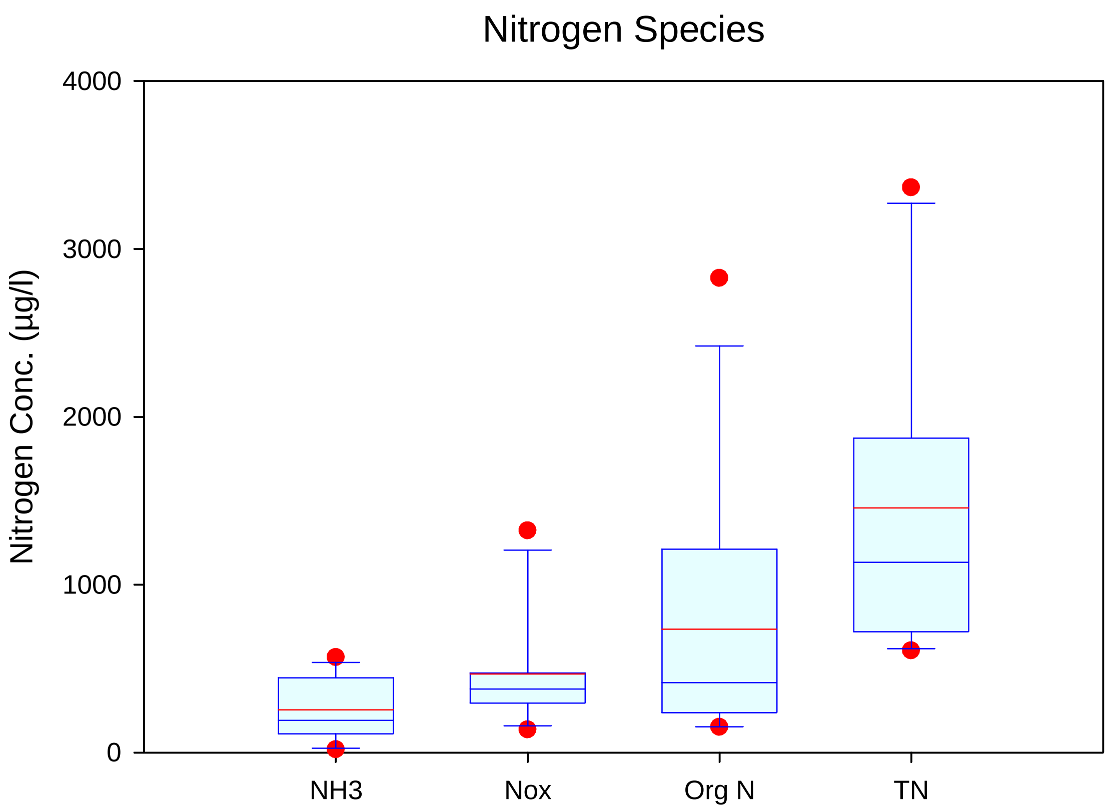


Figure 5-1. Statistical Summary of Measured Values for pH, Conductivity, Alkalinity, and TSS in Bulk Precipitation Samples Collected at the Chain-of-Lakes Complex Monitoring Site from October 2005-April 2006.

The pH values in bulk precipitation were found to be evenly distributed within the range of measured values. However, measured concentrations for conductivity and alkalinity appear to be concentrated primarily in lower portions of the range of measured values, with several elevated values indicated as outliers. A similar situation appears to exist for TSS, with the majority of the values concentrated in lower portions of the measured range.

A statistical summary of measured values for nitrogen and phosphorus species in bulk precipitation is given in Figure 5-2. Measured concentrations of ammonia occur within a relatively small range of values. A somewhat larger range of values was observed for NO_x, organic nitrogen, and total nitrogen. Several outliers were observed for each nitrogen species both, above and below the listed percentiles. The vast majority of measured phosphorus species also appear to occur within a relatively narrow range of values. However, significant values both above and below this range were observed, particularly for total phosphorus.



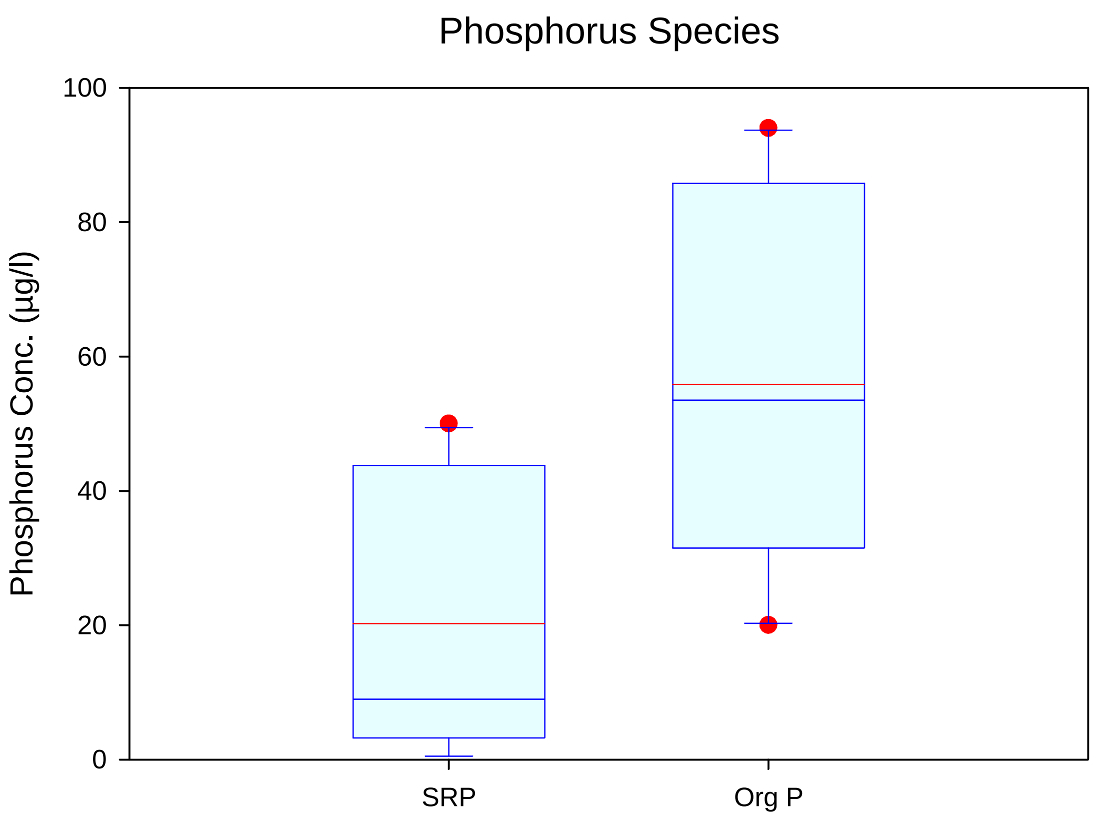


Figure 5-2. Statistical Summary of Measured Values for Nitrogen and Phosphorus Species in Bulk Precipitation Samples Collected at the Chain-of-Lakes Complex Monitoring Site from October 2005-April 2006.

5.1.1.2 Mass Loadings

Estimates of mass loadings of total nitrogen, total phosphorus, and TSS from bulk precipitation into Lakes May, Shipp, and Lulu were generated by multiplying the mean chemical characteristics of bulk precipitation (summarized in Table 5-1) times the estimated hydrologic inputs into each of the three lakes from direct precipitation (summarized in Table 4-2). The results of this analysis are summarized in Table 5-2. The values listed in this table reflect the estimated inputs of total nitrogen, total phosphorus, and TSS from bulk precipitation into Lakes May, Shipp, and Lulu on an average annual basis. This information is used in a subsequent section to develop overall nutrient budgets for the lakes. Overall, bulk precipitation contributes approximately 4813 kg of total nitrogen, 184.9 kg of total phosphorus, and 70,350 kg of TSS to Lakes May, Shipp, and Lulu on an annual basis.

TABLE 5-2

ESTIMATED AVERAGE ANNUAL MASS LOADINGS FROM BULK PRECIPITATION TO LAKES MAY, SHIPP, AND LULU

LAKE	MASS LOADING (kg)[1]		
	TOTAL N	TOTAL P	TSS
May	384	14.7	5,609
Shipp	2,098	80.6	30,667
Lulu	2,331	89.6	34,074
TOTALS:	**4,813**	**184.9**	**70,350**

1. Based on an annual precipitation volume of 213.8 ac-ft in Lake May, 1169 ac-aft in Lake Shipp, and 1299 ac-ft in Lake Lulu

5.1.2 Stormwater Runoff

5.1.2.1 Evaluation Methodology

The chemical characteristics of stormwater inputs into the three study lakes were evaluated using a combination of current field monitoring, previous runoff characterization evaluations for Lake May and Lake Lulu, and literature-based values. Two separate stormwater monitoring sites were selected to characterize runoff inputs. Each of the two monitoring sites is located on drainage sub-basin areas which discharge into Lake Shipp. One of the monitoring sites reflects a combination of residential and agricultural land use which discharges through Lake Shipp sub-basins 12 and 13 on the southwest side of Lake Shipp. These sub-basins have a combined surface area of approximately 161.8 acres and represent 24% of the total basin areas discharging to Lake Shipp. An overview of the combined sub-basin area is given in Figure 5-3.

The second stormwater monitoring site (site 2) is located near the point of discharge for Lake Shipp sub-basin 7. This sub-basin is primarily an industrial area, located on the east side of Lake Shipp, which covers an area of approximately 43.9 acres, representing 6.5% of the total area discharging into Lake Shipp. This site is designed to provide runoff characterization data for industrial-type activities which are located along the east sides of Lake Shipp and Lake May and extreme western portions of the Lake Lulu drainage basin. An overview of sub-basin 7 is given in Figure 5-4.

An aerial photograph of the stormwater monitoring site (site 1) for Lake Shipp sub-basin 12 is given on Figure 5-5. Stormwater monitoring was conducted in a shallow vegetated canal which provides the point of discharge for sub-basins 12 and 13 into Lake Shipp. This canal is located adjacent to the southeastern edge of the parking lot for Lake Shipp Park. A Sigma Model 900MAX-AV stormwater sampler was installed inside an insulated aluminum equipment shelter which was located adjacent to the canal. An ultrasonic flow probe was mounted on the bottom of the channel to provide a continuous record of discharges through the canal under stormwater and dry weather baseflow conditions. Sample tubing was also extended into the canal for collection of samples in a flow-proportioned mode. The automatic sampler was installed during late-September 2005 and monitoring was conducted at this site on a continuous basis from October 2005-May 2006.

An aerial photograph of the stormwater monitoring site for Lake Shipp sub-basin 7, reflecting industrial land use characteristics, is given in Figure 5-6. This monitoring site was located in a manhole at the rear of an industrial complex and adjacent to the CSX railroad. This manhole represents the final structure for sub-basin 7 prior to discharge into Lake Shipp. A Sigma Model 900MAX-AV autosampler was installed inside the manhole during late-September 2005. Stormwater monitoring at this location was conducted on a continuous basis from October 2005-March 2006.

Each of the autosamplers was programmed to collect samples in a flow-weighted mode, with each discrete sample placed into one of 24 one-liter bottles within the autosampler. The flow hydrographs were retrieved from each unit and used to segregate the collected samples into either baseflow or storm event conditions. A summary of monitored storm events at each of the two monitoring sites is given in Table 5-3. Eight flow-weighted composite stormwater samples were collected from Lake Shipp sub-basins 12/13, with 10 flow-weighted composite storm events collected from Lake Shipp sub-basin 7. The monitored storm events cover a wide range of rainfall depths, ranging from 0.13-1.66 inches.

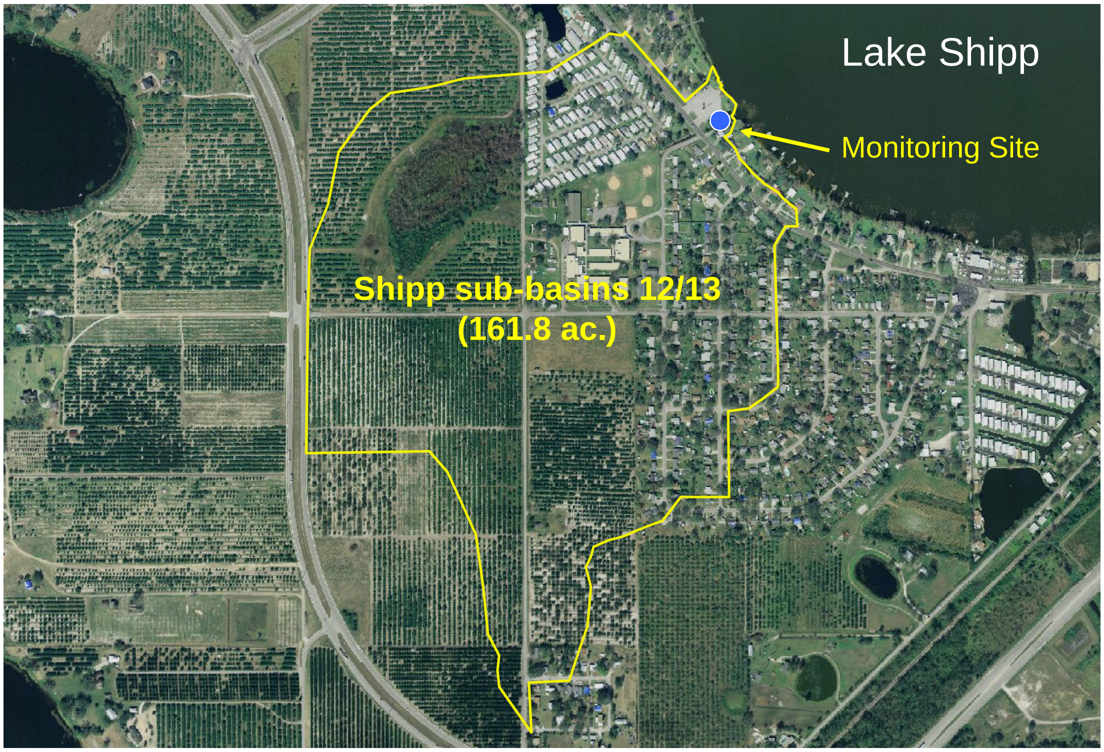


Figure 5-3. Overview of the Drainage Area for Lake Shipp Sub-basins 12 and 13.

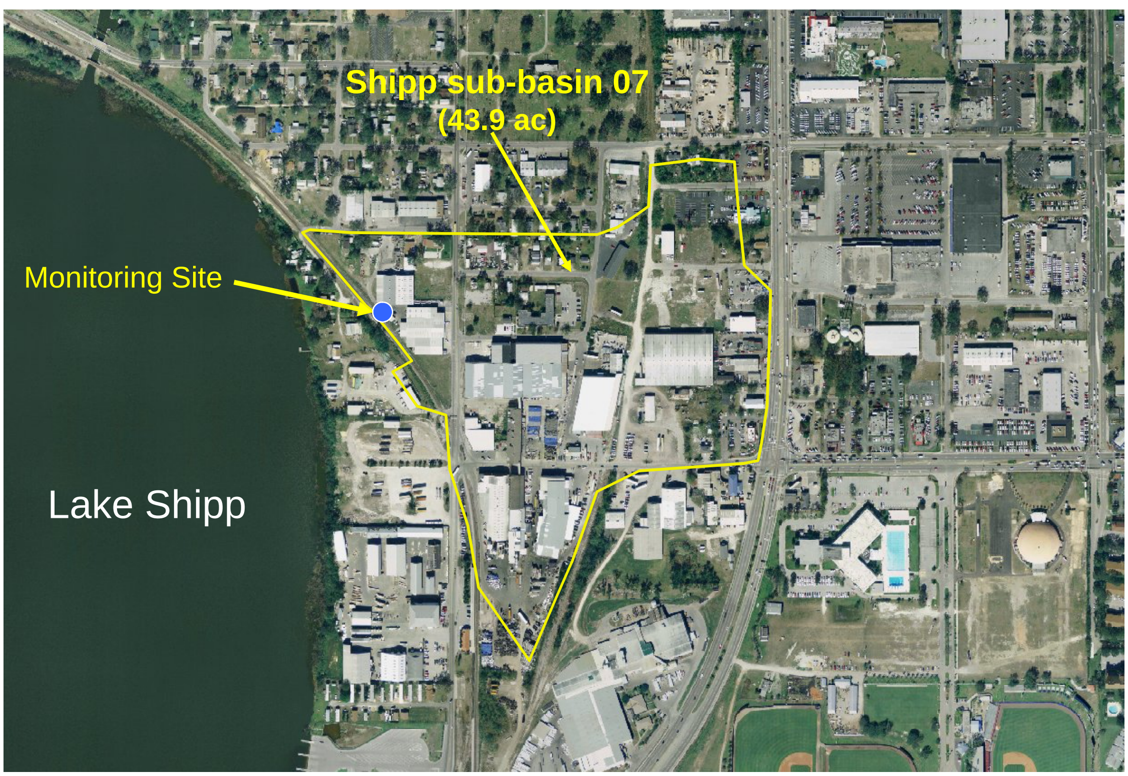


Figure 5-4. Overview of the Drainage Area for Lake Shipp Sub-basin 7.

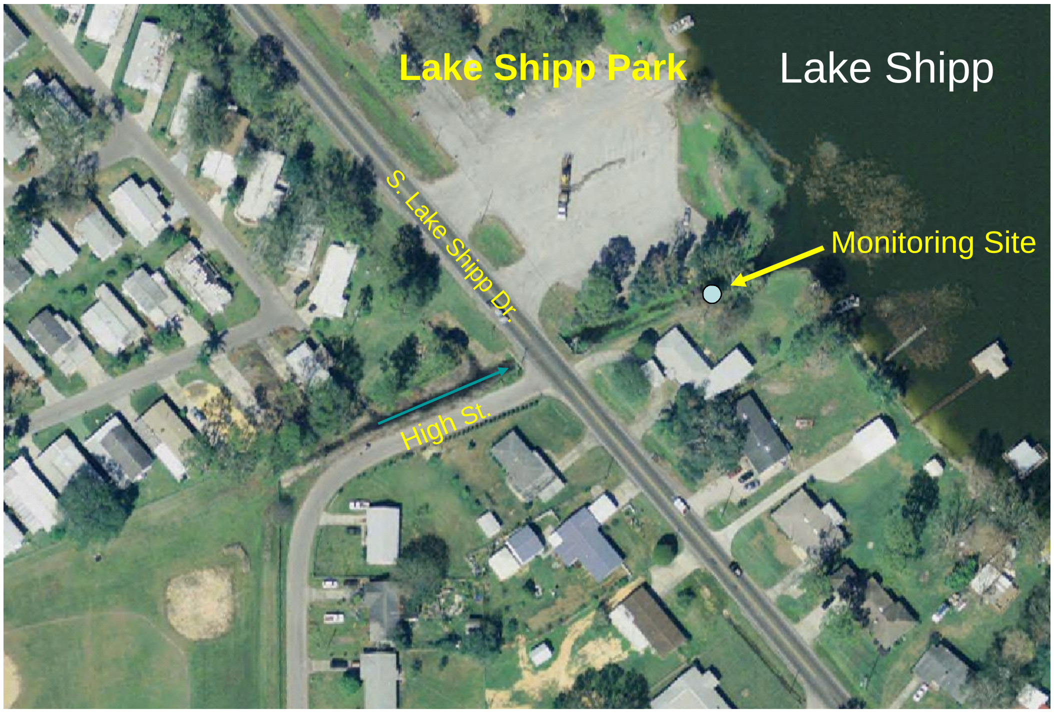


Figure 5-5. Aerial Photo of the Stormwater Monitoring Site (Site 1) for Lake Shipp Sub-basin 12.

Figure 5-6. Aerial Photo of the Stormwater Monitoring Site (Site 2) for Lake Shipp Sub-basin 7.

TABLE 5-3

SUMMARY OF MONITORED STORM EVENTS AT THE TWO MONITORING SITES IN LAKE SHIPP

SHIPP SUB-BASIN 12 (SITE 1)		SHIPP SUB-BASIN 7 (SITE 2)	
EVENT DATE	**EVENT RAINFALL (inches)**	**EVENT DATE**	**EVENT RAINFALL (inches)**
10/23/05	0.54	10/4/05	0.75
2/3/06	1.66	10/7/05	0.13 (daily total)
2/26/06	0.41	10/8/05	0.42
4/9/06	0.69	10/23/05	0.54
4/23/06	0.53	11/1/05	0.83
5/9/06	0.49	12/7/05	0.99
5/11/06	0.27	1/18/06	0.31
5/16/06	1.12	2/3/06	1.66
n = 8 events		2/26/06	0.41
		3/23/06	0.41
		n = 10 events	

5.1.2.2 Chemical Characteristics

Each of the collected composite stormwater samples was returned to the ERD Laboratory and analyzed for the laboratory parameters summarized in Table 2-5 with the exception that BOD was substituted for chlorophyll-a. A complete listing of individual laboratory analyses performed on the collected stormwater samples is given in Appendix G. A summary of the characteristics of stormwater samples collected from Lake Shipp sub-basins 7 and 12/13 from October 2005-May 2006 is given in Table 5-4. In general, stormwater runoff collected at the two monitoring sites was found to be approximately neutral in pH and moderately buffered, with measured mean alkalinities ranging from 46.9-69.9 mg/l. Mean conductivity values at the two sites range from 110-170 μmho/cm, somewhat lower than conductivity measurements commonly observed in urban runoff.

Measured total nitrogen concentrations at the two sites appear to be low to moderate in value, with mean concentrations ranging from 1101 μg/l in sub-basin 7 to 1461 μg/l in sub-basins 12/13. The dominant nitrogen species in sub-basin 7 is particulate nitrogen which comprises approximately 42% of the nitrogen present. Ammonia and NO_x contribute approximately 22% each of the total measured nitrogen, with the remaining nitrogen provided by dissolved organic nitrogen. In sub-basins 12/13, NO_x is the dominant nitrogen species present, comprising 39% of the total nitrogen measured at this site. Approximately 25% of the total nitrogen is contributed by particulate nitrogen, with 20% contributed by dissolved organic nitrogen and 16% contributed by ammonia.

TABLE 5-4

CHARACTERISTICS OF STORMWATER SAMPLES COLLECTED IN LAKE SHIPP SUB-BASINS 7 AND 12/13 FROM OCTOBER 2005 TO MAY 2006

PARAMETER	UNITS	SHIPP SUB-BASINS 12/13[1]			SHIPP SUB-BASIN 7[2]		
		mean	min	max	mean	min	max
pH	s.u.	7.22	6.93	7.60	7.15	6.89	7.67
Conductivity	µmho/cm	170	108	230	110	85	169
Alkalinity	mg/l	69.9	35.2	81.6	46.9	29.6	70.6
NH_3	µg/l	231	111	609	233	12	23
NO_x	µg/l	571	184	1316	240	70	356
Diss. Org N	µg/l	288	53	532	156	20	519
Particulate N	µg/l	372	224	763	473	38	1244
Total N	µg/l	1461	952	2194	1101	241	2480
SRP	µg/l	108	18	259	137	22	335
Diss. Org P	µg/l	30	7	61	36	6	112
Particulate P	µg/l	161	65	320	315	41	981
Total P	µg/l	299	134	509	488	128	1428
Turbidity	NTU	11.8	2.4	24.6	33.2	6.3	101
TSS	mg/l	46.0	10.2	94.6	75.7	11.6	23.6
BOD	mg/l	4.7	2.2	8.8	5.3	2.0	12.5

1. n = 8 samples
2. n = 10 samples

In contrast to the trend observed for total nitrogen, total phosphorus concentrations appear to be moderate to high in value at the two monitoring sites. The mean total phosphorus concentration discharging from sub-basins 12/13, reflecting primarily residential characteristics, is 299 µg/l. However, the mean total phosphorus concentration discharging from sub-basin 7 is 488 µg/l from an area which reflects primarily industrial activities. The dominant phosphorus species at each site is particulate phosphorus which comprises approximately 54% of the total phosphorus measured in sub-basins 12/13 and 65% of the total phosphorus measured in sub-basin 7. The second most significant phosphorus species is SRP which comprises 36% of the total phosphorus measured in sub-basins 12/13 and 28% of the total phosphorus measured in sub-basin 7.

In general, measured concentrations for turbidity, TSS, and BOD are similar to values commonly observed in urban runoff. Measured concentrations for each of these parameters are substantially greater in runoff collected from the industrial area (sub-basin 7) compared with characteristics measured in the residential area (sub-basins 12/13).

A statistical summary of measured values for BOD, conductivity, alkalinity, and TSS in stormwater runoff samples collected at the residential and industrial monitoring sites from October 2005-May 2006 is given in Figure 5-7 in the form of box and whisker plots. In general, BOD concentrations at the industrial site are slightly higher in the industrial runoff than measured in the residential runoff. In addition, the industrial site is characterized by a substantially higher degree of variability in measured BOD values. In contrast, conductivity and alkalinity values at the residential site appear to be greater than those observed at the industrial site, although the residential site appears to have a higher degree of variability in measured concentrations. A high degree of variability in measured TSS concentrations is also present at the industrial site, with a higher TSS concentration compared with the residential area.

A statistical summary of measured nitrogen species in stormwater runoff samples collected from the residential and industrial sites from October 2005-May 2006 is given in Figure 5-8. Measured ammonia concentrations appear to be substantially more variable at the industrial site, compared with the residential site, although the mean values appear to be similar. In contrast, the mean NO_x concentration is substantially higher at the residential site which also exhibits a higher degree of variability. A high degree of variability is apparent in particulate nitrogen and total nitrogen concentrations measured at the industrial site, with a higher mean particulate nitrogen in the industrial area and a higher total nitrogen concentration observed in the residential area.

A statistical summary of measured values for phosphorus species in stormwater runoff samples collected from the residential and industrial sites from October 2005-May 2006 is given in Figure 5-9. In general, the industrial site is characterized by a substantially higher degree of variability, as well as higher mean values, for each of the evaluated phosphorus species compared with concentrations measured at the residential area.

5.1.2.3 <u>Selection of Characterization Data</u>

The runoff model utilized by ERD provides for separate input characterization data for each of the identified land use categories present within the drainage basin areas for the three lakes. These identified land use categories include low-density residential, medium-density residential, high-density residential, institutional, commercial, industrial, highways, agriculture-citrus, recreational areas, open space, and wetlands. Direct characterization data for industrial and medium-density residential areas was collected as part of this study. As a result, the chemical characteristics of stormwater runoff collected from the industrial area within Lake Shipp sub-basin 7 (as summarized in Table 5-6) are assumed to be representative of industrial areas throughout the drainage basin areas for the three lakes. Runoff characterization data was also generated for the residential area located within Lake Shipp sub-basins 12/13. Runoff characteristics monitored at this site are assumed to be representative of medium-density residential areas discharging into the three lakes. Combined together, industrial and medium-density residential land use covers approximately 35% of the drainage sub-basin areas for the three lakes.

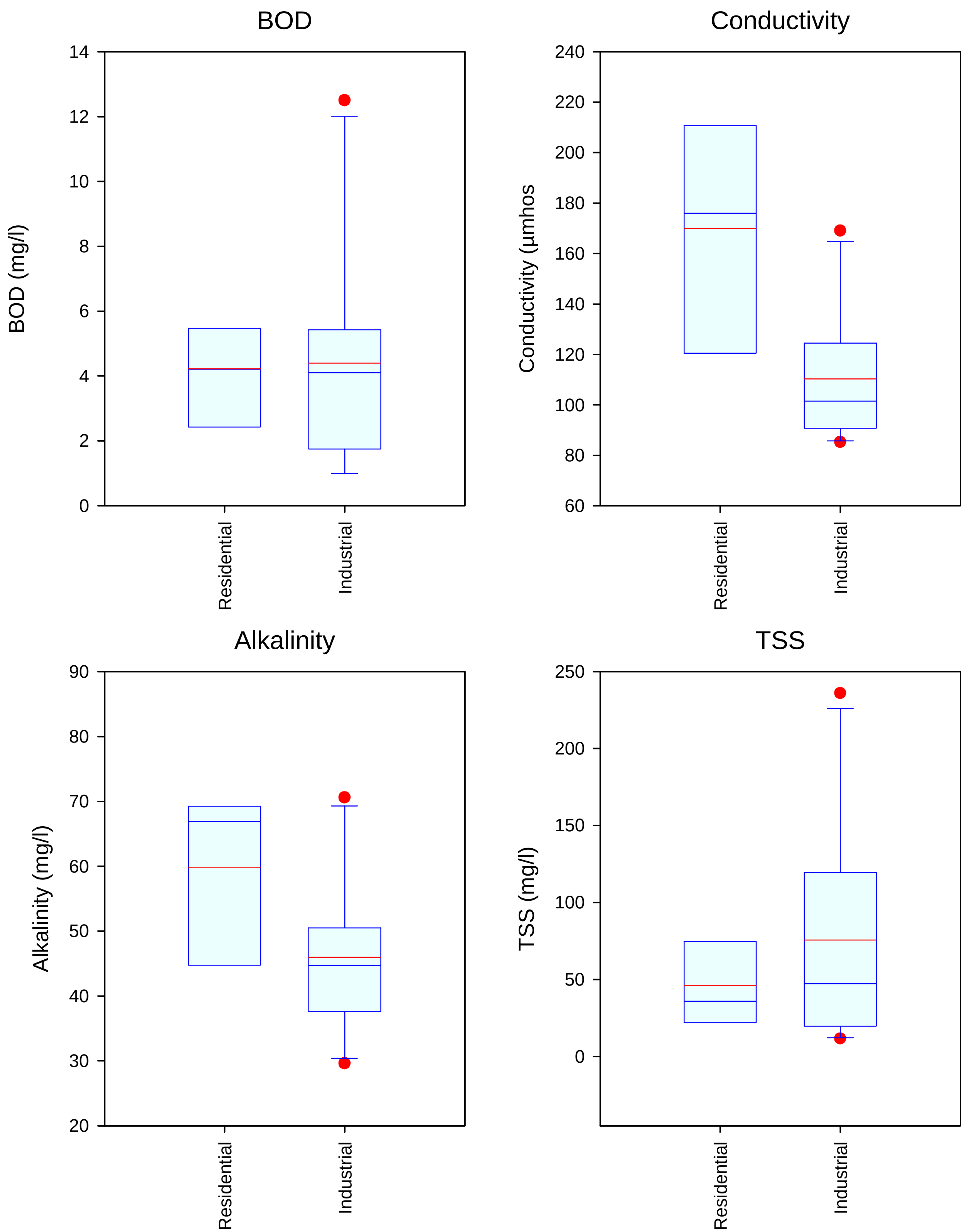


Figure 5-7. Statistical Summary of Measured Values for BOD, Conductivity, Alkalinity, and TSS in Stormwater Runoff Samples Collected at the Residential and Industrial Monitoring Sites from October 2005-May 2006.

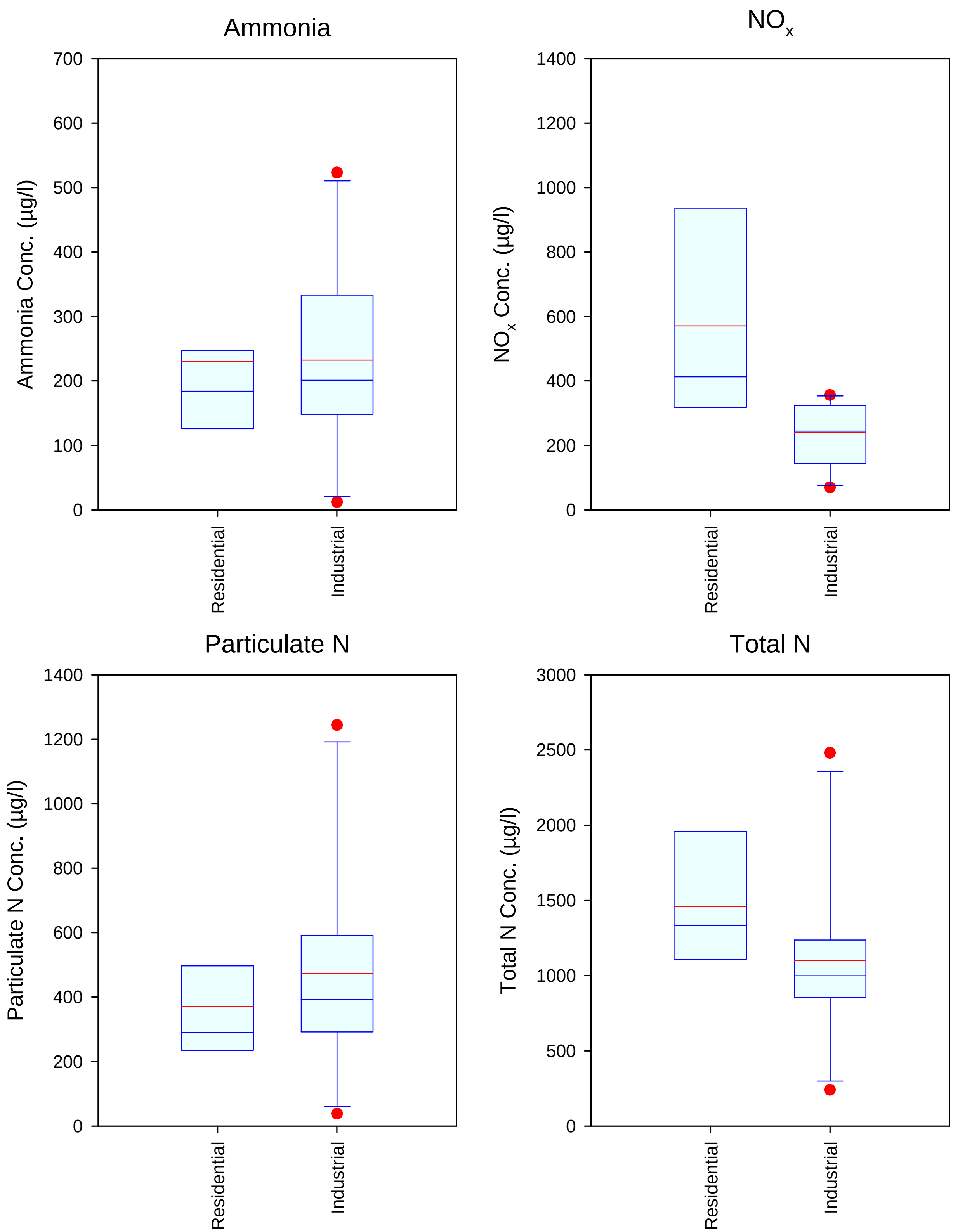


Figure 5-8. Statistical Summary of Measured Nitrogen Species in Stormwater Runoff Samples Collected at the Residential and Industrial Monitoring Sites from October 2005-May 2006.

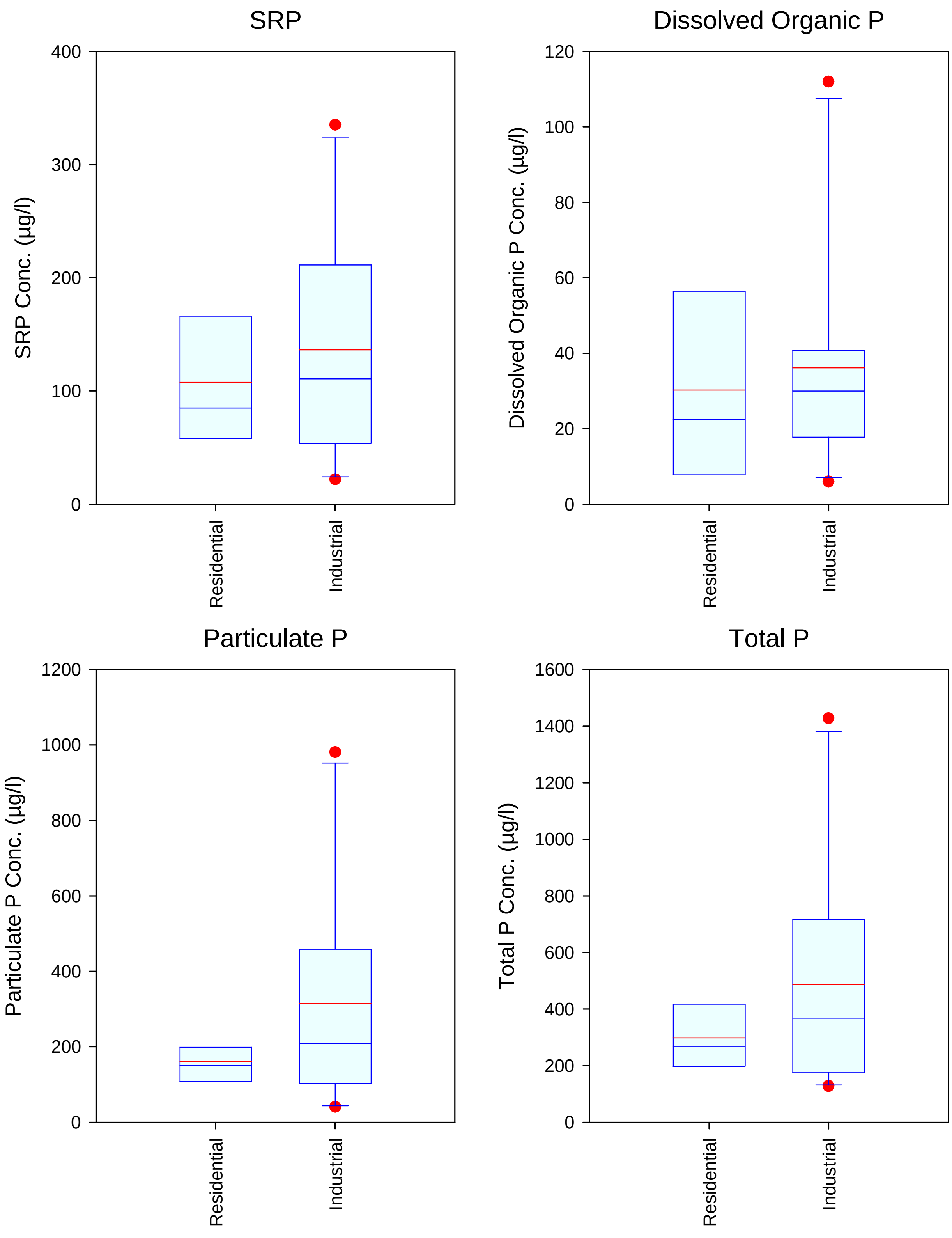


Figure 5-9. Statistical Summary of Measured Phosphorus Species in Stormwater Runoff Samples Collected at the Residential and Industrial Monitoring Sites from October 2005-May 2006.

Runoff characterization data for land use categories which were not directly monitored by ERD as part of this project are assumed using literature-based stormwater runoff concentrations for various land use categories in Florida. These runoff concentrations were obtained from the ERD Final Report titled "Evaluation of Stormwater Management Criteria in the State of Florida" dated June 2007, prepared for the Florida Department of Environmental Protection. This document includes a literature review of stormwater characterization studies performed within the State of Florida for a variety of land use categories. Characterization data for land uses other than medium-density residential and industrial were obtained from this source. A summary of assumed runoff characterization data for total nitrogen, total phosphorus, and TSS in land use categories which discharge into Lakes May, Shipp, and Lulu is given in Table 5-5, along with the data source utilized for the listed data. The information summarized in this table is used as input into the pollutant loading model to provide estimates of runoff generated pollutant loadings into each of the three lakes.

TABLE 5-5

ASSUMED STORMWATER RUNOFF CONCENTRATIONS FOR VARIOUS LAND USES

LAND USE CATEGORY	TYPICAL RUNOFF CONCENTRATION (mg/l)			DATA SOURCE*
	TOTAL N	TOTAL P	TSS	
Low-Density Residential	1.58	0.190	20.4	2
Medium-Density Residential	1.46	0.299	46.0	1
High-Density Residential	2.32	0.520	77.8	2
Institutional	1.58	0.190	20.4	2
Commercial	1.23	0.170	59.2	2
Industrial	1.10	0.488	75.7	1
Highway	1.64	0.220	37.3	2
Agriculture – Citrus	2.24	0.183	15.5	2
Recreational	2.00	0.306	33.0	2
Open Space	1.15	0.074	7.8	2
Wetland	1.00	0.190	10.2	2

*DATA SOURCE:
1. Field Monitoring
2. ERD (2006)

5.1.2.4 Removal Efficiencies for Existing Treatment Systems

As discussed in Section 3.5, many developed areas within the watersheds for Lakes May, Shipp, and Lulu have existing stormwater treatment systems. Locations and areas served by these treatment systems were identified by ERD as part of this project and are indicated on Figure 3-8. Stormwater treatment within the Lakes May, Shipp, and Lulu drainage basins consists primarily of dry retention, wet detention ponds, and alum treatment. Runoff generated in a few of the sub-basin areas discharges into depressional areas of wetlands which, although not formally permitted stormwater management systems, provide significant attenuation mechanisms for both runoff volume and mass loadings. As a result, removals associated with these areas are also included in the loading calculations.

A summary of assumed mass removal efficiencies for the listed stormwater management systems is given in Table 5-6 based on previous research and literature reviews conducted by ERD. The mass removal efficiencies for total nitrogen, total phosphorus, and TSS listed in this table are used to reduce the generated runoff loadings prior to discharge into the receiving waterbody or conveyance mechanism, resulting in the estimated mass loadings which entered all of the lakes during the 212-day monitoring period. As discussed in Section 4, depressional areas are assumed to retain approximately 95% of the annual runoff volume, and therefore, achieve a 95% annual load reduction for stormwater pollutants.

TABLE 5-6

ESTIMATED MASS REMOVAL EFFICIENCIES FOR TYPICAL STORMWATER MANAGEMENT SYSTEMS

SYSTEM TYPE	MASS REMOVAL EFFICIENCIES (%)		
	TOTAL N	TOTAL P	TSS
Dry Pond	80	80	80
Wet Pond	25	65	80
Alum Treatment	45	90	90
Depressional Area	95	95	95
Wetland	50	10	50

5.1.2.5 Mass Loadings

Estimates of mass loadings of total nitrogen, total phosphorus, and TSS discharging into each of the three lakes from stormwater runoff was calculated over the period from October 2005-April 2006. The runoff characterization data (summarized in Table 5-5) is used as input into the watershed model, provided in Appendix D, to provide estimates of the **generated** mass loadings of total nitrogen, total phosphorus, and TSS. These **generated** loadings are then attenuated for stormwater management systems present within each sub-basin area, based upon the stormwater treatment areas identified in Figure 3-8 and summarized in Table 3-7. Assumed pollutant removal efficiencies for stormwater management systems identified within the three drainage basin areas are given in Table 5-6. The estimated removal efficiencies for total nitrogen, total phosphorus, and TSS listed in Table 5-6 for each of the identified stormwater management options are used as attenuation factors for the **generated** mass loadings for each sub-basin area. The mass loadings removed by applicable stormwater treatment systems are then subtracted from the **generated** runoff loadings to provide estimates of runoff loadings actually discharging into Lakes May, Shipp, and Lulu.

In estimating runoff characteristics for each sub-basin area, the watershed model calculates a weighted runoff concentration for each sub-basin area based upon the percentage of land use present within the basin. This weighted runoff concentration is used as the input value within the watershed model which is then multiplied by the generated runoff volume.

A summary of estimated annual loadings of total nitrogen, total phosphorus, and TSS discharging from sub-basin areas into Lake May is given in Table 5-7. These values reflect the model predicted **generated** runoff loadings minus pollutant attenuation in stormwater treatment systems, depressional areas, and wetlands, and reflect estimated loadings actually reaching the receiving waterbody. During average annual conditions, stormwater runoff contributes approximately 510 kg/yr of total nitrogen, 40.1 kg/yr of total phosphorus, and 7372 kg/yr of TSS to Lake May. Calculated areal loading rates for each sub-basin area are also provided in Table 5-7. Higher than average areal phosphorus loadings to Lake May, in terms of kg/ac-yr, originate from sub-basins 1, 5, 6, 7, and 8. Sub-basins designated as 2, 3, 10, and 11 exhibit some of the lowest loadings rates for the evaluated parameters, particularly for total phosphorus and TSS. Sub-basins 2, 10, and 11 are equipped with an alum treatment system which provides treatment for virtually all runoff discharging from these basins. The only sub-basin area which appears to have areal loadings similar to the alum treated sub-basins is sub-basin 3 which consists primarily of a small undeveloped natural area. The mass loadings summarized in Table 5-7 are utilized in subsequent sections for generation of overall mass balances for the three lakes.

TABLE 5-7

MEAN ANNUAL RUNOFF LOADINGS OF TOTAL NITROGEN, TOTAL PHOSPHORUS, AND TSS DISCHARGING FROM SUB-BASIN AREAS TO LAKE MAY

SUB-BASIN NO.	AREA (acres)	RUNOFF VOLUME (ac-ft)	MASS LOADING (kg/yr)			PERCENT OF TOTAL (%)			AREAL LOADING (kg/ac-yr)		
			TN	TP	TSS	TN	TP	TSS	TN	TP	TSS
1	10.2	10.7	14.8	4.5	675	2.9	11.2	9.2	1.45	0.44	66.2
2	25.5	36.2	27.0	2.2	335	5.3	5.5	4.5	1.06	0.09	13.1
3	1.8	0.3	0.4	0.1	3	0.1	0.1	0.0	0.22	0.03	1.7
4	2.6	1.0	1.4	0.4	66	0.3	1.0	0.9	0.54	0.15	25.4
5	11.3	13.2	21.6	5.5	795	4.2	13.7	10.8	1.91	0.49	70.4
6	18.1	10.8	17.2	3.7	555	3.4	9.2	7.5	0.95	0.20	30.7
7	49.6	27.4	55.9	10.1	1709	11.0	25.2	23.2	1.13	0.20	34.5
8	2.7	4.3	6.0	0.4	45	1.2	1.0	0.6	2.22	0.15	16.7
9	5.5	1.7	3.0	0.6	92	0.6	1.5	1.2	0.55	0.11	16.7
10	81.1	124.7	106.4	3.4	829	20.9	8.5	11.2	1.31	0.04	10.2
11	145.0	306.8	256.5	9.3	2270	50.3	23.2	30.8	1.77	0.06	15.7
Totals	**353.4**	**537.1**	**510**	**40.1**	**7374**	**100.0**	**100.0**	**100.0**	**1.44**[1]	**0.11**[1]	**20.9**[1]

1. Mean value

Value represents 10-20% of annual load (yellow)

Value represents >20% of annual load (orange)

Represents higher than mean areal loading (pink)

A summary of estimated annual loadings of total nitrogen, total phosphorus, and TSS discharging from sub-basin areas into Lake Shipp is given in Table 5-8. Mass loadings originating from each of the sub-basin areas appear to be highly variable and related primarily to basin size. During average annual conditions, stormwater runoff contributes approximately 873 kg/yr of total nitrogen, 162 kg/yr of total phosphorus, and 23,184 kg/yr kg of TSS to Lake Shipp. Calculated areal loadings are also provided in Table 5-8 for total nitrogen, total phosphorus, and TSS for each sub-basin area. Average annual areal loadings of total nitrogen range from 0.07-5.75 kg/ac-yr with annual total phosphorus loadings ranging from 0.01-0.92 kg/ac-yr. The most elevated loadings originate in industrial areas along the east side of Lake Shipp. Average annual TSS loadings range from approximately 0.5-135.9 kg/ac-yr, with the highest TSS loadings also originating from industrial areas on the east side of Lake Shipp.

A summary of estimated average annual loadings of total nitrogen, total phosphorus, and TSS discharging from sub-basin areas to Lake Lulu is given in Table 5-9. On an average annual basis, stormwater runoff contributes approximately 800 kg/yr of total nitrogen, 85.6 kg/yr of total phosphorus, and 13,426 kg/yr of TSS to Lake Lulu. Areal total nitrogen loadings range from 0.54-3.78 kg/ac-yr. Total phosphorus loadings range from 0.03-0.54 kg/ac-yr, with the lowest loadings generally occurring in sub-basins (10 and 11) which are treated by alum stormwater treatment systems. Areal TSS loadings range from 5.3-176 kg/ac-yr, with the lowest loadings originating from an open area adjacent to Lake Lulu and the highest loadings originating from a commercial area with little or no stormwater treatment.

5.1.3 Dry Weather Baseflow

5.1.3.1 Chemical Characteristics

During the period from October 2005-April 2006, dry weather baseflow was observed only in the discharge to Lake Shipp from sub-basins 12/13. This input was monitored as part of the stormwater characterization study discussed in Section 5.1.2. Six dry weather baseflow samples were collected during the monitoring program from Lake Shipp sub-basins 12/13. Baseflow discharges at this site originate primarily as groundwater inflow into the open drainage canal. A complete listing of individual laboratory analyses performed on the collected dry weather baseflow samples is given in Appendix G.

A summary of the characteristics of dry weather baseflow collected from Lake Shipp sub-basins 12/13 from October 2005-May 2006 is given in Table 5-10. Dry weather baseflow was found to be approximately neutral in pH and moderately well buffered. Measured conductivity values range from approximately 204-284 μmho/cm and are typical of values commonly observed in urban areas. Baseflow samples discharging from sub-basins 12/13 were characterized by elevated levels of total nitrogen, with a mean value of 2465 μg/l and measured concentrations ranging from 836-5261 μg/l. The dominant nitrogen species present in the baseflow samples is particulate nitrogen which comprises approximately 44% of the mean total nitrogen measured at this site. The second most abundant nitrogen species is NO_x which contributes 33% of the total nitrogen measured. Approximately 14% of the total nitrogen is contributed by ammonia, with 9% contributed by dissolved organic nitrogen. In general, nitrogen concentrations measured in dry weather baseflow appear to be greater than concentrations measured in stormwater runoff at this site.

TABLE 5-8

MEAN ANNUAL RUNOFF LOADINGS OF TOTAL NITROGEN, TOTAL PHOSPHORUS, AND TSS DISCHARGING FROM SUB-BASIN AREAS TO LAKE SHIPP

SUB-BASIN NO.	AREA (acres)	RUNOFF VOLUME (ac-ft)	MASS LOADING (kg/yr)			PERCENT OF TOTAL (%)			AREAL LOADING (kg/ac-yr)		
			TN	TP	TSS	TN	TP	TSS	TN	TP	TSS
1	4.8	0.7	1.1	0.2	34	0.1	0.1	0.1	0.23	0.04	7.1
2	32.3	47.8	81.7	21.3	3,029	9.4	13.1	13.1	2.53	0.66	93.8
3	12.8	16.3	28.3	3.5	1,023	3.2	2.2	4.4	2.21	0.27	79.9
4	7.0	7.6	12.9	2.4	480	1.5	1.5	2.1	1.84	0.34	68.6
5	18.4	13.3	25.7	4.8	690	2.9	3.0	3.0	1.40	0.26	37.5
6	18.2	17.3	27.3	8.2	1,269	3.1	5.1	5.5	1.50	0.45	69.7
7	43.9	64.7	88.2	38.0	5,967	10.1	23.4	25.7	2.01	0.87	135.9
8	8.3	4.6	10.2	1.2	178	1.2	0.7	0.8	1.23	0.14	21.4
9	47.4	41.9	61.0	5.4	451	7.0	3.3	1.9	1.29	0.11	9.5
10	52.3	1.6	3.4	0.3	24	0.4	0.2	0.1	0.07	0.01	0.5
11	40.6	32.0	56.8	11.3	1,858	6.5	7.0	8.0	1.40	0.28	45.8
12	126.4	69.8	143.1	19.2	2,475	16.4	11.8	10.7	1.13	0.15	19.6
13	35.4	28.2	44.3	3.0	223	5.1	1.8	1.0	1.25	0.08	6.3
14	91.9	55.0	105.5	16.4	1,782	12.1	10.1	7.7	1.15	0.18	19.4
15	15.0	11.5	24.1	4.7	690	2.8	2.9	3.0	1.61	0.31	46.0
16	8.5	7.2	12.9	2.6	406	1.5	1.6	1.8	1.52	0.31	47.8
17	12.1	10.8	19.5	4.0	613	2.2	2.5	2.6	1.61	0.33	50.7
18	4.8	5.2	9.3	1.9	292	1.1	1.2	1.3	1.94	0.40	60.8
19	2.5	3.3	6.0	1.2	188	0.7	0.7	0.8	2.40	0.48	75.2
20	19.4	11.1	19.7	3.8	588	2.3	2.3	2.5	1.02	0.20	30.3
21	27.5	20.0	32.5	2.9	252	3.7	1.8	1.1	1.18	0.11	9.2
22	40.3	33.1	52.7	4.9	558	6.0	3.0	2.4	1.31	0.12	13.8
23	1.2	2.8	6.9	1.1	114	0.8	0.7	0.5	5.75	0.92	95.0
Totals	**671.0**	**505.8**	**873**	**162**	**23,184**	**100.0**	**100.0**	**100.0**	**1.63**[1]	**0.31**[1]	**45.4**[1]

1. Mean value

Value represents 10-20% of annual load

Value represents >20% of annual load

Represents higher than mean areal loading

TABLE 5-9

MEAN ANNUAL RUNOFF LOADINGS OF TOTAL NITROGEN, TOTAL PHOSPHORUS, AND TSS DISCHARGING FROM SUB-BASIN AREAS TO LAKE LULU

SUB-BASIN NO.	AREA (acres)	RUNOFF VOLUME (ac-ft)	MASS LOADING (kg/yr)			PERCENT OF TOTAL (%)			AREAL LOADING (kg/ac-yr)		
			TN	TP	TSS	TN	TP	TSS	TN	TP	TSS
1	12.2	11.6	29.3	4.1	486	3.7	4.8	3.6	2.41	0.34	40.0
2	32.9	16.2	43.6	9.7	1,447	5.4	11.3	10.8	1.33	0.30	44.1
3	5.4	2.4	4.3	0.9	135	0.5	1.1	1.0	0.80	0.17	25.1
4	137.8	57.0	73.9	13.0	724	9.2	15.2	5.4	0.54	0.09	5.3
5	24.1	14.4	17.8	3.3	182	2.2	3.9	1.4	0.74	0.14	7.6
6	21.6	9.3	21.6	3.2	353	2.7	3.7	2.6	1.00	0.15	16.3
7	40.4	29.4	58.1	8.5	1,628	7.3	9.9	12.1	1.44	0.21	40.3
8	3.2	2.3	5.7	0.9	93	0.7	1.1	0.7	1.78	0.28	29.1
9	144.0	199.4	210.6	6.9	1,552	26.3	8.1	11.6	1.46	0.05	10.8
10	87.9	141.7	119.8	2.6	717	15.0	3.0	5.3	1.36	0.03	8.2
11	7.8	6.1	10.9	2.1	345	1.4	2.5	2.6	1.40	0.27	44.2
12	3.3	2.3	4.2	0.9	132	0.5	1.0	1.0	1.27	0.26	40.0
13	3.7	2.6	4.6	0.9	145	0.6	1.1	1.1	1.24	0.24	39.2
14	5.3	3.8	6.9	1.4	216	0.9	1.6	1.6	1.30	0.26	40.8
15	5.1	3.7	6.7	1.4	211	0.8	1.6	1.6	1.31	0.27	41.4
16	6.4	3.9	7.0	1.4	221	0.9	1.6	1.6	1.09	0.22	34.5
17	16.5	40.6	62.3	8.9	2,907	7.8	10.4	21.6	3.78	0.54	176.2
18	8.1	4.4	7.9	1.6	242	1.0	1.9	1.8	0.98	0.20	29.9
19	10.0	2.7	5.8	1.2	172	0.7	1.4	1.3	0.58	0.12	17.2
20	8.6	17.9	32.5	2.0	188	4.1	2.3	1.4	3.78	0.23	21.9
21	23.7	31.7	40.6	8.2	728	5.1	9.6	5.4	1.71	0.35	30.7
22	21.4	18.1	26.0	2.5	602	3.2	2.9	4.5	1.21	0.12	28.1
Totals	**629.3**	**621.5**	**800**	**85.6**	**13,426**	**100.0**	**100.0**	**100.0**	**1.48**[1]	**0.22**[1]	**35.0**[1]

1. Mean value

Value represents 10-20% of annual load

Value represents >20% of annual load

Represents higher than mean areal loading

TABLE 5-10

CHARACTERISTICS OF DRY WEATHER BASEFLOW SAMPLES COLLECTED FROM LAKE SHIPP SUB-BASINS 12/13 FROM OCTOBER 2005 TO MAY 2006

PARAMETER	UNITS	SHIPP SUB-BASINS 12/13[1]		
		mean	min	max
pH	s.u.	7.35	7.01	7.54
Conductivity	μmho/cm	253	204	284
Alkalinity	mg/l	79.2	47.2	100
NH_3	μg/l	355	127	692
NO_x	μg/l	819	69	2831
Diss. Org N	μg/l	217	43	496
Particulate N	μg/l	1074	214	3360
Total N	μg/l	2465	836	5261
SRP	μg/l	14	2	37
Diss. Org P	μg/l	5	1	11
Particulate P	μg/l	84	4	248
Total P	μg/l	103	17	252
Turbidity	NTU	9.4	0.9	39.5
TSS	mg/l	28.3	1.0	127
BOD	mg/l	8.2	2.6	24.5

1. n = 6 samples

Phosphorus concentrations in baseflow from sub-basins 12/13 are lower than observed in stormwater runoff, with a mean total phosphorus of 103 μg/l in dry weather baseflow. The dominant phosphorus species is particulate phosphorus which contributes 82% of the phosphorus measured at this site. An additional 14% is contributed by SRP, with 4% contributed by dissolved organic phosphorus. Measured concentrations of turbidity and TSS appear to be lower in dry weather than observed in stormwater runoff, with more elevated BOD concentrations observed during baseflow conditions than runoff conditions.

5.1.3.2 Mass Loadings

Estimates of annual mass loadings of nitrogen and phosphorus discharging as a result of dry weather baseflow from Lake Shipp sub-basins 12/13 were generated by multiplying the mean baseflow characteristics (summarized in Table 5-10) times the estimated annual dry weather baseflow volume of 28.96 ac-ft. A summary of the results of this analysis is given in Table 5-11. During average annual conditions, baseflow from Lake Shipp sub-basins 12/13 contributes approximately 88.0 kg of total nitrogen, 3.7 kg of total phosphorus, and 1011 kg of TSS. This information is utilized in a subsequent section for development of pollutant inputs to the three lakes.

TABLE 5-11

ANNUAL MASS LOADINGS OF DRY WEATHER BASEFLOW ENTERING LAKE SHIPP FROM SUB-BASINS 12/13

VOLUME (ac-ft)	MASS LOADING (kg)		
	TOTAL N	TOTAL P	TSS
28.96	88.0	3.7	1011

5.1.4 Groundwater Seepage

5.1.4.1 Chemical Characteristics

Nutrient influx from groundwater seepage was quantified using a total of 26 underwater seepage meters installed at locations throughout each of the three lakes. A discussion of the hydrologic inputs resulting from groundwater seepage during the original and supplemental monitoring programs is given in Section 4.1.5. Each of the groundwater seepage samples collected during the two monitoring programs was analyzed in the ERD Laboratory for pH, alkalinity, conductivity, total nitrogen, and total phosphorus. A complete listing of laboratory measurements conducted on seepage samples collected at each of the 26 sites during the original monitoring program from October 2005-April 2006 is given in Appendix H.1. Laboratory measurements conducted on samples collected during the supplemental monitoring program from July-December 2008 are given in Appendix H.2.

The data summarized in Appendices H.1 and H.2 reflect the results of laboratory analyses conducted on each of the groundwater seepage samples collected during the original and supplemental monitoring programs. When the seepage meters are originally installed, approximately 3 inches of water are trapped inside the seepage meter above the lake volume. Based upon an isolated surface area of approximately 0.27 m^2 and a trapped water depth of approximately 3 inches, the water volume contained above the sediments within a typical seepage meter installation is approximately 20.6 liters. This volume represents lake water which was trapped inside the seepage meter during the installation process, and this volume must be flushed from each seepage meter before representative seepage samples can be collected.

An analysis was conducted for each seepage monitoring site during the original and supplemental monitoring programs to identify samples which were collected after the trapped volume of 20.6 liters had been purged from the seepage meter based on the field seepage meter measurements summarized in Appendix E. Samples collected prior to purging of the seepage meter are not considered in evaluation of mean chemical characteristics for seepage at each monitoring site. The mean chemical characteristics for each seepage meter site during the original and supplemental monitoring programs are assumed to be reflected by the mean of seepage characteristics collected after the initially trapped volume has been purged. However, seepage values at a few of the monitored sites were extremely low in value, and the minimum purging volume of 20.6 liters was never collected from the seepage meter. In these instances, the chemical characteristics of seepage samples are assumed to be reflected by the final seepage sample collected during either the original or supplemental monitoring programs since this value reflects the best estimate of actual seepage characteristics. A summary of the characteristics of seepage samples used for quantification of nutrient influx during the original monitoring program from October 2005-April 2006 is given in Appendix H.3, with a summary of seepage samples used for quantification of nutrient influx from July-December 2008 given in Appendix H.4.

A summary of mean chemical characteristics of seepage samples used to estimate seepage characteristics entering Lakes May, Shipp, and Lulu from October 2005-April 2006 is given in Table 5-12. The values summarized in this table reflect data which were collected after the seepage discharge had exceeded the purge volume for each seepage meter.

In general, groundwater seepage collected within the three lakes was found to be approximately neutral in pH and moderately to well buffered. Measured conductivity values in seepage appear to be similar to those measured in stormwater runoff, with values ranging from approximately 190-600 μmho/cm. A wide range of nitrogen concentrations was observed in seepage samples discharging into the three lakes, with mean values ranging from approximately 1500-11,000 μg/l. A similar degree of variability was observed for mean total phosphorus concentrations which range from approximately 16-1784 μg/l.

A summary of mean chemical characteristics of seepage samples used to estimate seepage characteristics entering Lakes May, Shipp, and Lulu under wet season conditions from July-December 2008 is given in Table 5-13. The values summarized in this table reflect data which were collected after the seepage discharge had exceeded the purge volume for each seepage meter.

In general, groundwater seepage collected within the three lakes during wet season conditions was found to be approximately neutral in pH and moderately to well buffered. Measured conductivity values in seepage appear to be similar to those measured in stormwater runoff, with mean site values ranging from approximately 203-525 μmho/cm. A wide range of nitrogen concentrations was observed in seepage samples discharging into the three lakes, with mean site values ranging from approximately 616-13,238 μg/l. A similar degree of variability was observed for mean site total phosphorus concentrations which range from 3-324 μg/l.

TABLE 5-12

MEAN CHARACTERISTICS OF SEEPAGE SAMPLES COLLECTED FROM LAKES MAY, SHIPP, AND LULU UNDER DRY SEASON CONDITIONS FROM OCTOBER 2005-APRIL 2006

LAKE	SITE	NO. OF SAMPLES	pH (s.u.)	ALKALINITY (mg/l)	CONDUCTIVITY (µmho/cm)	TOTAL N (µg/l)	TOTAL P (µg/l)
May	1	5	6.53	41.3	190	2,339	125
	2	3	7.27	221	596	10,087	63
	3	6	7.00	67.4	220	2,475	84
	4	5	7.45	123	325	3,356	77
	5	1	7.40	175	414	14,368	20
	Mean	--	7.13	126	349	6,525	74
Shipp	1	5	7.75	260	606	8,181	326
	2	5	7.37	108	314	2,786	443
	3	6	7.24	74.8	265	2,219	66
	4	4	7.56	126	339	3,070	195
	5	4	7.46	82.7	275	1,739	23
	6	2	6.89	46.6	270	1,775	42
	7	2	7.45	79.1	278	3,364	132
	8	1	6.94	47.4	253	5,858	306
	9	2	7.09	59.2	267	6,602	16
	10	1	7.37	76.1	254	7,509	18
	Mean	--	7.31	87.3	312	4,310	157
Lulu	1	5	7.76	199	527	8,249	415
	2	5	7.60	142	402	2,394	195
	3	6	7.91	183	467	4,366	479
	4	4	7.77	131	374	5,568	201
	5	4	7.53	101	314	2,352	70
	6	2	7.25	74.9	265	1,519	48
	7	2	7.70	96.2	292	5,040	289
	8	1	6.84	58.2	228	1,956	100
	9	2	6.97	86.0	337	5,092	1,784
	10	1	7.23	57.0	266	4,500	294
	11	1	7.26	48.8	226	878	28
	Mean	--	7.44	107	336	3,810	355

TABLE 5-13

MEAN CHARACTERISTICS OF SEEPAGE SAMPLES COLLECTED FROM LAKES MAY, SHIPP, AND LULU UNDER WET SEASON CONDITIONS FROM JULY-DECEMBER 2008

LAKE	SITE	NO. OF SAMPLES	pH (s.u.)	ALKALINITY (mg/l)	CONDUCTIVITY (µmho/cm)	TOTAL N (µg/l)	TOTAL P (µg/l)
May	1	1	6.37	41.8	203	616	233
	2	2	7.28	67.6	271	827	186
	3	1	7.76	219	525	9,237	255
	4	1	7.07	62.2	276	3,718	277
	5	0	--	--	--	--	--
	Mean	--	7.12	97.7	319	3,600	238
Shipp	1	3	7.19	92.2	331	3,208	128
	2	3	7.14	60.3	231	1,731	85
	3	1	6.33	28.6	219	966	191
	4	3	7.37	86.8	314	2,360	76
	5	2	7.80	94.2	297	1,678	95
	6	3	7.18	56.7	254	805	158
	7	1	7.37	64.2	247	1,431	147
	8	0	--	--	--	--	--
	9	2	6.73	41.7	289	3,902	124
	10	1	7.05	55.6	324	13,238	221
	Mean	--	7.10	64.5	278	3,258	136
Lulu	1	2	7.42	68.5	271	698	8
	2	3	6.75	46.2	218	1,484	3
	3	3	7.19	62.1	276	1,797	79
	4	1	7.86	71.4	297	1,561	9
	5	5	7.79	80.2	306	1,286	13
	6	0	--	--	--	--	--
	7	1	8.05	85.2	315	2,463	61
	8	1	7.42	67.8	293	2,322	55
	9	1	6.55	42.4	336	1,859	324
	10	1	7.50	65.8	269	1,396	56
	11	1	7.26	64.0	262	1,142	18
	Mean	--	7.38	65.4	284	1,601	63

A comparison of mean seepage characteristics during the original and supplemental monitoring programs is given in Table 5-14. Overall mean values are provided for each of the three lakes for the evaluated physical and chemical characteristics, with separate mean values provided for samples collected during the original dry season monitoring program and supplemental wet season monitoring programs. The values summarized on Table 5-14 reflect the overall mean of samples collected at all monitoring sites in each lake and provide an estimate of overall mean seepage characteristics for each lake and monitoring period.

In general, measured concentrations of pH, alkalinity, conductivity, and total nitrogen are lower in value in each of the three lakes during the supplemental monitoring program compared with values measured during the original monitoring program. These differences may be largely related to dilution of seepage with rain water since the supplemental monitoring program is characterized by a higher total rainfall than occurred during the original monitoring program. This trend is also apparent for total phosphorus concentrations in Lake Shipp and Lake Lulu which were lower during the supplemental program than measured during the original monitoring program. However, the opposite trend was observed in Lake May which exhibited substantially higher total phosphorus concentrations during the supplemental program than occurred during the original monitoring program. These differences may be somewhat related to the number of samples collected during the two monitoring program, since samples were collected at each of the five sites during the original monitoring period but were collected at only four of the five sites during the supplemental monitoring program. No usable seepage samples were collected at Site 5 during the supplemental monitoring program. This site was characterized by the lowest phosphorus concentration during the original monitoring program, and a similarly low value for this site during the supplemental monitoring program would have substantially reduced the mean total phosphorus concentration of 238 μg/l for Lake May during the supplemental program.

TABLE 5-14

COMPARISON OF MEAN SEEPAGE CHARACTERISTICS DURING THE ORIGINAL AND SUPPLEMENTAL MONITORING PROGRAMS

LAKE	PERIOD	pH (s.u.)	ALKALINITY (mg/l)	CONDUCTIVITY (μmho/cm)	TOTAL N (μg/l)	TOTAL P (μg/l)
May	Original (10/05-4/06)	7.13	126	349	6525	74
	Supplemental (7/08-12/08)	7.12	97.7	319	3600	238
Shipp	Original (10/05-4/06)	7.31	87.3	312	4310	157
	Supplemental (7/08-12/08)	7.10	64.5	278	3258	136
Lulu	Original (10/05-4/06)	7.44	107	336	3810	355
	Supplemental (7/08-12/08)	7.38	65.4	284	1601	63

Isopleth contour maps were developed for each of the physical and chemical parameters summarized in Tables 5-12 and 5-13. The mean values for each monitoring site during dry and wet season conditions summarized in these tables were averaged together to generate an overall mean value which is assumed to reflect seepage characteristics at each monitoring site on an average annual basis. These mean values were then used to generate isopleths contour maps for the evaluated parameters.

Estimated mean annual isopleths of pH values in groundwater seepage in Lakes May, Shipp, and Lulu are illustrated on Figure 5-10. In general, seepage entering each of the three lakes is approximately neutral in pH. However, slightly depressed pH values were observed along the eastern shoreline of Lake May and the northern-central portion of Lake Lulu.

Estimated mean annual isopleths of alkalinity concentrations in groundwater seepage entering Lakes May, Shipp, and Lulu are illustrated on Figure 5-11. In general, mean alkalinity values in seepage range from approximately 60-160 mg/l. Central portions of Lake Shipp and Lake Lulu exhibit alkalinity concentrations ranging from approximately 60-80 mg/l. Areas of elevated alkalinity concentrations are apparent along the southeastern portion of Lake May, northern portion of Lake Shipp, and northeastern and northwestern portions of Lake Lulu.

Mean annual isopleths of conductivity values in groundwater seepage entering Lakes May, Shipp, and Lulu are illustrated on Figure 5-12. Measured conductivity values within the lakes range from approximately 200-450 μmho/cm. Areas of elevated conductivity values are similar to the areas of elevated alkalinity values indicated on Figure 5-11.

Mean annual isopleths of total nitrogen concentrations in groundwater seepage entering Lakes May, Shipp, and Lulu are illustrated in Figure 5-13. In general, seepage nitrogen concentrations appear to be lowest in perimeter areas of each lake, with more elevated concentrations in central portions. This trend is particularly apparent in Lake May and less apparent in Lake Lulu. Seepage nitrogen concentrations around the perimeter of Lakes May and Shipp range from approximately 2000-3000 μg/l, increasing to values ranging from 7000-9000 μg/l near the center of the lakes.

Mean isopleths of total phosphorus concentrations in groundwater seepage entering Lakes May, Shipp, and Lulu are illustrated on Figure 5-14. The lowest seepage phosphorus concentrations occur in Lake May with virtually all seepage concentrations less than 200 μg/l. Slightly more elevated concentrations are apparent in Lake Shipp, although much of the lake exhibits concentrations similar to those in Lake May. The most elevated seepage phosphorus concentrations were observed in Lake Lulu, with concentrations as high as 1000 μg/l in north-central portions of the lake.

5.1.4.2 <u>Mass Loadings</u>

Mean seepage isopleths for nitrogen influx, in terms of $\mu g/m^2$-day were generated by combining the concentration isopleths for total nitrogen (given in Figure 5-13) with the hydrologic isopleths for groundwater seepage (summarized in Figure 4-11). This procedure results in estimates of nitrogen influx in terms of mass of nitrogen per square meter of lake surface per day. For purposes of this analysis, the term “influx” or “flux” is defined as the areal mass input or loading per unit of time.

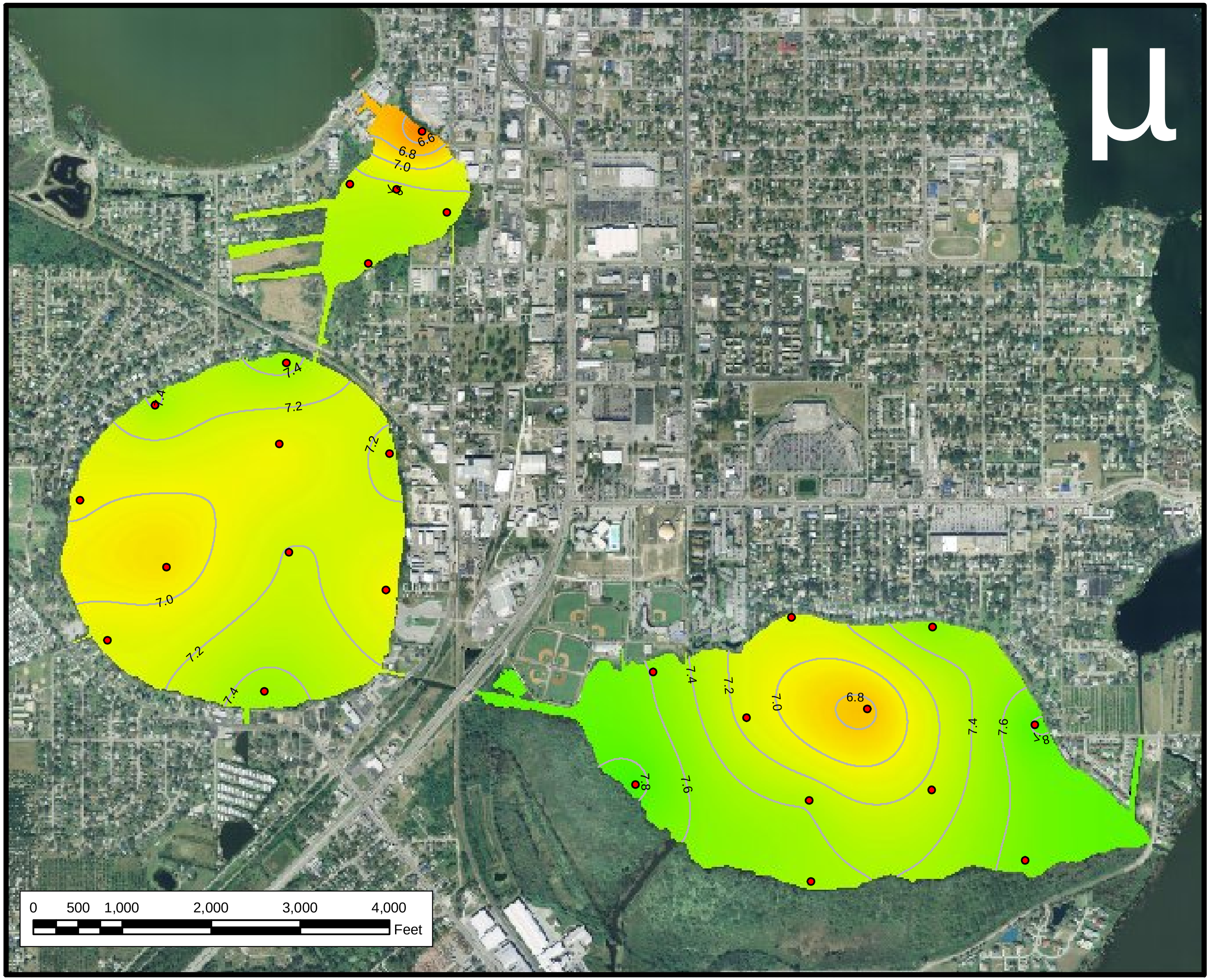


Figure 5-10. Estimated Mean Annual pH Values (s.u.) in Groundwater Seepage Entering Lakes May, Shipp, and Lulu.

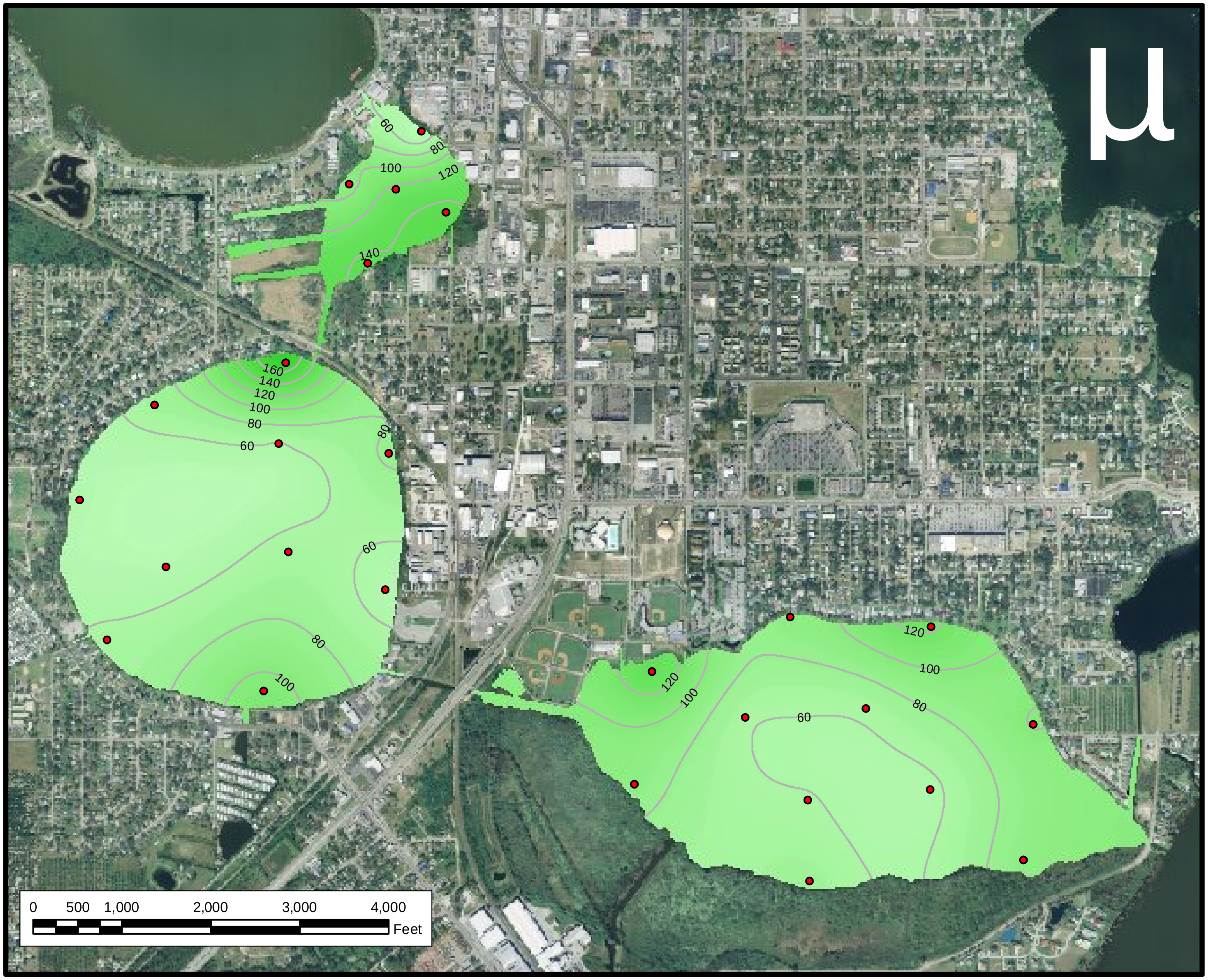


Figure 5-11. Estimated Mean Annual Alkalinity Concentrations (mg/l) in Groundwater Seepage Entering Lakes May, Shipp, and Lulu.

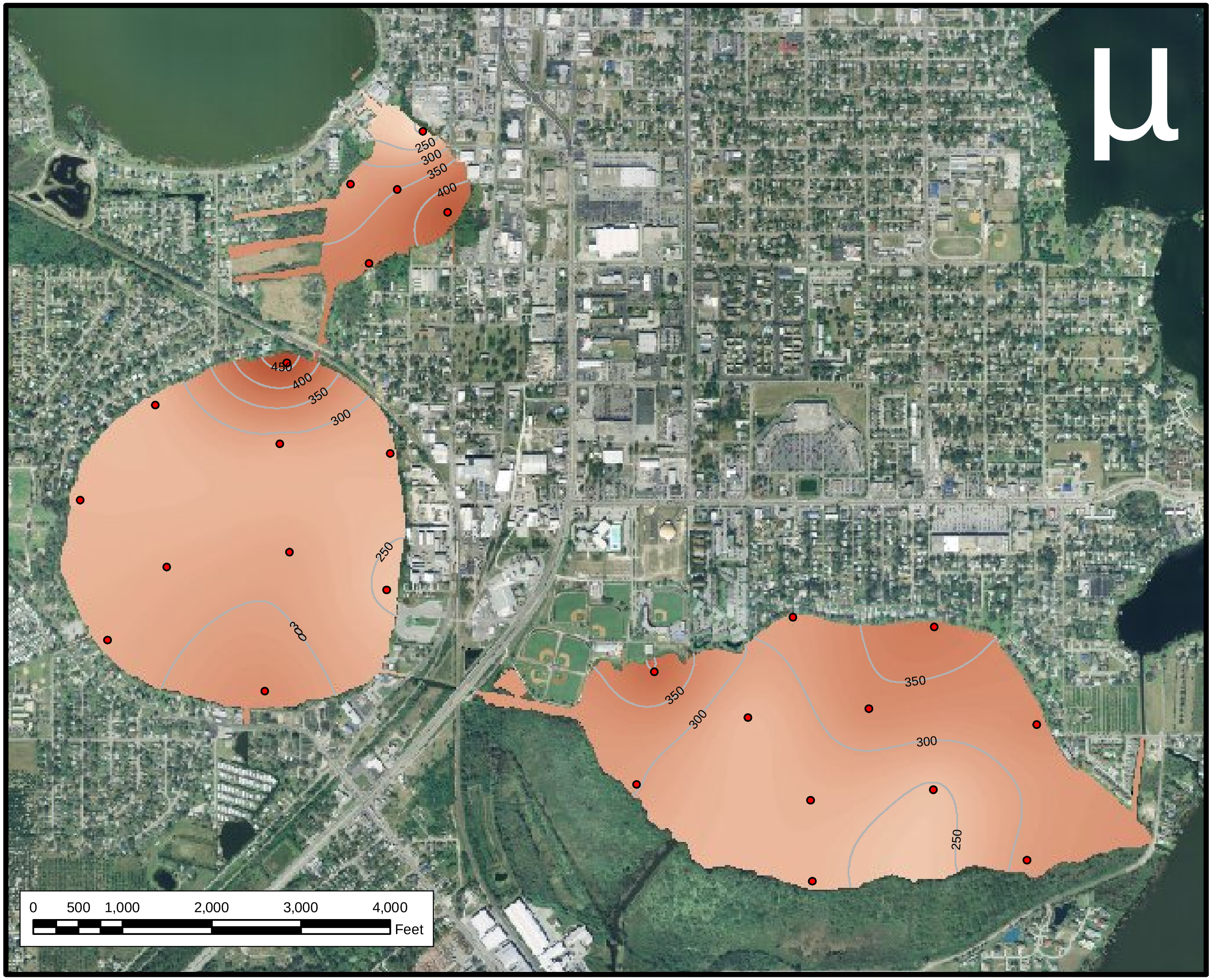


Figure 5-12. Estimated Mean Annual Conductivity Concentrations (µmho/cm) in Groundwater Seepage Entering Lakes May, Shipp, and Lulu.

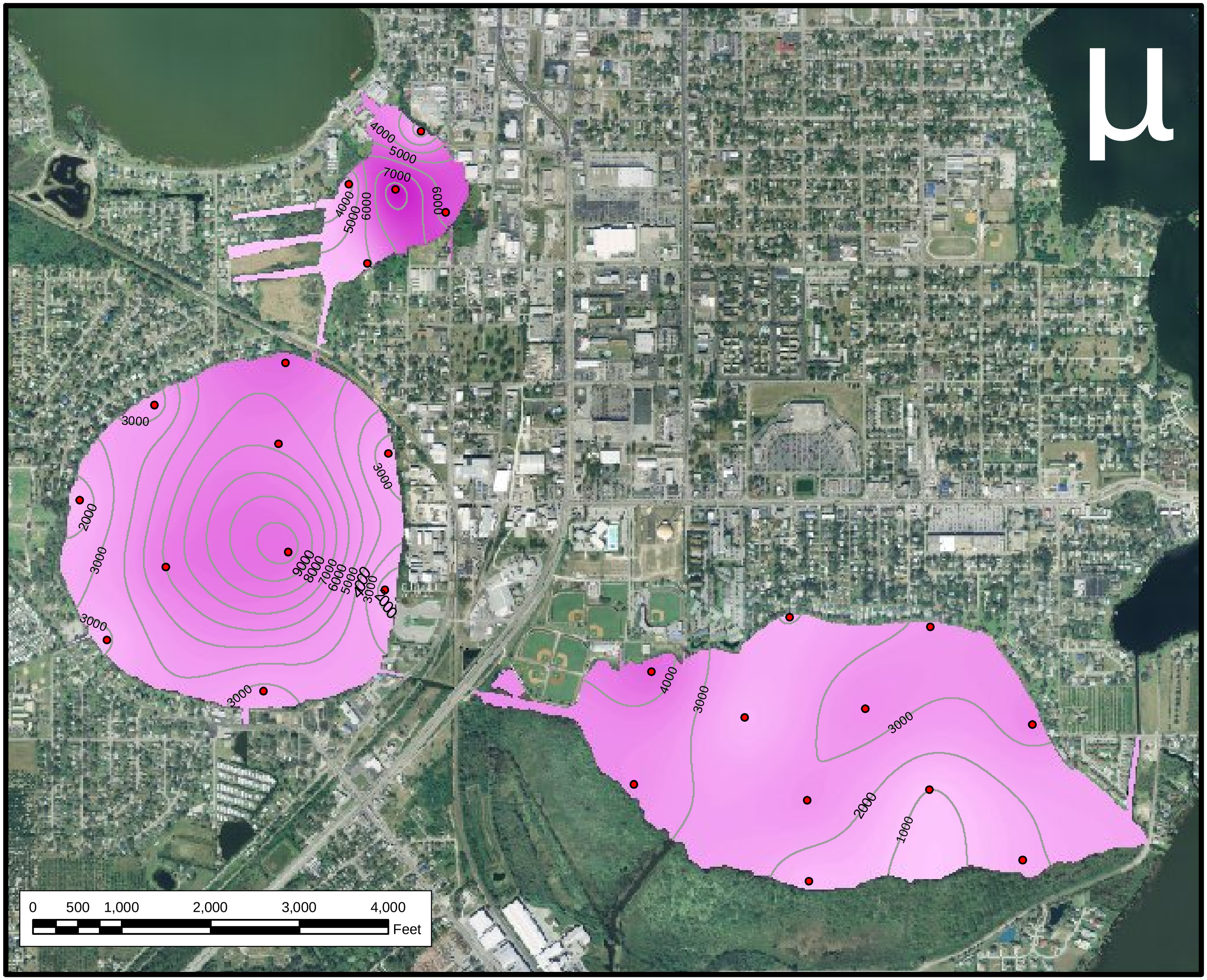


Figure 5-13. Mean Annual Isopleths of Total Nitrogen Concentrations in Groundwater Seepage Entering Lakes May, Shipp, and Lulu.

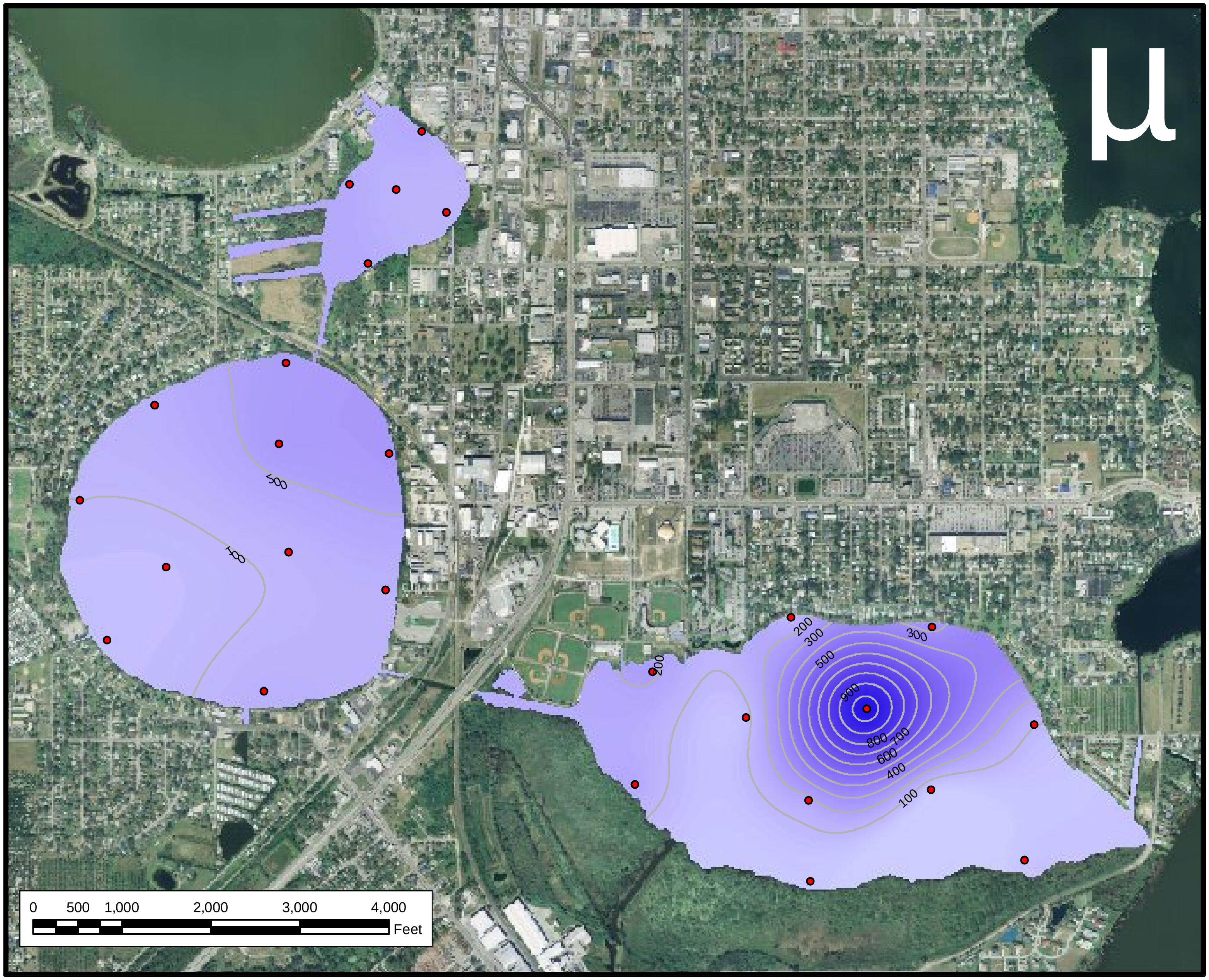


Figure 5-14. Mean Annual Isopleths of Total Phosphorus Concentrations in Groundwater Seepage Entering Lakes May, Shipp, and Lulu.

Isopleths of mean seepage influx of total nitrogen into the three lakes are given on Figure 5-15. In general, nitrogen influx from groundwater seepage ranges from approximately 2,000-16,000 $\mu g/m^2$-day within the lakes. Substantially elevated levels of nitrogen influx were observed along the northeast side of Lake May, eastern-central portions of Lake Shipp, and northwestern shoreline areas of Lake Lulu.

Mean seepage phosphorus influx isopleths are summarized on Figure 5-16. These isopleths were generated by combining the phosphorus concentration isopleths (summarized on Figure 5-14) with the seepage inflow hydrograph (summarized in Figure 4-11). In general, phosphorus influx into the three lakes from groundwater seepage ranges from approximately 200-800 $\mu g/m^2$-day. Elevated levels of phosphorus influx from groundwater seepage are apparent along the eastern and western shoreline areas of Lake Shipp, and northern portions of Lake Lulu.

The isopleths summarized in Figures 5-15 and 5-16 were integrated over a 365-day annual period to develop estimates of the total annual influx of nitrogen and phosphorus from groundwater seepage into the three lakes. A summary of estimated annual mass loadings to Lakes May, Shipp, and Lulu from groundwater seepage is given in Table 5-15. Overall, groundwater seepage contributes approximately 5123 kg of total nitrogen and 187 kg of total phosphorus to the three lakes each year. Calculated areal loadings of groundwater seepage are provided in the final columns of Table 5-15. These values reflect the mass influx divided by the lake surface area to allow comparison of seepage inputs between the three lakes. The mean total nitrogen influx into the three lakes is approximately 9.44 kg/ac-yr. Higher than average nitrogen loadings were observed in Lakes May and Shipp, with lower than average loadings observed in Lake Lulu. The overall mean phosphorus areal loading is approximately 0.29 kg/ac-yr. Areal phosphorus inputs from seepage are approximately equal in the three lakes.

TABLE 5-15

ESTIMATED ANNUAL MASS LOADINGS TO LAKES MAY, SHIPP, AND LULU FROM GROUNDWATER SEEPAGE

LAKE	MASS INFLUX (mg/m^2-day)		MASS INFLUX (kg)		AREAL LOADING (kg/ac)	
	TOTAL N	TOTAL P	TOTAL N	TOTAL P	TOTAL N	TOTAL P
May	8.58	0.191	641	14.3	12.7	0.28
Shipp	6.89	0.197	2814	80.5	10.2	0.29
Lulu	3.68	0.202	1668	91.7	5.43	0.30
Total:	**19.15**	**0.590**	**5123**	**187**	**9.44**[1]	**0.29**[1]

1. Mean value

Over the past 20 years, ERD has conducted extensive seepage monitoring in 38 lakes in Florida. The mean areal loadings of total nitrogen and total phosphorus from groundwater seepage for these lakes are 8.27 kg/ac-yr and 0.59 kg/ac-yr, respectively. Therefore, the measured areal loadings for total phosphorus in Lakes May, Shipp, and Lulu are approximately half of the mean seepage value. Influx of total nitrogen from seepage into Lakes May and Shipp is higher than the mean seepage measured by ERD, with nitrogen loadings from seepage in Lake Lulu less than the mean value.

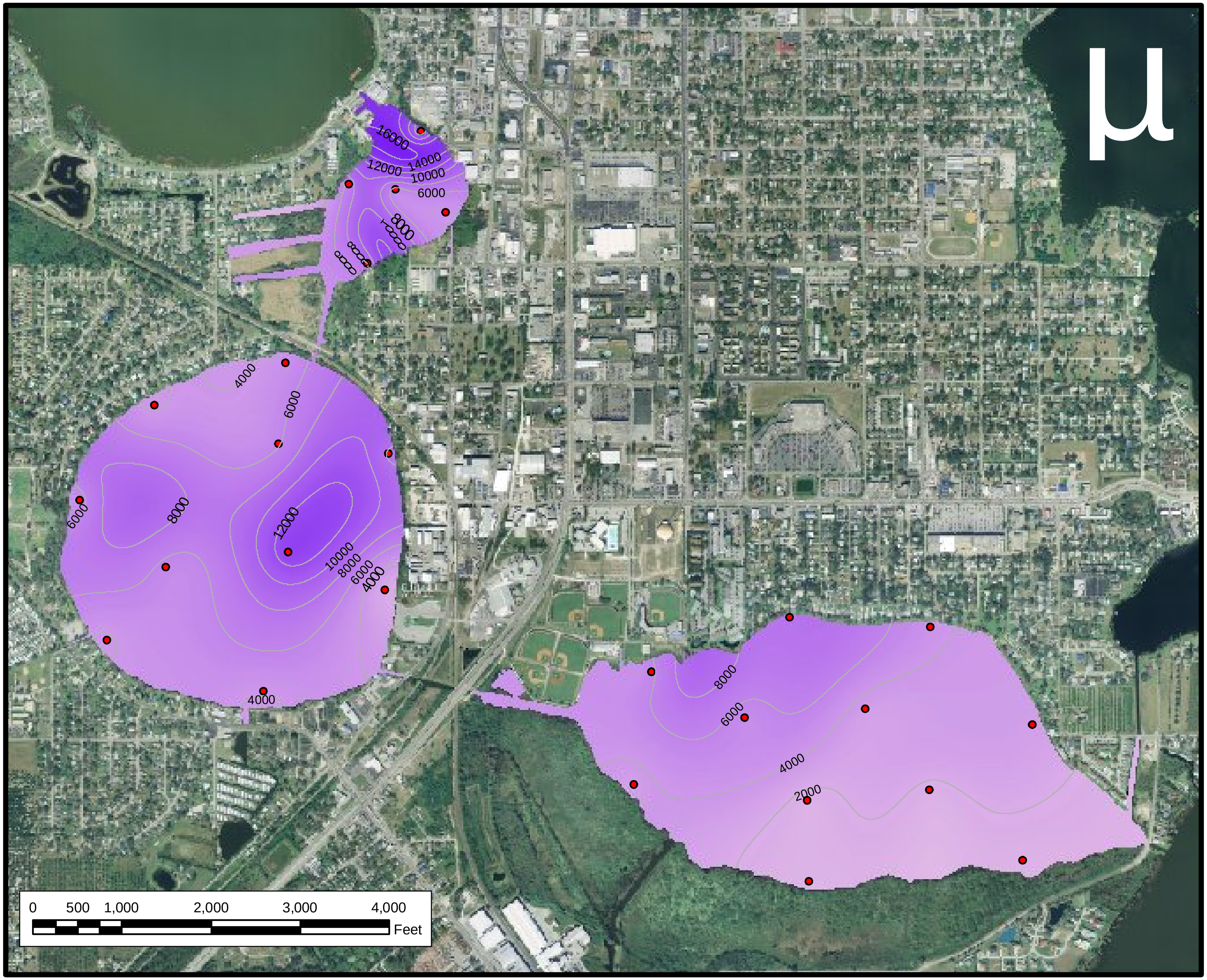


Figure 5-15. Isopleths of Annual Total Nitrogen Flux in Groundwater Seepage Entering Lakes May, Shipp, and Lulu.

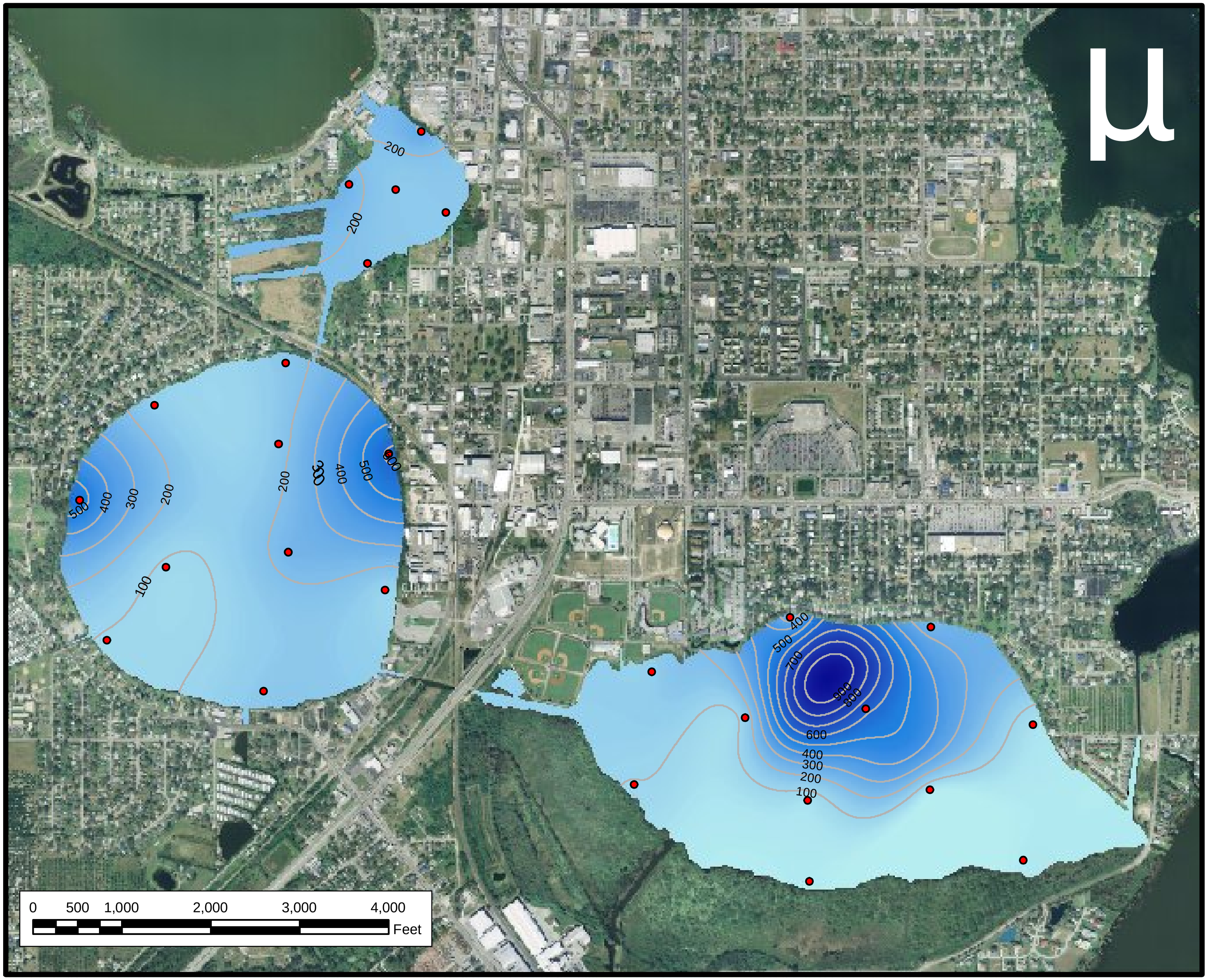


Figure 5-16. Isopleths of Annual Total Phosphorus Flux in Groundwater Seepage Entering Lakes May, Shipp, and Lulu.

5.1.5 Internal Recycling

Quantification of sediment phosphorus release as a result of internal recycling in lakes is difficult, and a variety of methods have been used by researchers to obtain this estimate. One method which has been used in reservoirs is called the Mass Balance Method. This method is best suited to a waterbody with well defined inputs and outputs. A mass balance is then conducted on the waterbody over a one- to two-week period. An increase of phosphorus mass within the lake, after accounting for inputs and losses, would suggest that a net internal loading has occurred. However, this method appears inappropriate for use in the Winter Haven Chain-of-Lakes since these lakes are impacted by a wide variety of diffuse hydrologic and pollutant sources.

A method which has been used extensively in deep northern lakes is to measure changes in phosphorus content in the hypolimnion of a stratified lake over an extended period of anoxia. The increase in phosphorus mass within the stratified hypolimnion can then be directly correlated with sediment release rates. However, this method also appears inappropriate for use in the Winter Haven Chain-of-Lakes since the lakes are relatively shallow and a well defined hypolimnion is not present.

A third method of quantifying the internal loadings is through trophic state modeling. Using this approach, hydrologic and nutrient inputs are estimated from all quantifiable sources. A trophic state model is then developed to predict water column concentrations of total phosphorus. If the model underestimates phosphorus concentrations, then a missing phosphorus load may be present which can be attributed to internal recycling. However, this methodology can be highly inaccurate and is dependent upon the accuracy of the estimated loadings for other variables.

Another method used for quantification of internal loadings is to perform sediment release experiments. In this method, large diameter sediment cores are collected from various loadings within the lake and incubated in the laboratory under a variety of conditions to simulate variability in the lake throughout the year. Changes in phosphorus concentrations are measured in the overlying sediments, and this information is extrapolated to an areal release rate within the lake. This is the only method of estimating internal loadings which provides a direct measurement of phosphorus release. This method has been used by ERD on multiple occasions in previous work efforts and was selected as the quantification method for the Winter Haven study.

Field and laboratory investigations were performed by ERD to quantify the mass of phosphorus released as a result of internal recycling from the sediments to the overlying water column in each of the three lakes under both aerobic and anoxic conditions. Large diameter lake sediment core samples were collected at multiple locations in each of the three lakes and incubated under anoxic and aerobic conditions. Periodic measurements of orthophosphorus and other water quality parameters were used to estimate sediment phosphorus release under the evaluated conditions. This information is utilized to provide an estimate of the significance of mass loadings of phosphorus from lake sediments as part of the overall nutrient budgets for Lakes May, Shipp, and Lulu.

5.1.5.1 **Field and Laboratory Procedures**

Multiple sediment core samples were collected in each of the three lakes using 4-inch diameter clear acrylic core tubes. Each of the acrylic tubes was driven into the sediments to the maximum possible depth using a large sledge hammer. A 4-inch x 4-inch wooden beam was placed on top of the acrylic core tube to evenly distribute the force of each sledge hammer blow and to prevent direct contact between the sledge hammer and the acrylic tube. Separate core samples were collected at two locations in Lake May, four locations in Lake Shipp, and four locations in Lake Lulu, comprising a total of 10 separate large diameter core samples collected for this evaluation. Locations used for collection of the sediment core tubes as indicated on Figure 5-17.

Each of the acrylic tubes was penetrated into the sediments to depths ranging from approximately 2-6 ft, depending upon the physical characteristics of the sediments at each of the selected monitoring sites or until a firm bottom material was encountered. The core tubes were retrieved intact, along with the overlying water column present at each of the collection sites. Upon retrieval to the surface, a rubber cap was attached to the bottom of each core tube to prevent loss of sediments. The collected water volume above the trapped sediments was carefully siphoned off until a water depth of 18 inches remained in each of the collected columns above the sediment-water interface. Each of the acrylic core tubes was then cut at a uniform height of 6 inches above the water level, leaving a 6-inch air space between the water level and the top of the column. A 4-inch PVC cap was then placed on the top of each collected core tube. Each of the collected core tubes was then returned to the ERD laboratory for incubation experimentation. All samples were transported to the ERD laboratory in a vertical position to avoid mixing of the sediment layers.

After return to the laboratory, each of the 10 collected core samples was attached to a laboratory work bench in a vertical position. Two separate 3-inch diameter holes were then drilled into the PVC cap attached to the top of each core sample. A 3-inch diameter semi-rigid polyethylene tube was inserted through one of the holes to a depth of approximately 2-3 inches above the sediment surface. An air stone diffuser was attached to the end of the tubing inside each core tube. This system was used to introduce selected gases into the core tubes to encourage aerobic or anoxic conditions.

A separate piece of polyethylene tubing was inserted into the second hole in the top of each core tube, approximately 1 inch below the level of the cap, but above the water level in each tube. The other end of the tubing was connected to a water trap to minimize loss of water from each column as a result of evaporation. This tubing also provided a point of exit for gases which were bubbled into each core tube. A schematic of the sediment incubation apparatus is given in Figure 5-18.

After initial set-up of the incubation apparatus, compressed air was introduced into each of the core tubes, through the individual diffusers, using a small compressor. This process quickly created aerobic conditions within each of the 10 core tubes. This aeration process was continued in each of the core tubes for a period of approximately 45 days. During the aeration process, the water within each of the core tubes was well mixed without disturbing the sediments, so that phosphorus released from the sediments could be quantified as a function of changes in phosphorus concentrations within the water column of each core tube. On approximately a 1-2 day interval, 20 ml of water was withdrawn from each of the columns using a 3-inch polyethylene tube and a plastic laboratory syringe. Each of the collected samples was immediately filtered using a 0.45 micron syringe type membrane filter and analyzed for general parameters and nutrients. However, only the results of the total phosphorus analyses are utilized in this report for purposes of estimating sediment phosphorus release rates.

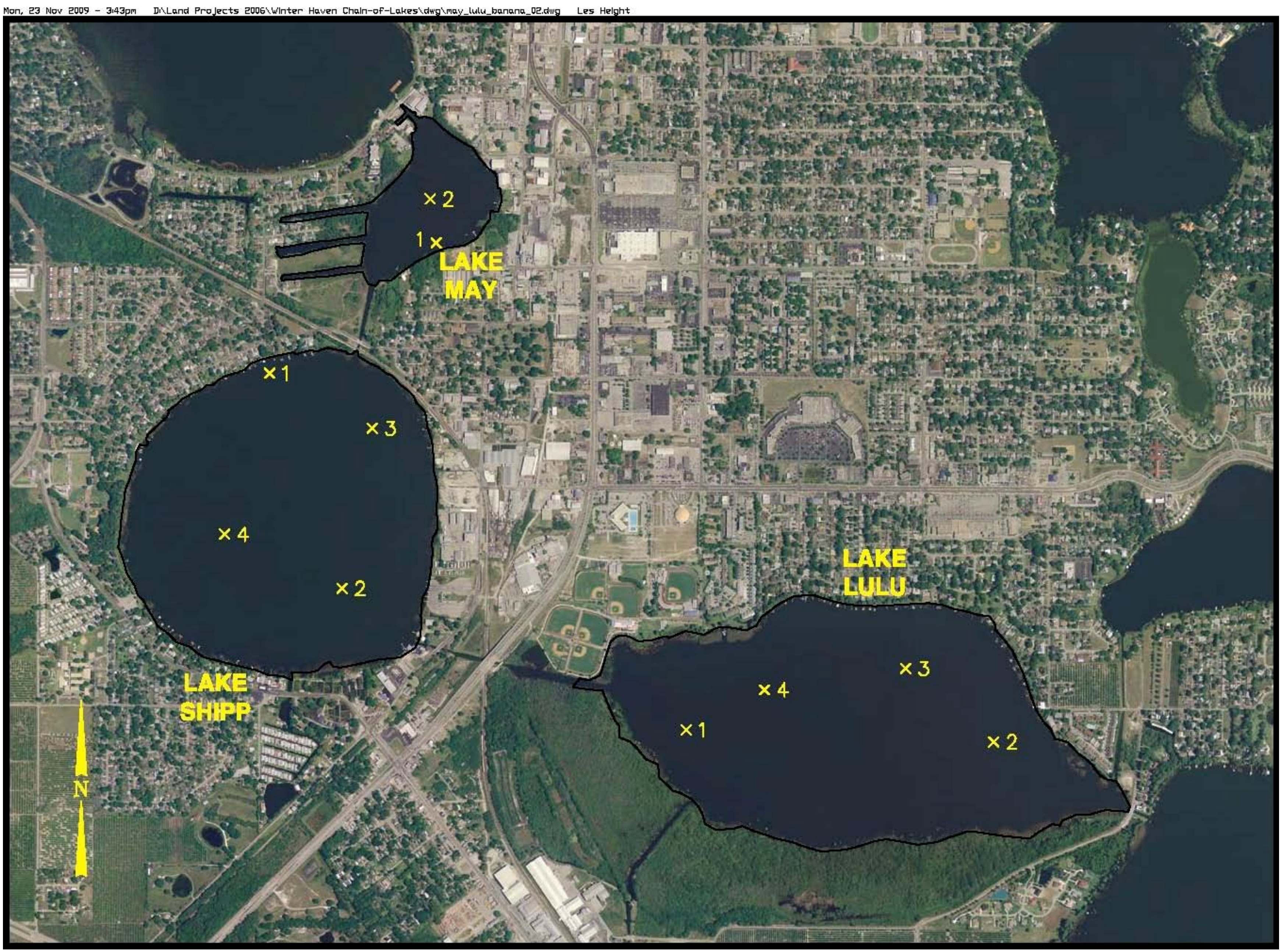


Figure 5-17. Collection Sites for the Large Diameter Sediment Samples Used in Incubation Experiments.

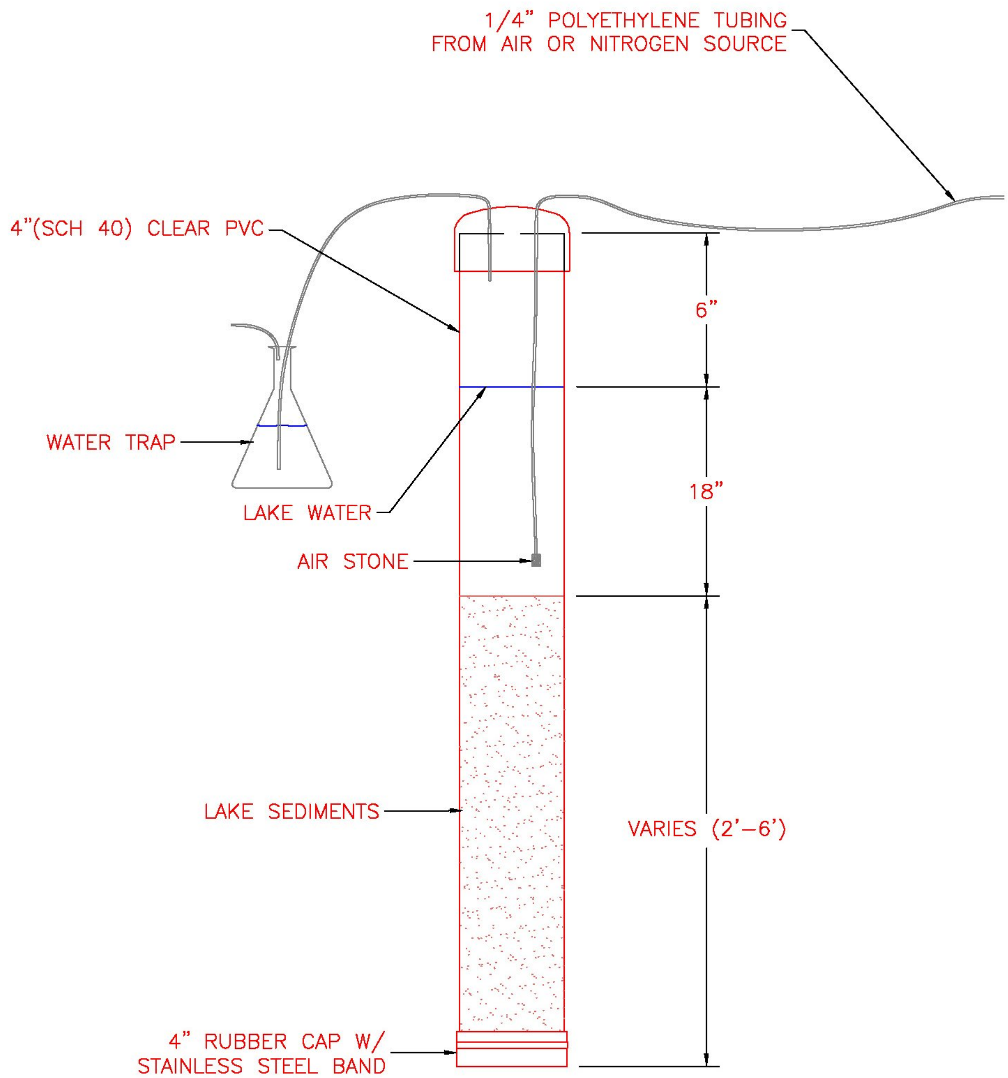


Figure 5-18. Schematic of Sediment Incubation Apparatus.

At the conclusion of the experimentation under aerobic conditions, the compressed air source was replaced with a pure nitrogen source. Nitrogen gas was gently bubbled through each of the 10 columns to remove existing dissolved oxygen and create anoxic conditions within each tube. In general, creation of anoxic conditions, as indicated by measurements of redox potential (< 200 mv) within each of the columns, occurred after approximately 5-7 days. At the onset of anoxic conditions, sample collection was conducted on a 1-2 day basis from each of the 10 columns using the method previously outlined for aerobic conditions. Incubation of samples under anoxic conditions was continued for approximately 60 days.

At the time of sample collection for the 4-inch sediment core samples, 2-inch diameter sediment core samples were also collected at each site using a stainless steel split spoon core collection device, to evaluate the physical and chemical characteristics of sediments in the vicinity of the core samples collected for the isolation experiments. Triplicate samples were collected at each site and the 0-10 cm layer from each sample was combined together to form a single composite 0-10 cm layer for each of the 10 monitored sites. The 0-10 cm layer was collected since sediment phosphorus release is typically regulated by the physical and chemical characteristics of this zone. Each of these collected samples was evaluated in the laboratory for pH, moisture content, organic content, wet density, total nitrogen, and total phosphorus. The chemical characteristics of each of the collected samples is assumed to be similar to sediment characteristics present in the large diameter sediment core samples collected at each of the monitoring sites.

Collection of the large diameter (4-inch) and smaller diameter (2-inch) sediment core samples was performed during May 2006. Experimentation under aerobic conditions was initiated in May and continued for a period of 45 days. Anoxic experimentation was initiated at the end of the aerobic experiments and was continued for a period of 60 days.

5.1.5.2 Results of Field and Laboratory Testing

A listing of the physical-chemical characteristics of sediment core samples used in the incubation experiments is given in Table 5-16. The two large diameter core samples collected in Lake May, identified as “shallow” and “deep”, appear to reflect primarily organic muck-type sediments based upon the low wet density and elevated values for moisture content and organic content. These samples also contain relatively elevated concentrations of both total nitrogen and total phosphorus.

TABLE 5-16

PHYSICAL-CHEMICAL CHARACTERISTICS OF SEDIMENT SAMPLES USED IN INCUBATION EXPERIMENTS

LAKE	SITE	WET DENSITY (g/cm^3)	MOISTURE CONTENT (%)	ORGANIC CONTENT (%)	NUTRIENTS (µg/cm^3 wet weight)		pH (s.u.)
					Total N	Total P	
May	Shallow	1.08	89.8	46.8	17,450	2,467	6.42
	Deep	1.08	89.9	48.1	18,493	2,100	6.63
Shipp	1	2.05	28.6	1.5	11,615	1,174	6.59
	2	1.07	92.0	42.8	18,891	2,122	6.15
	3	2.02	31.4	1.4	13,899	1,147	6.39
	4	1.34	73.4	14.8	21,659	2,849	6.10
Lulu	1	1.14	86.3	31.9	17,236	1,980	6.52
	2	1.08	90.9	45.2	19,721	1,598	6.21
	3	1.05	91.2	61.3	22,286	1,783	6.13
	4	1.44	68.5	7.5	16,086	816	6.48
Mean Value		**1.34**	**74.2**	**30.1**	**17,734**	**1,804**	**6.36**

Four separate large diameter core samples were collected from Lake Shipp. Based upon the physical-chemical characteristics summarized in Table 5-16, the sediment core samples collected at sites 1 and 3 appear to represent primarily sandy sediments, with only a small amount of organic muck present. The core sample collected at site 2 appears to reflect highly organic muck sediments, while the sample collected at site 4 appears to represent a mixture of sand and muck.

Four large diameter sediment core samples were also collected from Lake Lulu. Based upon the characteristics summarized in Table 5-16, core samples collected at sites 1, 2, and 3 appear to reflect primarily muck-type sediments, although the slightly higher wet density and lower values for moisture content and organic content observed at site 1 suggest a sand component as well. The sediment core sample collected at site 4 reflects a mixture of sand and organic muck.

A summary of sediment phosphorus speciation in sediment core samples used in the incubation experiments is given in Table 5-17. In general, the muck-type sediments collected at the two Lake May sites, Lake Shipp sites 2 and 4, and Lake Lulu sites 2 and 3 appear to have substantially higher total available phosphorus concentrations than samples which reflect sand or mixture characteristics. This suggests that the muck-type sediments have a higher release potential for phosphorus than sediments composed primarily of sand or mixtures.

TABLE 5-17

SEDIMENT PHOSPHORUS SPECIATION IN SEDIMENT CORE SAMPLES USED IN INCUBATION EXPERIMENTS

LAKE	SITE	SALOID-BOUND P ($\mu g/cm^3$)	IRON-BOUND P ($\mu g/cm^3$)	TOTAL AVAILABLE P ($\mu g/cm^3$)	PERCENT OF TOTAL[1] (%)	Al-BOUND P ($\mu g/cm^3$)	PERCENT OF TOTAL[2] (%)
May	Shallow	110	953	1,063	43	765	31
	Deep	48	1,483	1,531	73	469	22
Shipp	1	73	323	396	34	505	43
	2	332	594	926	44	225	11
	3	50	110	160	14	264	23
	4	110	737	847	30	1,624	57
Lulu	1	24	57	81	4	210	10
	2	529	343	872	55	527	33
	3	409	374	783	44	871	49
	4	73	106	179	22	83	10
Average		**176**	**508**	**684**	**36**	**554**	**29**

A graphical summary of sediment phosphorus release in Lake May under aerobic and anoxic conditions is given in Figure 5-19. Separate plots are provided for phosphorus release measured in sediment core samples collected from shallow and deep areas of Lake May. Release of phosphorus from the lake sediment core samples appears to be substantially greater under anoxic conditions than observed under aerobic conditions. Low rates of phosphorus release were observed under aerobic conditions in sediment core samples collected from both shallow and deep areas, with equilibrium phosphorus concentrations of approximately 20 μg/l within the core tubes under aerobic conditions. In contrast, substantially greater levels of phosphorus release were observed in the core tubes under anoxic conditions. Sediment iron-bound phosphorus associations are relatively stable under aerobic conditions but become unstable under anoxic conditions, allowing phosphorus to be released from the sediments into the overlying water column. Under anoxic conditions, equilibrium phosphorus concentrations reached 70-80 μg/l in the core samples from both shallow and deep areas.

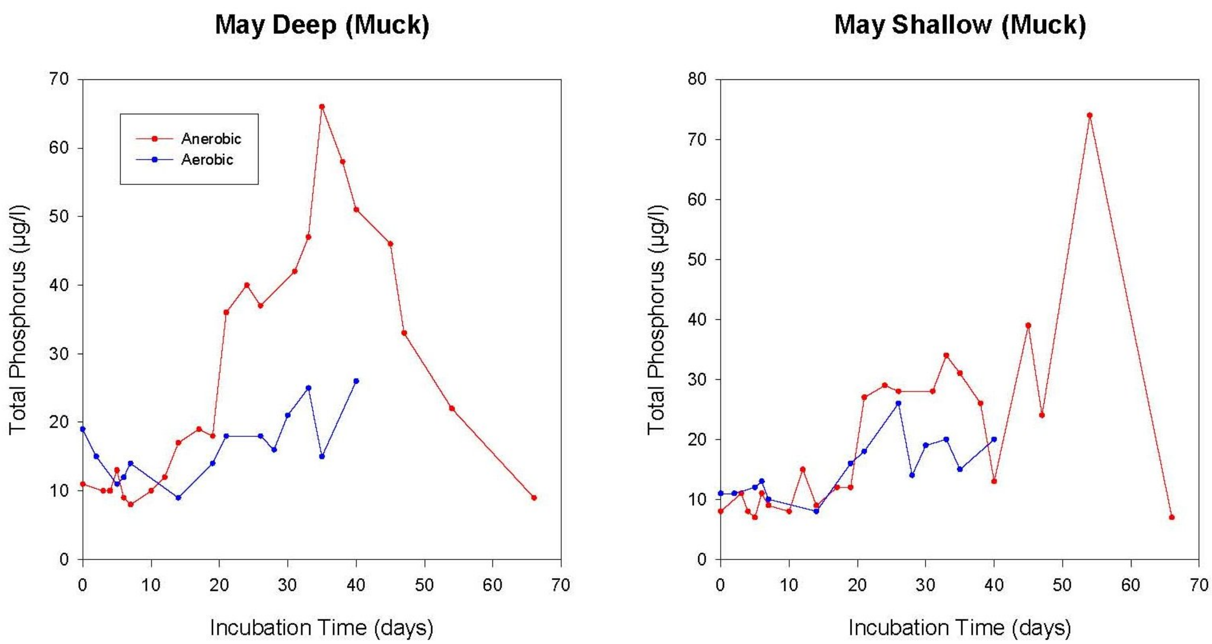


Figure 5-19. Release of Total Phosphorus in Lake May Sediments Under Aerobic and Anoxic Conditions.

A graphical comparison of phosphorus release from isolation chamber sediments in Lake Shipp under aerobic and anoxic conditions is given in Figure 5-20. Phosphorus release in Lake Shipp sediments under aerobic conditions was found to be extremely low in value at site 1 (sandy) and site 2 (muck), with slightly greater phosphorus release observed at sites 3 (sandy) and 4 (mixture). Phosphorus release was observed to increase under anoxic conditions for all sediment types, although the observed release was higher in the muck and mixture sediments than in sandy sediments. Under aerobic conditions, equilibrium total phosphorus concentrations within the three chambers ranged from approximately 10-125 μg/l. However, under anoxic conditions, sediments consisting of muck and a mixture exhibited equilibrium phosphorus concentrations ranging from approximately 250-500 μg/l.

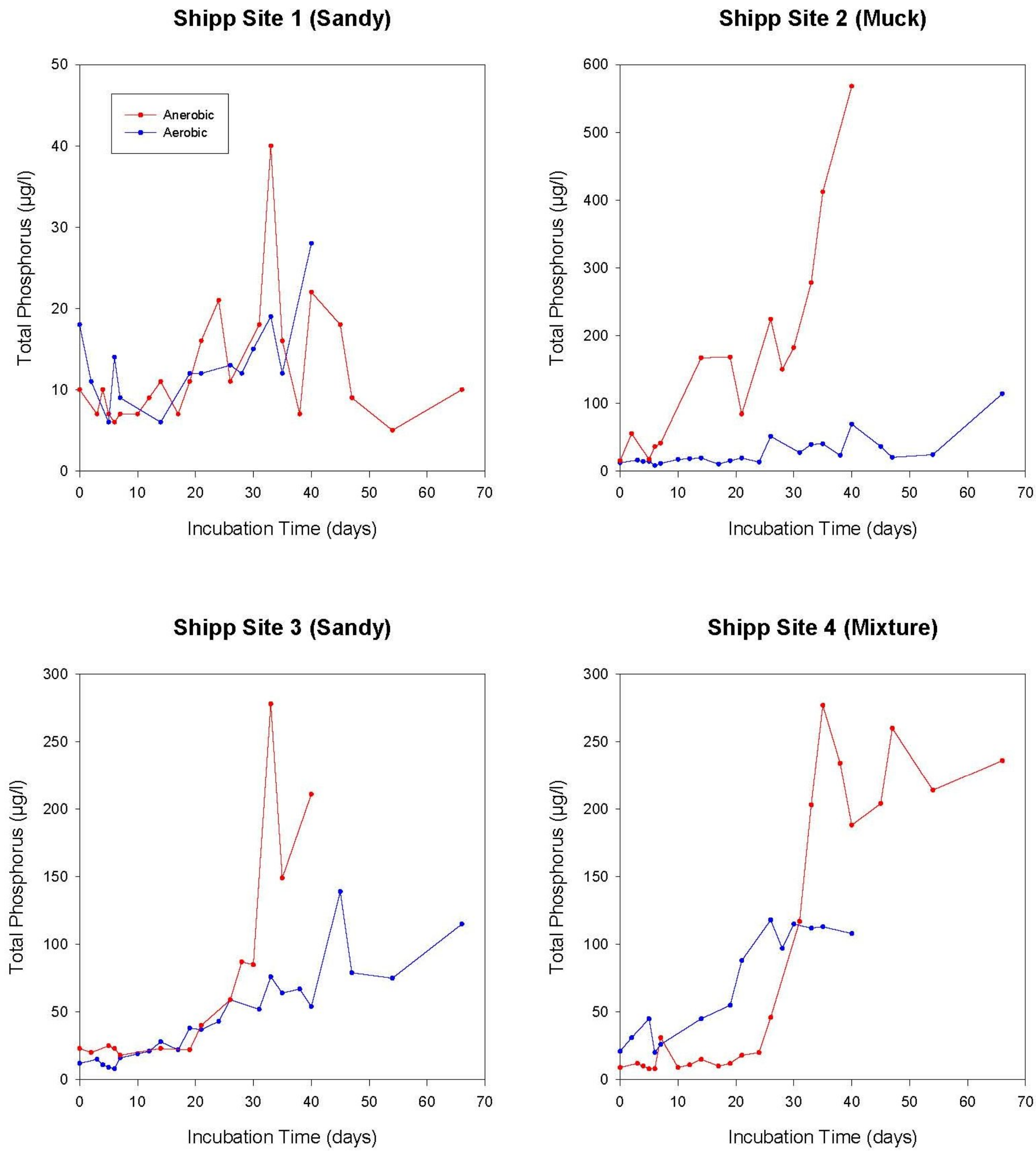


Figure 5-20. Release of Total Phosphorus in Lake Shipp Sediments Under Aerobic and Anoxic Conditions.

A graphical comparison of phosphorus release from isolation chamber sediments in Lake Lulu under aerobic and anoxic conditions is given in Figure 5-21. Under aerobic conditions, equilibrium phosphorus concentrations within the isolation chambers range from approximately 50-125 µg/l. However, under anoxic conditions, total phosphorus concentrations within the isolation tubes reached concentrations ranging from 250-350 µg/l which was observed in both the muck and mixture sediments.

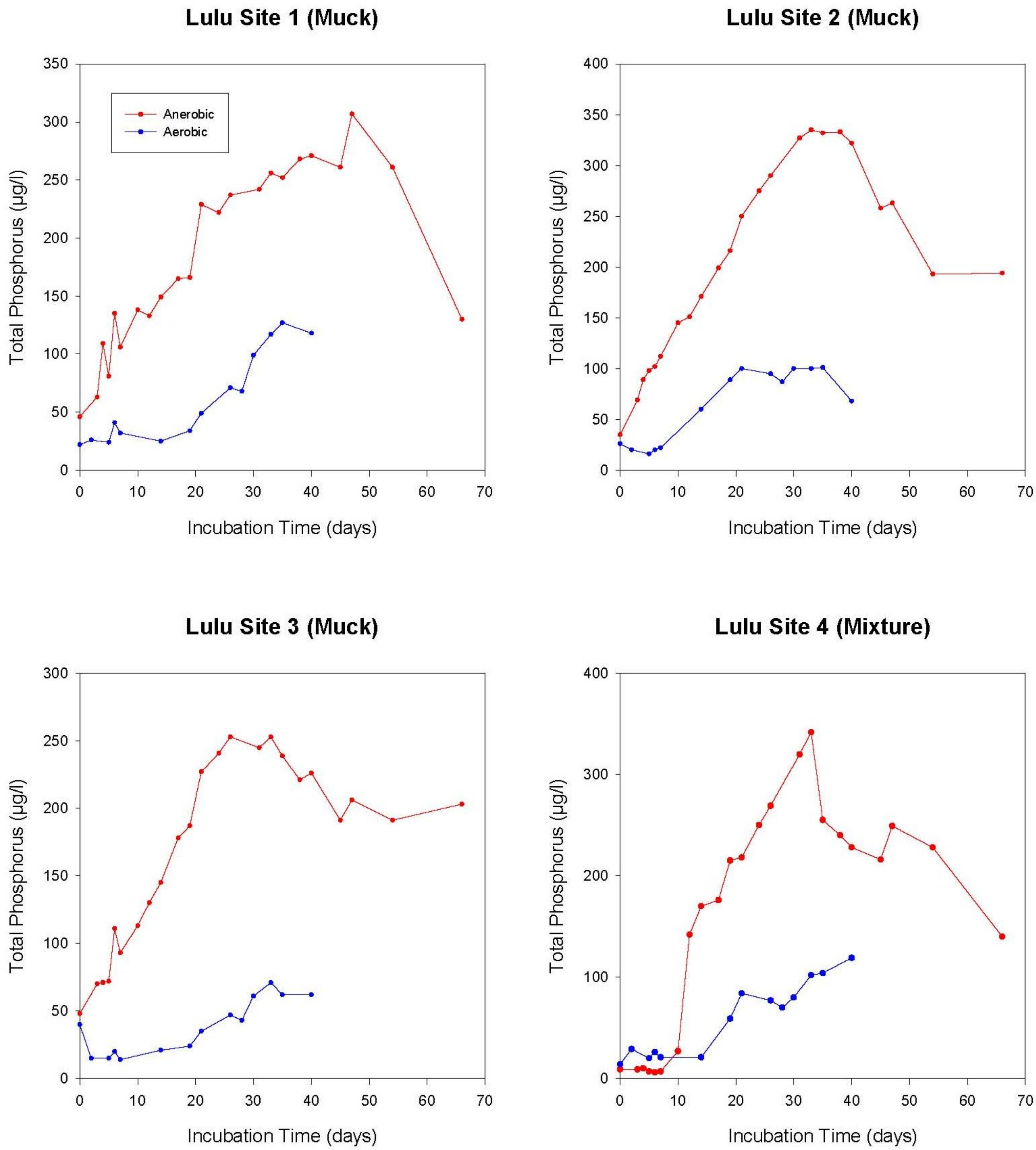


Figure 5-21. Release of Total Phosphorus in Lake Lulu Sediments Under Aerobic and Anoxic Conditions.

In general, the total phosphorus release observed in the incubated sediment samples from Lakes May, Shipp, and Lulu reflect extremely elevated values. The equilibrium phosphorus concentrations achieved within each of the isolation tubes is approximately 2-4 times greater under both aerobic and anoxic conditions than observed by ERD in sediments incubated from the Winter Park Chain-of-Lakes, a series of interconnected lakes in an urban setting with eutrophic water quality characteristics.

5.1.5.3 Mass Release

The results of the phosphorus release experiments discussed in the previous section were extrapolated to estimate annual sediment phosphorus release from Lakes May, Shipp, and Lulu. The first step in this extrapolation process is to develop estimates of sediment release rates within each of the 10 incubation chambers. The phosphorus release rate in the incubation experiments is defined as the slope of the rising limb of the total phosphorus release plots under aerobic and anoxic conditions presented in Figures 5-19 through 5-21. In some chambers, an initial delay in phosphorus release occurred as anoxic and aerobic conditions were established within each chamber. In these cases, the release rate is calculated using the data obtained between the start of the upward release trend and the maximum phosphorus concentrations measured within a sample. Regression relationships developed for estimation of sediment phosphorus release rates in the incubation experiments under aerobic and anoxic conditions are given in Appendix I.

A summary of calculated sediment phosphorus release rates observed in the incubation experiments under aerobic and anoxic conditions is given in Table 5-18. The release rates summarized in units of μg/l-day under aerobic and anoxic conditions reflect the slopes of the regression relationships provided in Appendix I for each incubation chamber. These release rates are normalized into an areal release rate by multiplying the measured release rates in terms of μg/l-day times the volume of water contained within each incubation chamber (3.63 liters) and dividing by the sediment surface area within each of the large diameter columns (0.13 ft^2). This process results in the final estimated areal release rates for aerobic and anoxic conditions listed in terms of μg P/ft^2-day.

TABLE 5-18

CALCULATED SEDIMENT P RELEASE RATES FOR THE INCUBATION EXPERIMENTS UNDER AEROBIC AND ANOXIC CONDITIONS

LAKE	SEDIMENT CHAMBER SITE	AEROBIC CONDITIONS		ANOXIC CONDITIONS	
		μg/l-day	μg/ft^2-day	μg/l-day	μg/ft^2-day
May	Shallow (1)	0.38	10.6	1.12	31.3
	Deep (2)	0.22	6.1	1.77	49.2
Shipp	1	0.35	9.8	0.81	22.6
	2	10.4[1]	--[1]	1.74	48.6
	3	2.11	58.9	1.55	75.4
	4	3.83	107	4.21	118
Lulu	1	2.66	74.3	5.04	141
	2	2.82	78.7	9.13	255
	3	1.28	35.7	8.13	227
	4	2.60	72.6	9.33	261

1. Data discarded from data set

Data collected in the incubation column collected from Lake Shipp site 2 under aerobic conditions was eliminated from the data set since these measurements are clearly outliers in the data set. Under aerobic conditions, the sediments in this column separated into several distinct layers, with the upper layer alternately floating to the surface then sinking. This type of separation, which occurs relatively infrequently in incubation experiments, artificially increases water column concentrations of phosphorus within the chambers by releasing and mixing pore water directly into the chamber rather than through the diffusion processes which normally occur. The elevated phosphorus release observed in this chamber (see Figure 5-20) is a result of the separation processes and does not reflect normal sediment phosphorus release processes.

In order to estimate overall sediment phosphorus release from each of the three lakes under aerobic and anoxic conditions, the information summarized in Table 5-18 must be extended to predict release rates throughout all portions of each lake. A series of regression analyses were conducted to evaluate relationships between sediment phosphorus release rates (referred to as the variable "Slope") as a function of physical-chemical characteristics of sediment samples used in the incubation experiments (as summarized in Table 5-16). Separate regression analyses were evaluated to estimate phosphorus release as a function of sediment characteristics under both aerobic and anoxic conditions. The basic multivariate model used for this analysis is summarized below:

Slope = pH + Moisture + Organic + Density + TN + TP + TN/TP

The "slope" term in this equation is equivalent to the values summarized in Table 5-16 (units of μg/l-day), while the remaining terms are based upon the physical-chemical characteristics of sediment samples summarized in Table 5-16. Regression analyses were conducted using the PROC REG module of SAS. The initial model run was conducted using the full model. The regression model passed the normality test, indicating that the data are normally distributed. Collinearity diagnostics were used to evaluate parameters involved in significant multicollinearities, and significance probabilities were evaluated to determine the level of significance for each variable in the model. Variables from the model which exhibited multicollinearities or non-significant t-test values (individual p values greater than 0.05) were sequentially removed. Changes in mean square error (mse) and R-square were evaluated after each modification of the model. The final models under aerobic and anoxic conditions reflect the models with the maximum mse and R-square values in which all remaining variables within the model exhibit a significant t-test at a 0.05 level of significance or better.

A summary of the results of the regression analyses for prediction of sediment phosphorus release as a function of sediment characteristics is given in Table 5-19. Under aerobic conditions, sediment phosphorus release is best predicted as a function of sediment organic content and sediment moisture content. This "best-fit" relationship exhibits an adjusted R-square of 0.841, indicating that the predictor variables of organic content and moisture content account for approximately 84.1% of the variability in measured sediment phosphorus release rates (slope). Under anoxic conditions, sediment release rate is best predicted as a function of total phosphorus and moisture content within the sediments. This "best-fit" relationship exhibits an adjusted R-square value of 0.853.

TABLE 5-19

RESULTS OF REGRESSION ANALYSES FOR PREDICTION OF SEDIMENT PHOSHORUS RELEASE AS A FUNCTION OF SEDIMENT CHARACTERISTICS

CONDITION	BEST-FIT EQUATION	ADJUSTED R-SQUARE
Aerobic	Slope = -0.06485 x Organic Content (%) + 0.05113 x Moisture Content (%)	0.841
Anoxic	Slope = -0.00608 x TP + 0.19005 x Moisture Content (%)	0.853

Sediment phosphorus release is primarily a diffusion process which is limited to the top 10-20 cm of sediment layers on the bottom of lakes. Although lake sediments may contain significant quantities of phosphorus at depths below 10-20 cm, it is unlikely that diffusion processes could extend to these depths within the sediments. As a result, the depth of the organic sediment layer has little impact on overall sediment phosphorus release to the water column.

The relationships summarized in Table 5-19 were developed for predictive purposes only and reflect the "best-fit" relationships for predicting sediment phosphorus release under aerobic and anoxic conditions. These relationships were not developed to identify predictor variables which are most significant in terms of regulating sediment phosphorus release but were instead selected to maximize predictive capabilities of the model. The R-square value for sediment phosphorus release under anoxic conditions is 0.853, indicating that sediment total phosphorus and moisture content explain approximately 85% of the variability in measured sediment phosphorus release under anoxic conditions. The information summarized in Table 5-19 allows the results of the sediment release experiments to be extrapolated throughout each of the three lakes based upon previously measured sediment characteristics and redox conditions near the sediment-water interface.

A subsequent analysis was conducted by ERD to examine the probability of anoxia in Lakes May, Shipp, and Lulu as a function of water depth. Since dissolved oxygen concentrations generally decrease as water depth increases, water depth is often a good predictor of the likelihood of anoxic conditions developing within a waterbody. Relationships between water depth and the probability of anoxia in Lakes May, Shipp, and Lulu were developed using the field monitoring data provided in Appendix A. Based upon these data, no anoxic conditions (defined as dissolved oxygen levels less than 1 mg/l) were observed at water depths of approximately 1 m or less. However, at a water depth of 1.5 m, anoxic conditions were observed approximately 2% of the time, with anoxic conditions observed approximately 17% of the time at a water depth of 2 m and approximately 28% of the time at a water depth of 2.5 m. This evaluation was continued to the maximum measured water depth of approximately 4.5 m.

The probability of anoxia was plotted as a function of water depth, resulting in the curvilinear relationship given in Figure 5-22. This relationship exhibits an R-square value of approximately 0.98, indicating that water depth explains approximately 98% of the variability in percentage of anoxia observed within the lakes. The relationship summarized in Figure 5-22 is utilized to estimate anoxic conditions at various water depths throughout Lakes May, Shipp, and Lulu. For example, at a water depth of approximately 2.0 m, the water-sediment interface will be anoxic approximately 17% of the time, with aerobic conditions exhibited approximately 83% of the time. Therefore, 17% of the time, sediment phosphorus release is based upon the anoxic relationship summarized in Table 5-18, with sediment release regulated by the aerobic equation approximately 83% of the time. This information is intersected with the sediment characteristics using GIS to develop an estimate of overall mass release from sediments within each of the three lakes at various depths over an annual period.

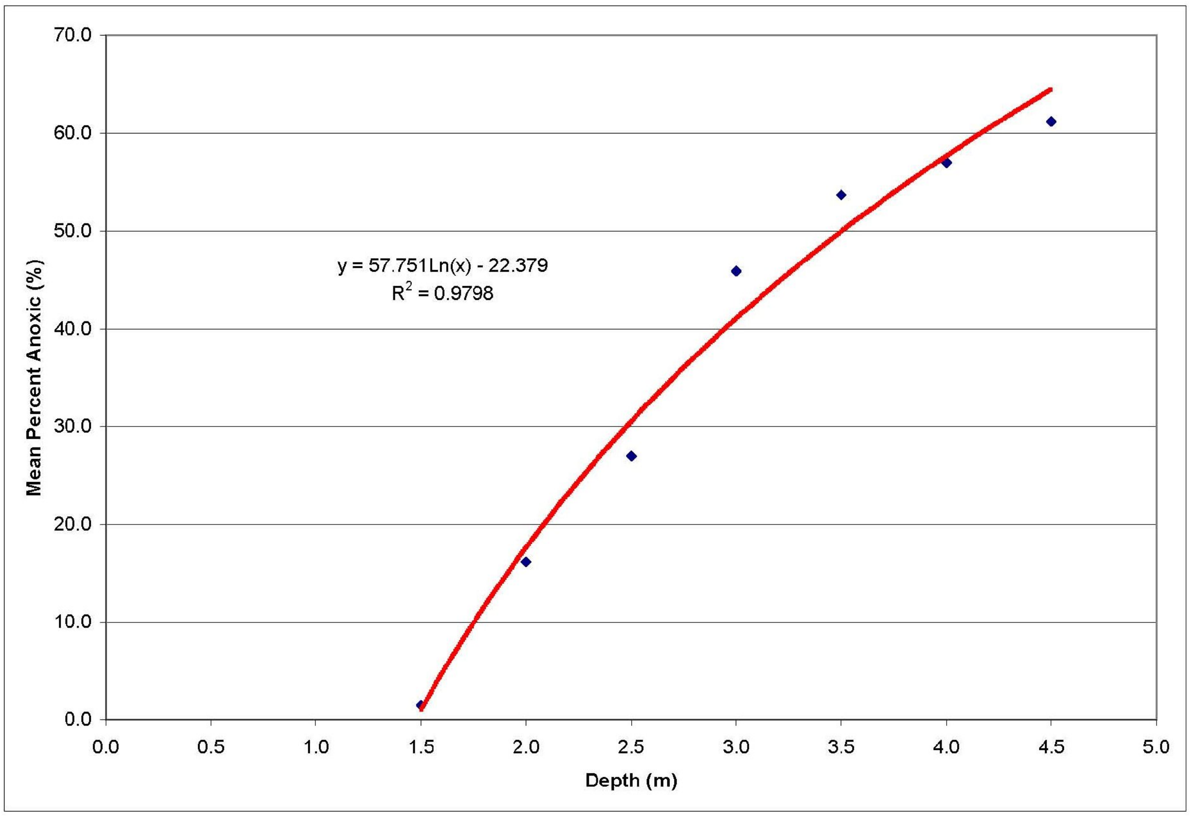


Figure 5-22. Relationship Between Water Depth and Probability of Anoxia in Lakes May, Shipp, and Lulu from October 2005-April 2006.

A summary of sediment phosphorus release isopleths in Lakes May, Shipp, and Lulu is given in Figure 5-23 based upon the methodology outlined in the previous paragraphs. Estimated sediment phosphorus release ranges from 500-3000 μg P/m^2-day within the three lakes. Sediment phosphorus release appears to be similar in Lakes May and Lulu, with substantially higher sediment phosphorus release believed to occur in Lake Lulu. The isopleth lines indicated on Figure 5-23 were integrated to obtain estimates of daily phosphorus release as well as total phosphorus release over an annual period.

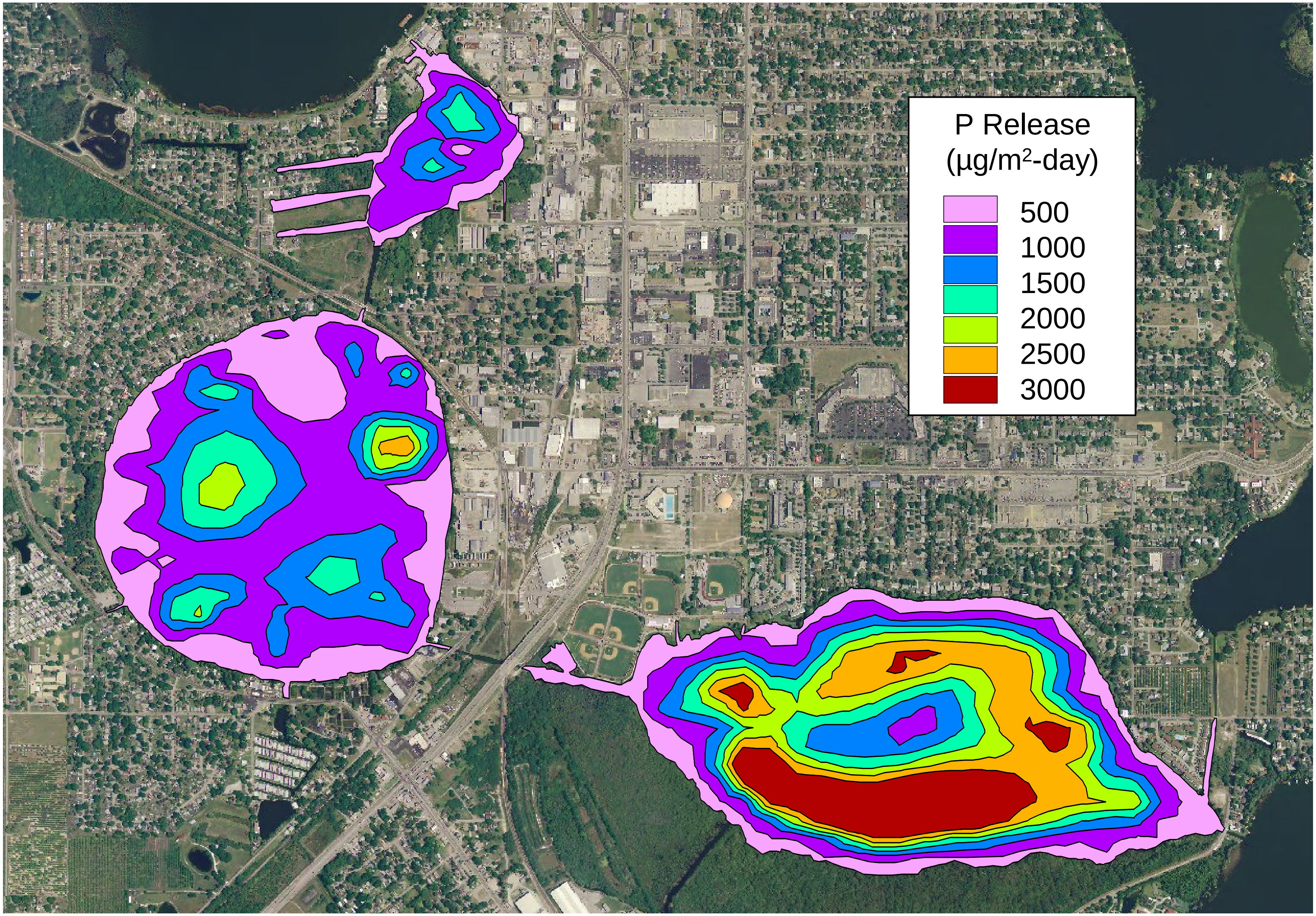


Figure 5-23. Estimated Sediment Phosphorus Release in Lakes May, Shipp, and Lulu.

A summary of estimated phosphorus release from Lakes May, Shipp, and Lulu is given in Table 5-20. Sediment phosphorus release contributes approximately 0.16 kg/day of phosphorus to Lake May, 0.96 kg/day to Lake Shipp, and 2.21 kg/day to Lake Lulu. Over an annual period, sediment release contributes 58.4 kg of phosphorus to Lake May, 350 kg to Lake Shipp, and 807 kg to Lake Lulu. Areal sediment phosphorus release values are provided in the final column of Table 5-20 for comparison purposes. On an areal basis, Lake May contributes approximately 1.16 kg of total phosphorus per acre per year, with 1.27 kg/ac-yr contributed in Lake Shipp. However, the sediment phosphorus release in Lake Lulu appears to be more than 2 times greater than release rates measured in Lakes May and Shipp, with a phosphorus release of 2.63 kg/ac-yr in Lake Lulu. The total estimated phosphorus release indicated in Table 5-20 is utilized in subsequent sections for development of nutrient budgets for the three lakes.

TABLE 5-20

ESTIMATED SEDIMENT PHOSPHORUS RELEASE FROM LAKES MAY, SHIPP, AND LULU

LAKE	PHOSPHORUS RELEASE		
	kg/day	kg/yr	kg/ac-yr
May	0.16	58.4	1.16
Shipp	0.96	350	1.27
Lulu	2.21	807	2.63

5.2 Characteristics of Nutrient Losses

Nutrient losses from Lakes May, Shipp, and Lulu occur as a result of deep recharge and exchange between interconnected lakes. Estimates of the magnitude of these losses are given in the following sections.

5.2.1 Deep Recharge

5.2.1.1 Evaluation Methodology

As discussed in Section 4, deep groundwater recharge removes approximately 0.74-0.82 ft/yr from Lakes May, Shipp, and Lulu. As this water migrates downward through the bottom sediments, dissolved constituents such as nitrogen and phosphorus, as well as TSS, enter the sediments with the downward flow and either become adsorbed into the sediments or continue migrating downward as part of the water movement. However, regardless of the ultimate fate of these constituents, deep recharge constitutes a net loss of nitrogen, phosphorus, and TSS from each of the three lakes.

Mass loadings of total nitrogen, total phosphorus, and TSS are a function of both the hydrologic losses and the concentrations of parameters in the lake water. A summary of mean water quality characteristics of Lake May, Shipp, and Lulu from October 2005-April 2006 is given in Table 5-21. It is assumed that the chemical characteristics of water lost to deep recharge are similar to the values listed in this table.

TABLE 5-21

MEAN WATER QUALITY CHARACTERISTICS OF LAKES MAY, SHIPP, AND LULU FROM OCTOBER 2005 TO APRIL 2006

LAKE	TOTAL N (µg/l)	TOTAL P (µg/l)	TSS (mg/l)
May	1236	63	15.2
Shipp	1589	59	17.2
Lulu	1096	52	13.4

5.2.1.2 Mass Losses

Estimates of mass loadings of total nitrogen, total phosphorus, and TSS lost as a result of deep recharge were calculated by multiplying the mean water quality characteristics for each of the three lakes (summarized in Table 5-21) times the estimated deep recharge volume from the three lakes (summarized in Table 4-15). The results of this analysis are summarized in Table 5-22. Overall, deep recharge removes approximately 836 kg of total nitrogen, 35.3 kg of total phosphorus, and 9614 kg of TSS from the three lakes each year.

TABLE 5-22

ESTIMATED ANNUAL MASS LOSSES FROM DEEP RECHARGE IN LAKES MAY, SHIPP, AND LULU

LAKE	VOLUME LOSS (ac-ft)	MASS LOSS (kg)		
		TOTAL N	TOTAL P	TSS
May	37.6	57.3	2.9	705
Shipp	224	439	16.3	4749
Lulu	252	340	16.1	4160
Total:	**514**	**836**	**35.3**	**9614**

5.2.2 Interconnected Lake Flow

5.2.2.1 Chemical Characteristics

As discussed in Section 4, an annual discharge of approximately 613 ac-ft/yr is assumed to occur from Lake May to Lake Shipp, with an outflow of 1287 ac-ft/yr from Lake Shipp to Lake Lulu. This water exchange carries nutrient loadings which reflect losses from one lake, but constitute inputs to the downstream lake. The magnitude of these exchanges is a function of the estimated hydrologic exchange, summarized in Figure 4-11 and Table 4-16, as well as the chemical characteristics of the lake water.

A summary of mean water quality characteristics for total nitrogen, total phosphorus, and TSS in Lakes May, Shipp, and Lulu from October 2005-April 2006 is given in Table 5-21. The values summarized in this table are assumed to reflect ambient water quality characteristics for the three lakes for estimation of mass transfer as a result of interconnected lake flow.

5.2.2.2 Mass Loadings

Estimates of annual mass loadings of total nitrogen, total phosphorus, and TSS discharging from Lake May to Lake Shipp and from Lake Shipp to Lake Lulu were calculated by multiplying the mean chemical characteristics for total nitrogen, total phosphorus, and TSS (listed in Table 5-21) times the estimated hydrologic discharge between the two lakes (summarized in Table 4-16). The results of this analysis are summarized in Table 5-23. The values listed in this table reflect the estimated annual losses of total nitrogen, total phosphorus, and TSS to adjacent interconnected waterbodies. This information is used in a subsequent section to develop overall nutrient budgets for the three lakes.

TABLE 5-23

ESTIMATED ANNUAL MASS LOSSES FROM INTERCONNECTED LAKE FLOWS FOR LAKES MAY, SHIPP, AND LULU

LAKE	MASS LOADING (kg)[1]		
	TOTAL N	TOTAL P	TSS
May to Shipp	934	47.6	11,491
Ship to Lulu	2,522	93.6	27,298

1. Based on an annual average outflow volume of 613 ac-ft from Lake May to Lake Shipp and 1287 ac-ft from Lake Shipp to Lake Lulu

5.2.3 Lake Lulu Miscellaneous Losses

5.2.3.1 Evaluation Techniques

As discussed in Section 4.3, unidentified hydrologic losses remove approximately 2008 ac-ft/yr of water from Lake Lulu. These losses result from the combined impacts of evapotranspiration from the large wetland area along the south shore of Lake Lulu, water losses to a perimeter ditch system along the southwest side of the lake, and leakage through the Lake Lulu outfall structure. Each of these hydrologic losses also contributes losses for nutrients and TSS as well.

5.2.3.2 Mass Loadings

Estimates of mass loadings of total nitrogen, total phosphorus, and TSS discharging from Lake Lulu as a result of unidentified sources were calculated by multiplying the mean characteristics for total nitrogen, total phosphorus, and TSS in Lake Lulu (listed in Table 5-21) times the estimated annual unidentified discharge of 2008 ac-ft. The results of this analysis are summarized in Table 5-24. The values listed in this table reflect the estimated losses of total nitrogen, total phosphorus, and TSS from Lake Lulu as a result of unidentified sources during average annual conditions. Overall unidentified discharges from Lake Lulu results in a mass loss of 2714 kg of total nitrogen, 129 kg of total phosphorus, and 33,183 kg of TSS each year.

TABLE 5-24

ESTIMATED MASS LOSSES FROM LAKE LULU FOR UNIDENTIFIED LOSSES

MASS LOSS (kg)		
TOTAL N	TOTAL P	TSS
2714	129	33,183

5.3 Estimated Mass Budgets

Estimated mean annual mass budgets were developed for total nitrogen, total phosphorus, and TSS for Lakes May, Shipp, and Lulu based upon the analyses presented in the previous sections. A discussion of the estimated annual mass budgets for nitrogen, phosphorus, and TSS is given in the following sections.

5.3.1 Total Nitrogen

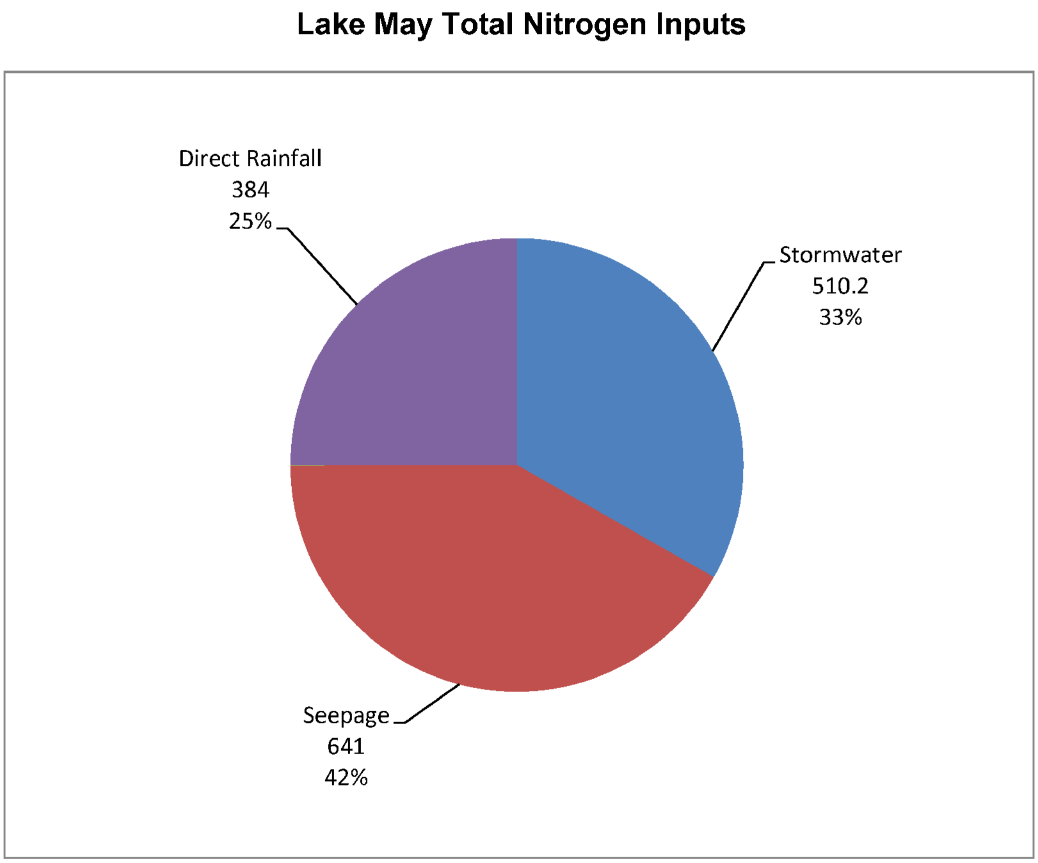
A summary of estimated mean annual mass inputs for total nitrogen in Lakes May, Shipp, and Lulu is given in Table 5-25 based upon discussions and analyses presented in previous sections. Groundwater seepage is the single largest contributor of nitrogen to Lakes May and Shipp, contributing 42% of the nitrogen inputs to Lake May and 41% to Lake Shipp. The second most significant contributor of nitrogen loadings to Lake May is stormwater runoff followed by direct precipitation. However, the second most significant nitrogen loading to Lake Shipp is bulk precipitation followed by stormwater and interconnected lake inflows. Stormwater is the least significant nitrogen source to Lake Lulu.

TABLE 5-25

ESTIMATED MEAN ANNUAL NITROGEN LOADINGS TO LAKES MAY, SHIPP, AND LULU

LAKE	PARAMETER	MASS (kg)	PERCENT OF TOTAL
May	Stormwater	510	33
	Groundwater Seepage	641	42
	Direct Rainfall	384	25
	Total:	1535	100
Shipp	Stormwater	873	13
	Groundwater Seepage	2814	41
	Direct Rainfall	2098	31
	Inflow from Lake May	934	14
	Baseflow	88	1
	Total:	6807	100
Lulu	Stormwater	800	11
	Groundwater Seepage	1668	23
	Direct Rainfall	2331	32
	Inflow from Lake Shipp	2522	34
	Total:	7321	100

A summary of estimated annual nitrogen mass losses to Lakes May, Shipp, and Lulu given in Table 5-26. The largest loss for nitrogen within Lakes Shipp and Lulu is sediment retention, contributing approximately 35-60% of the nitrogen losses in each lake. Deep recharge accounts for approximately 4-7% of the nitrogen losses, with discharges to interconnected waterbodies comprising the remainder. A graphical comparison of nitrogen inputs and losses to Lakes May, Shipp, and Lulu is given in Figures 5-24 through 5-26, respectively.



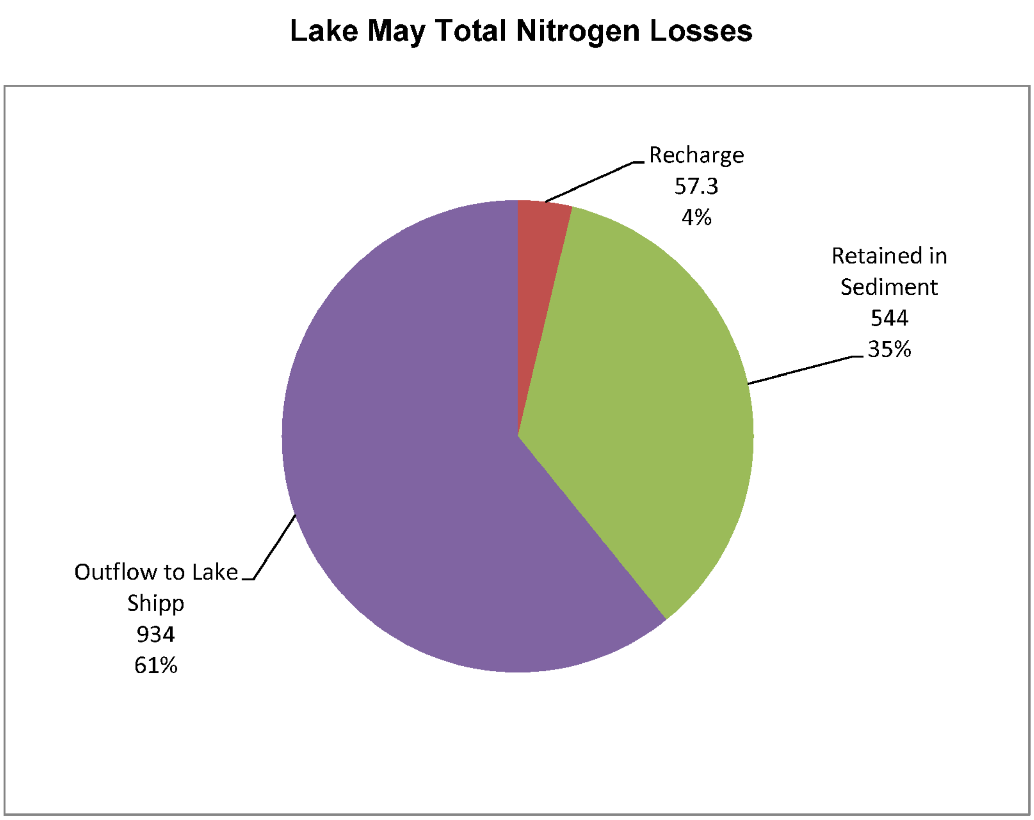
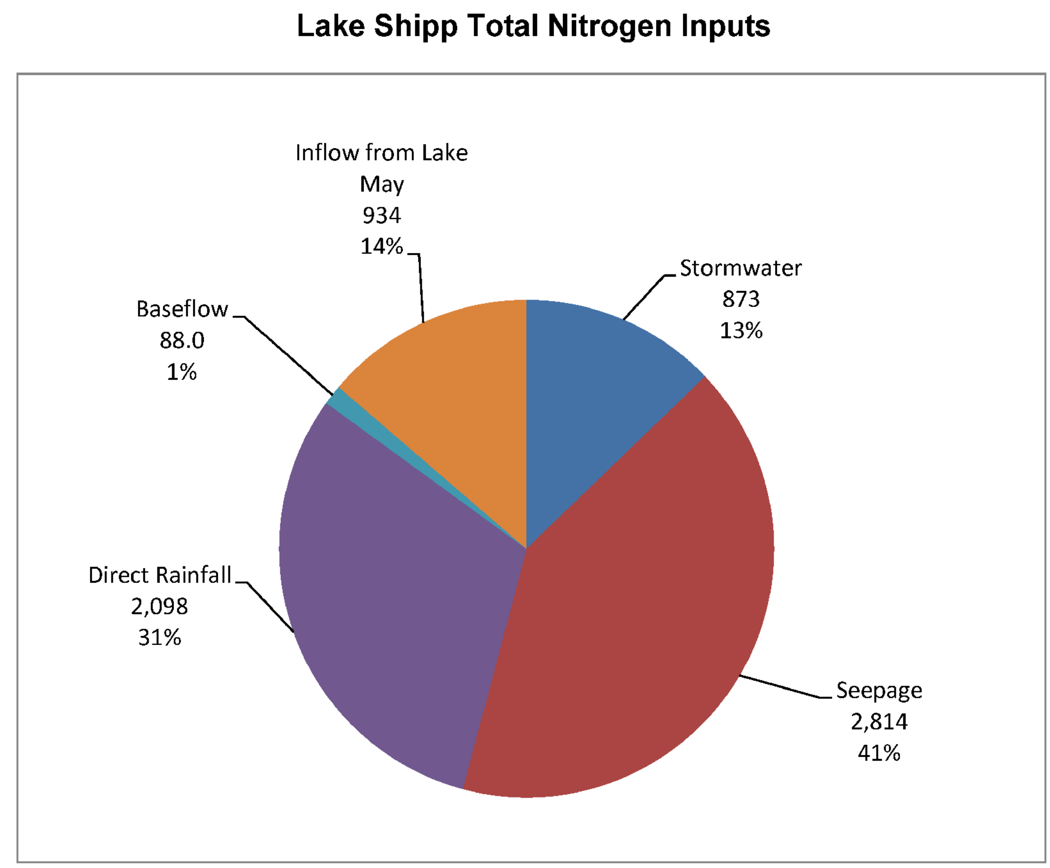


Figure 5-24. Summary of Mean Annual Nitrogen Inputs and Losses to Lake May.



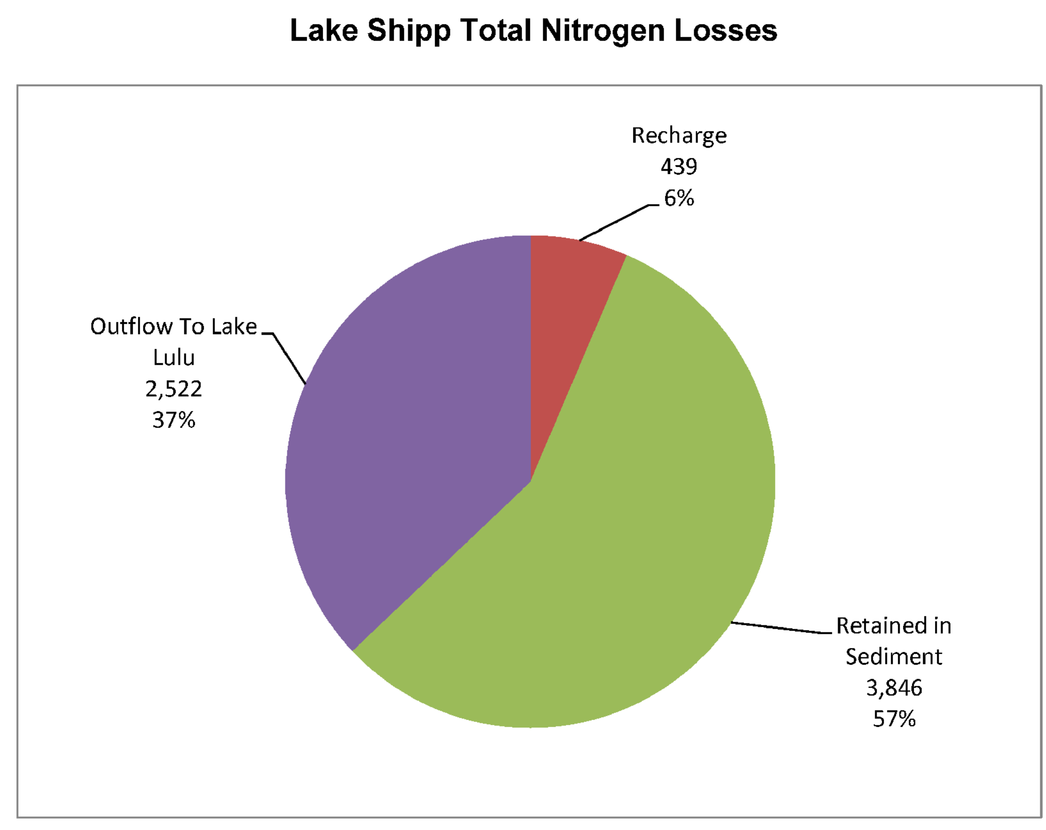
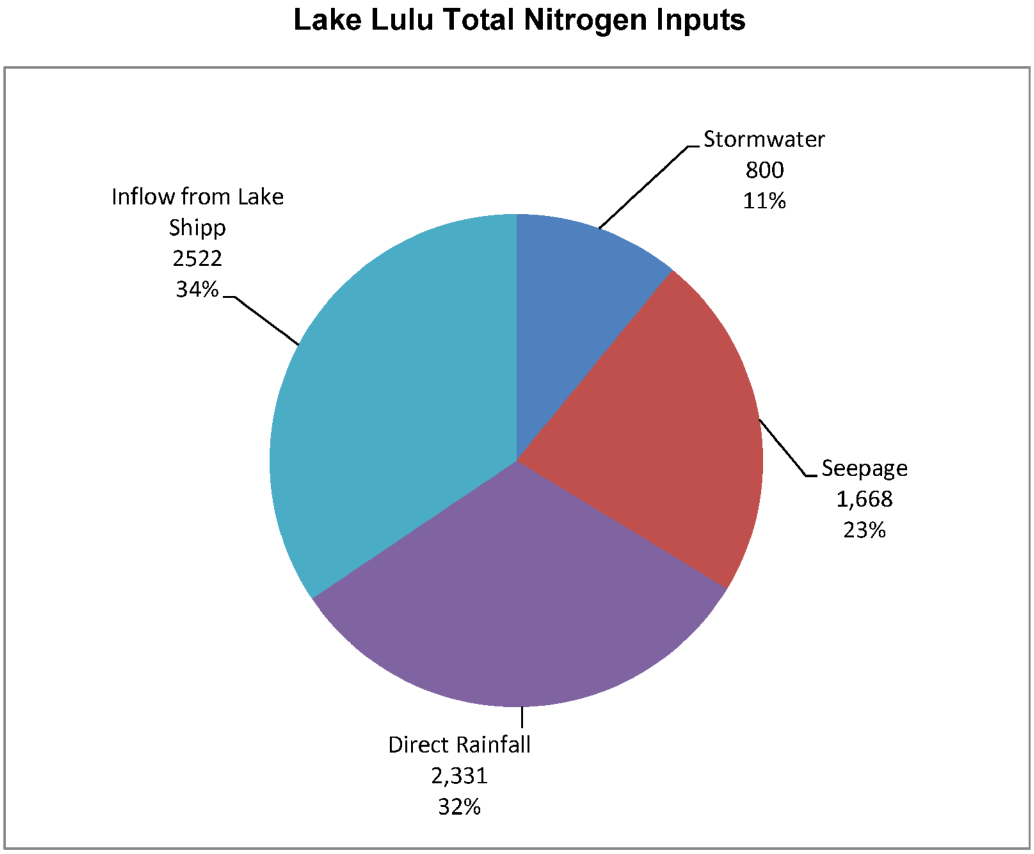


Figure 5-25. Summary of Mean Annual Nitrogen Inputs and Losses to Lake Shipp.



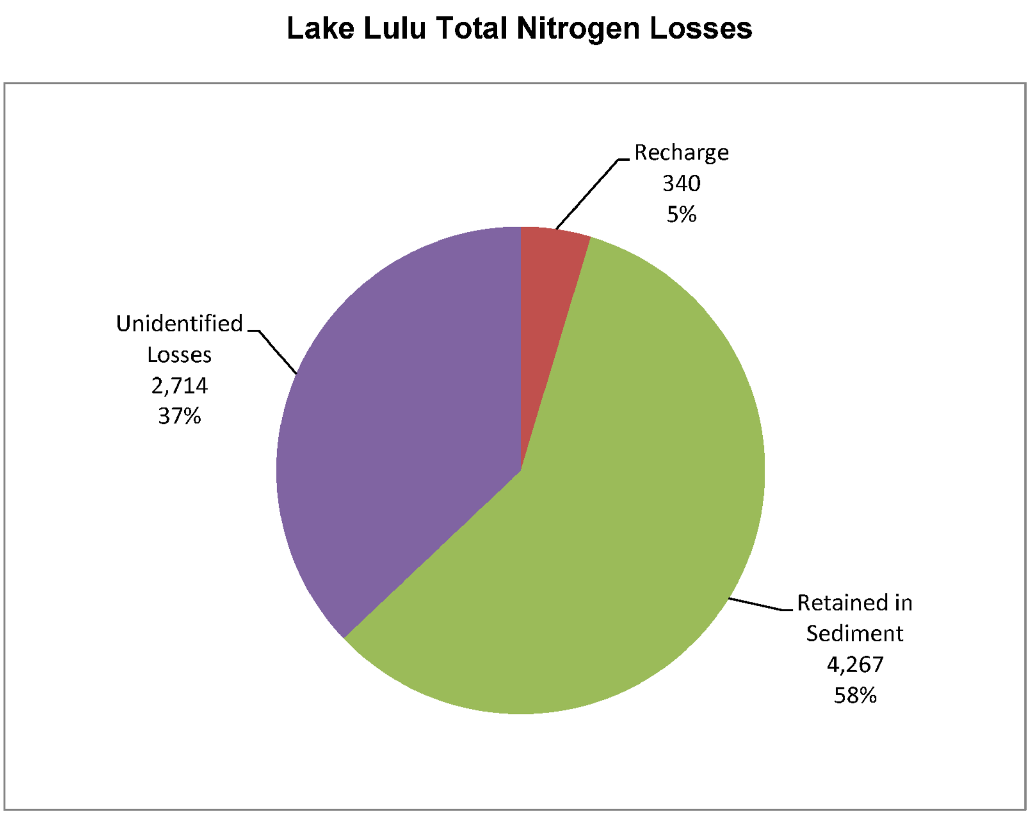


Figure 5-26. Summary of Mean Annual Nitrogen Inputs and Losses to Lake Lulu.

TABLE 5-26

ESTIMATED MEAN ANNUAL NITROGEN LOSSES FROM LAKES MAY, SHIPP, AND LULU

LAKE	PARAMETER	MASS (kg)	PERCENT OF TOTAL
May	Deep Recharge	57.3	4
	Outflow to Lake Shipp	934	61
	Retained in Sediments	544	35
	Total:	1535	100
Shipp	Deep Recharge	439	6
	Outflow to Lake Lulu	2522	37
	Retained in Sediments	3846	57
	Total:	6807	100
Lulu	Deep Recharge	340	5
	Unidentified Losses	2714	37
	Retained in Sediments	4267	58
	Total:	7321	100

5.3.2 Total Phosphorus

A summary of estimated annual phosphorus mass inputs to Lakes May, Shipp, and Lulu is given in Table 5-27. The single largest contributor of phosphorus loadings to each of the three lakes is internal recycling which contributes 46-69% of the total phosphorus loadings to the three lakes. Stormwater runoff contributes approximately 22-31% of the phosphorus loadings to Lakes May and Shipp, with groundwater seepage contributing 8-11% to each of the three lakes. Phosphorus inputs to Lake Lulu from stormwater, groundwater seepage, rainfall, and Lake Shipp inflow each contribute 7-8% of the annual loadings.

Estimated annual phosphorus mass losses to Lakes May, Shipp, and Lulu are summarized in Table 5-28. The vast majority of phosphorus inputs appear to be retained within the sediments of the three lakes, with approximately 51-88% of the phosphorus loadings lost to this source. Approximately 1-2% of the phosphorus is lost to deep recharge, with the remaining losses occurring as a result of discharges to other lakes in downstream waterbodies. Graphical comparisons of annual phosphorus inputs and losses to Lakes May, Shipp, and Lulu are given in Figures 5-27 through 5-29, respectively.

TABLE 5-27

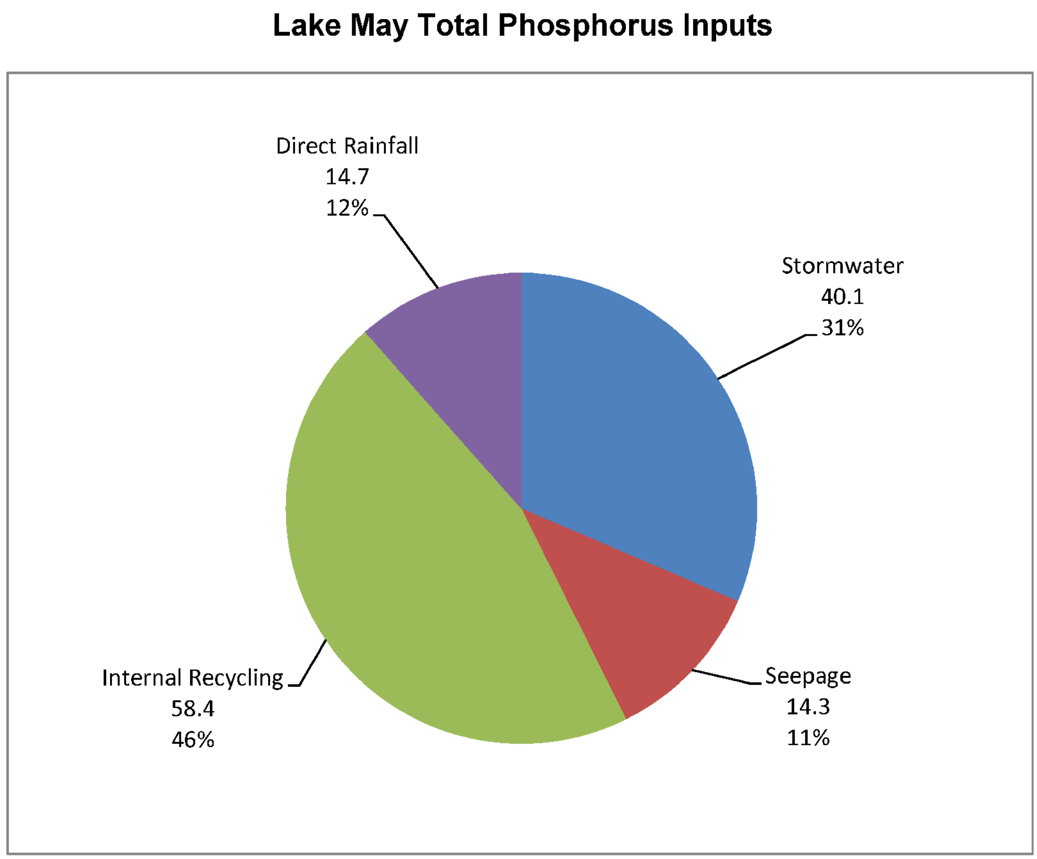
ESTIMATED MEAN ANNUAL PHOSPHORUS LOADINGS TO LAKES MAY, SHIPP, AND LULU

LAKE	PARAMETER	MASS (kg)	PERCENT OF TOTAL
May	Stormwater	40.1	31
	Groundwater Seepage	14.3	11
	Direct Rainfall	14.7	12
	Internal Recycling	58.4	46
	Total:	127.5	100
Shipp	Stormwater	162	22
	Groundwater Seepage	80.5	11
	Direct Rainfall	80.6	11
	Inflow from Lake May	47.6	7
	Baseflow	3.7	1
	Internal Recycling	350	48
	Total:	724	100
Lulu	Stormwater	85.6	7
	Groundwater Seepage	91.7	8
	Direct Rainfall	89.6	8
	Inflow from Lake Shipp	93.6	8
	Internal Recycling	807	69
	Total:	1168	100

TABLE 5-28

ESTIMATED MEAN ANNUAL PHOSPHORUS LOSSES FROM LAKES MAY, SHIPP, AND LULU

LAKE	PARAMETER	MASS (kg)	PERCENT OF TOTAL
May	Deep Recharge	2.9	2
	Outflow to Lake Shipp	47.6	37
	Retained in Sediments	77.0	61
	Total:	127.5	100
Shipp	Deep Recharge	16.3	2
	Outflow to Lake Lulu	93.6	13
	Retained in Sediments	614	85
	Total:	723.9	100
Lulu	Deep Recharge	16.1	1
	Unidentified Losses	129	11
	Retained in Sediments	1023	88
	Total:	1168	100



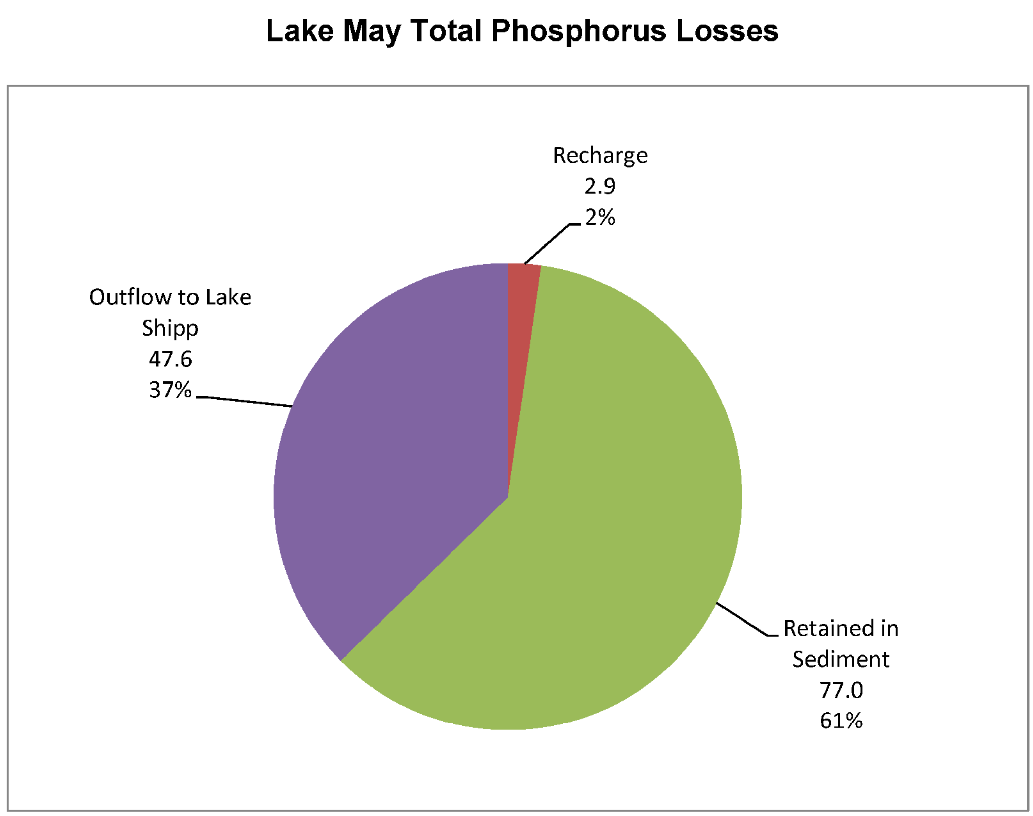
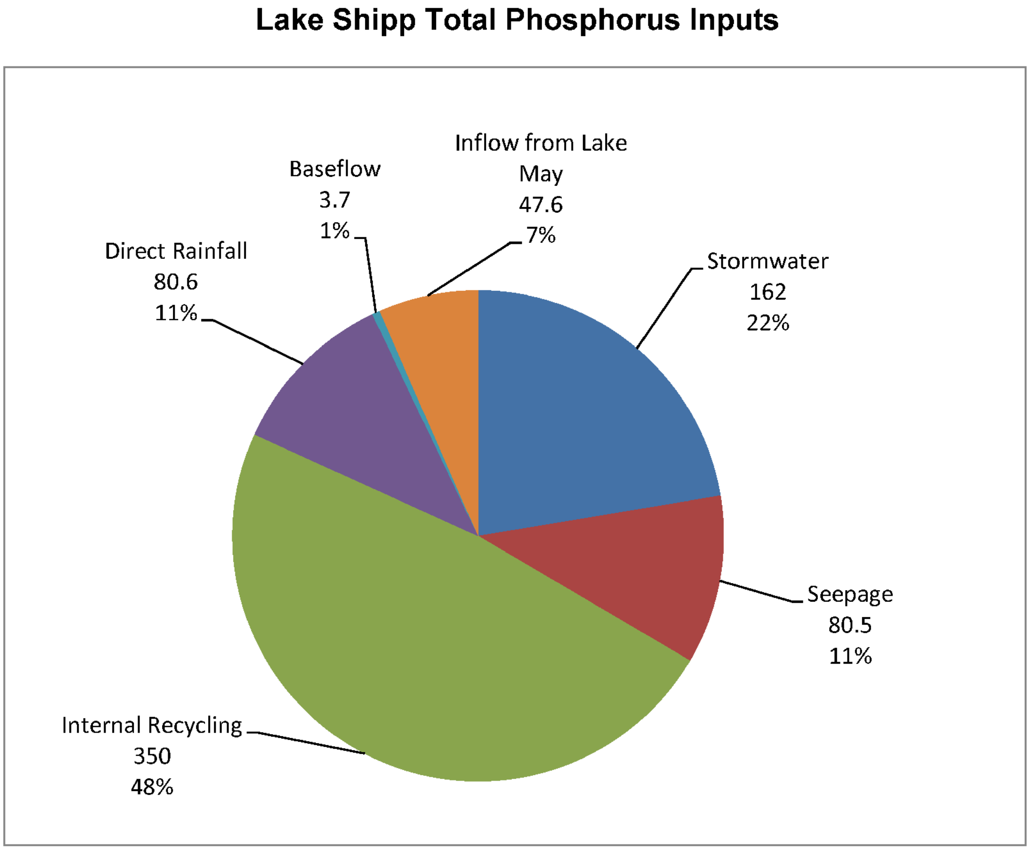


Figure 5-27. Summary of Mean Annual Phosphorus Inputs and Losses to Lake May.



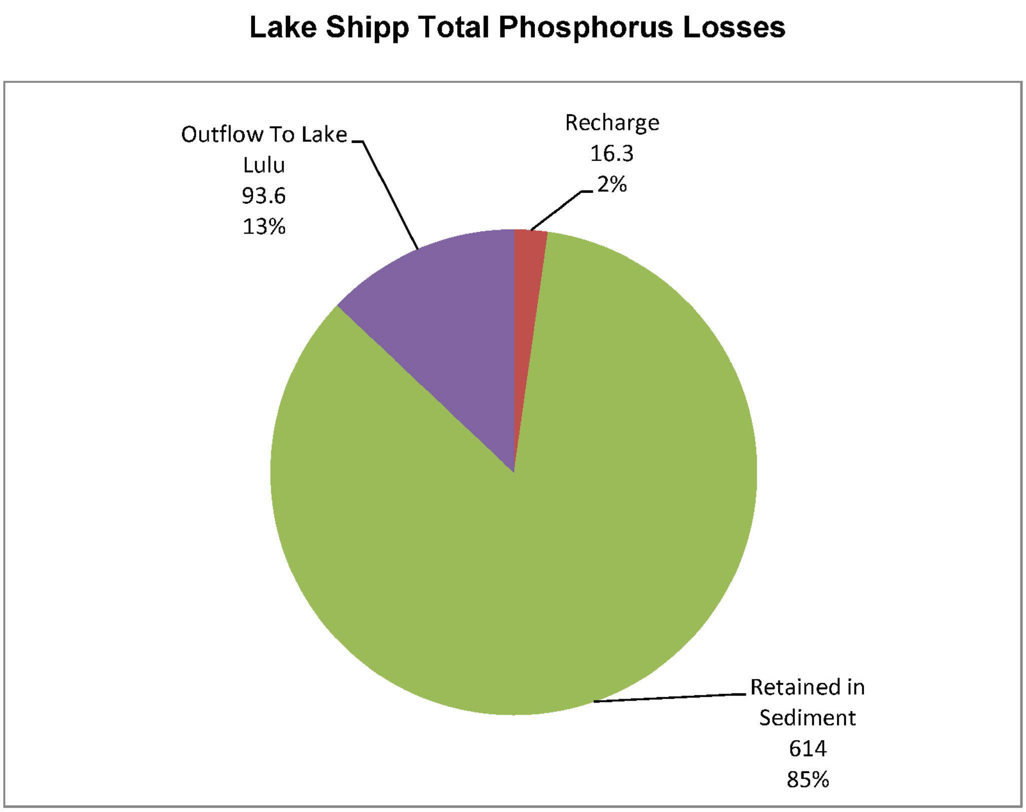
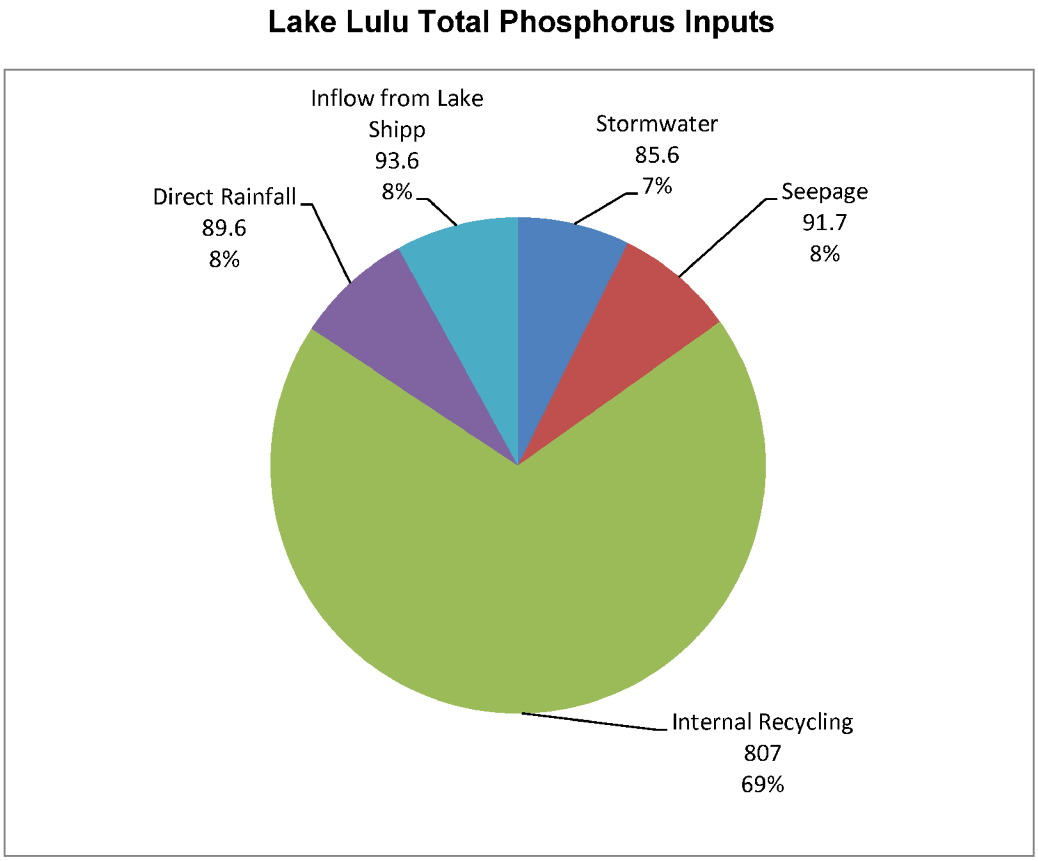


Figure 5-28. Summary of Mean Annual Phosphorus Inputs and Losses to Lake Shipp.



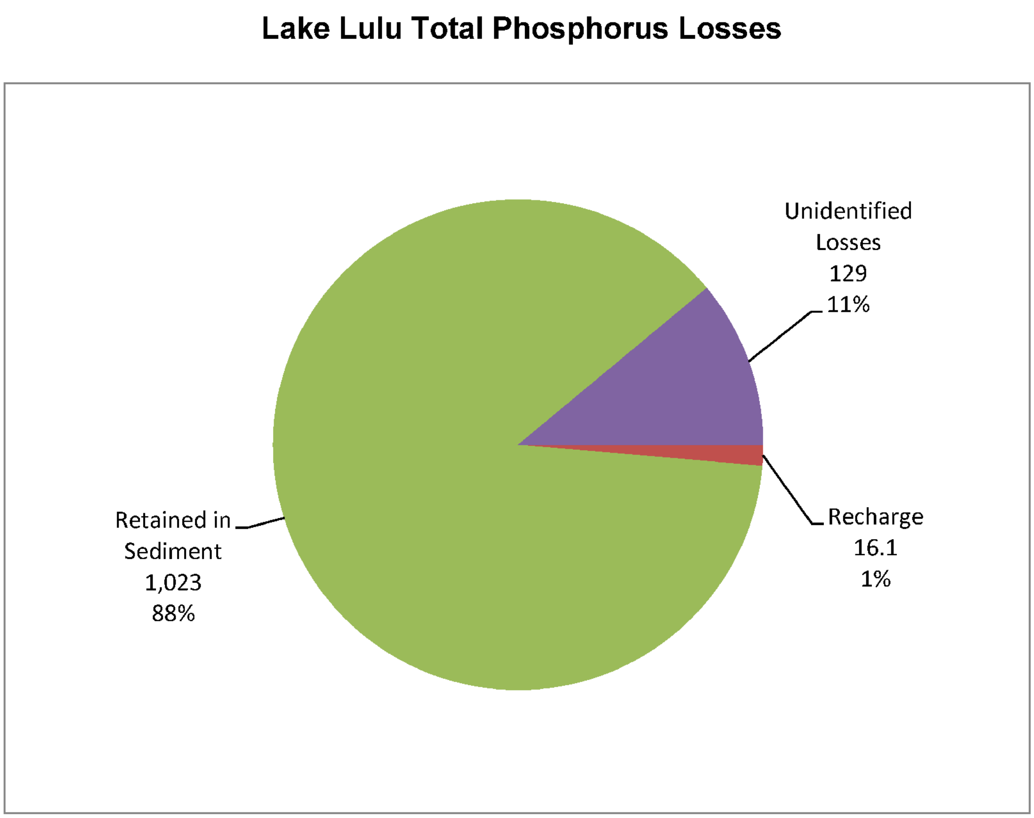


Figure 5-29. Summary of Mean Annual Phosphorus Inputs and Losses to Lake Lulu.

5.3.3 TSS

A comparison of estimated mean annual TSS mass inputs to Lakes May, Shipp, and Lulu is given in Table 5-29. TSS inputs are not included for groundwater seepage since it is assumed that this source contributes minimal TSS loadings. The dominant source of TSS loadings to Lake May is stormwater runoff which contributes approximately 57% of the total loadings. However, direct rainfall appears to be the largest contributor of TSS loadings to Lakes Shipp and Lulu, contributing 46% of the loadings to these lakes. Stormwater runoff contributes 18-35% of TSS loadings to Lakes Shipp and Lulu, with the remaining loadings occurring as a result of interconnected lake inflow.

TABLE 5-29

ESTIMATED MEAN ANNUAL TSS LOADINGS TO LAKES MAY, SHIPP, AND LULU

LAKE	PARAMETER	MASS (kg)	PERCENT OF TOTAL
May	Stormwater	7,374	57
	Bulk Precipitation	5,609	43
	Total:	12,983	100
Shipp	Stormwater	23,184	35
	Bulk Precipitation	30,667	46
	Inflow from Lake May	11,491	17
	Baseflow	1,011	2
	Total:	66,353	100
Lulu	Stormwater	13,426	18
	Bulk Precipitation	34,074	46
	Inflow from Lake Shipp	27,298	36
	Total:	74,798	100

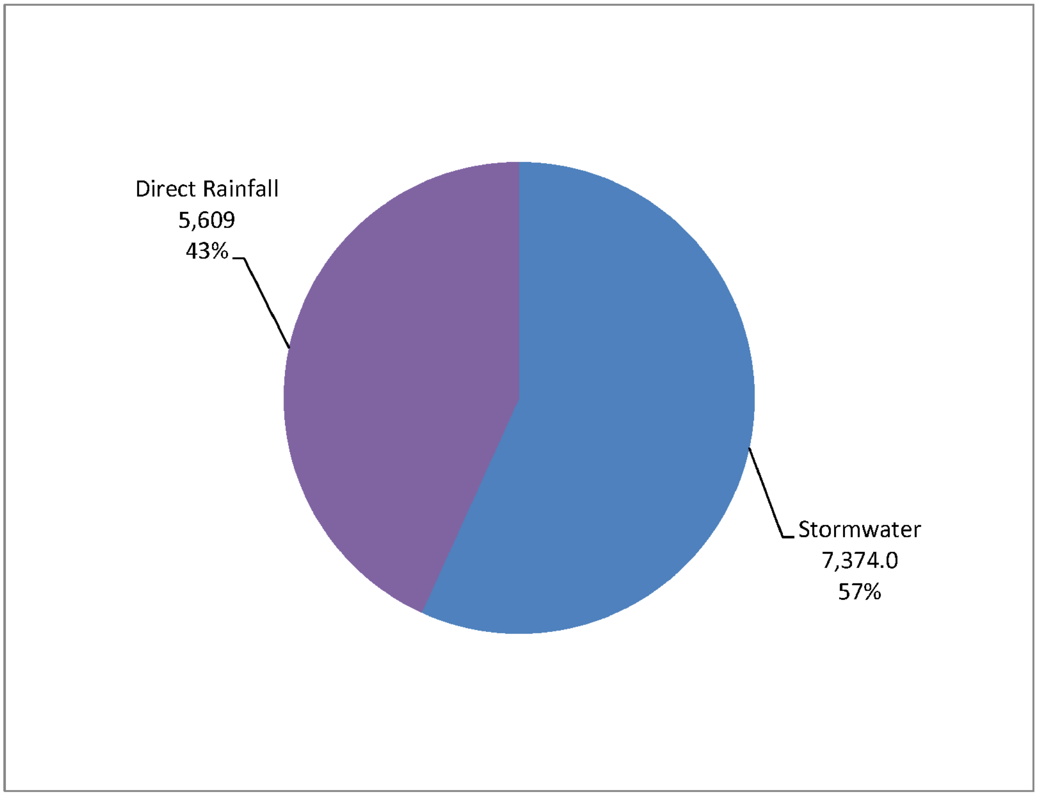
A summary of estimated mean annual TSS mass losses in Lakes May, Shipp, and Lulu is given in Table 5-30. Approximately 56-59% of the TSS loadings to Lakes Shipp and Lulu are retained within the sediments of the lakes, with the majority of the remaining solids lost as a result of exchange between interconnected waterbodies. However, sediment retention only accounts for 11% of the TSS losses in Lake May, with the remaining mass lost as a result of discharges to Lake Shipp. A graphical comparison of mean annual TSS inputs and losses to Lakes May, Shipp, and Lulu is given in Figures 5-30 through 5-32, respectively.

TABLE 5-30

ESTIMATED MEAN ANNUAL TSS LOSSES FROM LAKES MAY, SHIPP, AND LULU

LAKE	PARAMETER	MASS (kg)	PERCENT OF TOTAL
May	Outflow to Lake Shipp	11,491	89
	Retained in Sediments	1,492	11
	Total:	12,983	100
Shipp	Outflow to Lake Lulu	27,298	41
	Retained in Sediments	39,055	59
	Total:	66,353	100
Lulu	Unidentified Losses	33,183	44
	Retained in Sediments	41,615	56
	Total:	74,798	100

Lake May Total TSS Inputs



Lake May Total TSS Losses

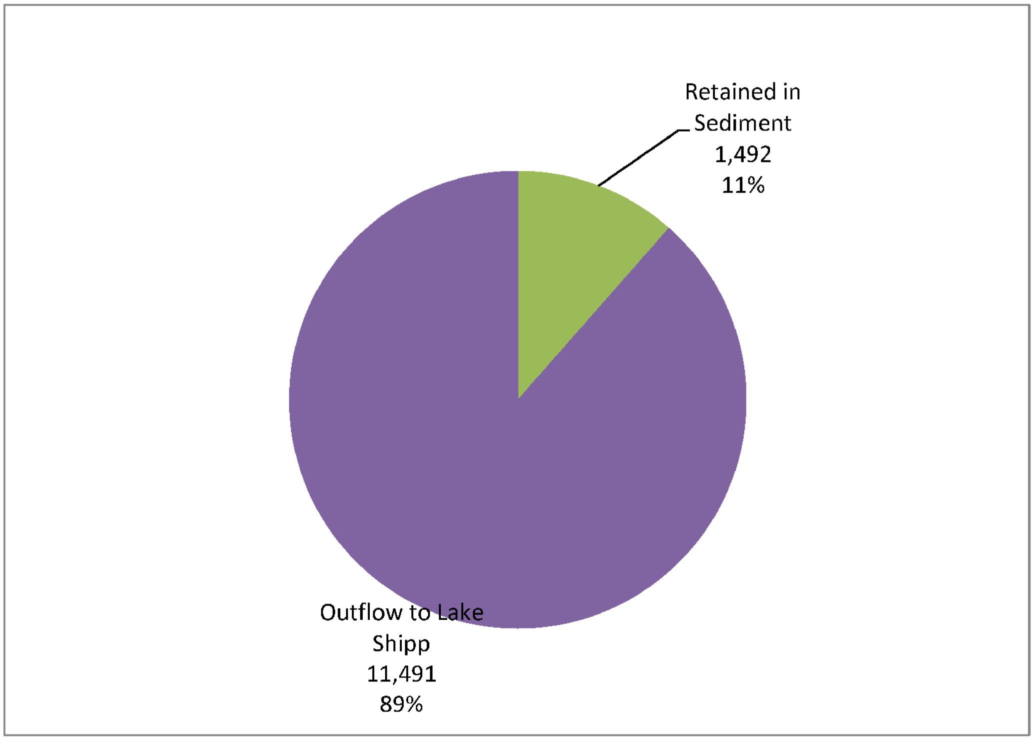
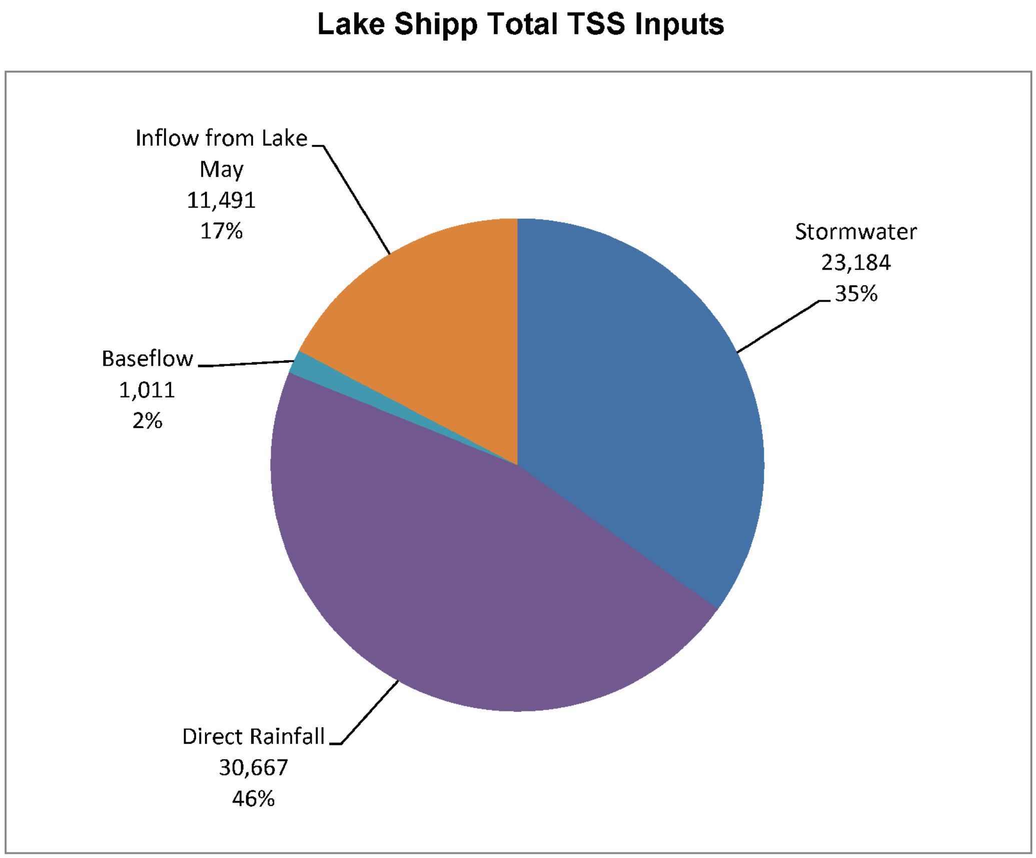


Figure 5-30. Summary of Mean Annual TSS Inputs and Losses to Lake May.



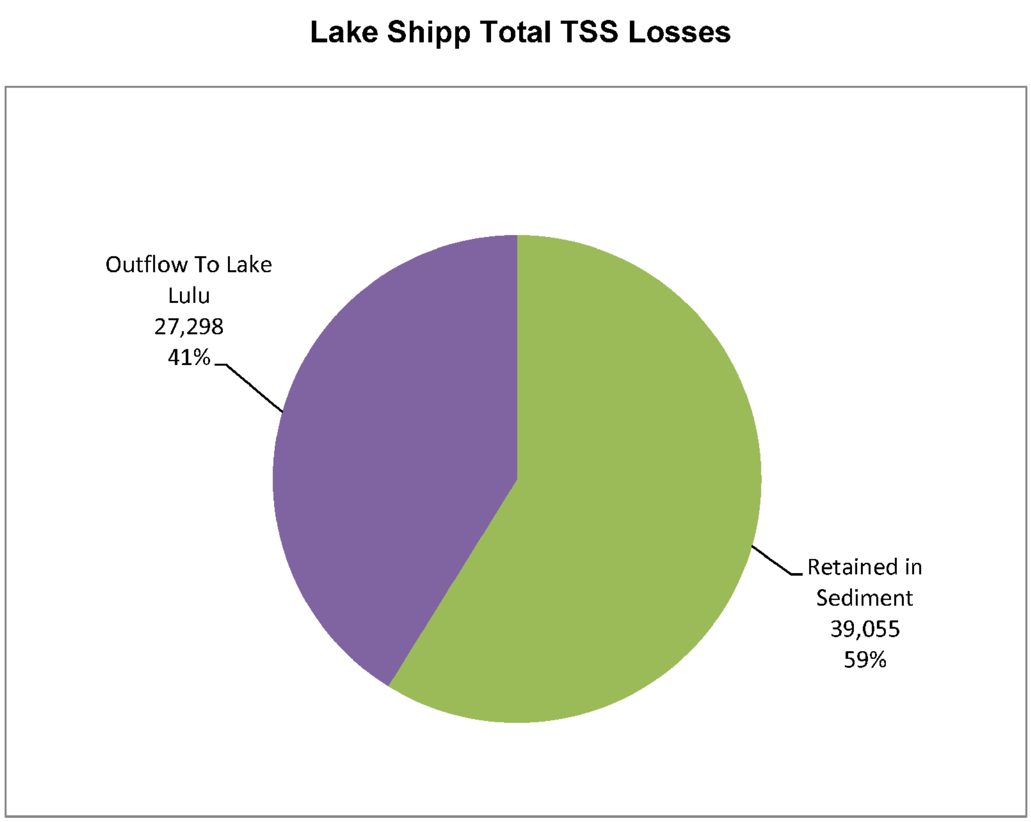
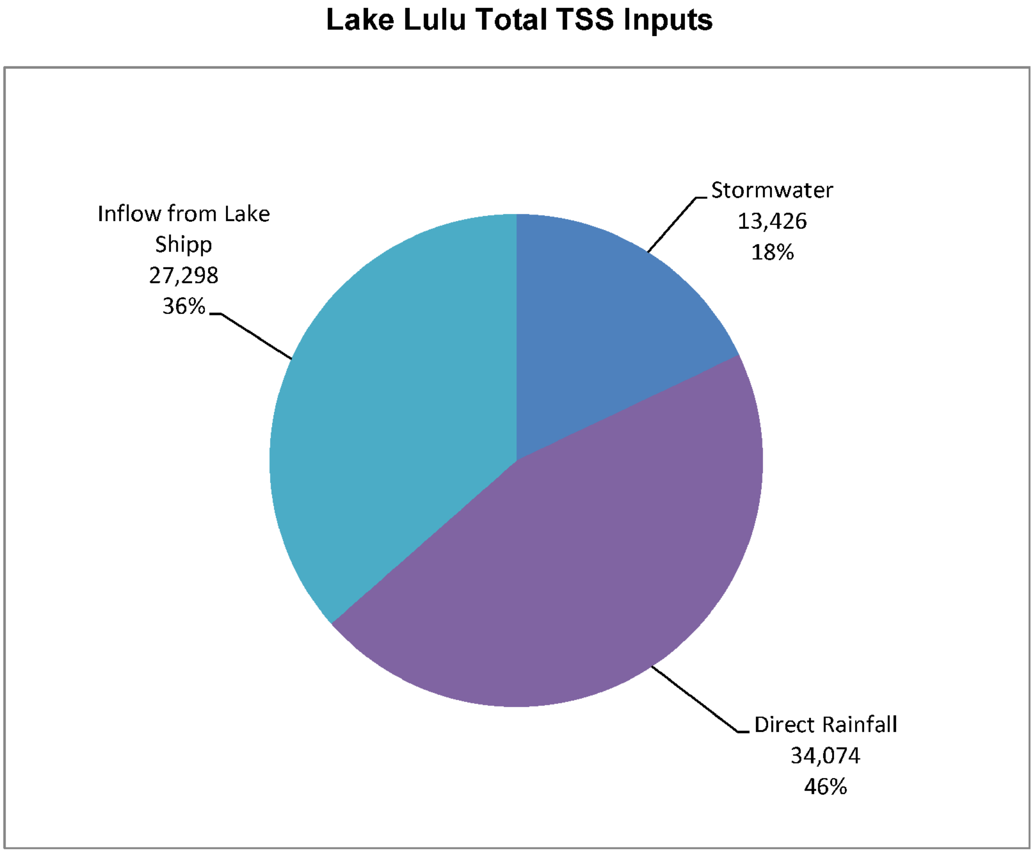


Figure 5-31. Summary of Mean Annual TSS Inputs and Losses to Lake Shipp.



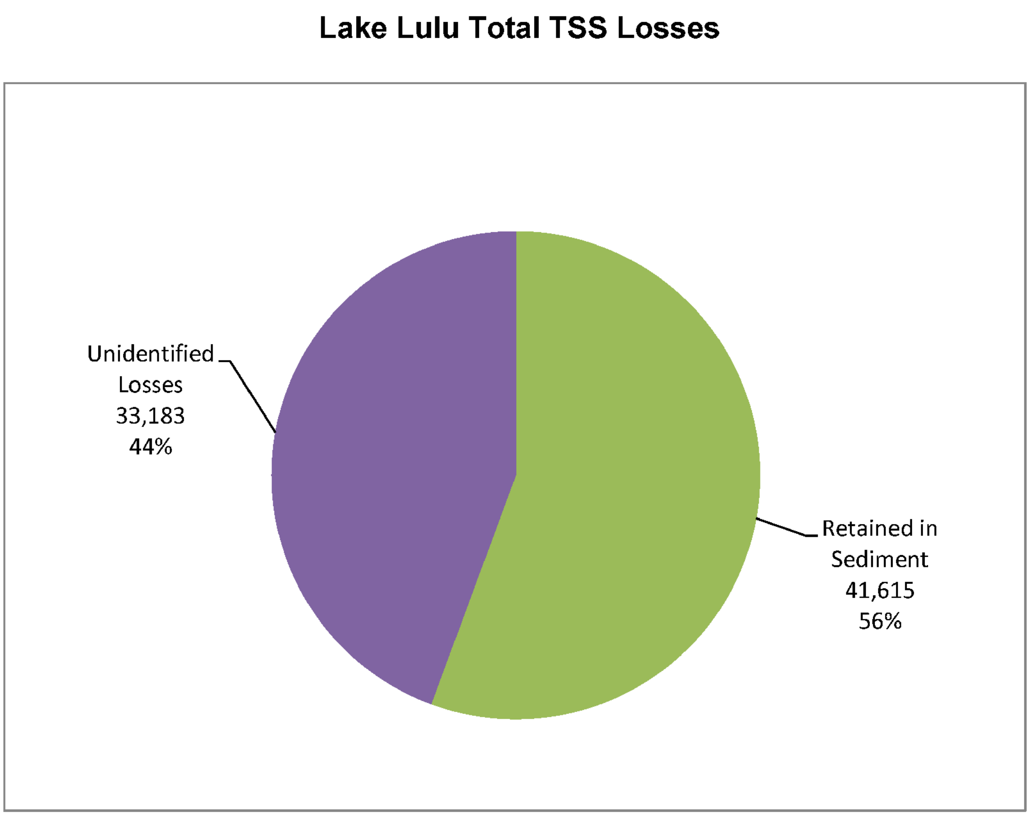


Figure 5-32. Summary of Mean Annual TSS Inputs and Losses to Lake Lulu.

SECTION 6

WATER QUALITY MODELS

Linked water quality models were developed for Lakes May, Shipp, and Lulu for use in evaluating anticipated water quality improvements resulting from evaluated sediment removal or inactivation options. Each of the water quality models is developed for an average annual period based upon the hydrologic budget summarized in Section 4 and the nutrient budgets summarized in Section 5. Phosphorus inputs summarized in Table 5-28 are assumed to represent annual phosphorus loadings into each of the three lakes. Each of the three models were calibrated under existing conditions using the results of the ambient water quality monitoring program summarized in Section 2 and used to predict improvements in water quality characteristics resulting from evaluated sediment management options.

Each of the three water quality models were developed using a modified Vollenweider phosphorus limitation model as proposed by Vollenweider (1976), Vollenweider and Dillon (1974), and Dillon and Rigler (1974). Prediction of in-lake phosphorus concentrations are based upon four parameters, including the estimated annual phosphorus input to each lake, a phosphorus retention coefficient which is based upon phosphorus sedimentation dynamics, the mean depth of each lake, and the flushing rate for each lake system.

The first step in modeling involves estimation of the phosphorus retention coefficient, R_{TP}, which is an estimate of the fraction of phosphorus inputs which are retained within the lake. The phosphorus retention coefficient for any lake can be estimated based upon the lake flushing time and mean depth as proposed by Vollenweider (1976):

$$R_{TP} = \frac{\sigma}{\rho\bar{z} + \sigma}$$

where:

R_{TP} = phosphorus retention coefficient (dimensionless)

ρ = lake flushing rate, Q/V = (inflow volume/time)/(lake volume)

$\bar{z}$ = lake mean depth = lake volume/surface area (m)

σ = sedimentation rate coefficient (1/time)

The sedimentation rate coefficient (σ) is often considered to be analogous to an apparent settling velocity for TP. This coefficient is different for each lake and is impacted by parameters such as flushing lake, mean depth, sediment composition degree, and impacts of boating activities, and hydraulic factors. The calculated phosphorus retention coefficient is analogous to the fraction of the phosphorus input which is retained within the lake. Both empirical and theoretical formulations for the phosphorus retention coefficient suggest that this coefficient decreases as the flushing rate of the lake increases. This inverse relationship appears appropriate since, as flushing rate increases, there is less time for phosphorus to settle, resulting in a decrease in the retention coefficient. Since σ is typically unknown, it is commonly used as a calibration factor for models.

Estimates of equilibrium total phosphorus concentrations within the three lakes are developed based upon the relationship proposed by Vollenweider and Dillon (1974):

$$TP = \frac{L_p \ (1 - R_{TP})}{\bar{z} * \rho}$$

where:

L_p = areal total phosphorus loading (g/m^2-time)

R_{TP} = phosphorus retention coefficient (dimensionless)

ρ = lake flushing rate (1/time)

$\bar{z}$ = mean depth (m)

For example, in Lake May:

1. ρ = lake flushing rate = Q/V

   Q = total annual inflow = 871 ac-ft/yr

   V = lake volume = 316 ac-ft

   ρ = 2.76/yr

2. $\bar{z}$ = lake mean depth = V/A (in m)

   A = lake mean depth = 50.5 ac

   $\bar{z}$ = 316 ac-ft/50.5 ac = 6.26 ft = 1.91 m

3. L_p = areal total phosphorus loading (g/m^2-time)

Total P Load = 127.8 kg/yr = 127,800 g/yr

Surface Area = 50.5 ac = 204,471 m^2

L_p = 127,800 g/yr ÷ 204,471 m^2 = 0.625 g/m^2-yr

Estimates of in-lake equilibrium chlorophyll-concentrations can also be calculated based on the empirical relationship between chlorophyll-a and total phosphorus developed by Harper (2006) specifically for Florida lakes:

$$\ln (chyl\text{-}a) = 1.058 \ \ln \ TP - 0.934$$

$$R^2 = 0.815$$

where:

TP = mean total phosphorus concentration (µg/l)

The model also estimates mean Secchi disk depth based upon the empirical relationship proposed by Harper (2006), developed specifically for Florida lakes, which results in an estimated Secchi disk depth in meters, based upon chlorophyll-a input in units of mg/m^3:

$$SD = \frac{[24.2386 + 0.3041 \times chyl - a]}{(6.0632 + chyl - a)}$$

$$R^2 = 0.807$$

where:

SD = Secchi disk depth (m)

chyl-a = chlorophyll-a concentration (mg/m^3)

Trophic State Index (TSI) values are calculated based upon the Florida Trophic State Index proposed by Brezonik (1984) which was developed specifically for Florida lakes. The empirical equations for calculating the Florida Trophic State Index are as follows for phosphorus-limited lakes:

TSI (Chyl-a)	=	16.8 + 14.4 ln (Chyl-a)	(Chyl-a in mg/m^3)
TSI (SD)	=	60.0 - 30.0 ln (SD)	(SD in m)
TSI (TP)	=	23.6 ln (TP) - 23.8	(TP in µg/l)
TSI (Avg)	=	1/3 [TSI (Chyl-a) + TSI (SD) + TSI (TP)]	

Average trophic state values less than 50 indicate oligotrophic conditions, values between 50 and 60 indicate mesotrophic conditions, and values from 61 to 70 indicate eutrophic conditions. Values over 70 represent hypereutrophic conditions.

A modified Vollenweider average annual mass balance model was developed for Lakes May, Shipp, and Lulu. The model includes hydrologic inputs to the three lakes from direct precipitation, stormwater runoff, dry weather baseflow (if present), groundwater seepage, and flow between interconnected lakes. Nutrient inputs to the three lakes include estimated loadings from bulk precipitation, stormwater runoff, groundwater seepage, dry weather baseflow (if present), flow between interconnected lakes, and internal recycling.

Hydrologic and mass losses from the three lakes are assumed to occur as a result of evaporation, evapotranspiration, deep recharge, and lake discharges. The net hydrologic inputs into the lakes are used to provide an estimate of mean detention time as well as the flushing rate for each lake which is utilized in calculation of the phosphorus retention coefficient and the equilibrium total phosphorus concentration. Phosphorus inputs to the lakes are used to generate estimates of the areal phosphorus loading rate and the final in-lake phosphorus concentration. Estimates of equilibrium chlorophyll-a concentrations and Secchi disk depth in the lake are calculated based upon the predicted in-lake phosphorus concentration.

After developing the trophic state model, initial model runs were performed to examine predicted water quality characteristics in the lakes based upon the estimated loadings of total phosphorus to each lake from the identified sources. Model calibration was performed using the sedimentation rate coefficient, (σ), which is present as a variable in both a numerator and denominator in the equation used for estimation of the phosphorus retention coefficient. The assumed sedimentation rate coefficient was varied for each of the three lakes until the model predicted TP concentration equaled the measured mean TP concentration in the three lakes based upon the field monitoring program from October 2005 to April 2006.

A summary of the results of the calibration procedure is given in Table 6-1. The required sedimentation rate coefficients for model calibrations were 2.7 for Lake May, 4.6 for Lake Shipp, and 8.4 for Lake Lulu. The observed variability in estimated sedimentation rate coefficients is due to a variety of factors including mean water depth, sediment stability, lake size, recreational activities, and hydraulic regimes. The resulting phosphorus retention coefficients are summarized in the final column of Table 6-1. Mean annual phosphorus retention coefficients range from 0.469 in Lake May to 0.802 in Lake Lulu. In general, the predicted phosphorus retention coefficients generated by the water quality model are within 10% of the calculated phosphorus retention coefficients obtained as part of the nutrient budgets presented in Section 5. A summary of the calibrated water quality models for Lakes May, Shipp, and Lulu under existing conditions is given in Appendix K.1. Calculated values are provided for detention time (t_d), P retention coefficient (R_{TP}), areal P loading (L_p), mean TP concentration (TP), chlorophyll-a concentration, Secchi disk depth, and TSI value (based on chlorophyll-a only).

The developed water quality model provides close estimates for water column concentrations of total phosphorus and chlorophyll–a in each of the three lakes. However, under existing conditions, the water quality model provides a poor estimate of Secchi disk depths, with observed Secchi disk measurements substantially less than those predicted by the model. As discussed previously, the empirical relationship between chlorophyll–a and Secchi disk was developed by Harper (2006) specifically for Florida lakes and provides a good estimate of Secchi disk depths as a function of chlorophyll-a values for a wide range of water body characteristics. The relationship assumes that chlorophyll–a is the primary predictor variable for Secchi disk depth within the lake. However, in Lakes May, Shipp, and Lulu, water column concentrations of both turbidity and TSS are substantially higher that commonly observed in urban lakes due to the continuous sediment re-suspension within the three lakes. As a result, Secchi disk measurements performed in these lakes are artificially lowered by the presence of inorganic particles within the water column in addition to algal cells. Therefore, the model over predicts Secchi disk depth under current conditions. However, it is believed that the model provides a better prediction of anticipated Secchi disk depth under post modification conditions since the sediment re-suspension will be reduced and chlorophyll–a will the primary regulator for Secchi disk measurements.

TABLE 6-1

RESULTS OF MODEL CALIBRATION PROCEDURES AND ASSUMED SEDIMENTATION RATE COEFFICIENTS

LAKE	MEAN TP CONC. FROM 10/05 – 4/06 (mg/l)	MODEL PREDICTED TP CONC. (mg/l)	SEDIMENTATION RATE COEFFICIENT (σ)	PHOSPHORUS RETENTION COEFFICIENT
May	0.063	0.063	2.7	0.469
Shipp	0.059	0.059	4.6	0.725
Lulu	0.052	0.052	8.4	0.802

SECTION 7

EVALUATION AND MANAGEMENT OF SEDIMENT IMPACTS

An analysis of the impacts and management options for reducing water quality impacts from existing sediment accumulations in Lakes May, Shipp, and Lulu are discussed in this section. Anticipated water quality improvements from sediment management options are evaluated using the water quality model developed in Section 6.

7.1 Significance of Sediment Impacts

As discussed in Section 2.3.1, significant accumulations of unconsolidated organic sediments currently exist within Lake May, Shipp, and Lulu. A summary of the volume of existing organic muck accumulations in Lakes May, Shipp and Lulu is given in Table 6-1. Sediment accumulations within the three lakes extend as deep as 12-18 feet in isolated pockets and contain sufficient volume to cover the entire bottom area of Lake May to mean dept of 6.0 feet, Lake Shipp to a mean dept of 2.3 feet, and Lake Lulu to mean dept of 2.7 feet. Overall, the three lakes contain approximately 1,770 acre feet (77,101,200 cubic feet or 2,855,600 cubic yards) of organic muck sediments.

Based on the work efforts conducted by ERD as part of this project, it is apparent that the existing sediment accumulations within the three lakes have a significant impact on water quality characteristics. Surface water monitoring conducted under "normal" and "windy" conditions concluded that windy conditions result in measurable increases in water column concentrations of total nitrogen, particulate phosphorus, total phosphorus, turbidity, TSS and chlorophyll a. Windy conditions were found to increase total phosphorus concentrations by approximately 11% in Lake May, 16% in Lake Shipp, and 20% in Lake Lulu. Windy conditions were found to increase TSS conditions concentrations by approximately 37% in Lake May, 33% in Lake Shipp, and 53% in Lake Lulu. These data appear to suggest that sediment accumulations in each of the three lakes are easily re-suspended under windy conditions, causing measurable changes in water column characteristics.

The evaluation of internal recycling, summarized in 5.1.5, indicates that significant phosphorus release occurs in each of the three lakes under both aerobic and anoxic conditions, although, the release is substantially greater under an anoxic environment. Sediment phosphorus release contributes approximately 1.16 kg/ac-yr to Lake May, 1.27 kg/ac-yr to Lake Shipp, and 2.63 kg/ac-yr to Lake Lulu. Based upon the phosphorus mass inputs, summarized in Table 5-28, internal recycling contributes approximately 46% of the total phosphorus inputs to Lake May, 49% of the phosphorus inputs to Lake Shipp, and 70% of the phosphorus inputs to Lake Lulu. Phosphorus inputs from internal recycling exceed inputs from storm water runoff by a factor of 1.5 in Lake May, 2.1 in Lake Shipp, and 9.4 in Lake Lulu. The analyses conducted by ERD provide clear evidence that internal recycling of phosphorus from the existing sediments is the single largest source of phosphorus to Lakes May, Shipp, and Lulu on an average annual basis.

TABLE 7-1

ESTIMATED ACCUMULATION OF ORGANIC MUCK SEDIMENTS IN LAKES MAY, SHIPP, AND LULU

LAKE	SEDIMENT VOLUME (ac-ft)	SEDIMENT DEPTH (ft)	
		MEAN	MAXIMUM
May	302.4	6.0	>18
Shipp	621.0	2.3	>15
Lulu	846.6	2.7	>12
TOTAL:	**1,770**		

Based on the water quality monitoring by ERD from October 2005 to April 2006, as well as, historical data for each of the three lakes, it appears that Lake May, Shipp, and Lulu have historically exhibited either phosphorus limited or nutrient balanced conditions. This trend implies that reductions in phosphorus loadings have the greatest opportunity for improvement of water quality characteristics in the three lakes. Since the most significant phosphorus loadings appear to occur as a result of internal recycling from existing sediments, reduction of these phosphorus loadings is necessary to create significant water quality improvements within these lakes.

7.2 Isolation Chamber Evaluations

A series of isolation chambers, also called limno corrals, was installed in Lakes May and Shipp to evaluate water quality impacts from existing sediments in each lake. An isolation chamber provides a mechanism for isolating a portion of the sediments and water column within the lake. Experiments can then be conducted to evaluate equilibrium water quality characteristics in isolation chambers with and without existing sediments to assist in quantifying current water quality impacts from existing sediments and anticipated water quality improvements from selected sediment management techniques. If other factors are held constant, equilibrium water quality characteristics achieved within the isolation chambers are directly regulated by water-sediment interactions. Isolation chambers have been previously used by Harper (1984) to evaluate impacts on algal productivity of a proposed dredging operations in Megginnis Arm of Lake Jackson in Tallahassee, as well as Lake Maggiore in St. Petersburg (ERD, 1994), and Lakes Dora and Beauclair in Lake County (ERD, 2003).

7.2.1 Initial Installation

Isolation chambers are designed to totally isolate a column of water so that equilibrium water quality characteristics can be evaluated without interference from other processes within the lake. An initial set of isolation chambers was installed in Lakes May and Shipp during December 2008. A schematic of a typical isolation chamber installed in Lakes May and Shipp is given in Figure 7-1. Each isolation chamber is supported by a 6-ft diameter x 4-ft tall aluminum cylinder, with a thickness of approximately 0.25 in, which is placed into the existing muck sediments to a depth of approximately 2-3 ft. A tubular aluminum frame with three support legs is attached to the aluminum cylinder. A double-layer reinforced 10 mil polyethylene bag, with a diameter of approximately 2 m (6.5 ft), is then placed over the aluminum frame. The double-layer bag is secured to the aluminum cylinder using a ratchet-type tie-down strap as shown on Figure 7-2. A 4-inch lip which was welded to the top of the aluminum ring prevents the double-layer bag from sliding off the aluminum ring. The cylinder was then loaded onto a boat and transported to the selected site. The top of the bag was not secured at this time.

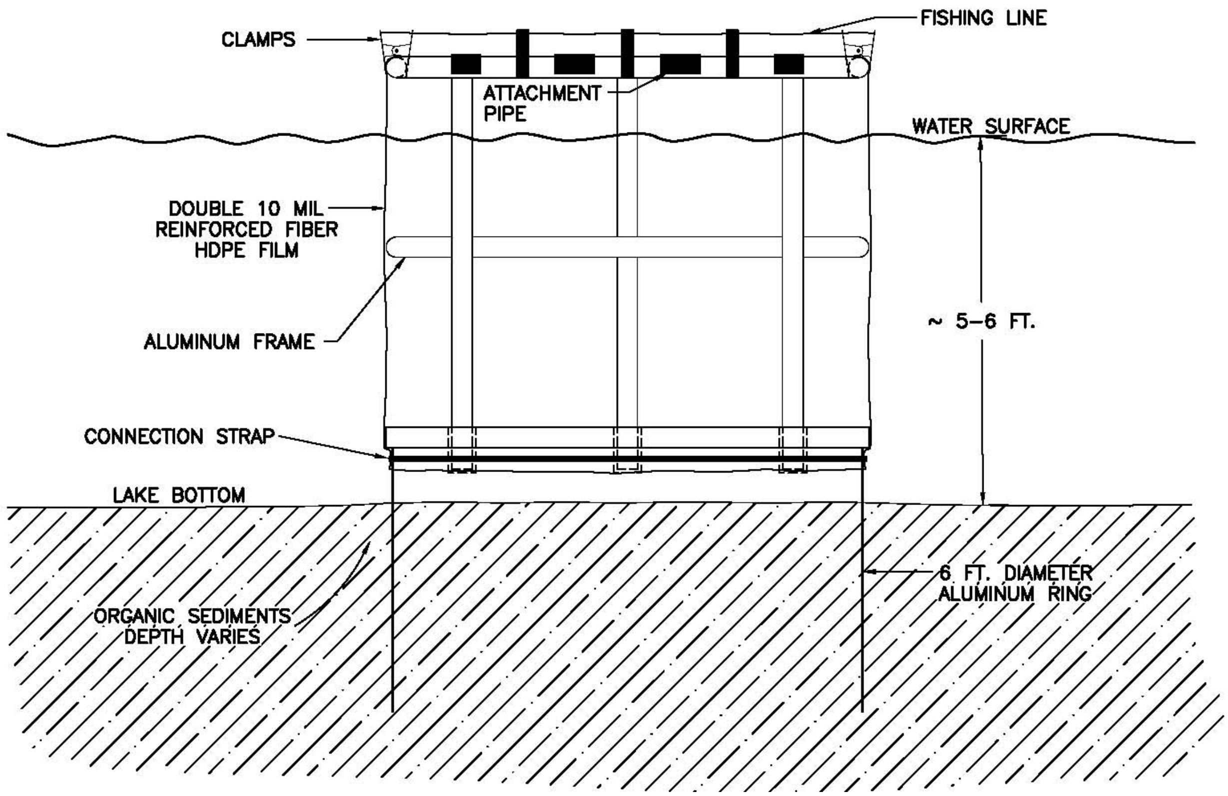


Figure 7-1. Typical Isolation Chamber Installation.

After reaching the selected sites, the chamber was placed into the water in an upright position. The fabric was not yet attached to the top of the upper frame so that water exchange could occur between the chamber and lake water. The circular rings were inserted into the sediments using a 40-lb slide hammer commonly used for inserting fence posts. Each aluminum frame was then adjusted so that the circular top portion of the frame extended approximately 12-18 inches above the top of the water surface. Each chamber was allowed to equilibrate for approximately 1-2 hours before the bag material was raised. Excess bag material was folded over the top of the aluminum frame into the center of the isolation chamber. The bag was connected to the aluminum frame using short sections of 1.5-inch diameter vacuum hose which was slit along one side. Each small hose section was stretched open and placed over the bag and aluminum frame. When released, the hose section snapped closed, providing a firm attachment for the bag at the top of the aluminum frame. Photographs of partial and completed installation of the isolation chambers are given in Figure 7-3.

Spring-loaded clamps were also attached at nine equally spaced locations around the top of the circular frame. A double strand of monofilament fishing line was stretched between each of the clamps in a circular pattern around the top of the aluminum frame. Previous isolation chamber research conducted by ERD indicated that the top of the isolation chamber frames are used by birds for roosting, and inputs of bird wastes into the isolation chamber can substantially affect the results of ongoing experiments. Monofilament line placed above the top of the aluminum frame helps prevent birds from landing on the frame and using it as a roost.

a. Reinforced Bag is Placed Over the Aluminum Cylinder and Ring

b. Bag is Secured to Bottom Cylinder Using a Ratchet Strap

Figure 7-2. Photographs of the Isolation Chambers Prior to Installation.

a. During Installation

b. Completed Installation

Figure 7-3. Photographs of Isolation Chamber Installation.

Two sets of three isolation chambers were installed in Lakes May and Shipp for a total of 12 separate isolation chambers. Three of the chambers in each lake were installed to isolate existing sediments and to evaluate potential water quality impacts from existing sediments within each lake. The second set of three isolation chambers was installed, and following installation, the muck sediments within the center of the aluminum ring were removed. A schematic of the isolation chamber with the sediments removed is illustrated on Figure 7-4. The existing sediments within each of these chambers were hydraulically dredged using a 4-inch Mud Hog pump. The pump was operated by a diver, and the suction pipe was rotated around the inside of the aluminum ring until all muck sediments had been removed to the historical sandy bottom. This process required removal of approximately 3-4 ft of sediments at the isolation chamber site selected in Lake May, and approximately 2-3 ft of sediments at the site selected in Lake Shipp. All dredging operations were conducted prior to raising and attaching the isolation chamber fabric so that water quality disturbances created by the dredging process could be exchanged with the existing lake water. Photographs of the completed isolation chamber installations in Lake May and Lake Shipp are given on Figure 7-5.

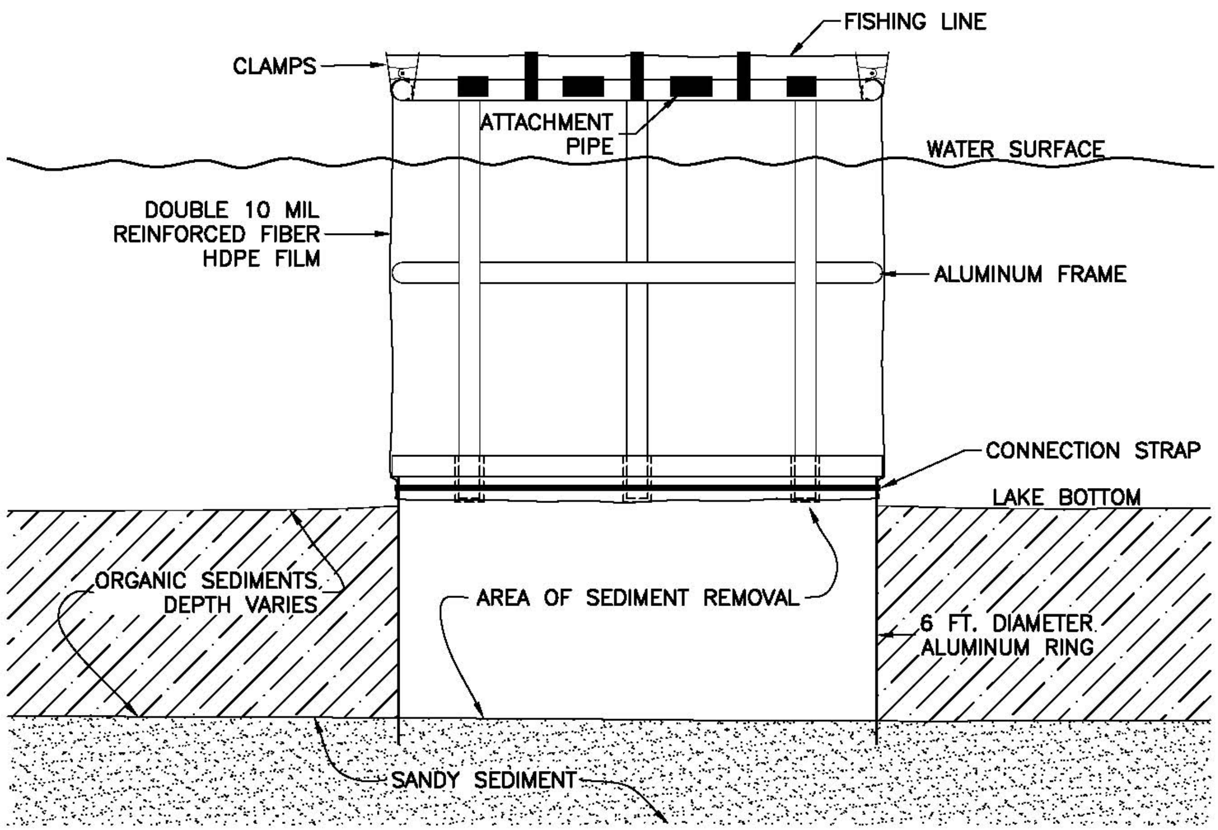
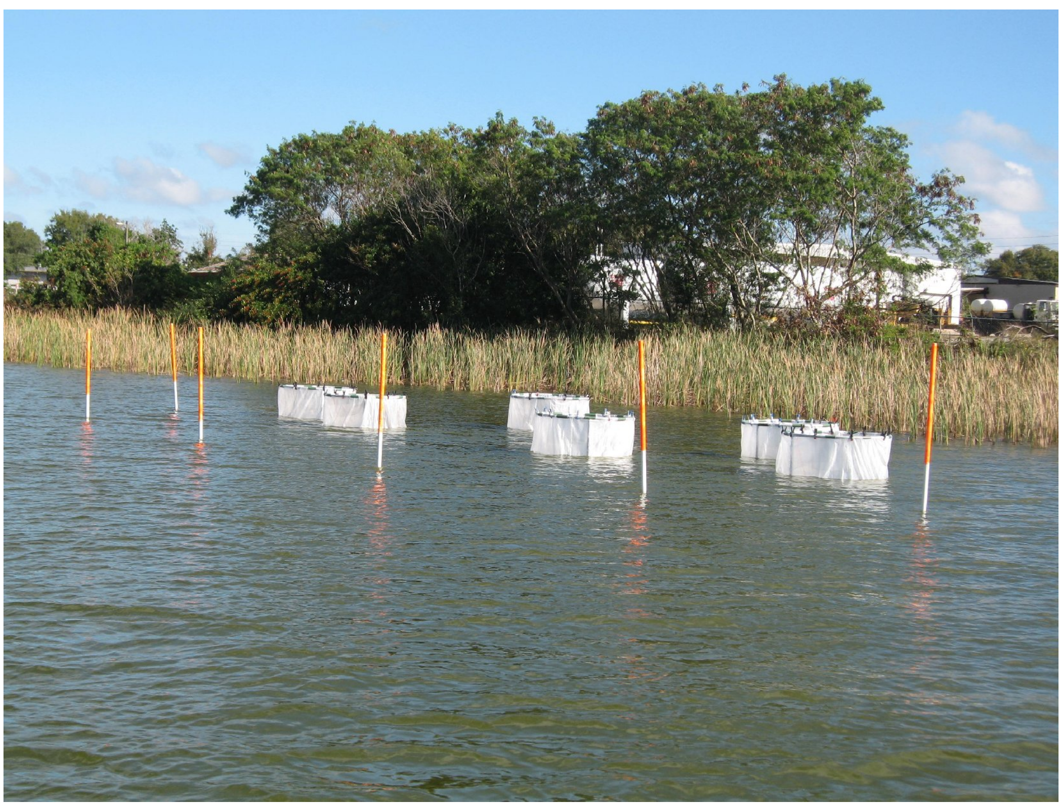


Figure 7-4. Schematic of Isolation Chamber with Sediments Removed.

Locations of the selected isolation chamber sites in Lakes May and Shipp are indicated on Figure 7-6. The monitoring sites were selected to provide a water depth ranging from 5-6 ft and an organic sediment depth of 3-4 ft in Lake May and 2-3 ft in Lake Shipp. Potential areas for installation of isolation chambers were identified by intersecting the water depth contours for Lake May (Figure 2-2) and Lake Shipp (Figure 2-3) with the muck depth contours provided in Figure 2-18 for Lake May and Figure 2-19 for Lake Shipp.

a. Lake May



b. Lake Shipp

Figure 7-5. Completed Isolation Chamber Installations in Lake May and Lake Shipp.

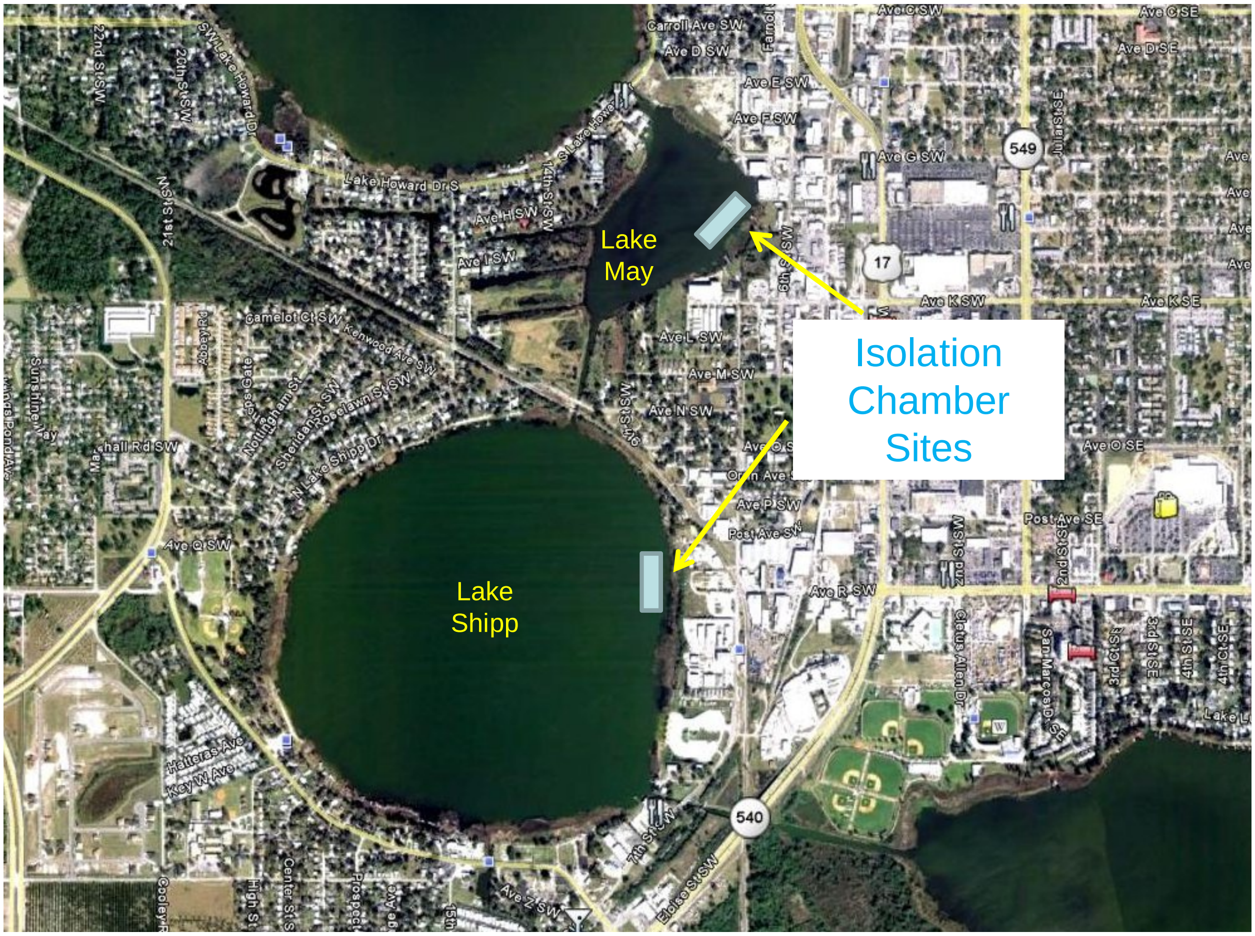


Figure 7-6. Locations of Selected Isolation Chamber Sites in Lakes May and Shipp.

Installation of the 12 isolation chambers was conducted during mid-December 2008. The isolation bags were attached to the top of the ring structures on December 19, 2008 which initiated the isolation period. The experimental design provides triplicate chambers to evaluate water quality characteristics with and without sediment contact in each of the two lakes. Monitoring was conducted in each of the 12 isolation chambers, as well as lake water outside of the chambers, on approximately a biweekly basis from December 2008-April 2009.

The isolation chamber monitoring conducted from December 2008-April 2009 represented primarily dry season conditions and relatively cool water temperatures when vertical circulation of the water column is prevalent. After reviewing the data generated during this period, it was decided to conduct an additional supplemental isolation chamber monitoring program to evaluate water quality conditions within the isolation chambers during warm water and wet season conditions. This additional monitoring was conducted using the originally installed isolation chambers in Lakes May and Shipp. The outer plastic fabric was removed from each isolation chamber to allow free water exchange with the surrounding lake water. New fabric enclosures were installed on each isolation chamber during July 2009 and a supplemental monitoring period was initiated on July 27, 2009. This monitoring was conducted from July-October 2009 to evaluate water column/sediment interactions under warm wet season conditions when water column stratification commonly occurs. Field monitoring for the supplemental monitoring program was identical to the monitoring program used for the original monitoring program.

7.2.2 Isolation Chamber Monitoring

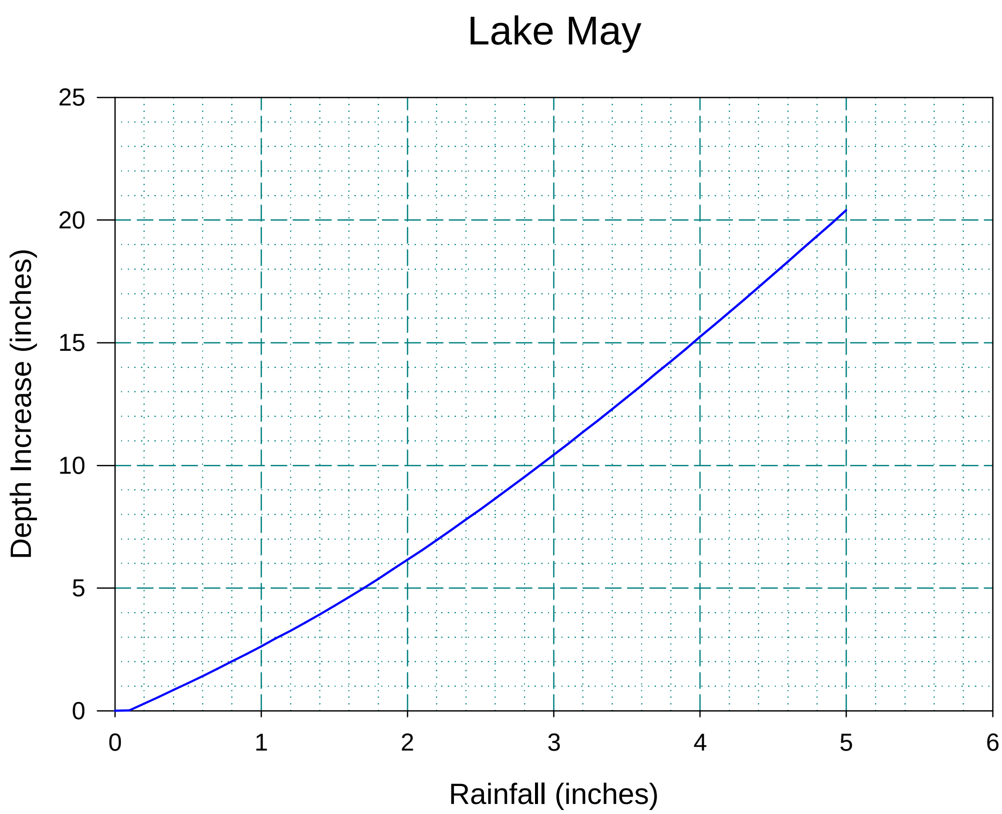
After installation of the plastic fabric during the original and supplemental monitoring programs, the isolation chambers were allowed to equilibrate for a period of approximately 24-72 hours to allow for settling of turbidity or suspended solids which may have been generated during the installation process. Initial water quality samples were then collected within each of the isolation chambers and lake water sites and the monitoring programs were then initiated.

Prior to each monitoring event, the water column within each isolation chamber was gently circulated using a 12-volt DC electric trolling motor which was mounted to the top of the tubular frame. The trolling motor was operated at low speed to provide sufficient agitation within each isolation chamber to provide complete mixing of the water column without disturbance of the bottom sediments isolated in the chamber. Agitation was continued for a period of approximately 60 seconds in each chamber. This process simulates vertical mixing of the water column which occurs on a periodic basis in the Winter Haven lakes.

After the mixing process was completed in each of the isolation chambers, surface water samples were collected from each chamber using a portable submersible pump which was lowered to the middle of the water column in each chamber. Water samples were also collected from the open lake water adjacent to each set of chambers using the same methodology. Samples used for chemical analysis of dissolved nutrients and dissolved aluminum were filtered in the field immediately following sample collection using a syringe apparatus with a 0.45 micron glass fiber disposable filter.

Field measurements were also collected within each isolation chamber and in open lake water adjacent to each set of isolation chambers on each monitoring date. Field measurements of pH, specific conductivity, temperature, dissolved oxygen, and ORP were collected at depths of 0.25 m, 0.5 m, and at 0.5 m intervals to the lake bottom within each isolation chamber and in the open lake using a Hydrolab H2O water quality monitor. In addition, a measurement of Secchi disk depth was also performed in each isolation chamber and in the open lake. Collected samples were analyzed for the parameters outlined in Table 2-5.

One of the criticisms regarding isolation chambers is that the water within the chambers is not subjected to the same loading sources that would occur within the open lake. However, the isolation chambers are still exposed to nutrient sources originating from groundwater seepage, bulk precipitation, and sediment nutrient release. The only significant nutrient source which does not impact the water within the isolation chambers is stormwater runoff. The experimental design for the isolation chambers was modified somewhat from previous isolation chamber projects in an attempt to incorporate impacts from stormwater runoff. When storm events occur, the incoming stormwater runoff rapidly mixes with the lake water, and the nutrients contained within the stormwater runoff are distributed throughout the lake. The hydrologic modeling summarized in Section 4 was used to develop relationships between rainfall depth and changes in water depths in Lakes May and Shipp. These relationships are illustrated on Figure 7-7. The values summarized in these figures represent changes in lake level as a function of single event or cumulative rainfall, and reflect additional nutrient loadings to Lakes May and Shipp which are not included inside the isolation chambers.



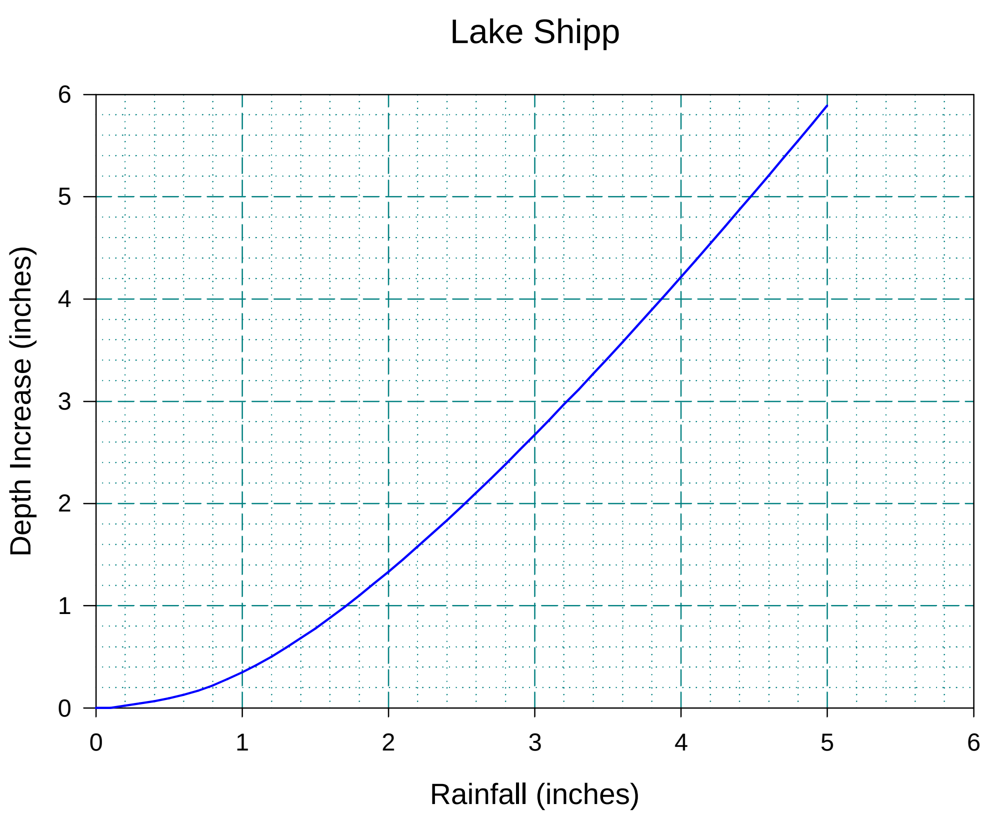


Figure 7-7. Changes in Water Depth as a Function of Rainfall Depth in Lakes May and Shipp.

After sample collection had been completed during each monitoring event, lake water was added to each of the isolation chambers to simulate additional nutrient inputs as a result of stormwater runoff. The recording rain gauge installed by ERD at the baseball complex on Lake Lulu was used to provide information on total rainfall depth between monitoring events. The cumulative rainfall was used to estimate the increase in water depth in Lakes May and Shipp resulting from stormwater runoff between monitoring events. Relationships were developed to convert the changes in water depth into an equivalent volume of water inside each isolation chamber. These relationships are summarized on Figure 7-8. Lake water was then added to each isolation chamber based upon these relationships using the cumulative rainfall between monitoring events. This water addition is intended to simulate additional nutrient loadings created by stormwater inflow into the lakes. Although some of the incoming stormwater pollutants will certainly have settled during the inter-event monitoring interval, this method at least attempts to simulate additional nutrient loadings to the chambers from stormwater runoff.

7.2.3 Results

The original isolation chamber monitoring program was initiated on December 18, 2008 and continued until April 9, 2009. Field monitoring was conducted on approximately a 2-3 week basis, with a total of seven monitoring events conducted during this program. The supplemental isolation chamber monitoring program was initiated on July 27, 2009 and continued until October 15, 2009, with a total of six monitoring events conducted during this period. A discussion of the results of these monitoring efforts is given in the following sections.

7.2.3.1 Field Parameters

A complete listing of vertical field profiles collected during the original and supplemental isolation chamber experiments is given in Appendix J.1. A discussion of field parameters measured in Lakes May and Shipp is given in the following sections.

7.2.3.1.1 Lake May

A graphical comparison of vertical field profiles of temperature measured in Lake May isolation chambers during dry season conditions (December 2008-April 2009) is given in Figure 7-9. The vertical profiles summarized on this figure reflect the mean of vertical profiles collected in each of the three chambers with sediment contact and without sediment contact for each monitoring date. In general, relatively uniform temperature profiles were observed in the isolation chambers with sediment contact and without sediment contact throughout the dry season monitoring program. Temperature profiles measured within the lake are similar to profiles observed within the isolation chambers.

A graphical comparison of vertical field profiles of pH measured in Lake May isolation chambers during dry season conditions (December 2008-April 2009) is given in Figure 7-10. Relatively isograde pH conditions were observed within the isolation chambers as well as the lake during the dry season monitoring program with pH values range from approximately 7.5-9.5. In general, a slight trend of decreasing pH with increasing water depth was observed within the isolation chambers and open lake during several of the monitoring events. This phenomenon appears to be more pronounced in the chambers without sediment contact, perhaps due to the deeper water depth within these chambers.

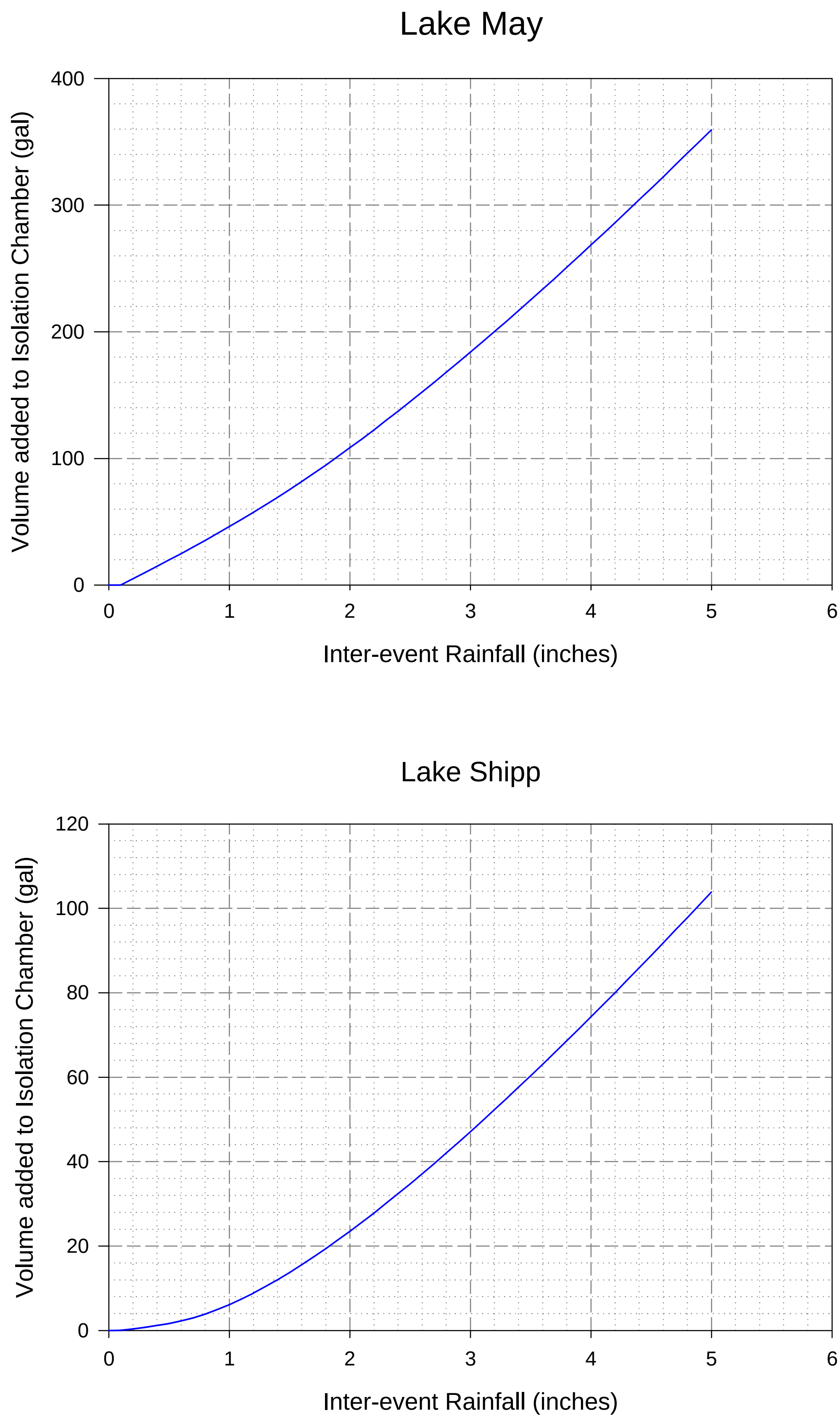


Figure 7-8. Estimated Isolation Chamber Water Addition as a Function of Inter-Event Rainfall.

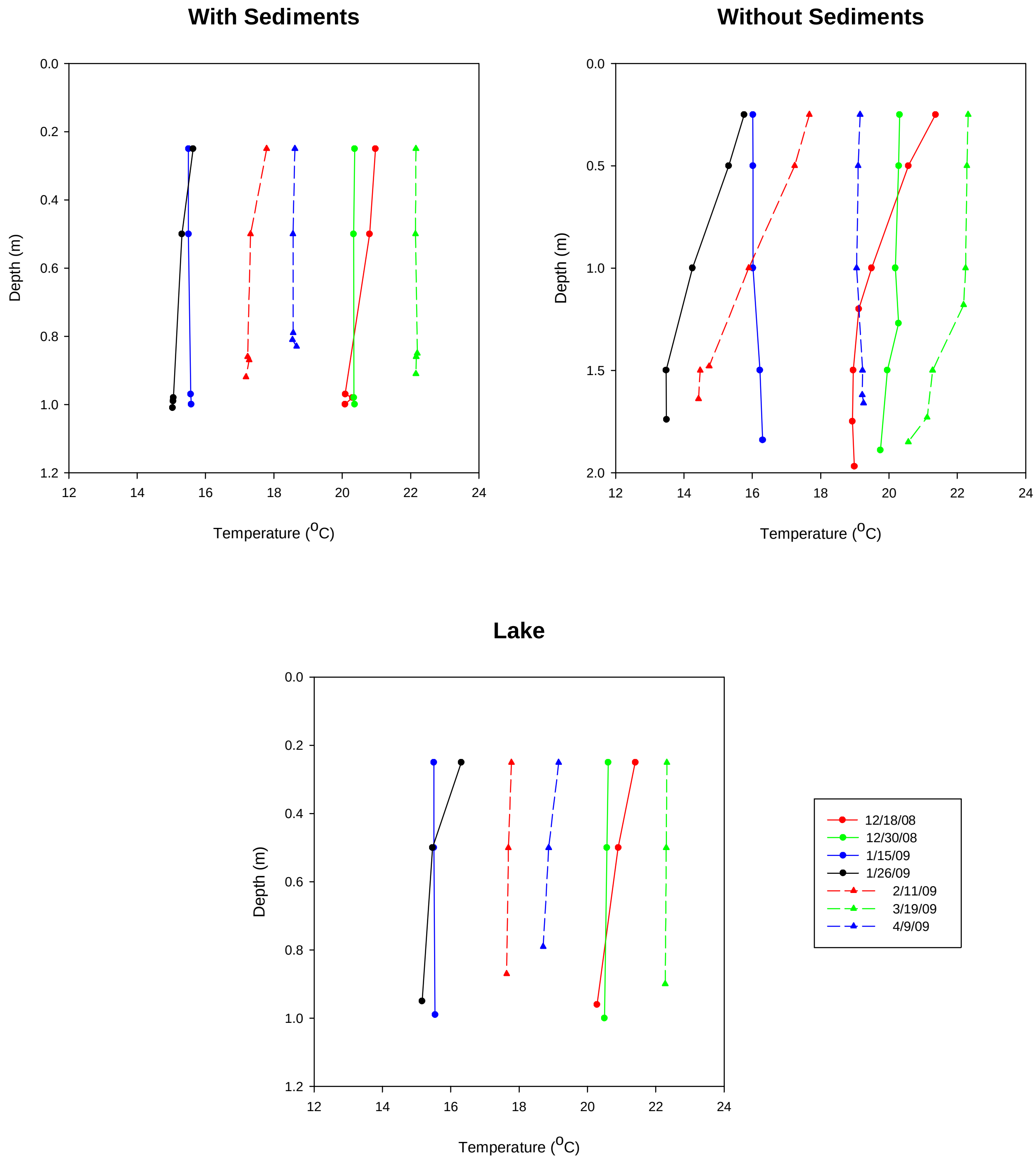


Figure 7-9. Vertical Field Profiles of Temperature Measured in Lake May Isolation Chambers During Dry Season Conditions (December 2008-April 2009).

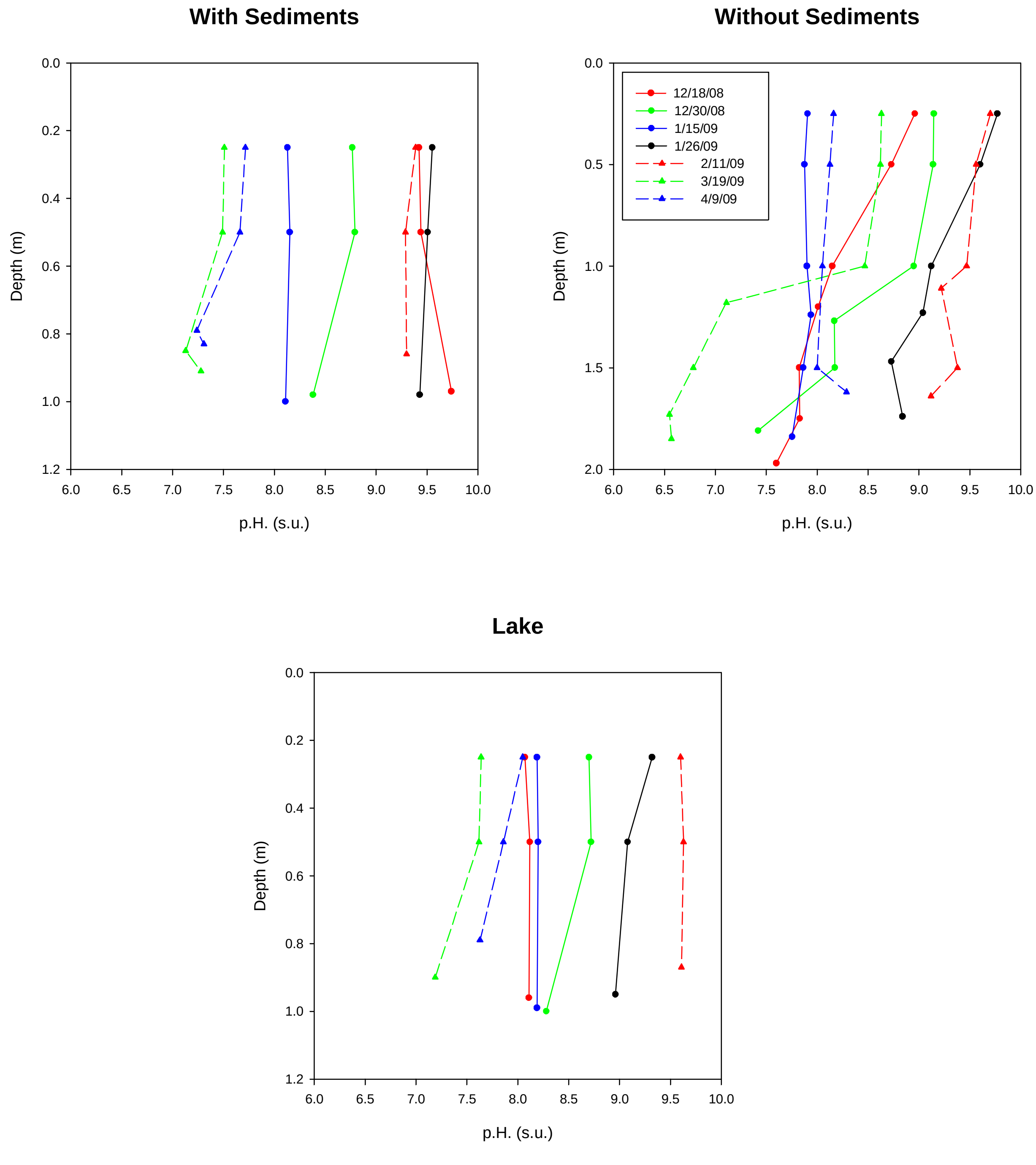


Figure 7-10. Vertical Field Profiles of pH Measured in Lake May Isolation Chambers During Dry Season Conditions (December 2008-April 2009).

A graphical comparison of vertical field profiles of conductivity measured in Lake May isolation chambers during dry season conditions (December 2008-April 2009) is given in Figure 7-11. Measured conductivity values were relatively uniform throughout the water columns within the isolation chambers as well as the open lake during dry season conditions. A slight trend of increases in specific conductivity was observed near the bottom of the isolation chambers during approximately half of the monitoring events.

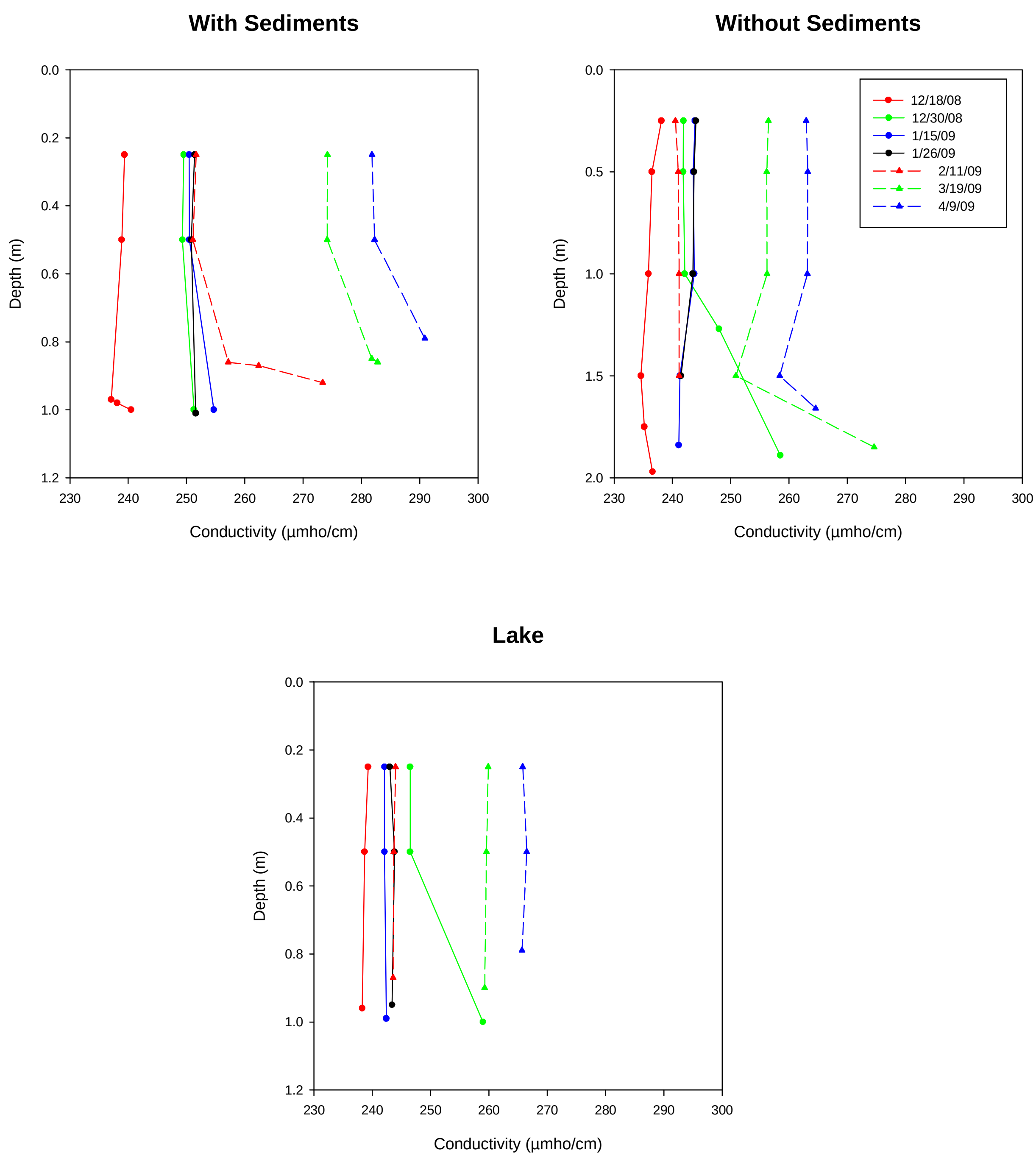


Figure 7-11 Vertical Field Profiles of Conductivity Measured in Lake May Isolation Chambers During Dry Season Conditions (December 2008-April 2009).

A graphical summary of field profiles of dissolved oxygen measured in the Lake May isolation chambers during dry season conditions (December 2008-April 2009) is given on Figure 7-12. Surface dissolved oxygen concentrations range from approximately 5-10 mg/l in the isolation chambers, with surface dissolved oxygen concentrations in the open lake ranging from approximately 7-10 mg/l. A general trend of decreasing dissolved oxygen with increasing water depth was observed both in the isolation chambers and in the open lake during virtually all monitoring events. Anoxic conditions, indicated by dissolved oxygen concentrations less than 1 mg/l, were observed in bottom layers of the isolation chambers with sediment contact during four of the eight monitoring events. Anoxic conditions in the isolation chambers without sediments were observed during only two of the eight monitoring events. Anoxic conditions within the lake were observed near the water-sediment interface during one monitoring event.

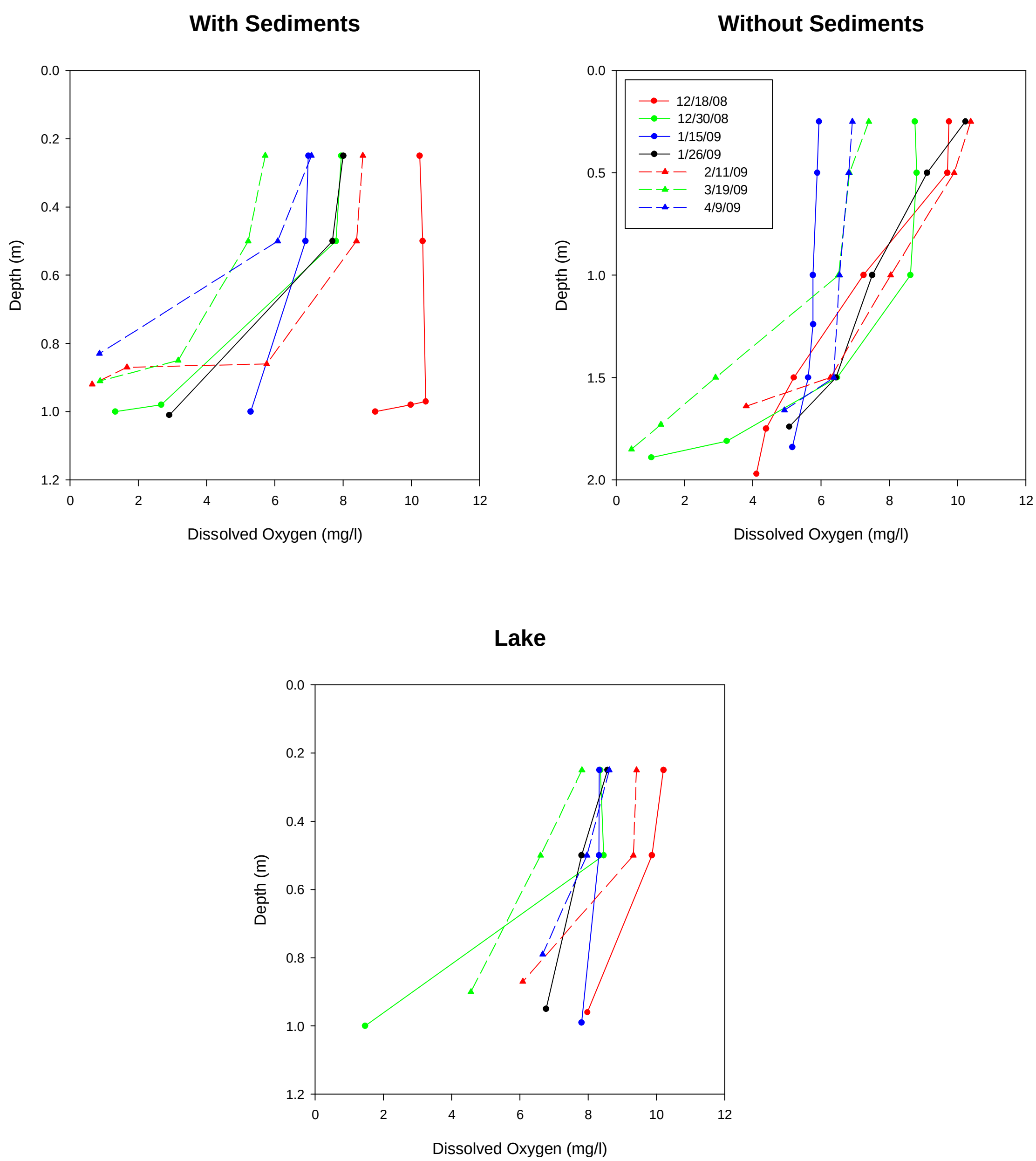


Figure 7-12. Vertical Field Profiles of Dissolved Oxygen Measured in Lake May Isolation Chambers During Dry Season Conditions (December 2008-April 2009).

A graphical summary of temperature profiles measured in Lake May isolation chambers during wet season conditions (July-October 2009) is given in Figure 7-13. In general, water column temperatures were relatively uniform in upper portions of the water column, with a general trend of decreasing temperature with increasing water depth in lower portions of the water column. Temperature decreases appear to be more pronounced in the isolation chambers than observed in the open lake.

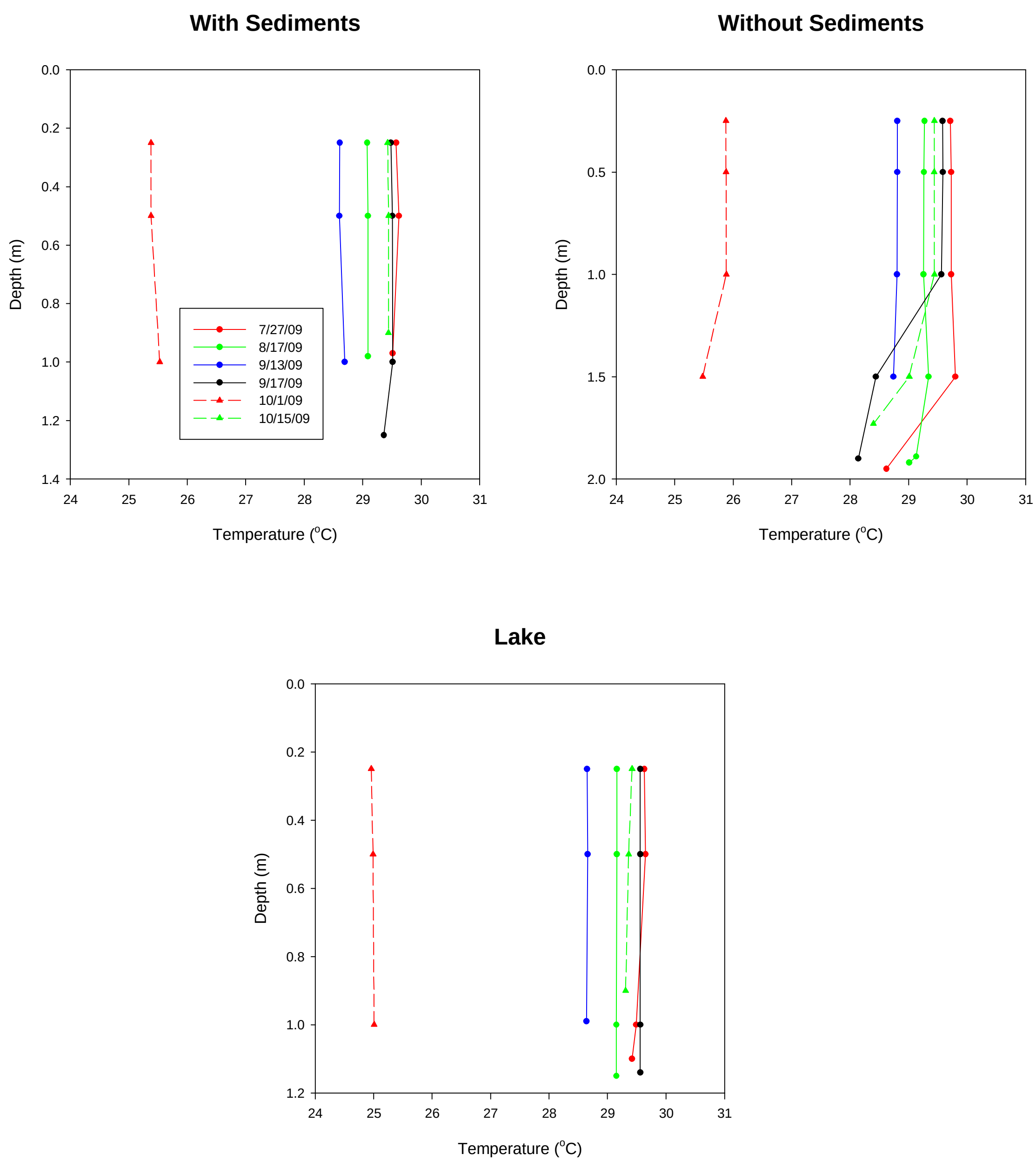


Figure 7-13. Vertical Field Profiles of Temperature Measured in Lake May Isolation Chambers During Wet Season Conditions (July-October 2009).

Vertical field profiles of pH measured in Lake May isolation chambers during wet season conditions (July-October 2009) are summarized on Figure 7-14. During wet season conditions, surface pH measurements ranged from approximately 6.7-8.0 within the isolation chambers, with pH measurements ranging from approximately 7-7.5 within the open lake. A general trend of decreasing water column pH with increasing water depth was observed within the isolation chambers as well as the open lake, although the phenomenon is more pronounced within the isolation chambers.

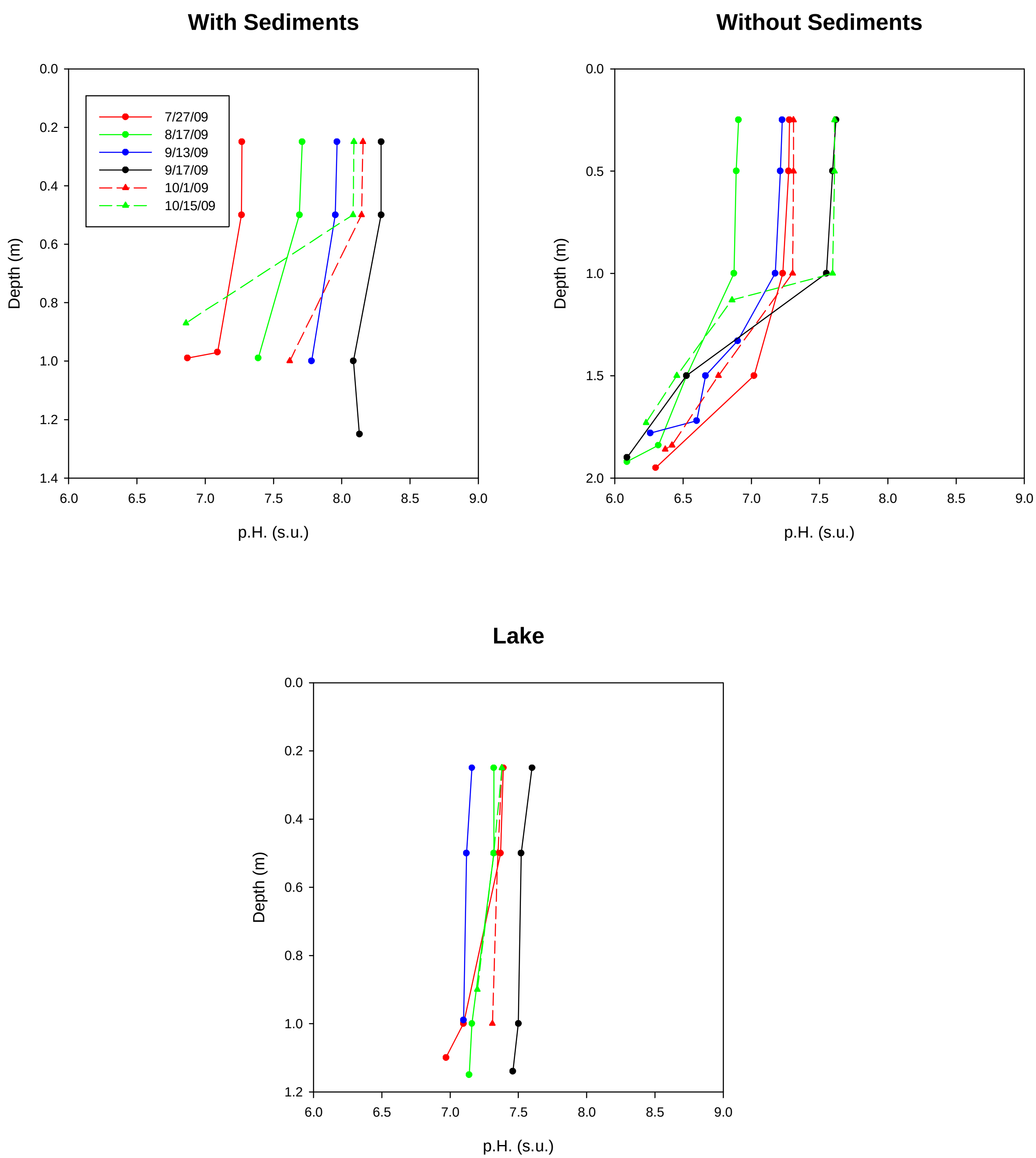


Figure 7-14. Vertical Field Profiles of pH Measured in Lake May Isolation Chambers During Wet Season Conditions (July-October 2009).

A graphical summary of conductivity measurements conducted in Lake May isolation chambers during wet season conditions (July-October 2009) is given in Figure 7-15. A general trend of increasing conductivity with increasing water depth was observed in the isolation chambers both with and without sediment contact. However, this phenomenon was more pronounced in the chambers without sediment contact, particularly in the deepest portions of the isolation chamber. Since the sediments had been removed from these chambers, the observed increases in specific conductivity are likely related to inputs from groundwater seepage. Relatively isograde conductivity values were observed within the open lake during wet season conditions.

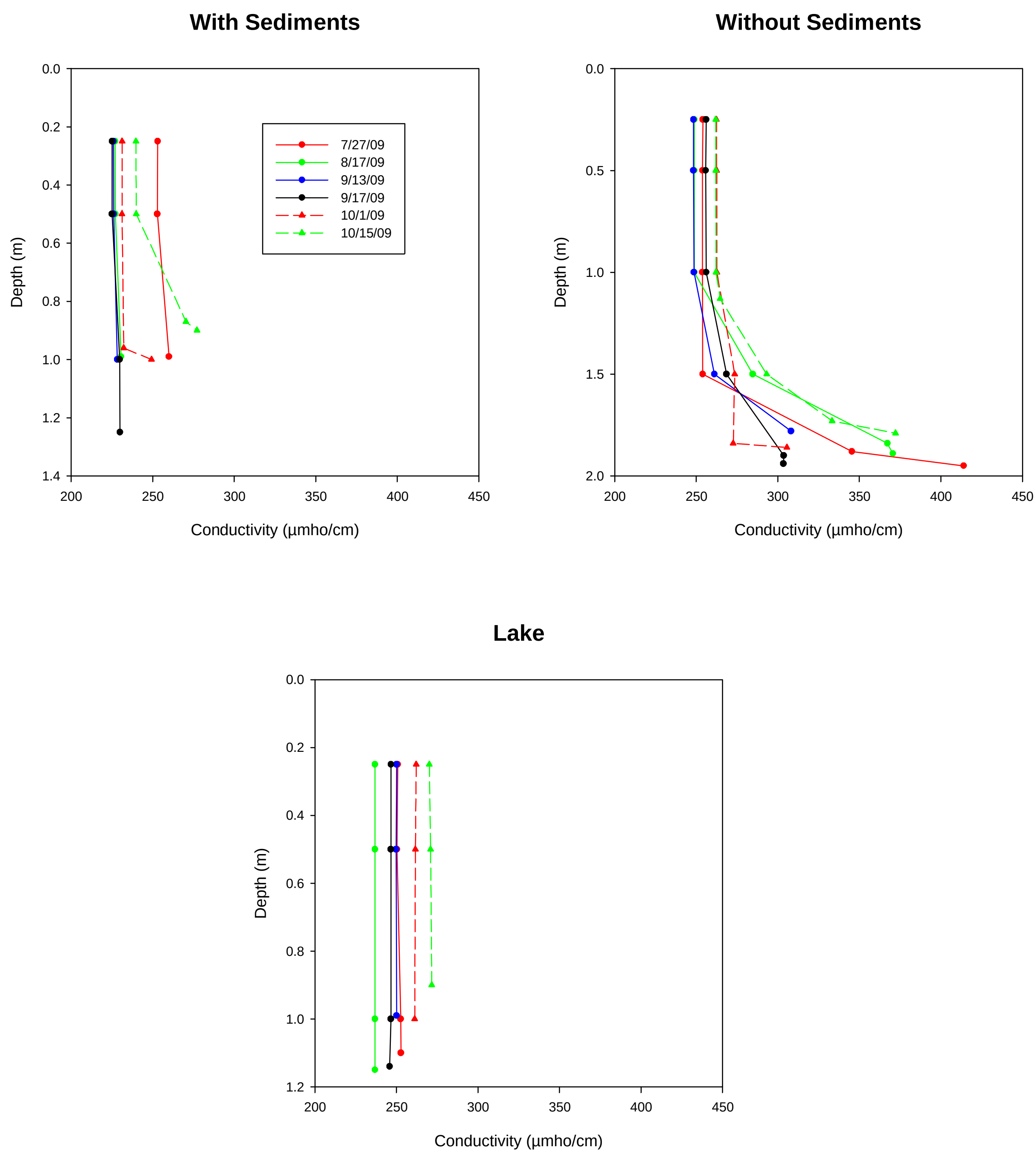


Figure 7-15. Vertical Field Profiles of Conductivity Measured in Lake May Isolation Chambers During Wet Season Conditions (July-October 2009).

A graphical summary of vertical field profiles of dissolved oxygen measured in Lake May isolation chambers under wet season conditions (July-October 2009) is given in Figure 7-16. In general, dissolved oxygen concentrations appear to be lower in the isolation chambers as well as the open lake during the warm weather wet season conditions than observed during the dry season conditions. Dissolved oxygen concentrations within the isolation chambers range from approximately 3-7 mg/l, with concentrations in the open lake ranging from 4-6 mg/l. A general trend of decreasing dissolved oxygen with increasing water depth was observed both in the isolation chambers and in the open lake, although the trend was much more apparent in the isolation chambers. Anoxic conditions were observed near the water-sediment interface in the isolation chambers both with and without sediments during virtually all monitoring dates.

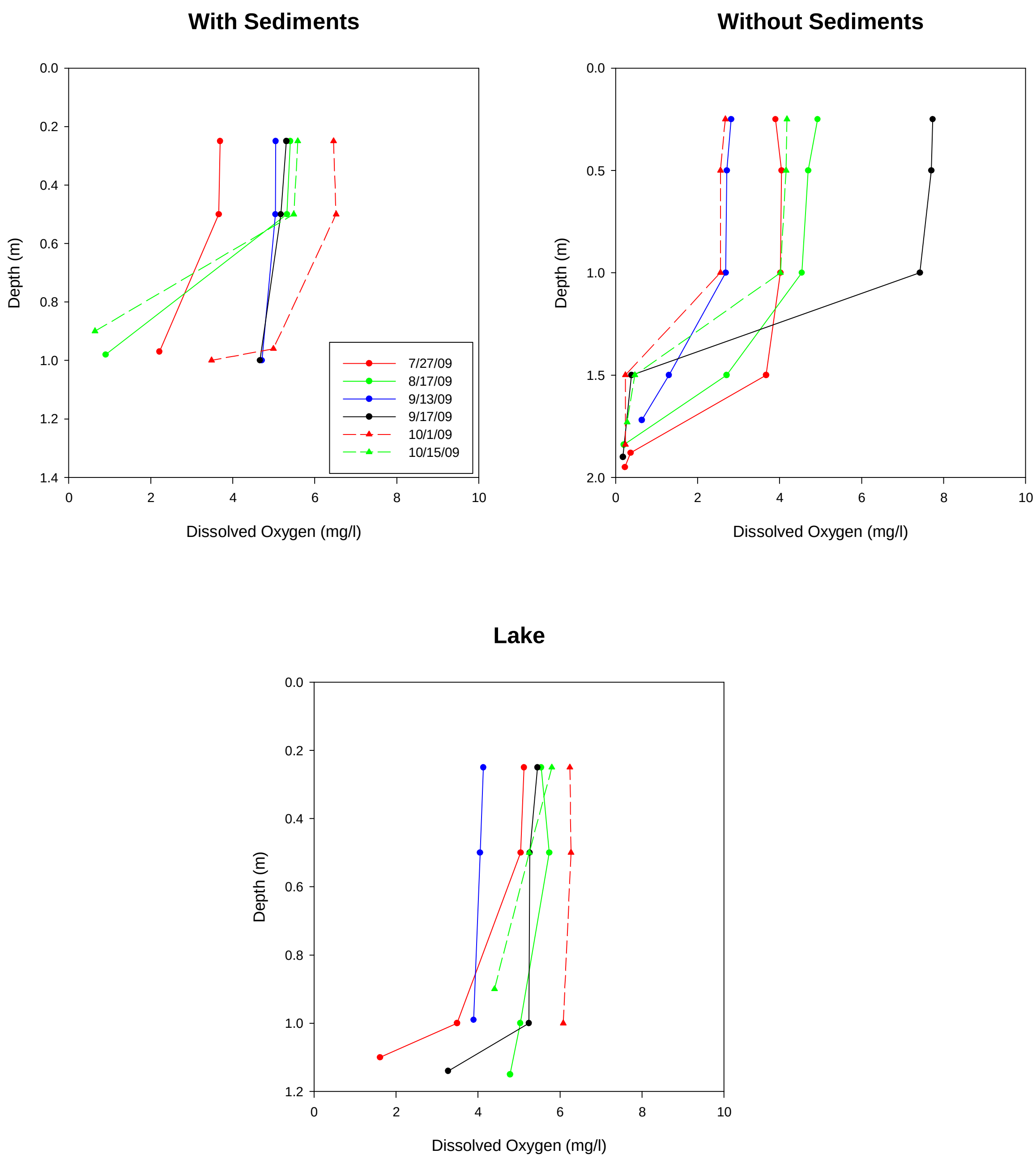


Figure 7-16. Vertical Field Profiles of Dissolved Oxygen Measured in Lake May Isolation Chambers During Wet Season Conditions (July-October 2009).

7.2.3.1.2 Lake Shipp

A graphical summary of vertical temperature profiles measured in Lake Shipp during the dry season monitoring program (December 2008-April 2009) is given in Figure 7-17. In general, temperature measurements within the isolation chambers and open lake were relatively uniform within the water column during a majority of the monitoring dates. A slight trend of decreasing temperature was observed in lower portions of the water column during a few of the monitoring dates.

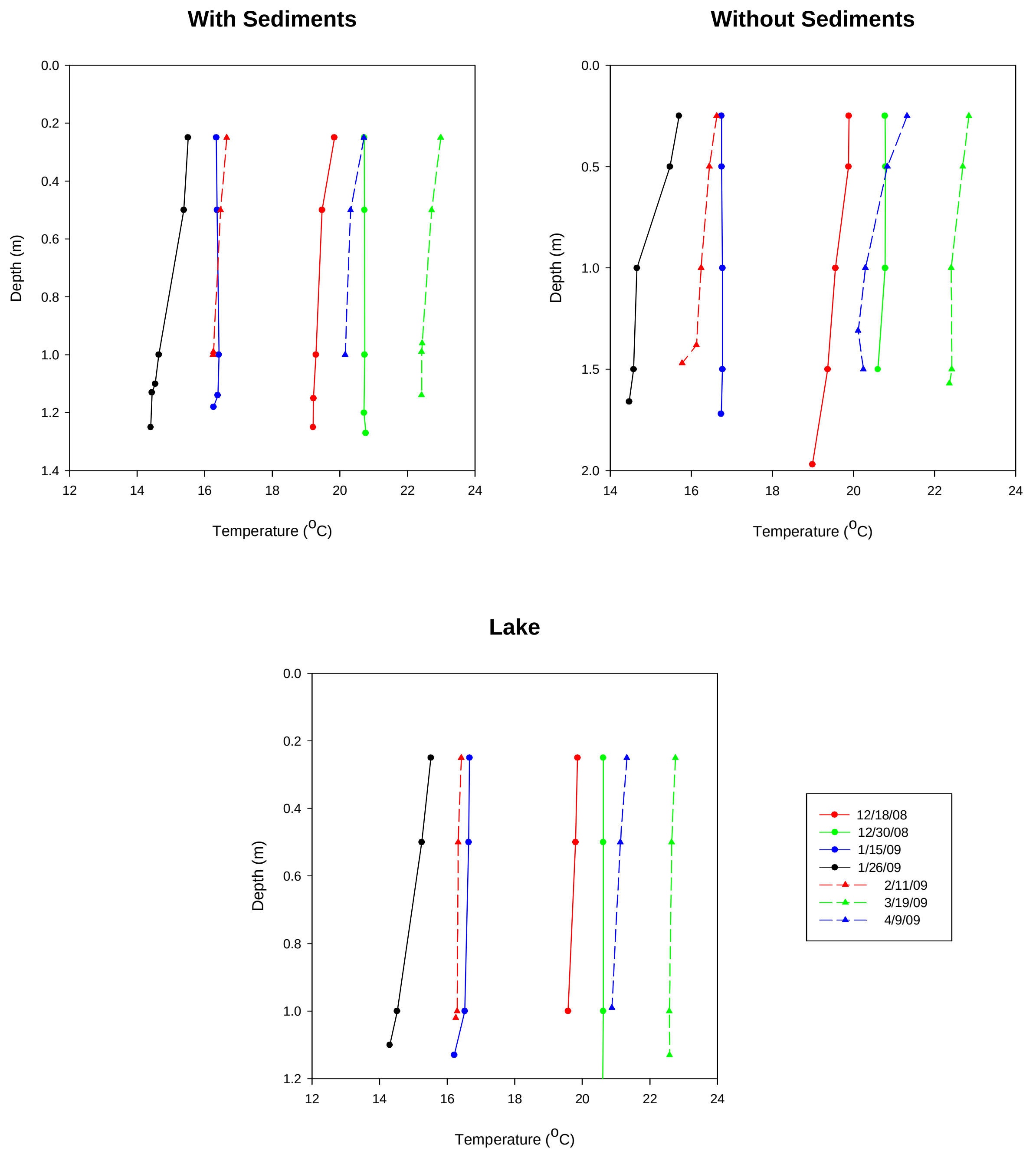


Figure 7-17. Vertical Field Profiles of Temperature Measured in Lake Shipp Isolation Chambers During Dry Season Conditions (December 2008-April 2009).

A graphical summary of vertical profiles of pH measurements in Lake Shipp isolation chambers during dry season conditions (December 2008-April 2009) is given in Figure 7-18. Under dry season conditions, measured pH values within the isolation chambers ranged from approximately 7.5-9.5, with open lake measurements ranging from approximately 8-9.5. Relatively uniform pH values were observed in upper portions of the water column in the isolation chambers as well as the open lake, with a tendency for lower pH values in deeper portions of the water column.

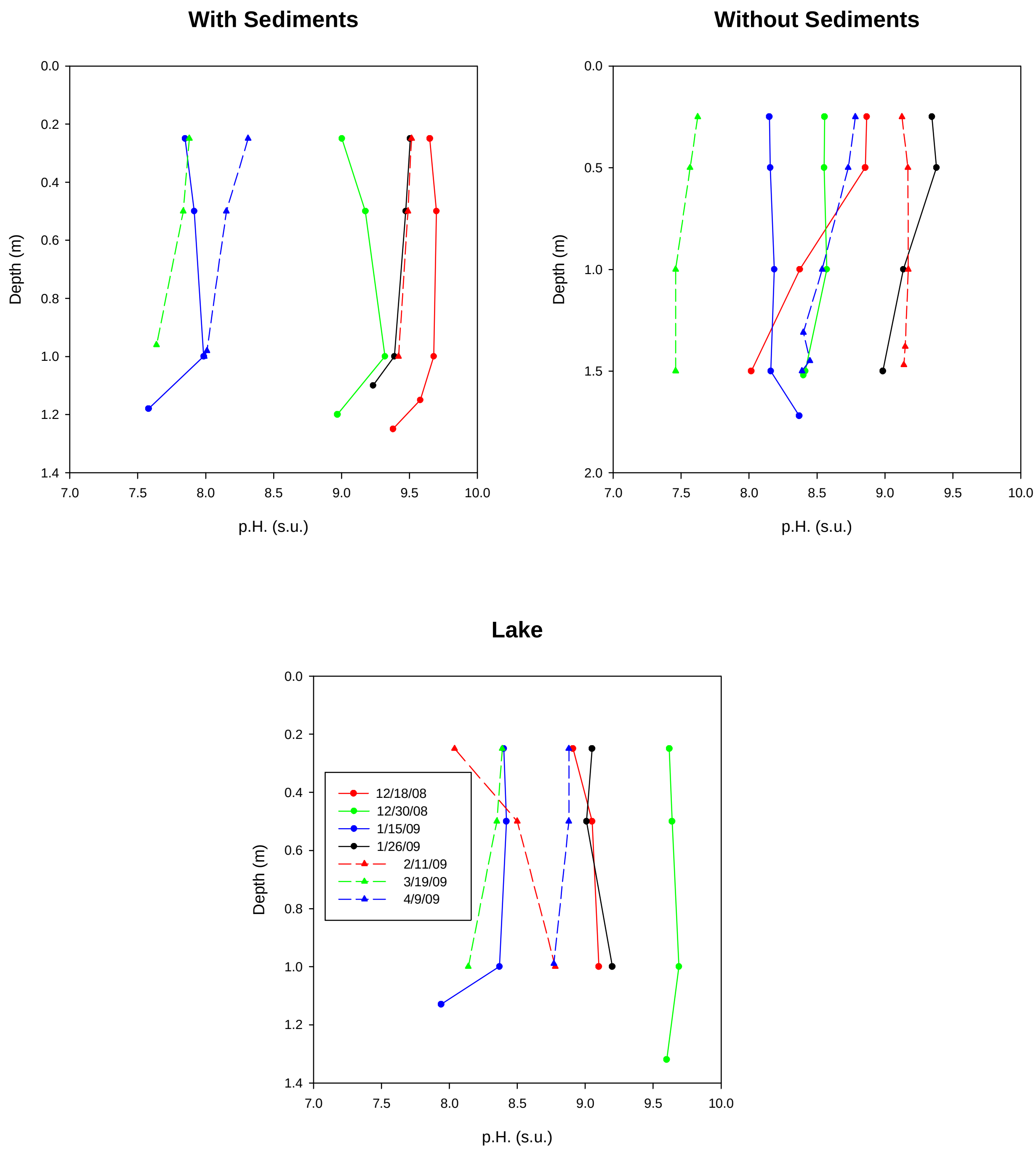


Figure 7-18. Vertical Field Profiles of pH Measured in Lake Shipp Isolation Chambers During Dry Season Conditions (December 2008-April 2009).

A graphical comparison of measured conductivity values in Lake Shipp isolation chambers during dry season conditions (December 2008-April 2009) is given in Figure 7-19. Relatively isograde conductivity values were observed throughout the water column in both the isolation chambers as well as the open lake. No significant trend of increasing specific conductivity was observed near the water-sediment interface at any of the monitoring sites.

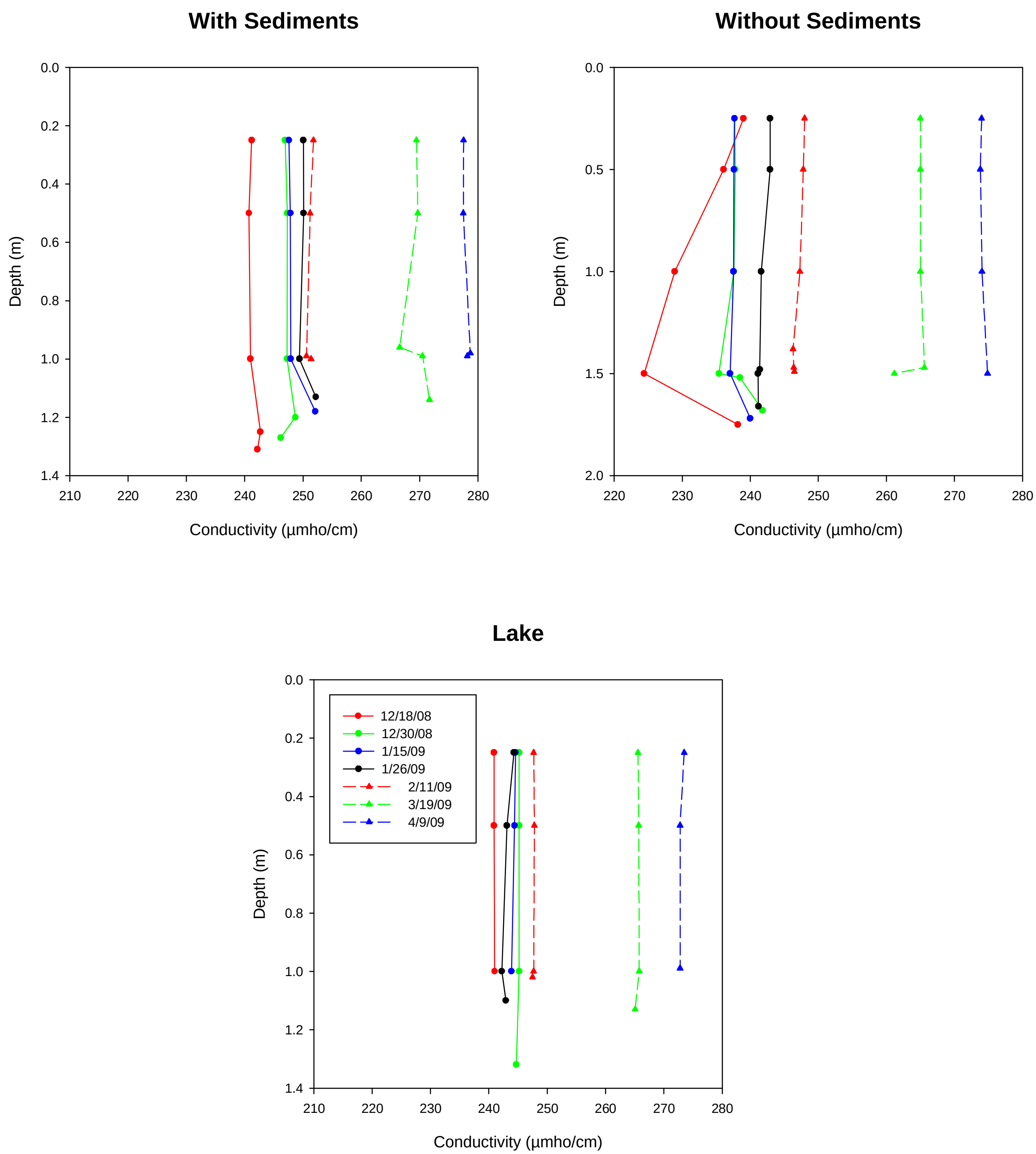


Figure 7-19. Vertical Field Profiles of Conductivity Measured in Lake Shipp Isolation Chambers During Dry Season Conditions (December 2008-April 2009).

A graphical comparison of vertical dissolved oxygen profiles measured in Lake Shipp during dry season conditions (December 2008-April 2009) is given on Figure 7-20. Dissolved oxygen profiles appear to be relatively similar between the isolation chambers and the open lake. Dissolved oxygen concentrations in the isolation chambers ranged from approximately 6-10 mg/l, with concentrations in the open lake ranging from approximately 7-12 mg/l. A general trend of decreasing dissolved oxygen was observed near the water-sediment interface in both the isolation chambers and open lake.

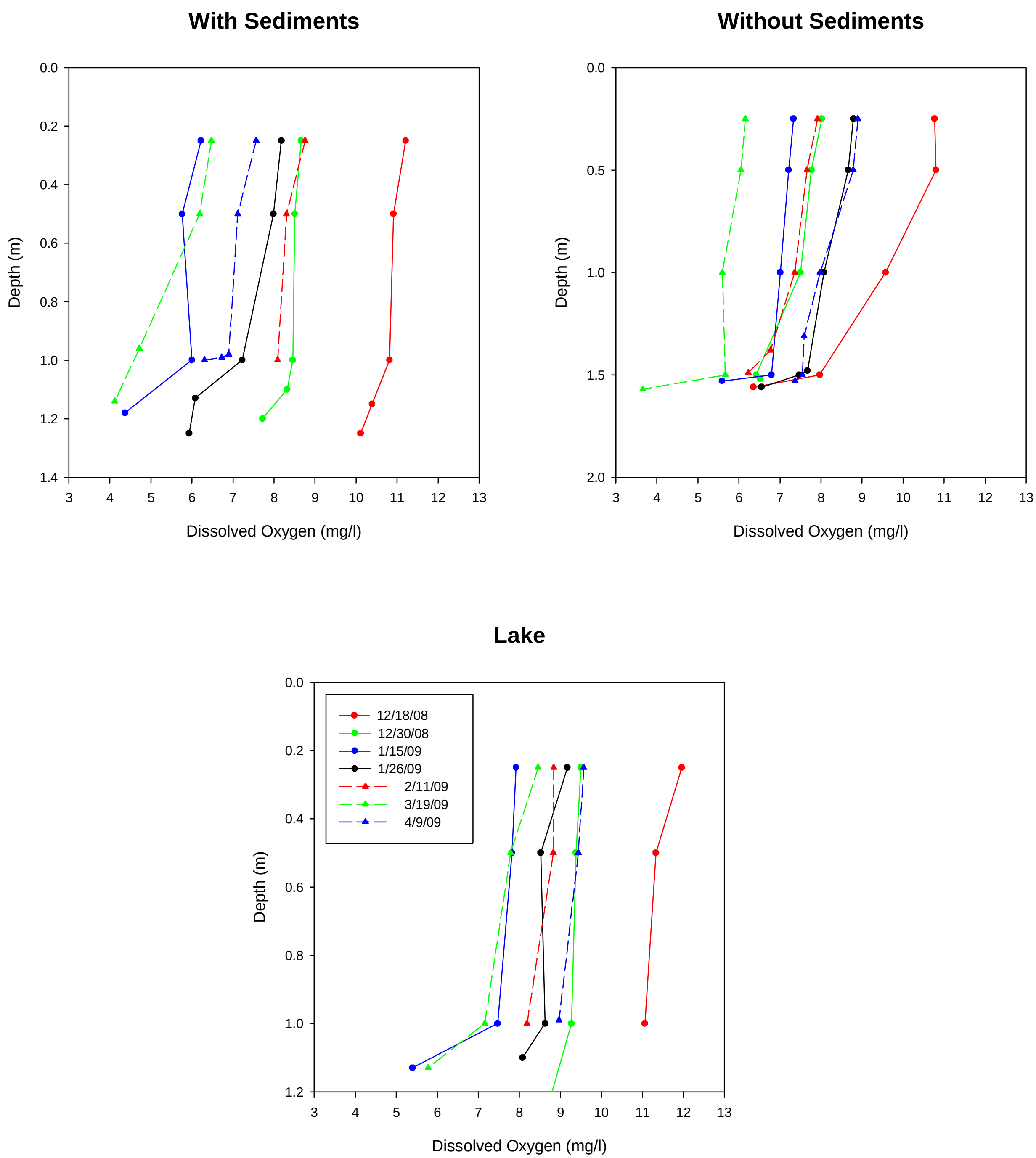


Figure 7-20. Vertical Field Profiles of Dissolved Oxygen Measured in Lake Shipp Isolation Chambers During Dry Season Conditions (December 2008-April 2009).

Vertical field profiles of temperature measurements conducted in Lake Shipp isolation chambers during wet season conditions (July-October 2009) are given on Figure 7-21. A general trend of decreasing temperature with increasing water depth was observed in both the isolation chambers and open lake.

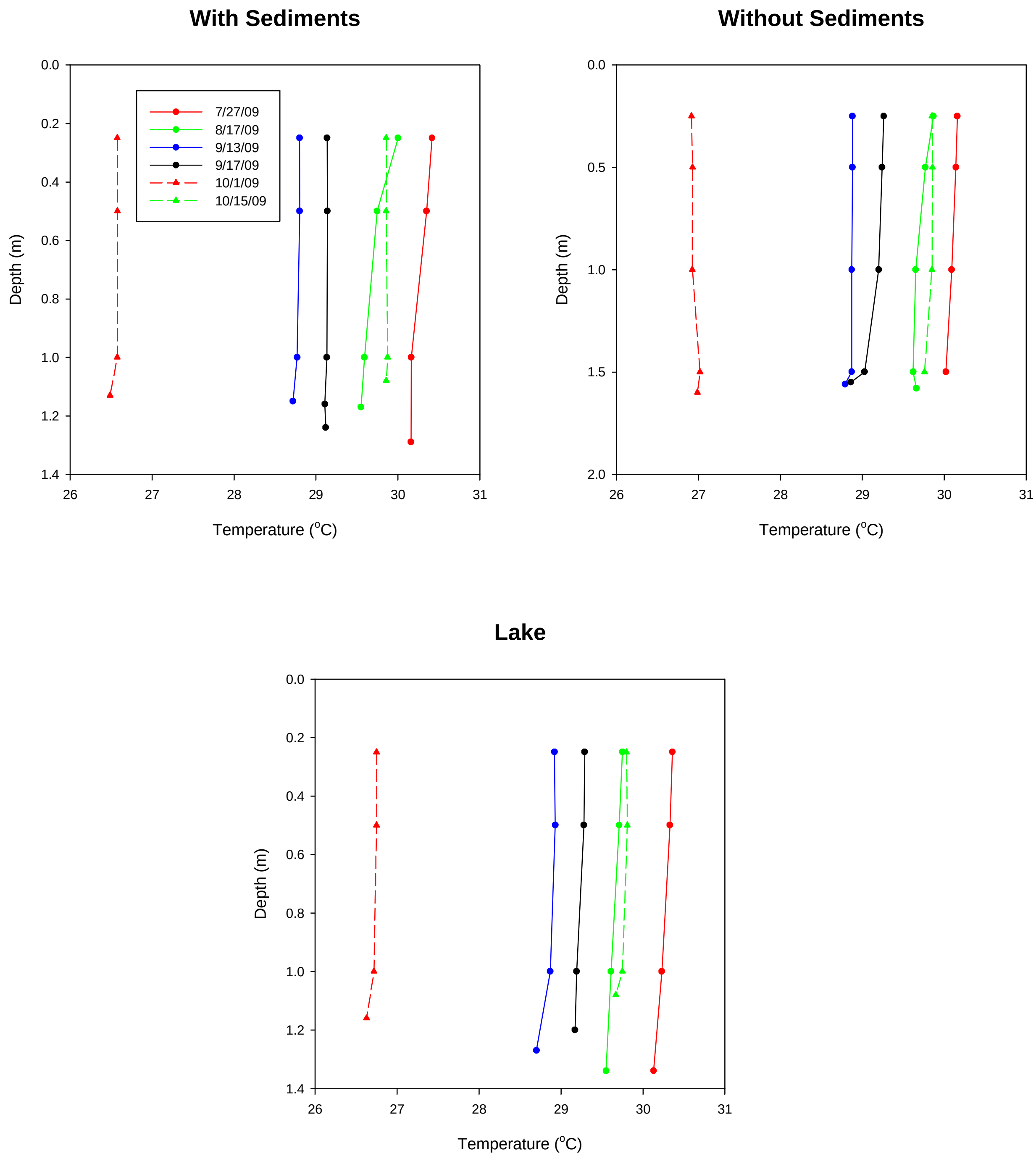


Figure 7-21. Vertical Field Profiles of Temperature Measured in Lake Shipp Isolation Chambers During Wet Season Conditions (July-October 2009).

A graphical comparison of vertical profiles of pH measured in the Lake Shipp isolation chambers during wet season conditions (July-October 2009) is given on Figure 7-22. Relatively isograde pH values were observed in upper portions of the water column at all of the monitoring sites, with a general trend of decreasing pH in lower portions of the water column. Surface pH values in the isolation chambers range from approximately 7-8.5, with in-lake surface pH values ranging from approximately 8-8.5.

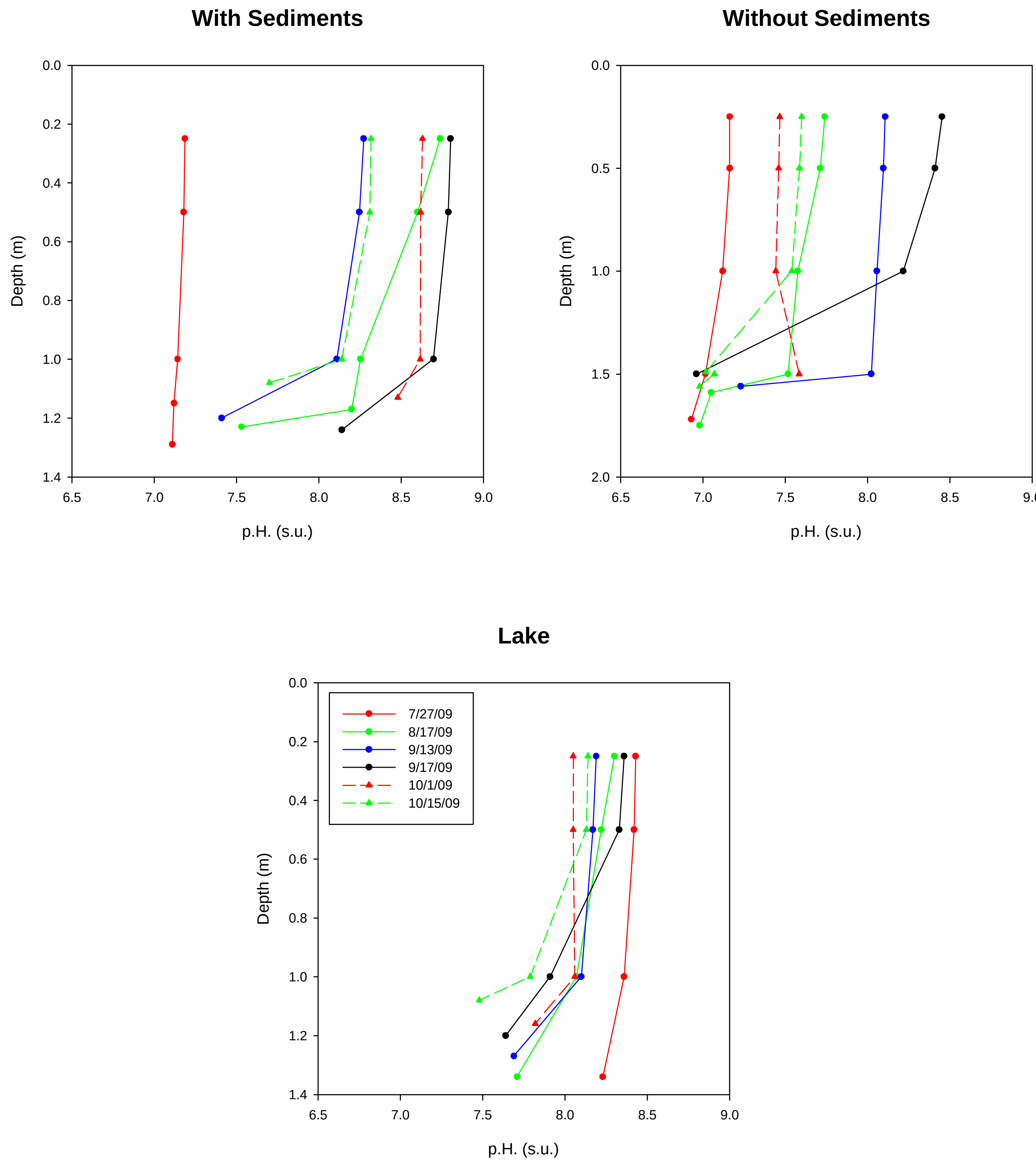


Figure 7-22. Vertical Field Profiles of pH Measured in Lake Shipp Isolation Chambers During Wet Season Conditions (July-October 2009).

A graphical comparison of measured conductivity values in Lake Shipp isolation chambers during wet season conditions (July-October 2009) is given on Figure 7-23. In general, conductivity measurements appear to be relatively uniform throughout the water column in both the isolation chambers and within the open lake. A slight trend of increasing conductivity was observed within the isolation chambers near the water-sediment interface, although this was not observed within the open lake.

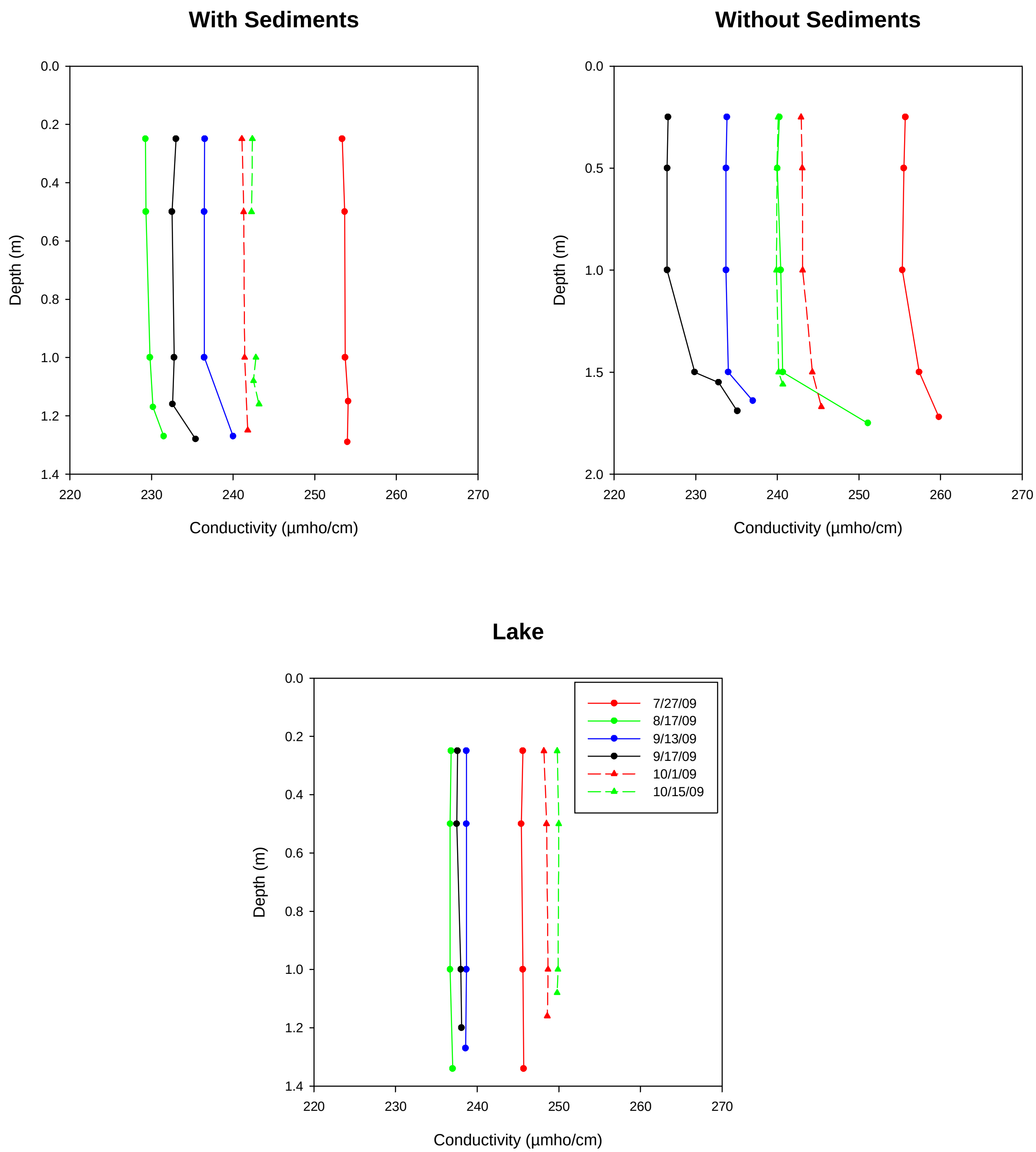


Figure 7-23. Vertical Field Profiles of Conductivity Measured in Lake Shipp Isolation Chambers During Wet Season Conditions (July-October 2009).

A graphical comparison of field measured dissolved oxygen concentrations in isolation chambers in Lake Shipp under wet season conditions (July-October 2009) is given on Figure 7-24. Surface dissolved oxygen concentrations within the isolation chambers ranged from approximately 2-7 mg/l, with values ranging from 5-7 mg/l within the open lake. A slight trend of decreasing dissolved oxygen with increasing water depth was observed in both the isolation chambers and open lake. Anoxic conditions were observed near the water-sediment interface on one occasion in the chambers with sediment contact, and on two separate occasions in the chambers without sediment contact. This phenomenon was not observed within the open lake.

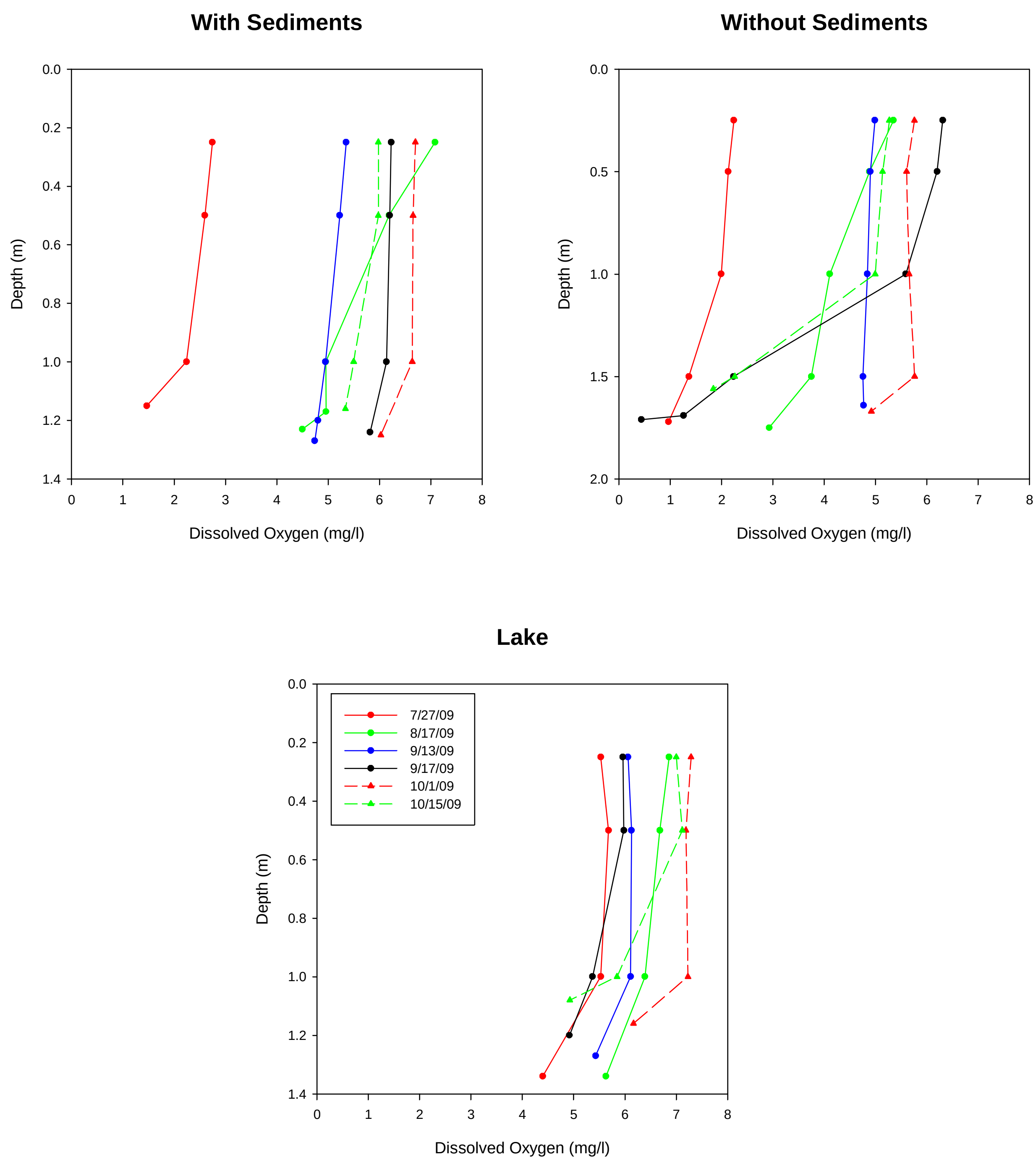


Figure 7-24. Vertical Field Profiles of Dissolved Oxygen Measured in Lake Shipp Isolation Chambers During Wet Season Conditions (July-October 2009).

7.2.3.2 Water Quality Characteristics

A complete listing of laboratory analyses conducted on water samples collected from the isolation chambers and open lake during the original dry season and supplemental wet season monitoring programs is given in Appendix J.2. A discussion of the results of these monitoring efforts is given in the following sections.

7.2.3.2.1 Lake May

A summary of mean characteristics of surface water samples collected in Lake May isolation chambers during wet and dry season conditions is given in Table 7-2. Under dry season conditions, nutrient concentrations measured within the open lake and in the chambers with sediment contact appear to be relatively similar. However, a slightly lower total nitrogen concentration and a substantially lower total phosphorus concentration were observed in chambers without sediment contact than in chambers with sediment contact. Substantially lower values for TSS and chlorophyll-a were also observed within the chambers without sediment contact. A similar trend was also observed during wet season conditions, with lower concentrations of total nitrogen, total phosphorus, chlorophyll-a, TSS, TSI, and turbidity in isolation chambers without sediment contact compared with chambers with sediment contact.

A summary of an analysis of variance (ANOVA) comparison of water quality characteristics in isolation chambers conducted in Lake May with and without sediments under dry season conditions is given in Table 7-3 for each of the measured parameters listed in Table 7-2. ANOVA comparisons were conducted using the GLM procedure of SAS. The data sets were evaluated for normality and equality of variances prior to testing. The calculated model significance level is provided, with values of 0.05 or less indicating statistically significant differences at the 0.05 level of significance or better, and values in excess of 0.05 indicating a lack of statistical significance. Mean values are provided for chambers with and without sediment contact. The results of a Tukey grouping analysis are also provided which identify statistically similar treatment types. Mean concentrations for each parameter are listed from highest to lowest for each treatment type.

Isolation chambers with sediment contact were found to have a significantly higher alkalinity value than observed in chambers without sediment contact. However, no statistically significant differences were observed for total nitrogen concentrations within the isolation chambers. In contrast, isolation chambers without sediment contact were found to have significantly lower mean concentrations for particulate nitrogen, particulate phosphorus, and total phosphorus than observed in chambers with sediment contact. Isolation chambers without sediment contact also exhibited significantly lower levels of TSS, chlorophyll-a, and TSI than chambers with sediment contact. The data suggest that under dry season conditions, the existing sediments in Lake May have statistically significant impacts on water column concentrations of particulate nitrogen, particulate phosphorus, total phosphorus, TSS, chlorophyll-a, and TSI. The mean TSI value of 61.3 observed under dry season conditions in the chambers with sediment contact reflects eutrophic conditions, while the mean TSI value of 49.5 observed in the chambers without sediments reflects borderline eutrophic/mesotrophic conditions.

TABLE 7-2

MEAN CHARACTERISTICS OF SURFACE WATER SAMPLES COLLECTED IN LAKE MAY ISOLATION CHAMBERS DURING DRY AND WET SEASON CONDITIONS

PARAMETER		UNITS	DRY SEASON			WET SEASON		
			Lake	With	Without	Lake	With	Without
pH		s.u.	8.42 (0.72)[1]	8.60 (0.95)	8.59 (1.08)	7.29 (0.16)	7.70 (0.72)	7.06 (0.63)
Conductivity		µmho/cm	249 (10)	258 (16)	247 (11)	252 (11)	239 (16)	269 (35)
Diss. Oxygen		mg/l	7.7 (1.9)	6.5 (2.7)	6.7 (2.4)	4.8 (0.1)	4.3 (1.9)	6.1 (2.0)
Secchi Depth		m	0.38 (0.02)	0.69 (0.10)	1.09 (0.19)	0.28 (0.03)	0.29 (0.07)	0.36 (0.07)
Alkalinity		mg/l	61.1 (4.0)	66.5 (5.8)	60.1 (6.1)	62.8 (2.6)	57.2 (5.2)	73.3 (11.0)
NH_3		µg/l	31 (18)	165 (130)	156 (204)	129 (116)	217 (241)	68 (30)
NO_x		µg/l	< 5 (<5)	13 (21)	63 (110)	< 5 (0)	< 5 (<5)	< 5 (0)
Diss. Org. N		µg/l	614 (281)	643 (225)	589 (116)	573 (387)	752 (362)	773 (298)
Particulate N		µg/l	833 (568)	673 (291)	484 (299)	769 (396)	1435 (461)	1252 (798)
Total N		µg/l	1519 (466)	1495 (422)	1292 (314)	1473 (107)	2407 (247)	2096 (715)
SRP		µg/l	<1 (<1)	3 (6)	2 (2)	1 (1)	1 (<1)	2 (2)
Diss. Org. P		µg/l	9 (7)	7 (7)	6 (7)	8 (4)	8 (3)	4 (2)
Particulate P		µg/l	53 (21)	48 (20)	25 (14)	25 (12)	46 (27)	33 (14)
Total P		µg/l	63 (23)	58 (21)	33 (14)	34 (10)	55 (27)	39 (14)
TSS		mg/l	23.2 (3.4)	13.3 (3.4)	8.0 (6.4)	14.4 (1.0)	23.6 (11.4)	12.8 (5.5)
Chyl-a		mg/m^3	36.0 (18.6)	24.9 (11.9)	15.7 (15.6)	51.5 (17.6)	82.7 (38.3)	60.6 (27.8)
Turb.		NTU	12.6 (2.7)	8.1 (3.0)	5.7 (4.2)	12.3 (2.2)	14.0 (4.9)	11.9 (4.1)
TSI	Chyl-a	--	66.6 (8.1)	61.3 (7.6)	49.5 (15.0)	72.8 (5.0)	78.3 (8.9)	74.1 (8.0)
	Avg.[2]	--	69.9 (3.4)	65.9 (5.3)	52.9 (11.7)	65.3 (6.8)	72.7 (10.7)	67.3 (8.5)

1. Numbers in parentheses indicate standard deviation
2. Calculated using chlorophyll-a and nutrients

TABLE 7-3

ANOVA COMPARISON OF WATER QUALITY CHARACTERISTICS IN ISOLATION CHAMBER EXPERIMENTS CONDUCTED IN LAKE MAY WITH AND WITHOUT EXISTING SEDIMENTS DURING DRY SEASON CONDITIONS (DECEMBER 2008-APRIL 2009)

PARAMETER	UNITS	MODEL SIGNIFICANCE LEVEL	TREATMENT TYPE	MEAN CONCENTRATION	TUKEY GROUPING
Alkalinity	mg/l	0.0005	With Without	66.5 60.1	A B
Ammonia	µg/l	0.8427	With Without	165 156	A A
NO_x	µg/l	0.0344	Without With	63 13	A B
Diss. Organic N	µg/l	0.2976	With Without	643 589	A A
Particulate N	µg/l	0.0316	With Without	673 484	A B
Total N	µg/l	0.0646	With Without	1495 1292	A A
SRP	µg/l	0.6261	With Without	2.5 1.9	A A
Diss. Organic P	µg/l	0.4837	With Without	7 6	A A
Particulate P	µg/l	0.0001	With Without	48 25	A B
Total P	µg/l	0.0001	With Without	58 33	A B
TSS	mg/l	0.0008	With Without	13.3 8.0	A B
Chlorophyll-a	mg/m^3	0.0258	With Without	24.9 15.7	A B
Turbidity	NTU	0.0001	With Without	8.1 5.7	A B
TSI[1]	--	0.0032	Without With	49.5 61.3	A B

1. Calculated using chlorophyll-a only

An ANOVA comparison of water quality characteristics in isolation chamber experiments conducted in Lake May with and without sediments under wet season conditions is given in Table 7-4. Similar to the trends observed under dry season conditions, no statistically significant differences were observed for total nitrogen between isolation chambers with and without sediment contact. However, isolation chambers without sediment contact were found to have significantly lower levels of dissolved organic phosphorus, total phosphorus, TSS, chlorophyll-a, and TSI than observed in chambers with existing sediments. However, although statistically significant under wet season conditions, the difference in TSI value between chambers with and without sediments is not as great as observed under dry season conditions, suggesting that sediment impacts may be more significant under dry season conditions when internal recycling is a more dominant component of the nutrient budget.

TABLE 7-4

ANOVA COMPARISON OF WATER QUALITY CHARACTERISTICS IN ISOLATION CHAMBER EXPERIMENTS CONDUCTED IN LAKE MAY WITH AND WITHOUT EXISTING SEDIMENTS DURING WET SEASON CONDITIONS (JULY-OCTOBER 2009)

PARAMETER	UNITS	MODEL SIGNIFICANCE LEVEL	TREATMENT TYPE	MEAN CONCENTRATION	TUKEY GROUPING	
Alkalinity	mg/l	0.0001	Without	73.3	A	
			With	57.2		B
Ammonia	µg/l	0.0140	With	217	A	
			Without	68		B
NO_x	µg/l	0.2065	With	< 5	A	
			Without	< 5	A	
Diss. Organic N	µg/l	0.8465	Without	773	A	
			With	752	A	
Particulate N	µg/l	0.4035	With	1435	A	
			Without	1252	A	
Total N	µg/l	0.0901	With	2407	A	
			Without	2096	A	
SRP	µg/l	0.0549	Without	2.1	A	
			With	1.0	A	
Diss. Organic P	µg/l	0.0001	With	8	A	
			Without	4	A	
Particulate P	µg/l	0.0693	With	46	A	
			Without	33	A	
Total P	µg/l	0.0309	With	55	A	
			Without	39		B
TSS	mg/l	0.0010	With	23.6	A	
			Without	12.8		B
Chlorophyll-a	mg/m^3	0.0458	With	82.7	A	
			Without	60.6		B
Turbidity	NTU	0.1761	With	14.0	A	
			Without	11.9	A	
TSI[1]	--	0.0496	Without	74.1	A	
			With	78.3		B

1. Calculated using chlorophyll-a only

The analyses summarized in Tables 7-3 and 7-4 indicate that the existing sediments in Lake May are exerting significant impacts on water column concentrations of total phosphorus, TSS, chlorophyll-a, and TSI under both dry and wet season conditions. The isolation chamber experiments suggest that removal of the existing sediments will result in lower equilibrium concentrations for these parameters than occur under existing conditions within the lake. However, improvements in water quality resulting from sediment removal may be more pronounced during dry season conditions.

7.2.3.2.2 Lake Shipp

A summary of mean characteristics of surface water samples collected in Lake Shipp isolation chambers during dry and wet season conditions is given in Table 7-5. During dry season conditions, water column concentrations of total nitrogen and total phosphorus appear to be relatively similar in the isolation chambers incubated with and without sediment contact. However, during wet season conditions, isolation chambers with sediment contact are characterized by lower mean concentrations for particulate nitrogen, total nitrogen, particulate phosphorus, total phosphorus, TSS, chlorophyll-a, and turbidity.

An ANOVA comparison of water quality characteristics in isolation chamber experiments conducted in Lake Shipp during dry season conditions is given in Table 7-6. Under dry season conditions, isolation chambers with sediment contact were found to have significantly higher concentrations for alkalinity and dissolved organic nitrogen, but no statistically significant differences were observed for total nitrogen in chambers with and without sediment contact. No statistically significant differences were observed for any phosphorus species or turbidity in chambers with and without sediment contact. However, isolation chambers without sediment contact were found to have significantly lower levels of chlorophyll-a and TSI during dry season conditions. Although statistically significant differences were observed in TSI with and without sediment contact, eutrophic conditions were still observed in both chambers.

An ANOVA comparison of water quality characteristics in isolation chamber experiments conducted in Lake Shipp during wet season conditions is given in Table 7-7. Under wet season conditions, isolation chambers with sediment contact were found to have significantly higher levels of both particulate nitrogen and total nitrogen compared with chambers without sediment contact. Isolation chambers with sediment contact were also found to have significantly higher levels for dissolved organic phosphorus, particulate phosphorus, total phosphorus, TSS, chlorophyll-a, and TSI than observed in isolation chambers without sediment contact. In contrast to the trend observed in Lake May, the data appear to suggest that sediment impacts in Lake Shipp are limited primarily to warm water wet season conditions with no statistically significant impacts observed during cool water dry season conditions. Chambers with sediment contact were characterized by a TSI of 72.9, reflecting hypereutrophic conditions, while the chambers without sediment contact exhibited eutrophic conditions.

7.2.3.3 Summary

The isolation chamber experiments discussed in the previous sections indicate that the existing sediments appear to have statistically significant impacts on water quality characteristics in both Lake May and Lake Shipp. In Lake May, the impacts appear to occur year-round, with statistically significant increases in phosphorus concentrations observed during both dry season and wet season conditions. In Lake Shipp, the impacts appear to be primarily limited to wet season conditions when warm water conditions occur within the lake.

TABLE 7-5

MEAN CHARACTERISTICS OF SURFACE WATER SAMPLES COLLECTED IN LAKE SHIPP ISOLATION CHAMBERS DURING DRY AND WET SEASON CONDITIONS

PARAMETER		UNITS	DRY SEASON			WET SEASON		
			Lake	With	Without	Lake	With	Without
pH		s.u.	8.80 (0.52)[1]	8.84 (0.83)	8.53 (0.62)	8.07 (0.26)	8.23 (0.63)	7.58 (0.68)
Conductivity		μmho/cm	251 (11)	254 (12)	247 (15)	243 (5)	239 (8)	240 (10)
Diss. Oxygen		mg/l	8.7 (1.4)	7.8 (1.8)	7.7 (1.6)	6.1 (0.8)	5.3 (1.5)	6.8 (1.7)
Secchi Depth		m	0.33 (0.08)	0.47 (0.10)	0.52 (0.13)	0.36 (0.40)	0.32 (0.14)	0.46 (0.17)
Alkalinity		mg/l	66.5 (3.2)	67.1 (3.1)	63.6 (6.0)	60.5 (3.0)	58.5 (3.1)	56.3 (5.2)
NH_3		μg/l	32 (21)	106 (116)	82 (67)	77 (78)	166 (128)	200 (165)
NO_x		μg/l	22 (50)	10 (11)	7 (9)	< 5 (0)	8 (13)	15 (26)
Diss. Org. N		μg/l	514 (100)	576 (124)	505 (72)	715 (130)	545 (308)	563 (281)
Particulate N		μg/l	1112 (197)	819 (158)	847 (199)	750 (249)	1578 (449)	1013 (432)
Total N		μg/l	1680 (214)	1511 (189)	1441 (245)	1544 (122)	2298 (428)	1792 (310)
SRP		μg/l	1 (1)	<1 (<1)	<1 (<1)	1 (<1)	1 (<1)	1 (<1)
Diss. Org. P		μg/l	11 (13)	7 (6)	5 (6)	12 (4)	3 (2)	6 (5)
Particulate P		μg/l	32 (15)	43 (25)	44 (23)	8 (3)	42 (19)	23 (9)
Total P		μg/l	44 (12)	50 (23)	50 (22)	21 (5)	46 (19)	30 (9)
TSS		mg/l	19.8 (3.4)	16.0 (3.1)	14.3 (5.1)	11.0 (3.5)	19.3 (8.8)	8.3 (4.1)
Chyl-a		mg/m^3	40.8 (22.3)	34.1 (15.7)	24.3 (12.1)	26.4 (13.2)	63.8 (38.2)	36.6 (22.3)
Turb.		NTU	11.0 (3.2)	8.1 (2.3)	8.7 (2.8)	10.2 (2.4)	13.9 (6.0)	10.6 (5.0)
TSI	Chyl-a	--	68.0 (8.8)	66.0 (7.1)	61.2 (6.7)	60.4 (14.1)	72.9 (12.1)	65.6 (10.3)
	Avg.[2]	--	66.3 (4.4)	66.5 (5.9)	63.8 (5.1)	53.9 (6.5)	68.9 (7.9)	60.3 (7.7)

1. Numbers in parentheses indicate standard deviation
2. Calculated using chlorophyll-a and nutrients

TABLE 7-6

ANOVA COMPARISON OF WATER QUALITY CHARACTERISTICS IN ISOLATION CHAMBER EXPERIMENTS CONDUCTED IN LAKE SHIPP WITH AND WITHOUT EXISTING SEDIMENTS DURING DRY SEASON CONDITIONS (DECEMBER 2008-APRIL 2009)

PARAMETER	UNITS	MODEL SIGNIFICANCE LEVEL	TREATMENT TYPE	MEAN CONCENTRATION	TUKEY GROUPING	
Alkalinity	mg/l	0.0138	With	67.1	A	
			Without	63.6		B
Ammonia	µg/l	0.3884	With	106	A	
			Without	82	A	
NO_x	µg/l	0.3650	With	10	A	
			Without	7	A	
Diss. Organic N	µg/l	0.0184	With	576	A	
			Without	505		B
Particulate N	µg/l	0.5874	Without	847	A	
			With	819	A	
Total N	µg/l	0.2771	With	1511	A	
			Without	1441	A	
SRP	µg/l	0.6329	Without	0.7	A	
			With	0.7	A	
Diss. Organic P	µg/l	0.3487	With	7	A	
			Without	5	A	
Particulate P	µg/l	0.8765	Without	44	A	
			With	43	A	
Total P	µg/l	0.9441	With	50	A	
			Without	50	A	
TSS	mg/l	0.1591	With	16.0	A	
			Without	14.2	A	
Chlorophyll-a	mg/m^3	0.0204	With	34.1	A	
			Without	24.3		B
Turbidity	NTU	0.4070	Without	8.7	A	
			With	8.1	A	
TSI[1]	--	0.0416	With	66.0	A	
			Without	61.2		B

1. Calculated using chlorophyll-a only

TABLE 7-7

ANOVA COMPARISON OF WATER QUALITY CHARACTERISTICS IN ISOLATION CHAMBER EXPERIMENTS CONDUCTED IN LAKE SHIPP WITH AND WITHOUT EXISTING SEDIMENTS DURING WET SEASON CONDITIONS (JULY-OCTOBER 2009)

PARAMETER	UNITS	MODEL SIGNIFICANCE LEVEL	TREATMENT TYPE	MEAN CONCENTRATION	TUKEY GROUPING
Alkalinity	mg/l	0.1409	With Without	58.5 56.3	A A
Ammonia	μg/l	0.5045	Without With	200 166	A A
NO_x	μg/l	0.2702	Without With	15 8	A A
Diss. Organic N	μg/l	0.8565	With Without	563 545	A A
Particulate N	μg/l	0.0005	With Without	1578 1013	A B
Total N	μg/l	0.0003	With Without	2298 1791	A B
SRP	μg/l	0.1071	With Without	1.1 0.7	A A
Diss. Organic P	μg/l	0.0056	Without With	6 3	A B
Particulate P	μg/l	0.0005	With Without	42 23	A B
Total P	μg/l	0.0031	With Without	46 30	A B
TSS	mg/l	0.0001	With Without	19.3 8.3	A B
Chlorophyll-a	mg/m^3	0.0133	With Without	63.8 36.6	A B
Turbidity	NTU	0.0834	With Without	13.9 10.6	A A
TSI[1]	--	0.0269	With Without	72.9 65.6	A B

1. Calculated using chlorophyll-a only

7.3 Sediment Management Options

Management of sediment phosphorus release from lake sediments can be achieved using both source removal and source reduction techniques. Source removal commonly involves dredging operations to remove the existing phosphorus rich sediments from the lake. Source reduction techniques include inactivation of phosphorus release using alum and water column aeration which is designed to reduce sediment phosphorus release by maintaining aerobic conditions at the water sediment interface. However, aeration as a phosphorus inactivation tool is most effective in deep water bodies which maintain a large anoxic hypolimnion for extended periods of time. Since Lakes May, Shipp, and Lulu are polymictic lakes which have no significant hypolimnion, it is unlikely that installation of aeration systems within the three lakes would have any measurable impact on sediment phosphorus release and, given the flocculent nature of the existing sediments, may actually increase sediment phosphorus release. As a result, aeration is not considered as a potential sediment management technique for Lakes May, Shipp, and Lulu. A discussion of the potential benefits of sediment removal and sediment inactivation is given in the following sections.

7.3.1 Sediment Removal

7.3.1.1 General Considerations

When properly conducted, sediment removal can be an effective technique to reduce nutrient release from lake sediments. The most appropriate sediment removal technique for Lakes May, Shipp, and Lulu appear to be hydraulic dredging using a suction cutter-head dredge. This technique has been previously used in Polk County for sediment removal in Banana Lake and Lake Hollingsworth. During the dredging process, an auger-type cutter-head is used to loosen the sediments and move them toward a suction devise located near the center of the cutter-head. The dredged slurry, containing as much as 30-40% solids, is then transported to a remote disposal area using a series of pumps and booster pumps.

One advantage of hydraulic dredging as a phosphorus reduction technique is the increase in water volume within the lake achieved following sediment removal. The hydraulic dredging process increase overall depth of the water column, reducing potential impacts of recreational activities and meteorological events on resuspension of bottom sediments. The increased lake volume also increases residence time within the lake which often increases overall phosphorus retention, with resulting water quality benefits. A summary of changes in lake volumes resulting from dredging in Lakes May, Shipp, and Lulu is given in Table 6-3. In this analysis, the existing lake volumes, obtained from Table 2-4, are increased by the estimated organic sediment volumes summarized in Table 6-1. If all of the existing organic muck sediments were to be removed from Lake May, the lake volume would increase by approximately by 96%. Sediment removal would result in a 24% increase in lake volume for Lake Shipp, and a 31% increase in lake volume for Lake Lulu.

One of the concerns associated with deepening the lakes through hydraulic dredging is that the deeper lakes will have an increased potential for development of thermal stratification, along with anoxic conditions in lower portions of the water column, which may increase the potential for phosphorus recycling within the lakes. However, the dredging process will remove the phosphorus-rich sediments which are responsible for the observed internal recycling under existing conditions. When these sediments are removed, the potential for internal recycling will be substantially reduced, even if anoxic conditions were to develop in lower regions of the lakes. Removal of the phosphorus-rich sediments will result in a reduction in available phosphorus loadings to the lake which will reduce algal productivity and increase water column clarity. As the water column clarity increases, solar radiation will penetrate into deeper portions of the lake, which will tend to inhibit development of anoxic conditions. As a result, the dredging process will remove a significant internal phosphorus source and increase light penetration within the lakes, both of which will tend to reduce development of anoxic conditions rather than increase the frequency of these conditions.

An unintended consequence of dredging the organic sediments is that the characteristics of groundwater inflow into the lake may be altered compared with existing conditions. Potential impacts on groundwater seepage from dredging activities were evaluated by ERD in Lake Maggiore in St. Petersburg as part of an evaluation on the projected water quality improvements from sediment removal in the lake. Seepage meters were installed within the lake in areas with existing sediments and in areas where the existing sediment accumulation had been removed. No statistically significant differences in seepage volume were observed between seepage in areas with and without the existing sediments. However, groundwater seepage in areas where sediments had been removed was found to contain statistically higher concentrations of total nitrogen compared with seepage collected from areas with existing sediments. It was hypothesized that migration through the existing sediments provided denitrification for nitrogen contained within the groundwater influx, and removal of the sediments eliminated this process, resulting in higher inflow nitrogen concentrations. Seepage concentrations of total phosphorus were unaffected by the sediment removal. If a similar process were to occur in Lakes May, Shipp, and Lulu, an increase in nitrogen loadings from groundwater seepage should have no significant impacts on algal productivity since each of the three lakes is primarily a phosphorus-limited system.

Estimated water depth contours in Lake May after removal of organic muck are indicated on Figure 7-25. Lake May would become a relatively deep lake, extending to depths of approximately 18-19 ft in central portions of the lake. Estimated water depth contours in Lake Shipp after removal of organic muck are indicated on Figure 7-26. After dredging, the water depth in Lake Shipp would be substantially increased, particularly in northern areas of the lake where water depths would range from approximately 18-27 ft. Estimated water depth contours in Lake Lulu after removal of organic muck are indicated on Figure 7-27. Lake Lulu would also become substantially deeper, particularly in northeastern areas of the lake where water depths would range from approximately 14-22 ft.

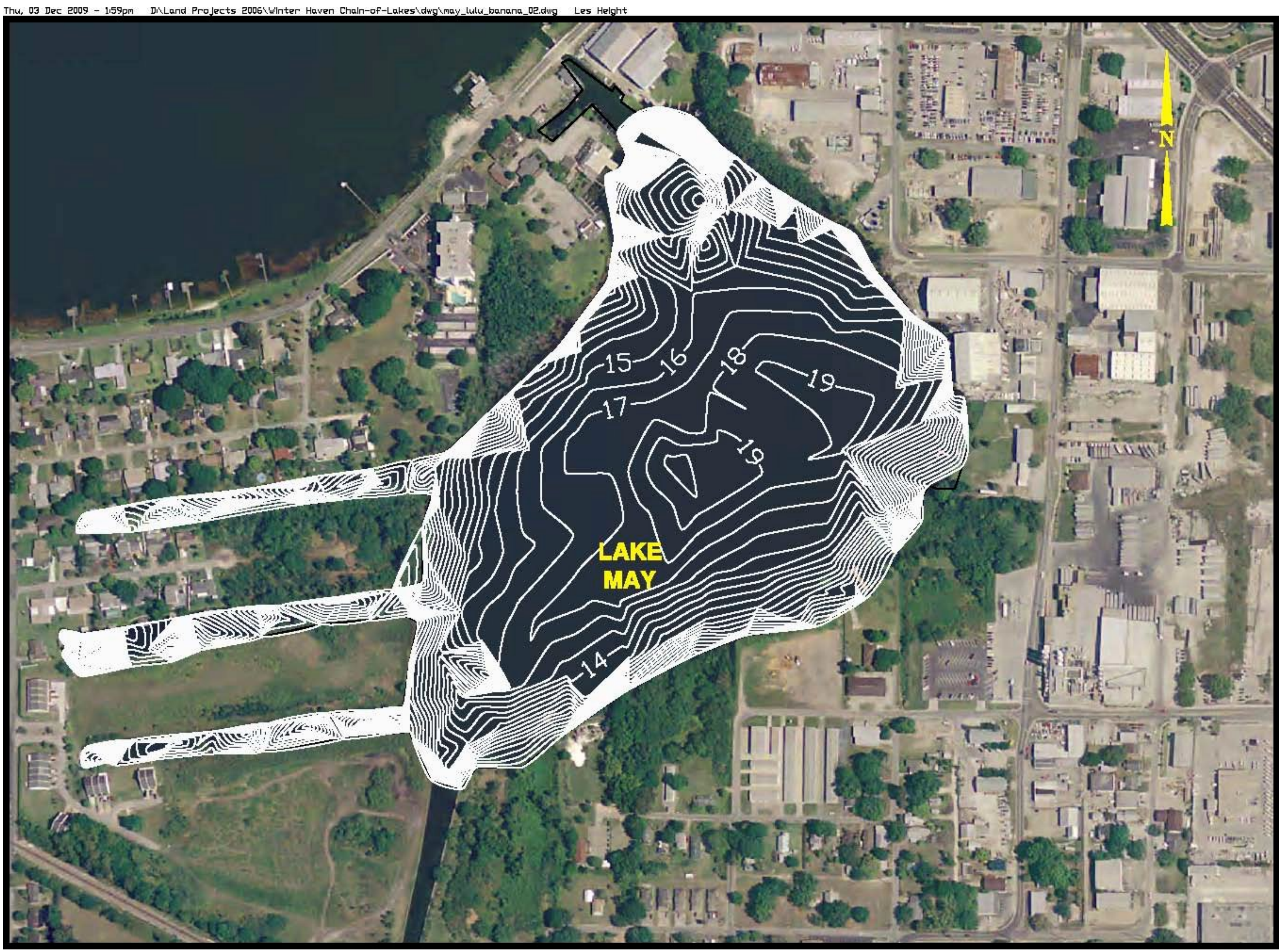


Figure 7-25. Estimated Water Depth Contours in Lake May After Removal of Organic Muck.

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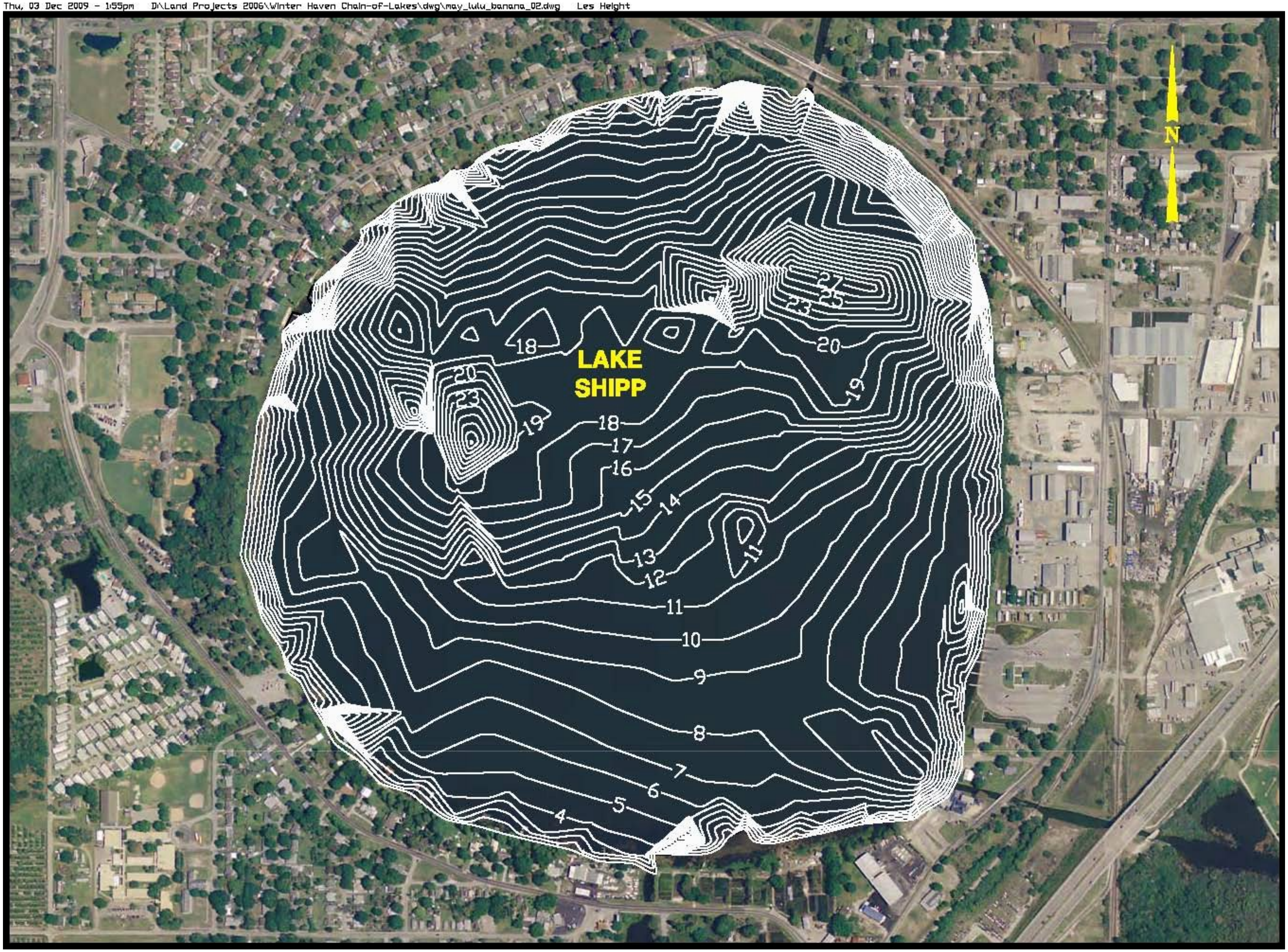

Figure 7-26. Estimated Water Depth Contours in Lake Shipp After Removal of Organic Muck.

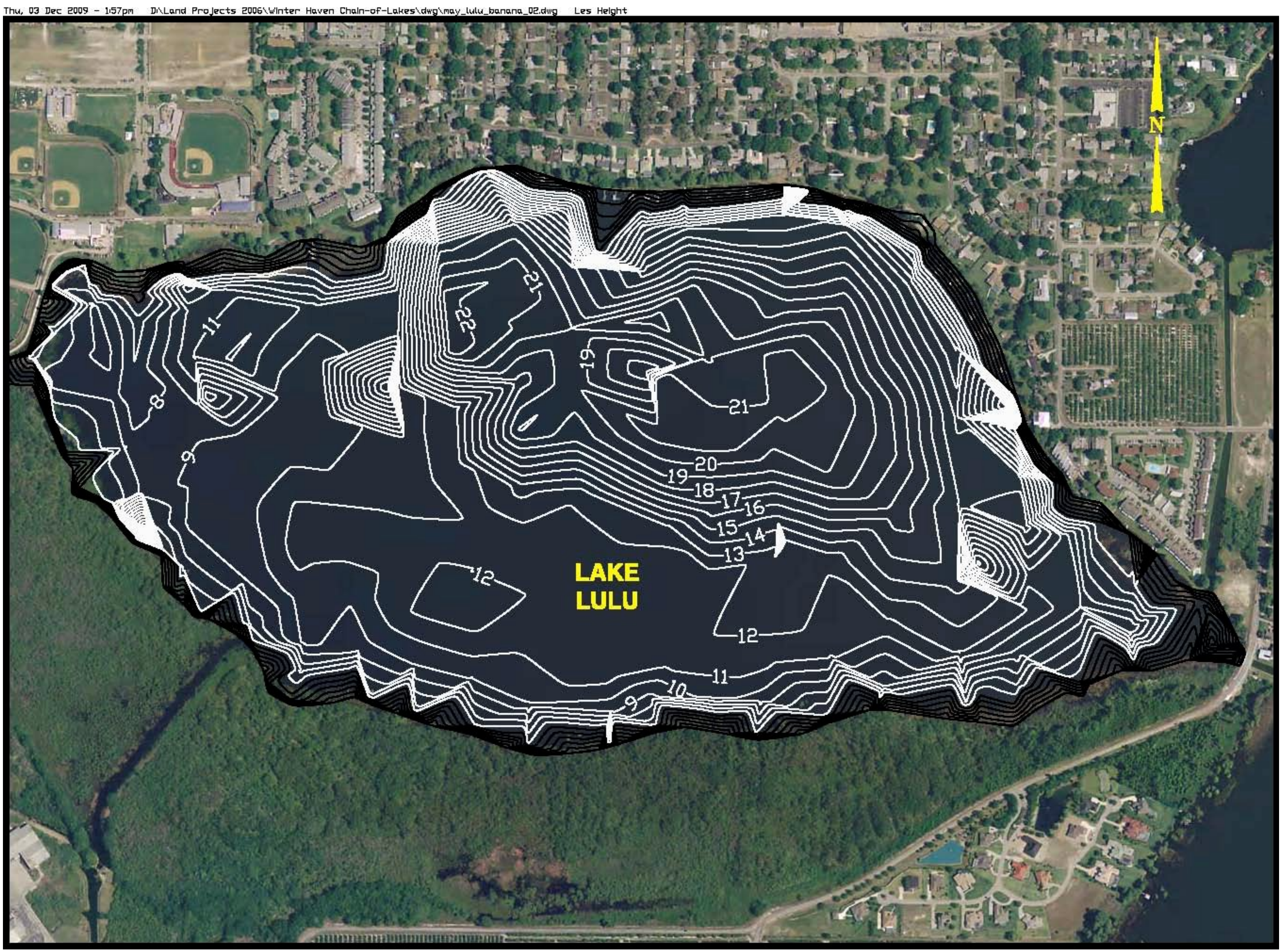

Figure 7-27. Estimated Water Depth Contours in Lake Lulu After Removal of Organic Muck.

However, sediment removal from Lakes May, Shipp, and Lulu as a phosphorus reduction technique has two significant drawbacks. First, a suitable spoil area(s) must be identified for placement of the dredged material from each lake. Since most slurry from hydraulic dredges contains only 10-20% solids, 80-90% of the slurry volume is water, indicating that the disposal areas must be approximately 4-5 times greater in volume than the sediment volume removed, assuming that the disposal will contain all of the generated material. Assuming a sediment volume of 1,770 acre ft within the three lakes, a disposal area designed to totally contain the dredged volume would require approximately 6,800 – 8,850 acre ft of available storage. Assuming that the storage area is capable of containing a slurry depth of 10 ft, the required disposal area would be approximately 700-900 acres in size. However, this area requirement can be substantially reduced if a flow through system is designed, and the treated slurry water is returned back into each of the three lakes. The requirement for dredge disposal areas may be substantially reduced, or perhaps eliminated, using a system recently designed by Genesis Systems which has developed a trailer mounted sludge processing system which can process dredged slurry at up to 3,000 gpm, generating trailerable solids and clear water which is returned back into the lake. The system can be used in any open area adjacent to the lake and has been shown to reduce dredging costs by approximately 33-50% since the remote disposal areas and associated containment burns and pumps are totally eliminated.

7.3.1.2 Total or Partial Removal

Assuming that sediment removal is selected as a management option for Lakes May, Shipp, and Lulu, the next issue that must be addressed is the depth of sediment removal. When dredging is performed for navigational activities, the deepening requirements are relatively straightforward. However, when sediment removal is proposed to control internal nutrient recycling, the removal requirements are less clearly defined. Ideally, sediment removal must occur to a depth at which nutrient release from the lake sediments no longer represents a significant loading to the lake system. In many instances this will require complete removal of the accumulated organic sediments to the historic firm lake bottom. However, if the sediment characteristics vary substantially with increasing depth, it is possible that a sediment layer could be reached which exhibits a minimal potential for nutrient release under anoxic conditions.

A limited evaluation of vertical variability in sediment characteristics in Lakes May, Shipp, and Lulu was conducted by ERD as part of this project. Sediment core samples were collected during June and August 2006 in each of the three lakes to the maximum possible depth using a 2-inch diameter PVC pipe. Sample sites were selected in areas with and without significant accumulations, as indicated on Figures 2-19 to 2-21. In most locations, the core device was capable of collecting sediments to a depth of approximately 3-4 ft below the sediment surface, depending upon sediment consistency and density. Locations of the deep sediment core sites are indicated on Figure 7-28. Five separate core samples were collected in Lake May, with 10 samples collected in Lakes Shipp and Lulu, for a total of 25 overall samples. Each core sample was divided into one foot increments of sediment depth, and a thoroughly mixed sample of each one foot increment was collected and analyzed for the general sediment characteristics summarized in Table 2-14. Photographs of the sediment core tubes and mixing processes are given on Figure 7-29.

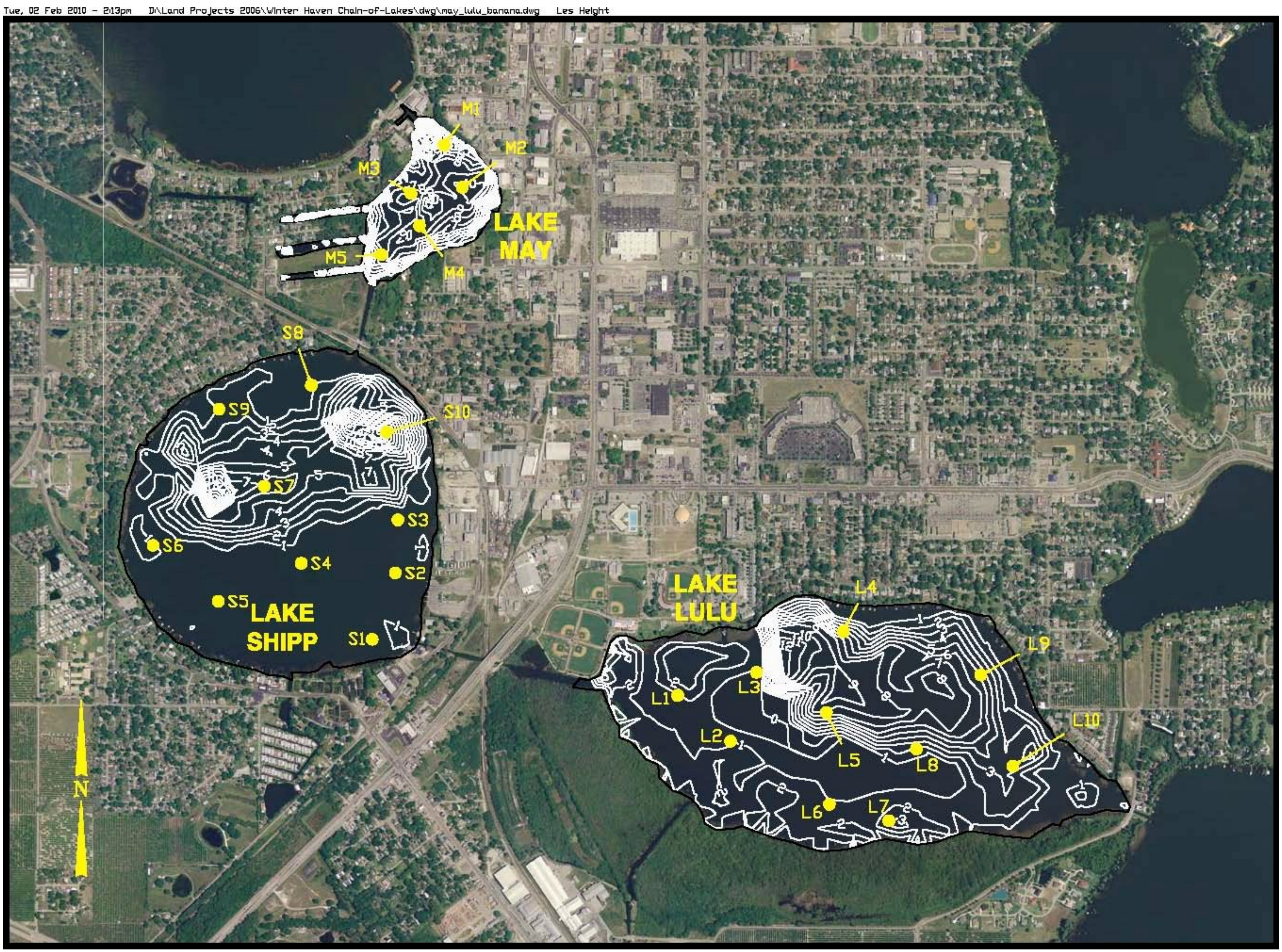

Figure 7-28. Locations of Deep Sediment Core Monitoring Sites in Lakes May, Shipp, and Lulu.

a. Intact Sediment Core in 2-inch PVC Pipe

b. Core Tubes Cut to Desired Lengths

c. Samples Combined in Bucket

d. Sediments Mixed to Create Sample

Figure 7-29. Photographs of the Deep Sediment Core Samples and Mixing Process.

A complete listing of the characteristics of vertical sediment samples collected in each of the three lakes as part of this evaluation is given in Table 7-8. A statistical summary of vertical variability of pH, density, moisture content, and organic content in Lake May sediments is given Figure 7-30 in the form of box and whisker plots. In these diagrams, the mean value for a given set of measurements is represented by the **blue** line, and the median value is indicated by the **red** line. In general, a trend of decreasing pH is apparent with increasing sediment depth in Lake May. However, sediment density, moisture content, and organic content appears to be relatively similar in the 0-1, 1-2, and 2-3 ft depth increments.

Vertical variability of total nitrogen and total phosphorus in Lake May sediments is illustrated on Figure 7-31. In general, total nitrogen concentrations appear relatively similar in each of the three sample layers. Sediment phosphorus concentrations appear to be similar in the 0-1 and 1-2 ft depths with a substantial decrease in phosphorus concentrations observed in the 2-3 ft depth sample. Although these data appear to show a decrease in total phosphorus with increasing depth, this trend should be further evaluated before conclusions are reached concerning the potential depth for dredging activities in Lake May.

Vertical variability of pH, density, moisture content, and organic content in Lake Shipp sediments are illustrated on Figure 7-32. A general trend of decreasing pH with increasing sediment depth is apparent in Lake Shipp similar to the trend in Lake May. However, a high degree of variability is apparent in measured density, moisture content, and organic content with increasing sediment depth in Lake Shipp. This high degree of variability is due to the fact that muck accumulations in Lake Shipp are relatively localized, and many areas in the lake exhibit sandy type sediment characteristics, which results in a high degree of variability in measured values.

Vertical variability of total nitrogen and total phosphorus in Lake Shipp sediments is illustrated on Figure 7-33. A general trend of increasing nitrogen concentrations is apparent with increasing sediment depth, while the trend for phosphorus is inconclusive. Further evaluation of sediment characteristics with increasing sediment depth is also recommended for Lake Shipp before decisions are made concerning depth of dredging activities.

TABLE 7-8

CHARACTERISTICS OF DEEP SEDIMENT CORE SAMPLES COLLECTED IN LAKES MAY, SHIPP, AND LULU

LAKE	SITE	SAMPLE DEPTH	DATE	pH (s.u.)	MOISTURE CONTENT (%)	ORGANIC CONTENT (%)	DENSITY (g/cm^3)	TOTAL NITROGEN (µg/cm^3)	TOTAL PHOSPHORUS (µg/cm^3)
May	1	0-12"	6/5/06	6.37	83.2	31.2	1.17	19,903	2,770
		12-18"	6/5/06	6.13	85.7	49.1	1.11	20,595	1,833
	2	0-12"	6/5/06	6.35	90.9	48.6	1.07	19,878	1,892
		12-24"	6/5/06	6.27	85.5	37.1	1.14	19,648	2,935
		24-36"	6/5/06	5.87	91.1	69.8	1.04	17,060	270
		36-46"	6/5/06	5.54	88.9	46.8	1.09	16,763	397
	3	0-12"	6/5/06	6.5	92.5	48.8	1.06	14,997	1,335
		12-24"	6/5/06	6.29	84.5	40.5	1.14	19,898	2,022
		24-36"	6/5/06	5.76	89.5	66.1	1.05	17,486	337
	4	0-12"	6/5/06	6.42	91.6	47.1	1.07	14,401	1,460
		12-24"	6/5/06	6.19	86.9	42.4	1.11	20,269	2,077
		24-36"	6/5/06	5.69	88.6	53.9	1.08	18,506	406
	5	0-12"	6/5/06	6.38	89.3	58.6	1.07	17,139	1,253
		12-24"	6/5/06	5.34	90.1	66.5	1.05	14,687	422
		24-36"	6/5/06	5.28	87.8	40.8	1.11	19,003	609
Lulu	1	0-12"	8/16/06	6.39	87.1	40.9	1.11	16,787	241
		12-21"	8/16/06	6.16	47.5	7.3	1.73	22,796	520
	2	0-7"	8/16/06	6.79	33.8	1.2	1.98	9,916	548
	3	0-11"	8/16/06	6.58	30.2	1.3	2.03	7,079	463
	4	0-12"	8/16/06	6.4	88.6	54.6	1.08	25,581	1,393
		12-24"	8/16/06	6.24	29.1	3.9	2.02	12,630	1,402
	5	0-12"	8/16/06	6.35	91.8	58.4	1.05	21,740	1,337
		12-24"	8/16/06	6.45	78.6	36.9	1.20	26,685	1,853
		24-29"	8/16/06	5.99	41.5	7.6	1.81	49,175	2,009
	6	0-12"	8/16/06	6.7	90.5	38.0	1.09	15,590	317
		12-24"	8/16/06	5.76	70.1	11.1	1.40	11,267	112
		24-31"	8/16/06	6.51	22.4	0.8	2.15	3,496	204
	7	0-12"	8/16/06	6.4	90.8	60.7	1.05	16,645	173
		12-24"	8/16/06	5.85	93.6	97.4	1.00	19,129	56
		24-29"	8/16/06	5.47	92.4	95.9	1.00	17,787	98
	8	0-12"	8/16/06	6.33	89.5	61.3	1.06	22,916	1,465
		12-21"	8/16/06	6.72	45.5	8.3	1.75	26,074	1,547
	9	0-12"	8/16/06	6.49	88.3	54.7	1.08	21,932	1,506
		12-23"	8/16/06	6.49	81.5	46.8	1.15	27,596	704
	10	0-12"	8/16/06	6.22	89.4	57.4	1.07	18,340	1,319
		12-24"	8/16/06	6.45	93.5	95.7	1.00	21,293	143
Shipp	1	0-12"	8/16/06	6.76	74.9	12.4	1.33	26,708	2,664
		12-24"	8/16/06	7.15	52.3	7.5	1.66	24,011	6,621
	2	0-3"	8/16/06	7.09	24.8	0.3	2.12	3,991	298
	3	0-3"	8/16/06	6.88	33.0	0.6	2.00	5,315	447
	4	0-12"	8/16/06	6.65	23.2	0.6	2.15	3,357	198
	5	0-12"	8/16/06	6.13	25.2	2.0	2.10	6,299	1,170
		12-18"	8/16/06	5.46	23.4	1.1	2.14	2,942	405
	6	0-12"	8/16/06	6.3	31.2	3.7	1.99	11,260	7,315
		12-13"	8/16/06	6.07	21.7	1.7	2.16	4,697	2,324
	7	0-12"	8/16/06	6.27	88.7	37.6	1.11	21,678	303
		12-24"	8/16/06	6.32	80.9	47.1	1.15	26,916	940
		24-32"	8/16/06	5.82	55.4	12.6	1.58	16,431	1,146
	8	0-12"	8/16/06	6.05	89.6	38.5	1.10	19,559	3,073
		12-24"	8/16/06	6.07	78.3	35.8	1.21	28,647	1,708
		24-31"	8/16/06	5.94	88.0	56.4	1.08	20,907	180
	9	0-12"	8/16/06	6.73	25.7	1.6	2.10	7,594	1,390
		12-16"	8/16/06	6.47	21.9	1.4	2.15	7,111	2,591
	10	0-5"	8/16/06	6.62	25.1	1.5	2.11	4,886	988
		24-29"	8/16/06	6.24	90.8	95.8	1.01	20,744	138

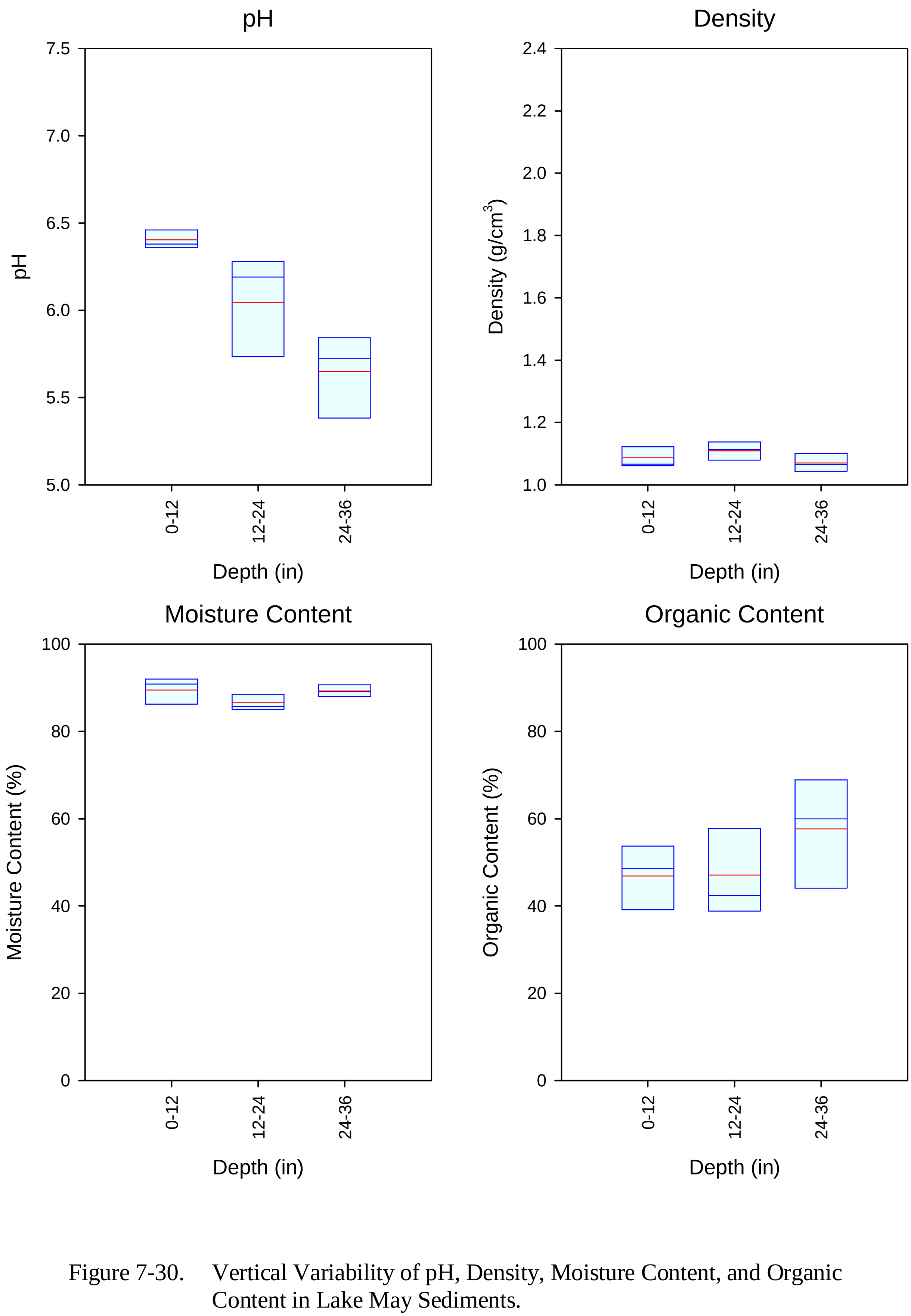

Figure 7-30. Vertical Variability of pH, Density, Moisture Content, and Organic Content in Lake May Sediments.

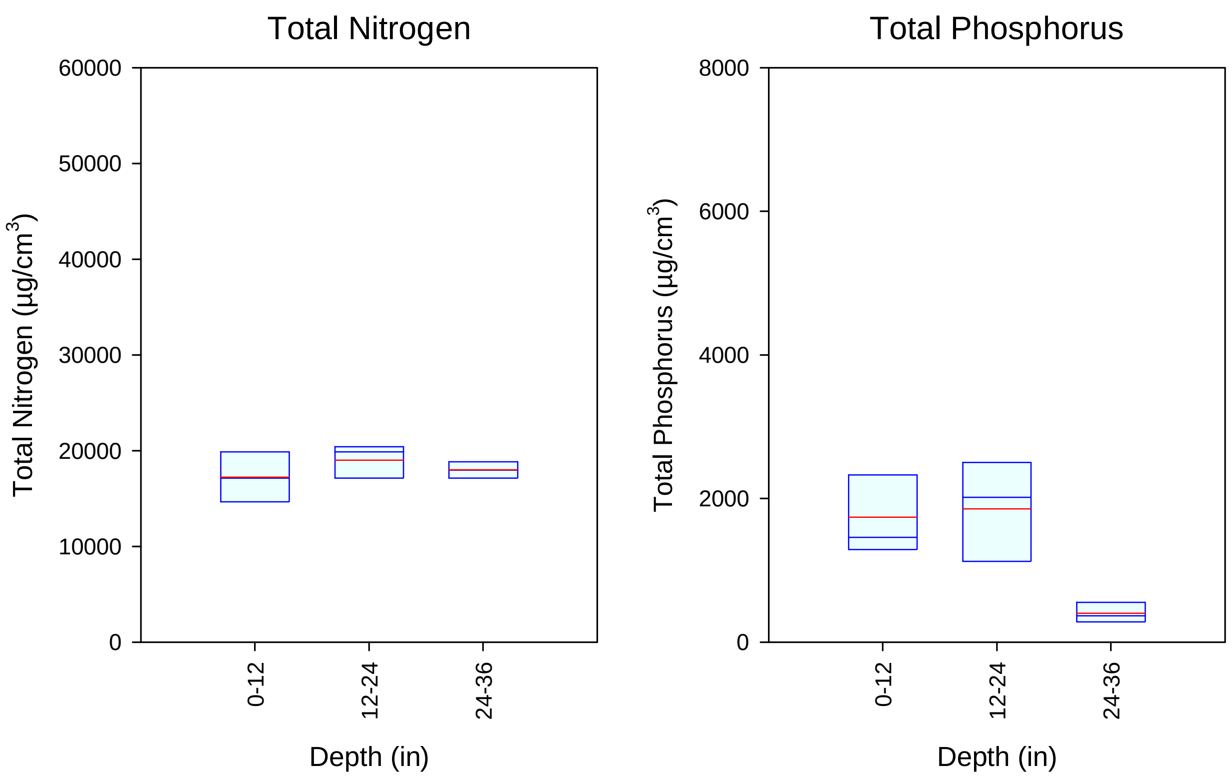

Figure 7-31. Vertical Variability of Total Nitrogen and Total Phosphorus in Lake May Sediments.

Vertical variability of pH, density, moisture content, and organic content in Lake Lulu sediments are illustrated on Figure 7-34. Similar to the trends in Lake May and Shipp, sediment pH appears to decrease with increasing sediment depth. A trend of increasing sediment density and decreasing moisture and organic content is apparent in Lake Lulu. This trend appears to be related to the fact that organic sediments in Lake Lulu are somewhat isolated, with some of the vertical sediment samples collected in areas which reflect primarily sandy type sediments. Vertical variability of total nitrogen and total phosphorus in Lake Lulu sediments is illustrated on Figure 7-35. No significant trend is apparent for either total nitrogen or total phosphorus within increasing sediment depth in Lake Lulu.

The sediment trends exhibited in Figures 7-30 through 7-35 are inconclusive concerning phosphorus characteristics and the potential for internal recycling as a function of sediment depth. These trends should be evaluated more fully if hydraulic dredging is selected as a management technique for the three lakes. As part of this re-evaluation, different sediment collection devices should be evaluated for use in obtaining intact sediment cores at deeper depths within the sediment layers. The core samples should be concentrated in areas where organic muck accumulations are the thickest and where sediment dredging activities are most likely. These additional analyses can be easily conducted as part of the design phase for any proposed dredging activities.

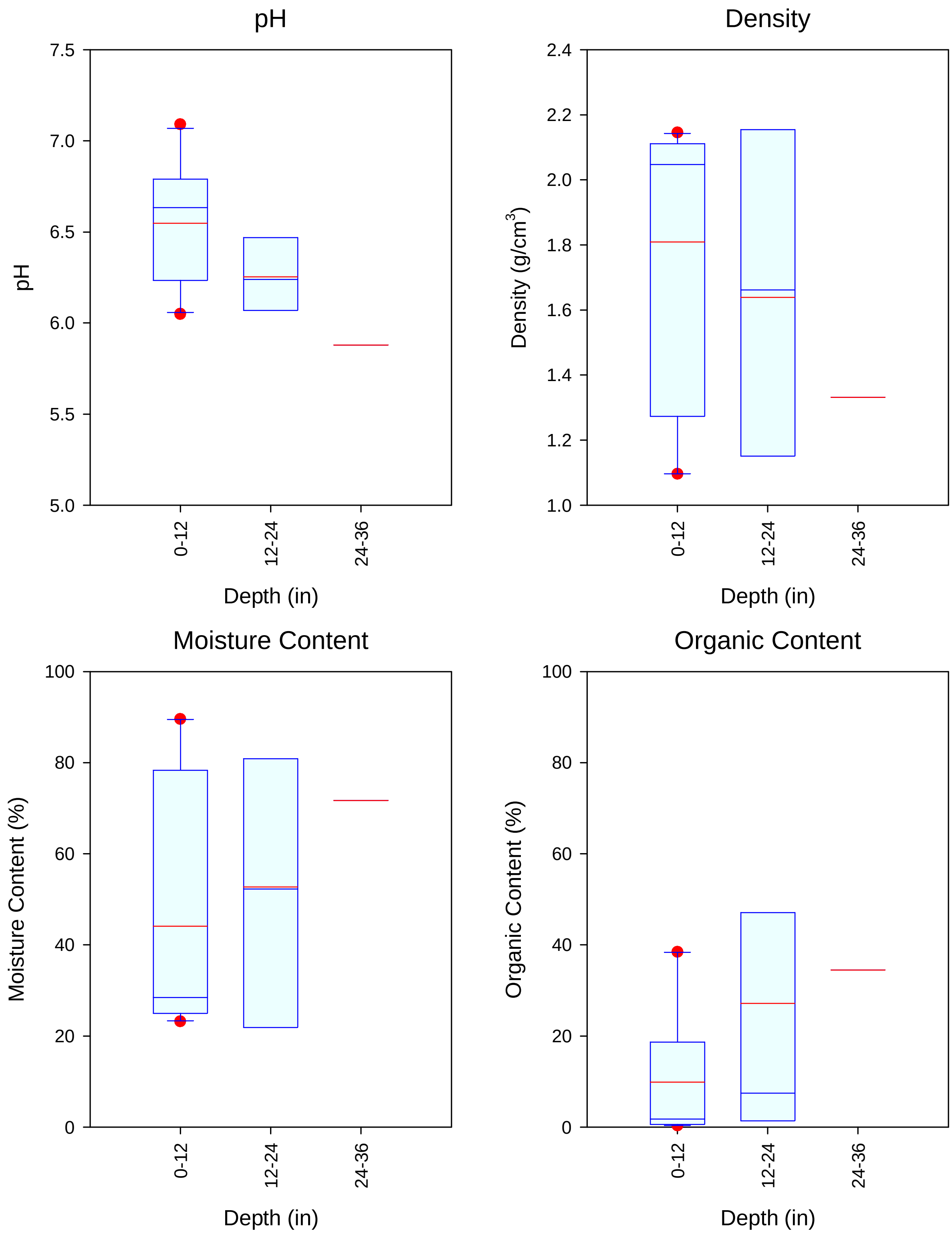

Figure 7-32. Vertical Variability of pH, Density, Moisture Content, and Organic Content in Lake Shipp Sediments.

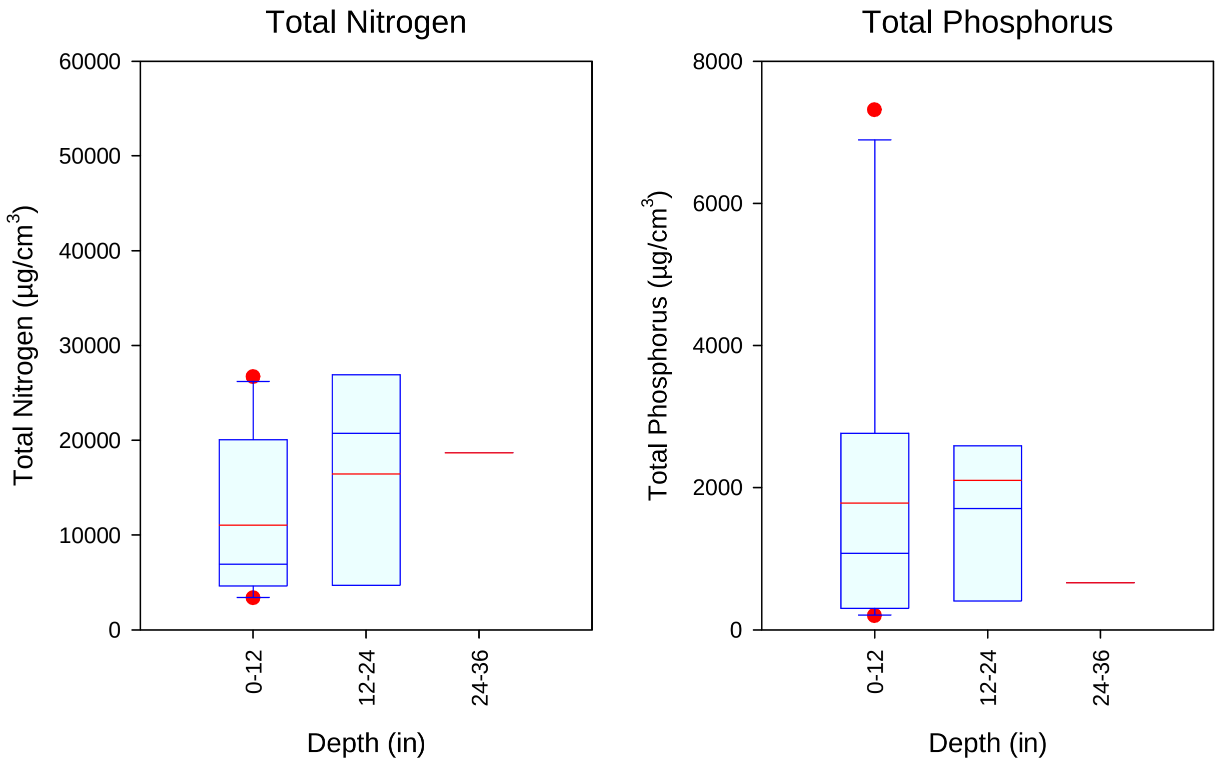

Figure 7-33. Vertical Variability of Total Nitrogen and Total Phosphorus in Lake Shipp Sediments.

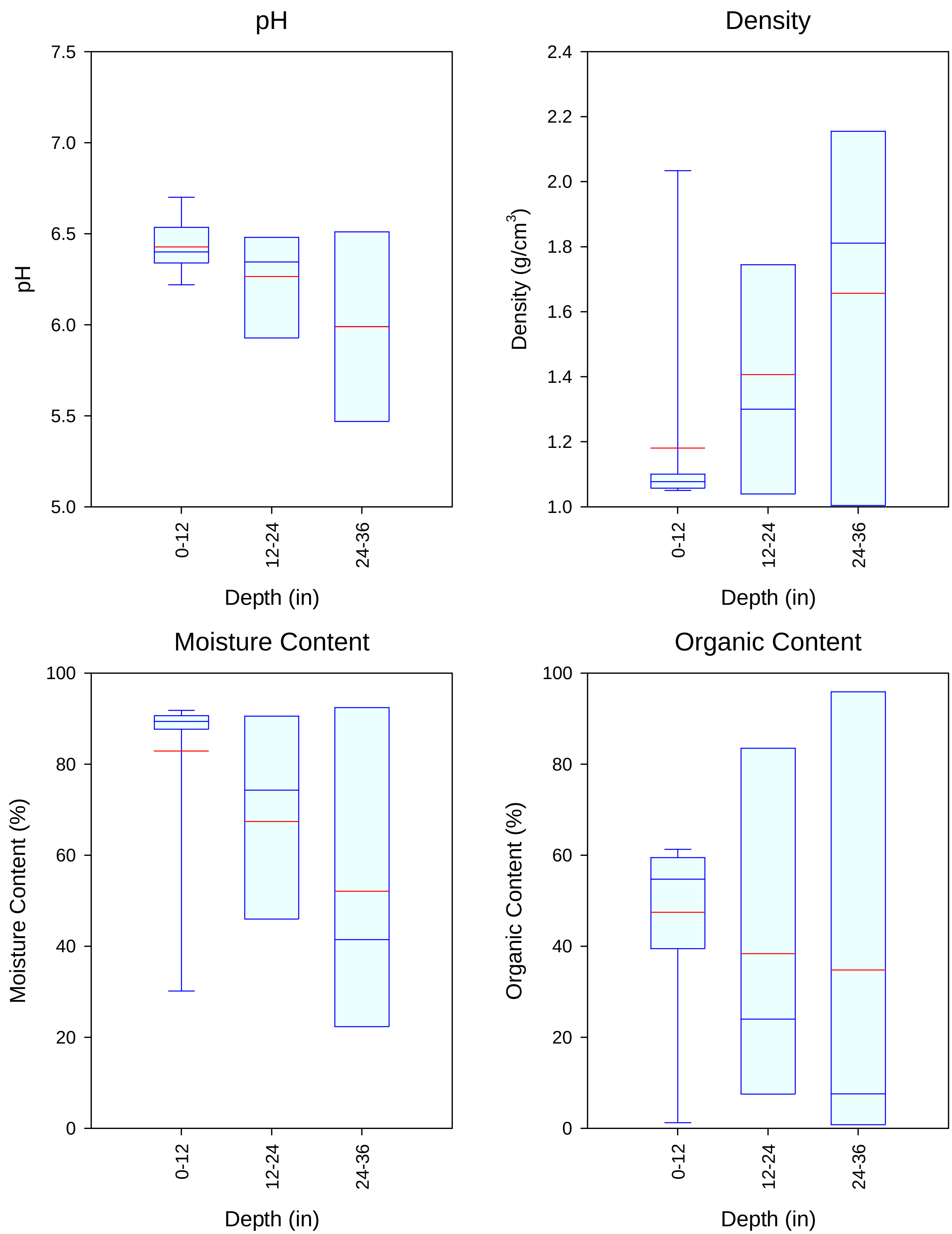

Figure 7-34. Vertical Variability of pH, Density, Moisture Content, and Organic Content in Lake Lulu Sediments.

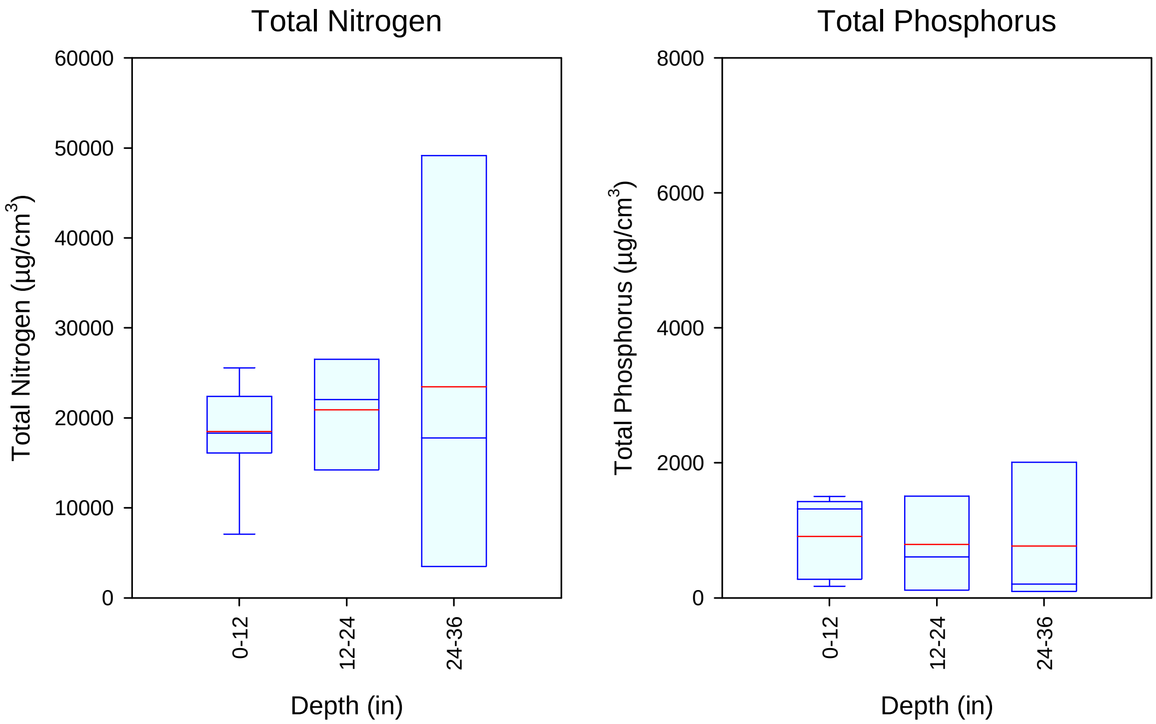

Figure 7-35. Vertical Variability of Total Nitrogen and Total Phosphorus in Lake Lulu Sediments.

7.3.1.3 Water Quality Benefits

Potential water quality benefits of sediment removal in Lakes May, Shipp, and Lulu were evaluated using the calibrated water quality model discussed in Section 6.2. For this analysis, it is assumed that removal of all organic sediment material will occur which will reduce internal recycling by approximately 80%. This value is assumed since sediment removal processes are rarely 100% efficient, and sediment deposits often remain which can still contribute to internal recycling, although at a substantially lower rate. This analysis also assumes that the associated lake volumes will be increased from the existing amounts to the predicted amounts summarized in Table 7-9.

A summary of the results of the water quality model used to evaluate the water quality benefits of sediment removal in Lakes May, Shipp, and Lulu is given in Appendix K.2. A summary of the results of this analysis is given in Table 7-10. In general, sediment removal from Lakes May, Shipp, and Lulu will result in substantial improvements in water quality characteristics in each of the three lakes. Water column concentrations of total phosphorus would be reduced by approximately 37% in Lake May, 41% in Lake Shipp, and 58% in Lake Lulu. Water column concentrations of chlorophyll-a would be reduced by approximately 38% in Lake May, 43% in Lake Shipp, and 61% in Lake Lulu. The resulting water column appearance and water clarity would be substantially better than exists in any of the three lakes under existing conditions. Secchi disk depths would average 0.75-1.42 m within the three lakes compared with an average of 0.4-0.6 m under existing conditions.

TABLE 7-9

CHANGES IN LAKE VOLUMES RESULTING FROM DREDGING IN LAKES MAY, SHIPP, AND LULU

LAKE	EXISTING LAKE VOLUME (ac-ft)	VOLUME AFTER SEDIMENT REMOVAL (ac-ft)	VOLUME INCREASE (%)	MEAN DETENTION TIME (days)	
				Current	After Dredging
May	316	618	96	132	259
Shipp	2589	3210	24	348	431
Lulu	2765	3612	31	280	366

TABLE 7-10

ANTICIPATED WATER QUALITY BENEFITS OF SEDIMENT REMOVAL IN LAKES MAY, SHIPP, AND LULU

LAKE	EXISTING CONDITIONS				AFTER DREDGING			
	Total P (mg/l)	Chyl-a (mg/m^3)	Secchi Disk (m)	TSI	Total P (mg/l)	Chyl-a (mg/m^3)	Secchi Disk (m)	TSI
May	0.063	48.2	0.51	80	0.040	29.7	0.93	72
Shipp	0.059	77.9	0.43	84	0.035	44.5	0.75	75
Lulu	0.052	35.6	0.58	76	0.022	14.0	1.42	59

In general, the level of confidence associated with a water quality model is a function of the confidence levels on the input data for the model and the ability of the model to predict water quality characteristics for the evaluated waterbodies. The input data for the water quality models for Lakes May, Shipp, and Lulu are based upon mean annual hydrologic conditions, and the predicted results can be expected to vary as hydrologic conditions vary. Hydrologic conditions affect the primary driving forces for the model, such as stormwater runoff, groundwater seepage, bulk precipitation, baseflow, and exchange between interconnected lake systems. Alterations of these components will result in subsequent alterations of predicted model results.

7.3.1.4 Dredging Costs

Costs associated with hydraulic dredging can be highly variable depending upon a variety of factors such as dredge capacity, availability of disposable areas, and distance to disposable areas, sludge dewatering requirements, booster pump requirements, and final sediment disposal. Since none of these factors have been fully evaluated at this time, a general sediment dredging cost of approximately $10.00 per cubic yard is assumed for this analysis. This value assumes that a shoreline dewatering facility would be used.

A summary of estimated costs for hydraulic dredging in Lakes May, Shipp, and Lulu is given in Table 7-11. Based on the previously determined organic sediment volumes, the estimated dredging costs for the three lakes range from $4,872,300 in Lake May to $13,665,000 in Lake Lulu for a total estimated dredging cost of $28,556,000.

TABLE 7-11

ESTIMATED COSTS FOR HYDRAULIC DREDGING IN LAKES MAY, SHIPP, AND LULU

LAKE	DREDGED VOLUME		ESTIMATED COST ($)
	ac-ft	yd^3	
May	302	487,227	4,872,300
Shipp	621	1,001,880	10,018,800
Lulu	847	1,366,493	13,665,000
TOTALS:	**1,770**	**2,855,600**	**28,556,000**

7.3.2 Sediment Inactivation

7.3.2.1 General Considerations

Sediment phosphorus inactivation is a lake restoration technique which is designed to substantially reduce sediment phosphorus release by combining available phosphorus in the sediments with a metal salt to form an insoluble inert precipitate which makes the sediment phosphorus unavailable for release into the overlying water column. Although salts of aluminum calcium and iron have been used for sediment inactivation in previous projects, aluminum salts are the clear compounds of choice for this application. Inactivation of sediment phosphorus using aluminum is often a substantially less expensive option for reducing sediment phosphorus release since removal of the existing sediments is not required.

Sediment phosphorus inactivation is most often performed using aluminum sulfate, commonly called alum, which is applied at the surface in a liquid form. Upon entering the water column, the alum forms an insoluble precipitate of aluminum hydroxide which attracts phosphorus, bacteria, algae, and suspended solids within the water column, settling these constituents into the bottom sediments. Upon reaching the bottom sediments, the residual aluminum binds tightly with phosphorus within the sediments, forming an inert precipitate which will not be re-released under any conceivable condition of pH or redox potential which could occur in a natural lake system. These sediment treatments have been shown to be effective from 2-20 years, depending upon the sediment accumulation rate within the lake from the remaining phosphorus sources.

Sediment phosphorus inactivation using alum has been shown to be less effective in shallow polymictic lakes with a loose flocculant sediment material. Under these conditions, frequent mixing of the upper sediment layers occurs which may cause the alum participate to be mixed into deeper sediment layers, reducing the effectiveness of the treatment. Based upon the physical characteristics of Lakes May, Shipp, and Lulu summarized in Table 2-4, and visual observations of water column and sediment characteristics, it does not appear that sediment inactivation is a feasible alternative for inactivation of phosphorus release for Lake May. Lake May is the shallowest of the three lakes, with a mean depth of approximately 6.3 ft and a maximum depth of only 10 ft. The existing sediments in Lake May are easily re-suspended by boating activity and wind, which can substantially shorten the anticipated effectiveness of an alum inactivation treatment. Therefore, inactivation of sediment phosphorus release in Lake May using alum is not considered to be feasible at this time.

In contrast, Lake Shipp and Lake Lulu are somewhat deeper water bodies with mean depths ranging from 9.0-9.4 ft and maximum water depths ranging from 13-14 ft. Although each of these lakes also exhibit sediment re-suspension under certain conditions, the frequency of these processes are substantially less than in Lake May. Based on visual observations of sediment characteristics, the sediment layers in Lakes Shipp and Lulu appear to be less flocculant than the surficial sediment layers in Lake May, further reducing the likelihood for sediment re-suspension. As a result, inactivation of sediment phosphorus release in Lakes Shipp and Lulu may be achieved using alum, although the longevity of the process may be somewhat reduced compared to the anticipated longevity for a deeper lake system.

7.3.2.2 <u>Chemical Requirements and Costs</u>

Sediment inactivation in Lakes Shipp and Lulu would involve the addition of liquid aluminum sulfate at the water surface. Upon entering the water, the alum would form insoluble precipitates which would settle onto the bottom while also clarifying the existing water column within the lakes. Upon entering the sediments, the alum will combine with existing phosphorus within the sediments, primarily saloid- and iron-bound associations, forming insoluble inert precipitates which will bind the phosphorus, making it unavailable for release into the overlying water column. It is generally recognized that the top 10 cm layer of the sediments is the most active in terms of release of phosphorus under anoxic conditions. Therefore, the objective of a sediment inactivation project is to provide sufficient alum to bind the saloid- and iron-bound phosphorus associations in the top 10 cm of the sediments.

Estimates of the mass of total available phosphorus within the top 0-10 cm layer of the sediments in Lakes Shipp and Lulu were generated by graphically integrating the total available phosphorus isopleths presented on Figure 2-30. The top 0-10 cm layer of the sediments is considered to be an active layer with respect to exchange of phosphorus between the sediments and the overlying water column. Inactivation of phosphorus within the 0-10 cm layer is typically sufficient to inactivate sediment release of phosphorus within a lake. Prior research involving sediment inactivation has indicated that an excess of aluminum is required within the sediments to cause phosphorus to preferentially bind with aluminum rather than other available compelling agents. Previous sediment inactivation projects performed by ERD have been conducted at molar Al:P ratios of 2, 3, 5, and 10, with most recent sediment inactivation projects performed using a 10:1 ratio.

A summary of estimated total available phosphorus in the sediments of Lake Shipp is given in Table 7-12. On a mass basis, the sediments of Lake Shipp contain approximately 42,103 kg of available phosphorus in the top 10 cm. On a molar basis, this equates to approximately 1,358,164 moles of available phosphorus to be inactivated as part of the sediment inactivation process. A summary of alum requirements for sediment inactivation is also provided in Table 7-12. Using an Al:P ratio of 10:1, sediment inactivation in Lake Shipp would require approximately 1,653,805 gallons of alum, equivalent to approximately 367 tankers of alum. Assuming a chemical cost of $0.90 cents per gallon, the chemical costs for sediment inactivation in Lake Shipp would be $1,488,425. The equivalent aerial aluminum dose for this application would be 327.5 g Al/m^2 which is approximately 6-10 greater than aerial aluminum does typically performed by ERD. The extraordinary amount of alum required for sediment inactivation in Lake Shipp is due to the extremely high values of available sediment phosphorus within the lake.

TABLE 7-12

LAKE SHIPP SEDIMENT INACTIVATION REQUIREMENTS

AVAILABLE P CONTOUR INTERVAL ($\mu g/cm^3$)	CONTOUR INTERVAL MID-POINT ($\mu g/cm^3$)	CONTOUR AREA (acres)	AVAILABLE P		ALUM REQUIREMENTS			
			kg	moles	Al:P RATIO = 5:1		Al:P RATIO = 10:1	
					moles Al	gal Alum	moles Al	gal Alum
<100	50	14.80	299	9,659	48,295	5,881	96,589	11,761
100-200	150	61.51	3,734	120,454	602,270	73,337	1,204,540	146,674
200-300	250	46.36	4,691	151,307	756,534	92,121	1,513,067	184,243
300-400	350	37.71	5,341	172,303	861,514	104,905	1,723,027	209,809
400-500	450	34.51	6,284	202,704	1,013,522	123,414	2,027,044	246,829
500-600	550	31.28	6,962	224,587	1,122,937	136,738	2,245,875	273,475
600-700	650	26.71	7,025	226,601	1,133,006	137,964	2,266,011	275,927
700-800	750	13.45	4,082	131,666	658,332	80,164	1,316,664	160,327
800-900	850	6.20	2,134	68,841	344,205	41,913	688,409	83,826
>900	950	4.04	1,551	50,041	250,203	30,467	500,407	60,933
Overall Totals:		**276.56**	**42,103**	**1,358,164**	**6,790,818**	**826,903**	**13,581,635**	**1,653,805**

	Al:P = 5:1	Al:P = 10:1
Estimated Chemical Cost ($):	744,213	1,488,425
Areal Aluminum Dose (g Al/m^2):	163.74	327.48
Number of Tankers:	183.8	367.5

A summary of estimated total available phosphorus in the sediments of Lake Lulu are given in Table 7-13. On a molar basis, the sediments on Lake Lulu contain approximately 30,637 kg of available phosphorus in the top ten centimeters of lake sediments. On a molar basis, this equates to approximately 988,291 moles of available phosphorus to be inactivated as part of the sediment inactivation process. Based on an Al:P ratio of 10:1, sediment inactivation in Lake Lulu would require approximately 1,203,420 gallons of alum or approximately 267 tankers. At an estimated chemical cost of $0.90 per gallon, the alum required for sediment inactivation in Lake Lulu would cost approximately $1,083,078. The aerial alum base corresponding to this application would be 214.4 g Al/m^2 which is an extremely elevated aerial aluminum dose due to the extremely high levels of available sediment phosphorus within the lake.

TABLE 7-13

LAKE LULU SEDIMENT INACTIVATION REQUIREMENTS

AVAILABLE P CONTOUR INTERVAL (µg/cm^3)	CONTOUR INTERVAL MID-POINT (µg/cm^3)	CONTOUR AREA (acres)	AVAILABLE P		ALUM REQUIREMENTS			
					Al:P RATIO = 5:1		Al:P RATIO = 10:1	
			kg	moles	moles Al	gal Alum	moles Al	gal Alum
<100	50	104.45	2,113	68,177	340,886	41,509	681,771	83,018
100-200	150	28.17	1,710	55,169	275,845	33,589	551,691	67,178
200-300	250	39.51	3,998	128,958	644,788	78,514	1,289,576	157,029
300-400	350	72.03	10,202	329,098	1,645,491	200,368	3,290,982	400,735
400-500	450	44.45	8,094	261,103	1,305,513	158,969	2,611,025	317,939
500-600	550	11.50	2,560	82,576	412,881	50,276	825,761	100,551
600-700	650	6.15	1,617	52,176	260,882	31,767	521,764	63,534
>700	750	1.13	342	11,034	55,171	6,718	110,342	13,436
Overall Totals:		**307.39**	**30,637**	**988,291**	**4,941,456**	**601,710**	**9,882,913**	**1,203,420**

	Al:P RATIO = 5:1	Al:P RATIO = 10:1
Estimated Chemical Cost ($):	541,539	1,083,078
Areal Aluminum Dose (g Al/m^2):	107.20	214.40
Number of Tankers:	133.7	267.4

Although sediment inactivation using alum is not recommended in Lake May, a summary of sediment inactivation requirements for Lake May is also provided for comparison purposes in Table 7-14. On a mass basis, the sediments in Lake May contain approximately 12,838 kg of available phosphorus in the top ten cm of the sediments which equates to approximately 414,140 moles of available phosphorus to be inactivated as part of the sediment inactivation process. Using an Al:P ratio of 10:1, sediment inactivation in Lake May would require approximately 504,288 gallons of alum or 112 tankers. At an estimated chemical cost of $0.90 per gallon, the alum costs for sediment inactivation in Lake May would be approximately $453,866. This application would correspond to an aerial aluminum dose of 546 g $A1/m^2$ which is approximately 2 times greater than the aerial application rates proposed for Lake Shipp or Lake Lulu. This extremely elevated aerial aluminum dose is a direct reflection of the extremely high levels of available phosphorus in the sediments in Lake May.

TABLE 7-14

LAKE MAY SEDIMENT INACTIVATION REQUIREMENTS

AVAILABLE P CONTOUR INTERVAL (µg/cm^3)	CONTOUR INTERVAL MID-POINT (µg/cm^3)	CONTOUR AREA (acres)	AVAILABLE P		ALUM REQUIREMENTS			
					Al:P RATIO = 5:1		Al:P RATIO = 10:1	
			kg	moles	moles Al	gal Alum	moles Al	gal Alum
<100	50	2.50	51	1,634	8,172	995	16,344	1,990
100-200	150	0.37	23	730	3,652	445	7,304	889
200-300	250	7.65	774	24,976	124,881	15,207	249,763	30,413
300-400	350	1.97	278	8,978	44,891	5,466	89,781	10,932
400-500	450	2.28	415	13,382	66,910	8,148	133,820	16,295
500-600	550	4.48	996	32,130	160,650	19,562	321,301	39,124
600-700	650	4.37	1,148	37,039	185,193	22,550	370,385	45,101
700-800	750	11.15	3,383	109,128	545,640	66,441	1,091,281	132,883
800-900	850	8.32	2,860	92,265	461,325	56,175	922,651	112,349
900-1000	950	6.46	2,484	80,115	400,574	48,777	801,147	97,554
>1000	1050	1.00	427	13,762	68,810	8,379	137,619	16,758
Overall Totals:		**50.54**	**12,838**	**414,140**	**2,070,698**	**252,144**	**4,141,396**	**504,288**

	Al:P RATIO = 5:1	Al:P RATIO = 10:1
Estimated Chemical Cost ($):	226,930	453,860
Areal Aluminum Dose (g Al/m^2):	273.23	546.45
Number of Tankers:	56.0	112.1

The required alum volumes summarized in Tables 7-13 and 7-14 are substantially higher than previous sediment inactivation projects performed by ERD in the Central Florida area due to the extremely elevated levels of available phosphorus in the sediments of the two lakes. The required total alum volume for the two lakes using the 10:1 ratio option is equivalent to approximately 635 tanker trucks. If this amount of alum were to be added into the two lakes during a single application, the applied water column dose would exceed be approximately 115 mg Al/liter in Lake Shipp and 78 mg Al/liter in Lake Lulu. In general, Central Florida lakes can withstand applications of approximately 5-10 mg Al/liter without exceeding the available buffering capacity within the water and causing undesirable reductions in pH. As a result, the required alum volume would need to be applied in multiple individual separate treatments, separated by periods of approximately 2-6 months, depending on recovery of pH and alkalinity within the lakes. The mobilization costs associated with the multiple applications will substantially increase the overall application costs.

Previous alum surface applications performed for inactivation of sediment phosphorus release by ERD have indicated that the greatest degree of improvement in surface water characteristics and the highest degree of inactivation of sediment phosphorus release are achieved through multiple applications of aluminum to the waterbody over a period of approximately 6-12 months. Each subsequent application results in additional improvements in water column quality and additional aluminum floc added to the sediments for long-term inactivation of sediment phosphorus release. The additional aluminum provided to the sediments also creates an active absorption mechanism for other phosphorus inputs into the water column as a result of groundwater seepage. Inputs of phosphorus from groundwater seepage into a lake can easily exceed inputs from internal recycling in only a few annual cycles. Multiple applications of alum provide an abundance of aluminum which can intercept groundwater inputs of phosphorus over a period of many years. As a result, multiple applications can eliminate phosphorus from the combined inputs resulting from internal recycling as well as groundwater seepage. Therefore, even though the required aluminum mass could be added through a single application if a buffering compound is used, the required aluminum additions for Lake Shipp and Lake Lulu, should be divided into a multiple separate surface treatments.

A potential alternative for sediment inactivation in Lakes Shipp and Lulu is to use a buffering compound in addition to the alum to neutralize the anticipated undesirable pH impacts reducing the number of required repeat applications. Sodium aluminate, an alkaline form of alum, is commonly used in these applications as the buffering agent. Sodium aluminate provides a high level of buffering, as well as supplemental aluminum ions, which reduces the total amount of alum required during the application process. If alum and sodium aluminate are used in combination, changes in pH within the lake during the application process can be minimized.

In general, the simultaneous addition of 1 gallon of sodium aluminate for every 4.0 gallons of alum is sufficient to create neutral pH conditions during the application process. One gallon of alum provides approximately 8.21 moles of available aluminum for sediment inactivation, while one gallon of sodium aluminate provides 21.46 moles of aluminum. Therefore, the use of sodium aluminate not only provides pH buffering, but it can also reduce the amount of alum required for the inactivation project. As seen in Table 6-6, the total estimated alum volume for Lake Shipp at an Al:P ratio of 10:1, without the use of supplemental buffering agents, is approximately 1,653,805 gallons. If sodium aluminate is used as a buffering agent, the total chemical requirements necessary to generate an equivalent total mass of available aluminum are 1,000,489 gallons of alum combined with 250,122 gallons of sodium aluminate.

As recommended previously, this application should be divided into a minimum of 2-3 separate applications, with approximately one-third of the required chemical volume for alum and sodium aluminate applied during each application. As seen in Table 7-12, the total estimated alum volume for sediment inactivation in Lake Lulu, at an Al:P ratio of 10:1, without the use of supplemental buffering agents, is 1,203,420 gallons. If sodium aluminate is used as a buffering agent, the total chemical requirements necessary to generate an equivalent total mass of available aluminum are 728,023 gallons of alum combined with 182,006 gallons of sodium aluminate.

A summary of estimated application costs for sediment inactivation in Lake Shipp is given in Table 7-15 based on the 10:1 Al:P ratio option. This estimate assumes an alum volume of 1,000,489 gallons and a sodium aluminate volume of 250,122 gallons will be applied. It is assumed that the alum and sodium aluminate are purchased at a government contract price. Planning and mobilization costs are estimated to be approximately $5000 per application, which includes initial planning, mobilization of equipment to the site, demobilization at the completion of the application process, and clean-up. Estimates of man-hour requirements for the application are provided based upon experience with similar previous applications by ERD. A labor rate of $125/hour is assumed which includes labor costs, water quality monitoring, expenses, equipment rental, insurance, mileage, and application equipment fees. The estimated cost for sediment inactivation in Lake Shipp is $1,939,766 or approximately $969,903 per application.

TABLE 7-15

ESTIMATED APPLICATION COSTS FOR SEDIMENT INACTIVATION IN LAKE SHIPP (Based on 2 separate treatments)

PARAMETER	AMOUNT REQUIRED/ TREATMENT	UNIT COST/ TREATMENT	COST/ TREATMENT	TOTAL COST
1. Chemicals				
A. Alum	1,000,489 gallons	$0.90/gallon[1]	$450,220	$ 900,440
B. Sodium Aluminate	250,122 gallons	$3.00/gallon	$375,183	$ 750,366
2. Labor				
A. Planning and Mobilization	2 applications	$5000/application	$ 5,000	$ 10,000
B. Chemical Application	2224 man-hours	$125/hour[2]	$139,000	$278,000
3. Lab Testing	Pre-/Post-samples x 2 events	$500/event	$ 500	$ 1,000
		TOTAL:	**$ 969,903**	**$ 1,939,766**

1. Assumed contract cost
2. Includes raw labor, water quality monitoring, insurance, expenses, application equipment, mileage, and rentals

A summary of estimated application costs for sediment inactivation in Lake Lulu is given in Table 7-16 based on the 10:1 Al:P ratio option. This estimate assumes an alum volume of 728,023 gallons and a sodium aluminate volume of 128,006 gallons will be applied. It is assumed that the alum and sodium aluminate are purchased at a government contract price. Planning and mobilization costs are estimated to be approximately $5000 per application, which includes initial planning, mobilization of equipment to the site, demobilization at the completion of the application process, and clean-up. Estimates of man-hour requirements for the application are provided based upon experience with similar previous applications by ERD. A labor rate of $125/hour is assumed which includes labor costs, water quality monitoring, expenses, equipment rental, insurance, mileage, and application equipment fees. The estimated cost for sediment inactivation in Lake Lulu is $1,412,239 or approximately $706,119 per application.

TABLE 7-16

ESTIMATED APPLICATION COSTS FOR SEDIMENT INACTIVATION IN LAKE LULU (Based on 2 separate treatments)

PARAMETER	AMOUNT REQUIRED/ TREATMENT	UNIT COST/ TREATMENT	COST/ TREATMENT	TOTAL COST
1. Chemicals				
A. Alum	728,023 gallons	$0.90/gallon[1]	$327,610	$ 655,221
B. Sodium Aluminate	182,006 gallons	$3.00/gallon	$273,009	$ 546,018
2. Labor				
A. Planning and Mobilization	2 applications	$5000/application	$ 5,000	$ 10,000
B. Chemical Application	1600 man-hours	$125/hour[2]	$100,000	$200,000
3. Lab Testing	Pre-/Post-samples x 2 events	$500/event	$ 500	$ 1,000
		TOTAL:	**$ 706,119**	**$ 1,412,239**

1. Assumed contract cost
2. Includes raw labor, water quality monitoring, insurance, expenses, application equipment, mileage, and rentals

7.3.2.3 Longevity of Treatment

After initial application, the alum precipitate will form a visible floc layer on the surface of the sediments within the lake. This floc layer will continue to consolidate for approximately 30 days, reaching maximum consolidation at that time. Due to the unconsolidated nature of the sediments in much of the lake, it is anticipated that a large portion of the floc will migrate into the existing sediments rather than accumulate on the surface as a distinct layer. This process is beneficial since it allows the floc to sorb soluble phosphorus during migration through the surficial sediments. Any floc remaining on the surface will provide a chemical barrier for adsorption of phosphorus which may be released from the sediments.

Based on previous experiences by ERD, as well as research by others, it appears that a properly applied chemical treatment will be successful in inactivation of the available phosphorus in the sediments of Lake Shipp and Lake Lulu. However, several factors can serve to reduce the effectiveness and longevity of this treatment process. First, wind action can cause the floc to become prematurely mixed into deeper sediments, reducing the opportunity for maximum phosphorus adsorption. Significant wind re-suspension has been implicated in several alum applications in shallow lakes which exhibited reduced longevity. However, in the absence of wind re-suspension, alum inactivation in lake sediments has resulted in long-term benefits ranging from 3 to more than 10 years. Due to the depth of Lake Shipp and Lake Lulu, it is not anticipated that wind-induced re-suspension will be a significant problem.

Another factor which can affect the perceived longevity and success of the application process is recycling of nutrients by macrophytes from the sediments into the water column. This recycling will bypass the inactivated sediments since phosphorus will cross the sediment-water interface using vegetation rather than through the floc layer. Although this process will not affect the inactivation of phosphorus within the sediments, it may result in increases in dissolved phosphorus concentrations which are unrelated to sediment-water column processes. However, the degree of macrophyte growth in Lake Shipp and Lake Lulu appear to be limited, confined primarily to shoreline areas, and recycling of phosphorus by macrophytes does not appear to be a significant concern.

A final factor affecting the longevity of an alum treatment is significant upward migration of groundwater seepage through the bottom sediments. This seepage would almost certainly contain elevated phosphorus levels which would be adsorbed onto the aluminum floc, reducing the floc which is available for interception of sediment phosphorus release. If groundwater seepage loadings are significant, an additional available pool of aluminum will be present within the sediments. If deserved, the chemical additions can be increased to account for the seepage phosphorus loadings.

7.3.2.4 <u>Water Quality Benefits</u>

Potential water quality benefits of alum sediment inactivation in Lakes May, Shipp, and Lulu were evaluated using the water quality model discussed in Section 6.2. For this analysis, it is assumed that the alum sediment inactivation process will reduce internal recycling by approximately 80% in Lakes Shipp and Lulu. The alum floc within the sediments will also provide significant removal for phosphorus entering the lakes as a result of groundwater seepage. For purposes of this analysis, an 80% reduction in phosphorus loadings from groundwater seepage in Lakes Shipp and Lulu is also assumed as a result of the sediment inactivation process. Physical characteristics of each lake are assumed to remain the same as current conditions.

A summary of the results of the water quality models used to evaluate the water quality benefits of sediment inactivation in Lakes Shipp and Lulu is given in Appendix K.3, and the results of this analysis are given in Table 7-17. Alum sediment inactivation in Lakes Shipp and Lulu will result in substantial improvements in water quality characteristics in each of the lakes. Equilibrium water column concentrations of total phosphorus would be reduced by approximately 51% in Lake Shipp and 65% in Lake Lulu. Water column concentrations of chlorophyll-a would be reduced by approximately 47% in Lake May, 53% in Lake Shipp, and 68% in Lake Lulu. However, even with these improvements in water quality, Lakes May and Shipp would still exhibit eutrophic water quality characteristics, as indicated by the calculated TSI values. However, Lake Lulu would convert to a mesotrophic status following the alum sediment inactivation.

TABLE 7-17

ANTICIPATED WATER QUALITY BENEFITS OF ALUM SEDIMENT INACTIVATION IN LAKES MAY, SHIPP, AND LULU

LAKE	EXISTING CONDITIONS				AFTER TREATMENT			
	Total P (mg/l)	Chyl-a (mg/m^3)	Secchi Disk (m)	TSI	Total P (mg/l)	Chyl-a (mg/m^3)	Secchi Disk (m)	TSI
May[1]	0.063	48.2	0.72	80	0.063	48.2	0.72	80
Shipp	0.059	77.9	0.57	84	0.031	39.4	0.80	73
Lulu	0.052	35.6	0.84	76	0.018	11.6	1.57	56

1. Analysis assumes that sediment inactivation is not conducted in Lake May

The resulting water column appearance and water clarity in each of the three lakes would be substantially better than exists under current conditions. Secchi disk depths within the lakes would range from 0.7-1.6 m compared with a current average of 0.6-0.8 m. The anticipated water quality improvements resulting from alum sediment inactivation are greater than predicted for the dredging option since the alum sediment inactivation provides treatment for both sediments and groundwater inflow. As discussed previously, alum treatment would be most effective in Lakes Shipp and Lulu which have a deeper water column depth and a more consolidated sediment layer than Lake May. Alum sediment inactivation is not recommended for Lake May due to the shallow depth and frequent sediment resuspension.

7.3.3 Water Level Manipulation

One of the potential management options currently being considered by the City of Winter Haven is an increase in water levels within the Chain-of-Lakes by approximately 2 ft. A summary of changes in lake volume resulting from a 2-ft increase in water level in Lakes May, Shipp, and Lulu is given in Table 7-18. Estimates of the resulting volume were generated by multiplying the lake surface area by 2 ft and adding this to the existing estimated lake volume. As indicated in Table 7-18, a 2-ft increase in water level will increase available lake volumes by approximately 20-30% within the three lakes. These values are somewhat less than the predicted increase in volume resulting from whole-lake dredging, as summarized in Table 7-9.

Changes in water quality characteristics resulting from a 2-ft increase in water level are difficult to predict. This increase in water level may reduce sediment resuspension from wind action and boating activities in Lakes Shipp and Lulu. However, due to the existing shallow water depth in Lake May and the characteristics of the accumulated sediments, wind action and boating activities will still be capable of resuspending significant sediment material in Lake May even after a 2-ft increase in water level. An increase in water levels may result in an increase in anoxic conditions near the water-sediment interface, and although direct resuspension of sediments may be reduced, internal recycling may actually be increased with this option. In view of the potential positive and negative impacts which could occur from increases in water levels, it appears unlikely that this action would result in measurable water quality improvements within the three lakes.

TABLE 7-18

CHANGES IN LAKE VOLUME RESULTING FROM A 2-FT INCREASE IN WATER LEVEL

LAKE	EXISTING LAKE VOLUME (ac-ft)	VOLUME WITH 2-FT INCREASE IN WATER LEVEL (ac-ft)	VOLUME INCREASE (%)
May	316	417	32
Shipp	2589	3142	21
Lulu	2765	3379	22

7.3.4 "No Action" Alternative

The final alternative evaluated for Lakes May, Shipp, and Lulu is the "no action" alternative where the existing conditions within the lakes and adjacent watersheds are maintained. If no remedial actions are undertaken, water quality characteristics within the three lakes will likely remain constant on a short-term basis. Sediment accumulation within the three lakes will continue at approximately the same rate which occurs under existing conditions. In highly eutrophic lakes (such as Lakes May, Shipp, and Lulu), the sediment accumulation rate is typically on the order of 1-2 cm per year or approximately 1 inch per year. Sediment accumulation within the lake will continue, adding an additional foot of sediment material every 10-20 years.

Over a long-term basis, the continued sediment accumulation will reduce available water depths and result in additional resuspension and internal recycling. Water quality characteristics within the lakes will exhibit a steady decline. However, the timing and rate of this predicted decline in water quality characteristics is directly related to the rate of sedimentation within the lakes which is not known at this time.

SECTION 8

RECOMMENDATIONS

Based upon the evaluations presented in the previous sections, it is apparent that internal phosphorus recycling from lake sediments is a significant source of phosphorus loadings to Lakes May, Shipp, and Lulu. Isolation chamber experiments conducted in Lakes May and Shipp indicated that the existing sediments in the two lakes are contributing to phosphorus concentrations in the overlying water column. Significantly higher phosphorus concentrations were observed in isolation chambers with existing sediments compared with isolation chambers where the sediments had been removed. In Lake May, statistically higher phosphorus concentrations were observed in isolation chambers with sediments under both dry and wet season conditions compared with isolation chambers without sediments. In Lake Shipp, the significance of the existing sediments is limited primarily to wet season conditions.

Based upon the field monitoring and laboratory analyses conducted by ERD, as well as the nutrient budget summarized in Section 5, it appears that sediment phosphorus release is the most significant phosphorus source in each of the three lakes and substantially exceeds inputs from stormwater runoffs. Substantial reductions in sediment phosphorus inputs are necessary to improve water quality characteristics in each lake. The phosphorus reductions can be achieved using either sediment removal or sediment inactivation techniques.

Because of the physical characteristics of Lake May, combined with the shallow water depth and flocculent surficial sediments, sediment removal is recommended for management of internal phosphorus release in Lake May. Existing accumulations of organic muck in Lake May occupy a volume of approximately 302 acre ft above the firm lake bottom. Sediment inactivation will require removal of all or portions of these sediments at an estimated cost of approximately $4.9 million. Due to the shallow nature of the lake, sediment inactivation using alum does not appear feasible for Lake May.

Inactivation of existing sediment phosphorus release in Lakes Shipp and Lulu can be achieved using either sediment removal or sediment inactivation techniques. Sediment removal from Lake Shipp will require dredging approximately 421 acre ft of organic sediments at an estimated cost of approximately $10 million. Sediment removal in Lake Lulu will require excavation of approximately 847 acre ft of organic sediments at an estimated cost of approximately $13.7 million. The possibility of achieving sediment inactivation by dredging to lesser depths in Lakes Shipp and Lulu should be evaluated further during the design phase for any proposed dredging process.

Sediment inactivation in Lakes Shipp and Lulu can also be achieved using a chemical addition of alum and sodium aluminate. Estimated costs for this application are approximately $1.94 million for Lake Shipp and $1.41 million for Lake Lulu. Of the two lakes, Lake Lulu should be given priority for possible sediment inactivation given that internal recycling contributes 70% of the annual phosphorus loading to this lake. However, chemical inactivation does not reduce sediment accumulations, and the issue of the existing sediment accumulations in the two lakes may still need to be addressed at a later date. Therefore, selection of either sediment removal or sediment inactivation for Lakes Shipp and Lulu should be based upon availability of funding along with an evaluation of both long term and short term goals of the City of Winter Haven.

One of the primary factors which impacts the rate and degree of continued water quality deterioration within Lakes May, Shipp, and Lulu is the sedimentation rate within the three lakes, since water quality characteristics in the lakes will likely decline as muck depths increase. Unfortunately, the rate of sedimentation within the lakes is not known at this time. Therefore, it is recommended that a sedimentation rate study be implemented to evaluate the rate of accumulation of organic sediments. This will provide valuable information to more fully evaluate the "no action" alternative and allow prediction in changes in sedimentation rate resulting from implementation of the recommended sediment management options.

APPENDICES

APPENDIX A

FIELD PROFILES COLLECTED IN LAKES MAY, SHIPP, AND LULU FROM OCTOBER 2005-APRIL 2006

Lake	Site	Date	Time	Level (m)	Temp (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (µg/l)	DO (mg/l)	DO (%Sat)	Redox (mV)	Turbidity (NTU)	Secchi (m)
May	Site 1	8/25/05	8:45	0.25	30.52	7.37	186	119	6.2	82	363	13.3	0.58
May	Site 1	8/25/05		0.50	30.53	7.35	185	118	5.9	79	368	11.7	0.58
May	Site 1	8/25/05		1.00	30.52	7.32	186	119	5.7	77	371	11.9	0.58
May	Site 1	8/25/05		1.50	30.52	7.32	186	119	5.7	76	375	11.9	0.58
May	Site 1	8/25/05		2.00	30.69	6.57	426	273	0.3	4	173	>1000	0.58
May	Site 1	8/25/05		2.06	30.67	6.57	480	307	0.3	4	154	>1000	0.58
May	Site 2	8/25/05	9:00	0.25	30.44	7.35	188	120	6.3	84	283	14.6	0.56
May	Site 2	8/25/05		0.50	30.45	7.35	188	120	6.2	84	290	14.4	0.56
May	Site 2	8/25/05		1.00	30.45	7.35	188	121	6.2	82	300	14.4	0.56
May	Site 2	8/25/05		1.50	30.44	7.34	189	121	6.2	83	306	14.4	0.56
May	Site 2	8/25/05		2.00	30.44	7.20	190	122	5.2	69	217	>1000	0.56
May	Site 2	8/25/05		2.19	30.44	6.87	257	165	1.7	24	204	>1000	0.56
Lulu	Site 1	8/25/05	10:23	0.25	31.34	8.13	208	133	7.1	97	327	11.8	0.58
Lulu	Site 1	8/25/05		0.50	31.35	8.18	209	134	7.2	97	333	11.1	0.58
Lulu	Site 1	8/25/05		1.00	31.33	8.17	208	133	7.1	97	338	11.3	0.58
Lulu	Site 1	8/25/05		1.50	31.31	8.18	208	133	7.1	96	340	11.0	0.58
Lulu	Site 1	8/25/05		2.00	31.26	8.15	209	134	6.9	94	342	11.3	0.58
Lulu	Site 1	8/25/05		2.50	31.12	8.07	209	134	6.7	91	341	11.9	0.58
Lulu	Site 1	8/25/05		3.00	30.98	6.91	308	197	0.5	6	151	>1000	0.58
Lulu	Site 1	8/25/05		3.09	30.92	6.63	308	197	0.3	4	133	>1000	0.58
Lulu	Site 2	8/25/05	10:37	0.25	30.88	7.58	210	134	6.4	86	255	12.7	0.58
Lulu	Site 2	8/25/05		0.50	30.91	7.58	211	135	6.1	82	268	11.9	0.58
Lulu	Site 2	8/25/05		1.00	30.91	7.57	210	134	5.9	80	278	11.2	0.58
Lulu	Site 2	8/25/05		1.50	30.92	7.59	211	135	5.9	79	287	11.3	0.58
Lulu	Site 2	8/25/05		2.00	30.91	7.58	211	135	7.0	82	292	11.5	0.58
Lulu	Site 2	8/25/05		2.50	30.91	7.56	211	135	5.7	87	295	12.1	0.58
Lulu	Site 2	8/25/05		3.00	30.82	6.67	312	200	0.3	4	138	>1000	0.58
Lulu	Site 2	8/25/05		3.09	30.72	6.49	328	210	0.2	2	116	>1000	0.58
Lulu	Site 3	8/25/05	10:05	0.25	31.21	7.59	203	130	5.8	80	319	12.3	0.56
Lulu	Site 3	8/25/05		0.50	31.19	7.55	202	129	5.7	77	322	11.8	0.56
Lulu	Site 3	8/25/05		1.00	31.14	7.51	204	131	5.6	76	324	12.3	0.56
Lulu	Site 3	8/25/05		1.50	31.08	7.45	203	130	5.4	72	323	12.3	0.56
Lulu	Site 3	8/25/05		1.82	31.05	7.38	202	129	5.2	69	322	177.8	0.56
May	Site 1	10/6/05	100404	0.25	27.25	7.73	222	142	7.6	96	164	7.7	0.54
May	Site 1	10/6/05	100533	0.50	27.26	7.66	222	142	7.5	94	166	8.2	0.54
May	Site 1	10/6/05	100620	1.00	27.22	7.57	221	141	7.2	91	165	8.9	0.54
May	Site 1	10/6/05	100659	1.50	27.21	7.56	222	142	7.1	89	166	13.3	0.54
May	Site 1	10/6/05	100837	1.55	27.20	7.33	238	152	5.4	69	127	206.0	0.54
May	Site 2	10/6/05	101416	0.25	27.43	7.75	219	140	7.4	93	152	7.9	0.54
May	Site 2	10/6/05	101507	0.50	27.40	7.72	219	140	7.2	92	153	8.5	0.54
May	Site 2	10/6/05	101543	1.00	27.36	7.65	220	141	7.0	89	153	8.5	0.54
May	Site 2	10/6/05	101622	1.50	27.33	7.56	220	141	6.7	85	151	9.6	0.54
May	Site 2	10/6/05	101757	1.66	27.32	7.50	220	141	6.5	82	153	17.7	0.54
Shipp	Site 1	10/6/05	103651	0.25	27.43	8.48	217	139	8.5	108	190	8.0	0.54
Shipp	Site 1	10/6/05	103736	0.50	27.43	8.49	218	140	8.5	107	190	9.6	0.54
Shipp	Site 1	10/6/05	103843	1.00	27.42	8.48	217	139	8.4	107	190	10.2	0.54
Shipp	Site 1	10/6/05	103946	1.50	27.36	8.36	218	140	8.0	102	188	11.3	0.54
Shipp	Site 1	10/6/05	104036	2.00	27.31	8.21	218	140	7.8	98	185	11.5	0.54
Shipp	Site 1	10/6/05	104242	2.50	27.41	6.38	333	213	0.5	6	39	>1000	0.54
Shipp	Site 1	10/6/05	104312	2.54	27.42	6.35	342	219	0.4	5	33	>1000	0.54
Shipp	Site 2	10/6/05	104751	0.25	27.11	7.74	218	140	7.0	88	90	11.2	0.54
Shipp	Site 2	10/6/05	104828	0.50	27.10	7.76	218	140	7.0	88	95	12.2	0.54
Shipp	Site 2	10/6/05	104905	1.00	27.10	7.74	219	140	7.0	88	98	11.9	0.54
Shipp	Site 2	10/6/05	104955	1.50	27.06	7.69	218	140	6.9	87	101	12.2	0.54
Shipp	Site 2	10/6/05	105106	2.00	26.98	7.53	218	140	6.5	81	103	13.5	0.54
Shipp	Site 2	10/6/05	105154	2.50	26.97	7.53	218	140	6.4	80	105	13.7	0.54
Shipp	Site 2	10/6/05	105331	3.00	26.93	7.33	219	140	5.4	68	90	306.0	0.54
Shipp	Site 2	10/6/05	105429	3.12	27.00	6.50	235	150	0.7	8	49	>1000	0.54
Shipp	Site 3	10/6/05	110104	0.25	27.21	7.35	219	140	5.7	72	102	7.8	0.54
Shipp	Site 3	10/6/05	110142	0.50	27.29	7.36	219	140	5.9	74	105	11.8	0.54
Shipp	Site 3	10/6/05	110234	1.00	27.06	7.27	219	140	5.2	65	105	13.3	0.54
Shipp	Site 3	10/6/05	110323	1.50	26.97	7.15	219	140	4.5	57	105	14.9	0.54
Shipp	Site 3	10/6/05	110425	1.69	26.96	7.12	218	140	4.4	55	106	16.4	0.54
Lulu	Site 3	10/6/05	111833	0.25	27.52	8.11	237	152	7.9	100	148	11.2	0.56
Lulu	Site 3	10/6/05	111919	0.50	27.50	8.10	237	152	7.9	101	150	9.5	0.56
Lulu	Site 3	10/6/05	112016	1.00	27.37	7.94	237	152	7.4	94	147	9.9	0.56
Lulu	Site 3	10/6/05	112116	1.50	27.30	7.44	237	152	6.1	77	137	12.6	0.56
Lulu	Site 3	10/6/05	112205	2.00	27.28	7.30	236	151	5.6	71	135	15.8	0.56
Lulu	Site 3	10/6/05	112243	2.13	27.28	7.31	236	151	5.6	71	136	17.2	0.56

Lake	Site	Date	Time	Level (m)	Temp (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (µg/l)	DO (mg/l)	DO (%Sat)	Redox (mV)	Turbidity (NTU)	Secchi (m)
Lulu	Site 1	10/6/05	112921	0.25	27.88	8.48	236	151	8.8	112	166	11.5	0.56
Lulu	Site 1	10/6/05	113018	0.50	27.83	8.47	236	151	8.7	111	165	11.6	0.56
Lulu	Site 1	10/6/05	113112	1.00	27.83	8.43	236	151	8.7	110	166	14.3	0.56
Lulu	Site 1	10/6/05	113149	1.50	27.79	8.37	236	151	8.5	108	165	12.5	0.56
Lulu	Site 1	10/6/05	113240	2.00	27.69	8.25	237	152	8.1	103	164	13.5	0.56
Lulu	Site 1	10/6/05	113508	2.50	27.65	6.52	273	175	0.3	4	108	>1000	0.56
Lulu	Site 1	10/6/05	113547	2.59	27.66	6.55	296	189	0.3	4	93	>1000	0.56
Lulu	Site 2	10/6/05	114238	0.25	28.00	7.54	241	154	6.7	86	127	13.9	0.52
Lulu	Site 2	10/6/05	114322	0.50	27.98	7.54	241	154	6.8	87	128	11.0	0.52
Lulu	Site 2	10/6/05	114419	1.00	27.47	7.35	239	153	5.8	74	125	9.9	0.52
Lulu	Site 2	10/6/05	114455	1.50	27.39	7.35	239	153	5.9	74	127	9.6	0.52
Lulu	Site 2	10/6/05	114542	2.00	27.15	7.30	239	153	5.5	69	125	73.0	0.52
Lulu	Site 2	10/6/05	114712	2.26	27.40	6.68	289	185	0.4	5	42	>1000	0.52
Lulu	Site 2	10/20/05	11:29	0.25	27.24	8.36	212	0	9.0	135	449	11.2	0.54
Lulu	Site 2	10/20/05	11:30	0.50	27.11	8.41	212	0	9.0	134	447	11.1	0.54
Lulu	Site 2	10/20/05	11:31	1.00	26.46	8.41	212	0	8.9	131	443	11.4	0.54
Lulu	Site 2	10/20/05	11:31	1.50	26.26	7.90	213	0	7.3	108	417	12.3	0.54
Lulu	Site 2	10/20/05	11:32	2.00	26.15	7.44	214	0	5.1	75	396	15.4	0.54
Lulu	Site 2	10/20/05	11:33	2.50	26.12	7.17	247	0	4.1	61	163	> 1000	0.54
Lulu	Site 2	10/20/05	11:34	2.78	26.24	6.76	326	0	0.6	9	126	> 1000	0.54
Lulu	Site 1	10/20/05	11:45	0.25	28.12	8.43	213	0	8.9	136	320	10.9	0.58
Lulu	Site 1	10/20/05	11:46	0.50	28.03	8.40	213	0	9.3	142	320	11.1	0.58
Lulu	Site 1	10/20/05	11:47	1.00	27.94	8.31	213	0	8.7	132	320	11.0	0.58
Lulu	Site 1	10/20/05	11:47	1.50	27.43	8.17	213	0	8.0	121	316	10.8	0.58
Lulu	Site 1	10/20/05	11:48	2.00	26.33	7.59	213	0	6.1	89	291	10.8	0.58
Lulu	Site 1	10/20/05	11:49	2.50	26.30	7.14	275	0	3.7	55	89	> 1000	0.58
Lulu	Site 1	10/20/05	11:50	2.84	26.44	6.90	314	0	0.3	4	96	> 1000	0.58
Lulu	Site 3	10/20/05	12:01	0.25	28.25	8.43	213	0	8.6	132	318	11.3	0.56
Lulu	Site 3	10/20/05	12:01	0.50	28.12	8.40	213	0	8.8	133	318	11.4	0.56
Lulu	Site 3	10/20/05	12:02	1.00	27.97	8.24	213	0	8.1	123	313	11.2	0.56
Lulu	Site 3	10/20/05	12:03	1.50	27.62	8.38	213	0	8.7	131	322	11.5	0.56
Lulu	Site 3	10/20/05	12:03	2.00	27.59	7.96	213	0	7.5	113	303	11.5	0.56
Lulu	Site 3	10/20/05	12:04	2.31	26.94	7.53	214	0	5.0	75	211	> 1000	0.56
Shipp	Site 3	10/20/05	12:18	0.25	26.23	8.63	193	0	8.6	127	350	15.0	0.42
Shipp	Site 3	10/20/05	12:19	0.50	26.16	8.53	193	0	8.2	120	347	14.4	0.42
Shipp	Site 3	10/20/05	12:19	1.00	26.01	8.43	194	0	8.1	118	343	15.0	0.42
Shipp	Site 3	10/20/05	12:20	1.50	25.84	7.77	194	0	6.4	93	314	21.3	0.42
Shipp	Site 3	10/20/05	12:21	2.00	25.83	7.69	194	0	6.3	92	313	25.7	0.42
Shipp	Site 3	10/20/05	12:22	2.14	25.84	7.65	194	0	6.3	92	310	40.8	0.42
Shipp	Site 2	10/20/05	12:26	0.25	27.02	8.85	193	0	9.5	142	369	14.7	0.43
Shipp	Site 2	10/20/05	12:27	0.50	26.93	8.88	192	0	9.6	142	371	15.0	0.43
Shipp	Site 2	10/20/05	12:28	1.00	26.60	8.75	193	0	8.9	132	365	14.8	0.43
Shipp	Site 2	10/20/05	12:28	1.50	26.48	8.70	193	0	8.6	127	364	14.2	0.43
Shipp	Site 2	10/20/05	12:29	2.00	26.37	8.69	193	0	8.6	127	364	14.2	0.43
Shipp	Site 2	10/20/05	12:29	2.50	25.97	8.10	194	0	7.0	102	337	14.7	0.43
Shipp	Site 2	10/20/05	12:30	3.00	25.94	7.88	194	0	6.4	94	329	17.1	0.43
Shipp	Site 2	10/20/05	12:31	3.50	25.92	7.78	194	0	6.2	90	325	20.5	0.43
Shipp	Site 2	10/20/05	12:32	3.71	25.91	7.66	194	0	6.0	88	250	> 1000	0.43
Shipp	Site 1	10/20/05	12:37	0.25	27.74	8.95	193	0	9.9	150	354	14.9	0.43
Shipp	Site 1	10/20/05	12:37	0.50	27.24	9.04	193	0	10.3	155	360	14.9	0.43
Shipp	Site 1	10/20/05	12:38	1.00	26.91	8.97	193	0	9.7	145	361	14.9	0.43
Shipp	Site 1	10/20/05	12:40	1.50	26.76	8.94	193	0	9.4	140	363	14.8	0.43
Shipp	Site 1	10/20/05	12:41	2.00	26.05	8.21	194	0	7.1	104	331	15.0	0.43
Shipp	Site 1	10/20/05	12:41	2.50	26.03	8.05	193	0	7.2	105	327	15.8	0.43
Shipp	Site 1	10/20/05	12:43	3.00	26.05	6.58	215	0	4.0	59	63	> 1000	0.43
Shipp	Site 1	10/20/05	12:44	3.34	26.27	6.36	317	0	0.2	3	101	> 1000	0.43
May	Site 2	10/20/05	12:52	0.25	27.27	8.62	198	0	9.7	146	315	14.8	0.43
May	Site 2	10/20/05	12:53	0.50	26.77	8.67	197	0	10.4	155	320	15.3	0.43
May	Site 2	10/20/05	12:53	1.00	26.35	8.40	198	0	9.4	139	310	15.7	0.43
May	Site 2	10/20/05	12:54	1.50	25.97	7.60	198	0	5.8	86	276	62.2	0.43
May	Site 2	10/20/05	12:56	1.75	25.98	6.92	369	0	0.6	9	138	> 1000	0.43
May	Site 1	10/20/05	13:01	0.25	28.30	8.76	198	0	10.2	156	311	15.0	0.47
May	Site 1	10/20/05	13:02	0.50	28.23	8.77	198	0	10.3	157	319	14.8	0.47
May	Site 1	10/20/05	13:03	1.00	26.13	7.92	197	0	7.6	111	283	17.3	0.47
May	Site 1	10/20/05	13:05	1.50	26.19	6.61	423	0	0.2	3	89	> 1000	0.47
May	Site 1	10/20/05	13:06	1.55	26.18	6.60	444	0	0.2	2	74	> 1000	0.47

Lake	Site	Date	Time	Level (m)	Temp (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (µg/l)	DO (mg/l)	DO (%Sat)	Redox (mV)	Turbidity (NTU)	Secchi (m)
May	Site 1	11/7/05	9:00	0.25	23.06	7.84	187	120	8.8	122	400	14.7	0.52
May	Site 1	11/7/05	9:01	0.50	22.86	7.75	187	120	8.5	117	397	14.8	0.52
May	Site 1	11/7/05	9:01	1.00	22.84	7.70	187	120	8.1	112	395	14.5	0.52
May	Site 1	11/7/05	9:02	1.50	22.73	7.63	187	119	7.8	107	392	14.2	0.52
May	Site 1	11/7/05	9:03	2.00	22.72	7.44	191	122	6.8	93	294	> 1000	0.52
May	Site 1	11/7/05	9:04	2.03	22.74	7.24	196	126	4.7	65	237	> 1000	0.52
May	Site 2	11/7/05	9:15	0.25	23.06	7.75	190	121	8.7	121	342	15.3	0.52
May	Site 2	11/7/05	9:16	0.50	23.05	7.73	190	121	8.7	120	342	15.4	0.52
May	Site 2	11/7/05	9:16	1.00	23.05	7.71	190	121	8.7	120	344	15.4	0.52
May	Site 2	11/7/05	9:17	1.50	23.03	7.69	190	121	8.5	118	344	15.1	0.52
May	Site 2	11/7/05	9:17	2.00	22.99	7.63	190	121	8.2	113	344	24.0	0.52
May	Site 2	11/7/05	9:19	2.19	23.01	7.10	230	147	2.9	40	261	> 1000	0.52
Shipp	Site 1	11/7/05	9:52	0.25	22.76	7.95	189	121	8.6	118	380	16.1	0.42
Shipp	Site 1	11/7/05	9:52	0.50	22.68	7.99	189	121	8.6	118	382	16.2	0.42
Shipp	Site 1	11/7/05	9:53	1.00	22.31	8.14	189	121	8.6	117	391	16.0	0.42
Shipp	Site 1	11/7/05	9:53	1.50	22.03	7.97	189	121	7.9	107	383	15.7	0.42
Shipp	Site 1	11/7/05	9:54	2.00	21.98	7.72	189	121	7.0	95	371	15.8	0.42
Shipp	Site 1	11/7/05	9:55	2.50	21.96	7.54	190	121	6.0	80	362	16.9	0.42
Shipp	Site 1	11/7/05	9:56	3.00	21.98	6.89	195	125	3.4	46	165	> 1000	0.42
Shipp	Site 1	11/7/05	9:57	3.34	22.05	6.61	279	178	0.6	8	175	> 1000	0.42
Shipp	Site 2	11/7/05	10:02	0.25	23.02	8.81	188	121	9.7	134	322	14.8	0.44
Shipp	Site 2	11/7/05	10:03	0.50	23.01	8.82	189	121	9.7	134	327	14.4	0.44
Shipp	Site 2	11/7/05	10:03	1.00	22.99	8.81	189	121	9.6	134	330	14.8	0.44
Shipp	Site 2	11/7/05	10:04	1.50	22.98	8.79	189	121	9.5	131	332	15.1	0.44
Shipp	Site 2	11/7/05	10:04	2.00	22.95	8.75	189	121	9.1	126	334	15.2	0.44
Shipp	Site 2	11/7/05	10:05	2.50	22.92	8.63	189	121	8.9	123	332	14.9	0.44
Shipp	Site 2	11/7/05	10:06	3.00	22.59	8.05	190	121	6.6	91	305	15.9	0.44
Shipp	Site 2	11/7/05	10:06	3.50	22.13	7.61	189	121	4.9	66	287	17.6	0.44
Shipp	Site 2	11/7/05	10:07	4.00	21.84	7.39	189	121	3.9	52	282	18.6	0.44
Shipp	Site 2	11/7/05	10:08	4.48	21.89	6.65	266	170	1.3	17	87	> 1000	0.44
Shipp	Site 3	11/7/05	10:14	0.25	22.91	8.74	188	121	9.7	134	299	15.2	0.45
Shipp	Site 3	11/7/05	10:14	0.50	22.90	8.76	189	121	9.4	131	305	15.1	0.45
Shipp	Site 3	11/7/05	10:15	1.00	22.88	8.77	189	121	9.7	134	312	15.0	0.45
Shipp	Site 3	11/7/05	10:16	1.50	22.84	8.75	189	121	9.5	132	315	15.0	0.45
Shipp	Site 3	11/7/05	10:16	2.00	22.84	8.74	189	121	9.2	128	319	15.3	0.45
Shipp	Site 3	11/7/05	10:17	2.50	22.79	8.72	189	121	9.4	129	322	22.1	0.45
Shipp	Site 3	11/7/05	10:17	2.68	22.78	8.69	189	121	9.4	129	320	> 1000	0.45
Lulu	Site 2	11/7/05	12:03	0.25	23.48	8.45	205	131	9.5	133	399	11.3	0.59
Lulu	Site 2	11/7/05	12:03	0.50	23.48	8.46	205	131	9.6	134	400	11.3	0.59
Lulu	Site 2	11/7/05	12:04	1.00	23.42	8.46	205	131	9.6	134	400	11.3	0.59
Lulu	Site 2	11/7/05	12:05	1.50	22.68	7.92	204	131	7.9	109	372	12.1	0.59
Lulu	Site 2	11/7/05	12:05	2.00	22.36	7.68	205	131	6.6	90	360	13.4	0.59
Lulu	Site 2	11/7/05	12:06	2.50	22.15	7.55	206	132	7.1	96	355	196.2	0.59
Lulu	Site 2	11/7/05	12:08	2.81	22.36	6.55	388	248	0.3	4	140	> 1000	0.59
Lulu	Site 1	11/7/05	12:12	0.25	23.43	8.13	205	131	9.0	126	288	12.1	0.56
Lulu	Site 1	11/7/05	12:13	0.50	23.42	8.13	205	131	8.9	124	295	12.3	0.56
Lulu	Site 1	11/7/05	12:13	1.00	23.11	7.96	205	131	8.2	114	291	12.3	0.56
Lulu	Site 1	11/7/05	12:14	1.50	22.78	7.62	205	131	6.3	87	280	12.1	0.56
Lulu	Site 1	11/7/05	12:15	2.00	22.09	7.45	205	131	5.7	77	276	13.6	0.56
Lulu	Site 1	11/7/05	12:15	2.50	22.03	7.36	205	131	5.5	75	275	16.0	0.56
Lulu	Site 1	11/7/05	12:17	2.93	22.20	6.56	289	185	0.7	9	151	> 1000	0.56
Lulu	Site 3	11/7/05	12:23	0.25	23.83	8.46	205	131	9.3	131	318	14.0	0.57
Lulu	Site 3	11/7/05	12:24	0.50	23.83	8.46	205	131	9.3	131	321	11.5	0.57
Lulu	Site 3	11/7/05	12:24	1.00	23.81	8.46	205	131	9.3	130	323	11.5	0.57
Lulu	Site 3	11/7/05	12:25	1.50	23.76	8.43	205	131	9.2	129	324	11.6	0.57
Lulu	Site 3	11/7/05	12:25	2.00	23.54	7.98	205	131	7.6	106	306	11.4	0.57
Lulu	Site 3	11/7/05	12:26	2.50	22.87	7.52	203	130	3.3	45	284	15.9	0.57
Lulu	Site 3	11/7/05	12:27	2.64	22.80	7.24	205	131	2.6	36	271	680.9	0.57
May	Site 1	11/22/05	7:46	0.25	20.12	7.31	195	0	7.8	103	367	17.1	0.47
May	Site 1	11/22/05	7:46	0.50	20.13	7.31	195	0	7.7	101	368	17.1	0.47
May	Site 1	11/22/05	7:47	1.00	20.12	7.33	195	0	7.6	99	368	16.9	0.47
May	Site 1	11/22/05	7:48	1.50	20.13	7.33	195	0	7.5	98	369	17.8	0.47
May	Site 1	11/22/05	7:50	1.89	20.15	6.94	222	0	5.0	65	194	>1000	0.47
May	Site 2	11/22/05	8:06	0.25	20.25	7.40	196	0	7.5	98	299	16.4	0.47
May	Site 2	11/22/05	8:07	0.50	20.24	7.42	196	0	7.5	98	301	16.3	0.47
May	Site 2	11/22/05	8:08	1.00	20.24	7.42	195	0	7.5	99	302	16.2	0.47
May	Site 2	11/22/05	8:08	1.50	20.23	7.42	196	0	7.5	99	304	15.9	0.47
May	Site 2	11/22/05	8:09	2.00	20.20	7.40	195	0	7.4	98	292	245.2	0.47
May	Site 2	11/22/05	8:11	2.13	20.65	7.04	244	0	0.4	5	138	>1000	0.47

Lake	Site	Date	Time	Level (m)	Temp (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (µg/l)	DO (mg/l)	DO (%Sat)	Redox (mV)	Turbidity (NTU)	Secchi (m)
Shipp	Site 1	11/22/05	8:51	0.25	20.57	7.79	193	0	8.4	111	340	20.0	0.42
Shipp	Site 1	11/22/05	8:51	0.50	20.58	7.87	193	0	8.3	110	341	20.4	0.42
Shipp	Site 1	11/22/05	8:52	1.00	20.58	7.90	193	0	8.2	109	343	20.0	0.42
Shipp	Site 1	11/22/05	8:53	1.50	20.58	7.90	193	0	8.2	108	344	19.6	0.42
Shipp	Site 1	11/22/05	8:53	2.00	20.58	7.91	193	0	8.1	108	345	19.8	0.42
Shipp	Site 1	11/22/05	8:54	2.50	20.58	7.88	193	0	8.2	108	346	19.6	0.42
Shipp	Site 1	11/22/05	8:55	3.00	21.44	6.47	383	0	0.5	7	187	>1000	0.42
Shipp	Site 1	11/22/05	8:56	3.25	21.42	6.45	379	0	0.3	4	117	>1000	0.42
Shipp	Site 2	11/22/05	9:04	0.25	20.91	7.85	194	0	8.4	111	286	20.5	0.45
Shipp	Site 2	11/22/05	9:05	0.50	20.89	7.96	193	0	8.3	110	295	20.1	0.45
Shipp	Site 2	11/22/05	9:05	1.00	20.87	7.98	193	0	8.3	110	299	20.0	0.45
Shipp	Site 2	11/22/05	9:06	1.50	20.87	7.97	193	0	8.2	109	302	19.9	0.45
Shipp	Site 2	11/22/05	9:06	2.00	20.83	7.95	192	0	8.2	109	305	19.7	0.45
Shipp	Site 2	11/22/05	9:07	2.50	20.82	7.94	192	0	8.2	109	308	19.6	0.45
Shipp	Site 2	11/22/05	9:08	3.00	20.80	7.92	193	0	8.1	108	310	19.5	0.45
Shipp	Site 2	11/22/05	9:08	3.50	20.75	7.90	193	0	8.0	107	313	19.5	0.45
Shipp	Site 2	11/22/05	9:09	3.64	20.75	7.90	193	0	8.0	107	314	20.2	0.45
Shipp	Site 3	11/22/05	9:15	0.25	20.08	7.72	193	0	8.1	106	323	21.5	0.44
Shipp	Site 3	11/22/05	9:15	0.50	20.10	7.76	193	0	8.0	105	325	21.1	0.44
Shipp	Site 3	11/22/05	9:16	1.00	20.12	7.77	192	0	8.1	105	327	20.3	0.44
Shipp	Site 3	11/22/05	9:17	1.50	20.10	7.76	192	0	8.0	105	327	20.0	0.44
Shipp	Site 3	11/22/05	9:17	2.00	20.05	7.76	192	0	8.0	105	328	20.5	0.44
Shipp	Site 3	11/22/05	9:18	2.50	20.07	7.75	193	0	7.8	102	329	20.7	0.44
Shipp	Site 3	11/22/05	9:19	2.88	21.00	7.07	193	0	0.5	7	109	>1000	0.44
Lulu	Site 3	11/22/05	10:17	0.25	20.35	7.60	209	0	7.8	103	341	16.4	0.48
Lulu	Site 3	11/22/05	10:17	0.50	20.36	7.61	209	0	7.7	102	340	16.7	0.48
Lulu	Site 3	11/22/05	10:18	1.00	20.31	7.63	209	0	7.6	100	342	16.1	0.48
Lulu	Site 3	11/22/05	10:18	1.50	20.22	7.58	209	0	7.5	99	341	15.2	0.48
Lulu	Site 3	11/22/05	10:19	2.00	20.20	7.56	209	0	7.5	99	341	14.8	0.48
Lulu	Site 3	11/22/05	10:20	2.30	20.14	7.51	208	0	6.8	89	340	>1000	0.48
Lulu	Site 1	11/22/05	10:31	0.25	20.19	7.77	209	0	8.4	110	356	18.5	0.45
Lulu	Site 1	11/22/05	10:31	0.50	20.22	7.80	209	0	8.1	107	357	18.4	0.45
Lulu	Site 1	11/22/05	10:32	1.00	20.22	7.83	209	0	8.1	107	357	18.3	0.45
Lulu	Site 1	11/22/05	10:33	1.50	20.22	7.82	209	0	7.9	104	358	18.1	0.45
Lulu	Site 1	11/22/05	10:33	2.00	20.22	7.78	209	0	8.1	106	358	18.2	0.45
Lulu	Site 1	11/22/05	10:34	2.50	20.23	7.80	209	0	7.9	104	352	109.7	0.45
Lulu	Site 1	11/22/05	10:36	2.78	21.80	6.63	422	0	0.3	4	93	>1000	0.45
Lulu	Site 2	11/22/05	10:44	0.25	20.09	7.57	208	0	7.6	100	287	20.4	0.47
Lulu	Site 2	11/22/05	10:45	0.50	20.09	7.59	208	0	7.6	99	291	18.7	0.47
Lulu	Site 2	11/22/05	10:46	1.00	20.10	7.59	208	0	7.7	101	297	19.5	0.47
Lulu	Site 2	11/22/05	10:47	1.50	20.09	7.59	208	0	7.5	99	301	19.1	0.47
Lulu	Site 2	11/22/05	10:47	2.00	20.09	7.59	208	0	7.5	99	303	18.9	0.47
Lulu	Site 2	11/22/05	10:48	2.50	20.65	7.05	259	0	0.7	10	177	>1000	0.47
Lulu	Site 2	11/22/05	10:49	2.55	21.09	6.94	418	0	0.3	4	96	>1000	0.47
May	Site 1	11/29/05	8:51	0.25	20.56	7.44	190	122	7.7	102	374	12.9	0.64
May	Site 1	11/29/05	8:52	0.50	20.56	7.40	191	122	7.3	97	371	13.0	0.64
May	Site 1	11/29/05	8:52	1.00	20.55	7.39	190	122	7.3	96	371	13.2	0.64
May	Site 1	11/29/05	8:53	1.50	20.55	7.37	191	122	7.2	95	370	13.2	0.64
May	Site 1	11/29/05	8:53	2.00	20.54	7.35	190	122	7.1	94	370	13.2	0.64
May	Site 1	11/29/05	8:55	2.25	20.52	7.12	190	122	0.7	9	247	>1000	0.64
May	Site 2	11/29/05	9:06	0.25	20.83	7.46	196	125	7.2	96	312	13.7	0.63
May	Site 2	11/29/05	9:07	0.50	20.83	7.41	196	126	7.1	95	313	13.9	0.63
May	Site 2	11/29/05	9:07	1.00	20.83	7.39	197	126	7.1	95	316	14.2	0.63
May	Site 2	11/29/05	9:08	1.50	20.83	7.38	196	126	7.0	93	318	14.5	0.63
May	Site 2	11/29/05	9:09	2.00	20.83	7.34	196	126	6.9	92	320	119.6	0.63
May	Site 2	11/29/05	9:11	2.17	20.89	6.88	270	173	0.5	6	185	>1000	0.63
Shipp	Site 1	11/29/05	9:19	0.25	20.58	7.74	194	124	8.2	109	290	17.4	0.52
Shipp	Site 1	11/29/05	9:20	0.50	20.57	7.73	194	124	8.0	106	294	17.4	0.52
Shipp	Site 1	11/29/05	9:21	1.00	20.57	7.74	194	124	8.0	105	299	17.9	0.52
Shipp	Site 1	11/29/05	9:21	1.50	20.58	7.75	194	124	7.8	103	302	17.9	0.52
Shipp	Site 1	11/29/05	9:22	2.00	20.57	7.72	194	124	7.9	105	304	18.0	0.52
Shipp	Site 1	11/29/05	9:22	2.50	20.57	7.75	194	124	7.7	102	308	17.7	0.52
Shipp	Site 1	11/29/05	9:23	3.00	20.57	7.65	194	124	5.8	77	267	>1000	0.52
Shipp	Site 1	11/29/05	9:25	3.37	20.84	6.49	295	189	0.5	7	82	>1000	0.52
May	Site 1	12/14/05	8:14	0.25	16.24	7.52	192	123	9.4	114	369	16.0	0.49
May	Site 1	12/14/05	8:15	0.50	16.23	7.50	192	123	8.9	108	369	13.7	0.49
May	Site 1	12/14/05	8:16	1.00	16.21	7.50	193	123	8.8	107	370	13.8	0.49
May	Site 1	12/14/05	8:16	1.50	16.19	7.51	193	123	8.6	103	370	13.9	0.49
May	Site 1	12/14/05	8:21	1.86	16.42	7.22	216	138	3.5	42	309	>1000	0.49

Lake	Site	Date	Time	Level (m)	Temp (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (µg/l)	DO (mg/l)	DO (%Sat)	Redox (mV)	Turbidity (NTU)	Secchi (m)
May	Site 2	12/14/05	8:32	0.25	16.16	7.54	196	125	8.9	107	346	14.7	0.51
May	Site 2	12/14/05	8:33	0.50	16.17	7.55	196	125	8.7	106	348	14.6	0.51
May	Site 2	12/14/05	8:34	1.00	16.09	7.52	195	125	8.4	101	348	14.8	0.51
May	Site 2	12/14/05	8:35	1.50	15.97	7.47	195	125	7.7	93	347	14.5	0.51
May	Site 2	12/14/05	8:40	2.00	16.14	7.14	233	149	0.5	6	292	>1000	0.51
Shipp	Site 1	12/14/05	8:48	0.25	16.89	8.00	194	124	9.2	113	344	20.2	0.39
Shipp	Site 1	12/14/05	8:49	0.50	16.89	8.06	194	124	8.9	109	347	19.8	0.39
Shipp	Site 1	12/14/05	8:50	1.00	16.85	8.04	194	124	8.8	108	349	19.8	0.39
Shipp	Site 1	12/14/05	8:50	1.50	16.82	7.99	194	124	8.5	104	348	20.1	0.39
Shipp	Site 1	12/14/05	8:51	2.00	16.67	7.90	194	124	8.3	101	346	19.9	0.39
Shipp	Site 1	12/14/05	8:52	2.50	16.55	7.82	194	124	7.9	97	345	20.0	0.39
Shipp	Site 1	12/14/05	8:54	3.00	17.92	6.54	393	252	1.0	13	75	>1000	0.39
Shipp	Site 1	12/14/05	8:55	3.20	17.87	6.51	398	255	0.5	7	62	>1000	0.39
Shipp	Site 2	12/14/05	9:01	0.25	16.89	8.00	195	125	9.2	113	260	19.2	0.39
Shipp	Site 2	12/14/05	9:02	0.50	16.84	8.02	195	125	9.1	111	268	19.2	0.39
Shipp	Site 2	12/14/05	9:02	1.00	16.81	7.98	195	125	8.6	105	272	20.2	0.39
Shipp	Site 2	12/14/05	9:03	1.50	16.81	7.93	195	125	8.6	105	276	20.9	0.39
Shipp	Site 2	12/14/05	9:04	2.00	16.80	7.92	195	125	8.4	102	280	21.3	0.39
Shipp	Site 2	12/14/05	9:05	2.50	16.78	7.91	195	125	8.2	101	285	22.3	0.39
Shipp	Site 2	12/14/05	9:06	3.00	16.67	7.86	195	125	8.2	100	287	22.2	0.39
Shipp	Site 2	12/14/05	9:06	3.50	16.69	7.80	195	125	8.2	100	288	23.3	0.39
Shipp	Site 2	12/14/05	9:07	4.00	16.91	7.21	203	130	3.6	44	137	>1000	0.39
Shipp	Site 2	12/14/05	9:10	4.18	17.72	6.66	207	133	0.5	7	160	>1000	0.39
Shipp	Site 3	12/14/05	9:16	0.25	16.55	7.77	195	125	8.9	108	282	19.8	0.37
Shipp	Site 3	12/14/05	9:17	0.50	16.59	7.81	195	125	8.8	107	287	19.9	0.37
Shipp	Site 3	12/14/05	9:18	1.00	16.53	7.85	195	125	8.6	104	290	20.0	0.37
Shipp	Site 3	12/14/05	9:19	1.50	16.43	7.82	195	125	8.4	102	293	20.0	0.37
Shipp	Site 3	12/14/05	9:20	2.00	16.41	7.80	195	125	8.2	100	295	20.7	0.37
Shipp	Site 3	12/14/05	9:21	2.50	16.40	7.74	195	125	7.8	94	291	71.9	0.37
Shipp	Site 3	12/14/05	9:24	2.85	16.62	7.00	203	130	3.0	37	173	>1000	0.37
Lulu	Site 3	12/14/05	9:37	0.25	17.03	7.46	212	135	7.7	94	291	11.3	0.62
Lulu	Site 3	12/14/05	9:38	0.50	16.96	7.46	212	136	7.3	90	292	11.1	0.62
Lulu	Site 3	12/14/05	9:39	1.00	16.91	7.48	212	135	6.8	83	293	11.4	0.62
Lulu	Site 3	12/14/05	9:39	1.50	16.44	7.44	211	135	6.2	75	293	11.1	0.62
Lulu	Site 3	12/14/05	9:40	2.00	16.25	7.35	211	135	5.9	71	292	10.8	0.62
Lulu	Site 3	12/14/05	9:42	2.26	16.25	7.23	211	135	5.1	62	290	>1000	0.62
Lulu	Site 1	12/14/05	9:55	0.25	17.02	7.65	212	135	8.4	103	324	11.3	0.63
Lulu	Site 1	12/14/05	9:55	0.50	16.96	7.66	211	135	8.2	101	325	11.7	0.63
Lulu	Site 1	12/14/05	9:56	1.00	16.73	7.64	211	135	8.0	98	325	11.7	0.63
Lulu	Site 1	12/14/05	9:57	1.50	16.61	7.59	211	135	7.5	92	323	12.0	0.63
Lulu	Site 1	12/14/05	9:58	2.00	16.58	7.51	212	135	7.1	87	322	12.3	0.63
Lulu	Site 1	12/14/05	10:00	2.50	17.50	7.05	388	248	0.6	8	161	>1000	0.63
Lulu	Site 1	12/14/05	10:01	2.64	17.46	7.08	386	247	0.5	6	141	>1000	0.63
Lulu	Site 2	12/14/05	10:07	0.25	16.81	7.91	210	134	9.0	110	277	11.2	0.57
Lulu	Site 2	12/14/05	10:08	0.50	16.62	7.98	210	134	8.9	108	283	11.6	0.57
Lulu	Site 2	12/14/05	10:09	1.00	16.55	7.98	210	135	8.6	105	288	11.7	0.57
Lulu	Site 2	12/14/05	10:09	1.50	16.50	7.95	210	134	8.8	108	291	11.9	0.57
Lulu	Site 2	12/14/05	10:10	2.00	16.48	7.91	211	135	8.7	106	292	12.7	0.57
Lulu	Site 2	12/14/05	10:12	2.50	16.74	7.55	238	152	5.6	68	209	>1000	0.57
Lulu	Site 2	12/14/05	10:17	2.66	17.52	7.25	269	172	1.9	24	246	>1000	0.57
May	Site 1	12/28/05	8:55	0.25	15.01	7.67	199	127	9.2	108	475	14.2	0.58
May	Site 1	12/28/05	8:56	0.50	15.00	7.69	199	127	9.0	106	474	13.9	0.58
May	Site 1	12/28/05	8:57	1.00	14.99	7.70	199	127	8.9	104	475	13.8	0.58
May	Site 1	12/28/05	8:58	1.50	14.92	7.69	198	127	8.9	104	474	14.0	0.58
May	Site 1	12/28/05	8:59	2.00	14.89	7.66	199	127	7.9	93	473	55.8	0.58
May	Site 1	12/28/05	9:04	2.17	15.55	7.17	207	132	0.9	11	283	>1000	0.58
May	Site 2	12/28/05	9:15	0.25	15.24	7.55	198	127	8.1	96	408	14.8	0.56
May	Site 2	12/28/05	9:15	0.50	15.18	7.55	198	127	8.0	95	413	15.2	0.56
May	Site 2	12/28/05	9:16	1.00	15.09	7.51	198	127	7.7	91	419	14.8	0.56
May	Site 2	12/28/05	9:17	1.50	15.03	7.40	199	127	6.9	81	422	14.2	0.56
May	Site 2	12/28/05	9:18	2.00	15.00	7.32	200	128	6.7	79	425	14.1	0.56
May	Site 2	12/28/05	9:23	2.38	15.12	6.97	397	254	0.5	6	303	>1000	0.56
Shipp	Site 1	12/28/05	10:12	0.25	15.48	8.30	198	127	10.8	129	494	18.2	0.43
Shipp	Site 1	12/28/05	10:13	0.50	15.48	8.33	198	127	10.6	126	495	18.1	0.43
Shipp	Site 1	12/28/05	10:14	1.00	15.42	8.34	199	127	9.9	118	495	18.0	0.43
Shipp	Site 1	12/28/05	10:15	1.50	15.38	8.35	199	127	10.6	126	495	18.4	0.43
Shipp	Site 1	12/28/05	10:17	2.00	15.36	8.35	199	127	10.5	125	495	18.5	0.43
Shipp	Site 1	12/28/05	10:19	2.50	15.31	8.34	199	127	9.8	117	496	18.5	0.43
Shipp	Site 1	12/28/05	10:21	3.00	15.08	7.69	208	133	9.0	106	256	>1000	0.43
Shipp	Site 1	12/28/05	10:25	3.40	15.43	6.72	449	287	0.6	7	223	>1000	0.43

Lake	Site	Date	Time	Level (m)	Temp (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (µg/l)	DO (mg/l)	DO (%Sat)	Redox (mV)	Turbidity (NTU)	Secchi (m)
Shipp	Site 2	12/28/05	10:36	0.25	15.64	7.87	199	127	9.6	115	361	19.2	0.40
Shipp	Site 2	12/28/05	10:37	0.50	15.58	7.89	199	127	9.7	115	366	19.7	0.40
Shipp	Site 2	12/28/05	10:37	1.00	15.54	7.88	199	127	9.4	113	368	19.9	0.40
Shipp	Site 2	12/28/05	10:38	1.50	15.41	7.84	199	127	9.5	113	370	20.1	0.40
Shipp	Site 2	12/28/05	10:39	2.00	15.35	7.82	199	127	9.5	113	374	19.7	0.40
Shipp	Site 2	12/28/05	10:39	2.50	15.34	7.82	199	127	9.8	116	378	19.4	0.40
Shipp	Site 2	12/28/05	10:40	3.00	15.27	7.83	199	127	9.9	117	381	19.3	0.40
Shipp	Site 2	12/28/05	10:41	3.50	15.26	7.82	199	127	9.9	117	387	19.6	0.40
Shipp	Site 2	12/28/05	10:43	4.00	15.27	7.80	199	127	9.7	115	321	28.1	0.40
Shipp	Site 2	12/28/05	10:46	4.40	16.22	6.61	213	137	0.6	8	183	>1000	0.40
Shipp	Site 3	12/28/05	11:00	0.25	15.63	8.37	198	127	11.0	132	378	18.2	0.40
Shipp	Site 3	12/28/05	11:01	0.50	15.74	8.40	198	127	11.1	132	383	18.7	0.40
Shipp	Site 3	12/28/05	11:03	1.00	15.50	8.30	199	127	9.9	118	387	18.7	0.40
Shipp	Site 3	12/28/05	11:04	1.50	15.47	8.22	199	127	9.7	115	392	19.4	0.40
Shipp	Site 3	12/28/05	11:05	2.00	15.27	7.97	201	129	9.1	108	385	19.5	0.40
Shipp	Site 3	12/28/05	11:06	2.50	15.09	7.81	206	132	9.3	110	384	19.6	0.40
Shipp	Site 3	12/28/05	11:07	3.00	15.00	7.59	207	132	8.1	95	324	>1000	0.40
Shipp	Site 3	12/28/05	11:09	3.00	15.00	7.38	211	135	5.4	63	199	>1000	0.40
Shipp	Site 3	12/28/05	11:11	3.09	15.47	7.10	232	148	0.5	6	122	>1000	0.40
Lulu	Site 3	12/28/05	12:18	0.25	15.66	7.65	214	137	8.5	102	444	10.2	0.45
Lulu	Site 3	12/28/05	12:19	0.50	15.55	7.64	214	137	8.4	100	444	10.3	0.45
Lulu	Site 3	12/28/05	12:20	1.00	15.56	7.66	214	137	8.3	99	445	10.2	0.45
Lulu	Site 3	12/28/05	12:21	1.50	15.42	7.67	214	137	8.4	99	448	10.4	0.45
Lulu	Site 3	12/28/05	12:21	2.00	15.36	7.68	214	137	8.4	99	448	11.2	0.45
Lulu	Site 3	12/28/05	12:22	2.50	15.16	7.71	214	137	8.8	104	451	12.6	0.45
Lulu	Site 3	12/28/05	12:27	2.78	15.09	7.71	213	136	4.5	53	454	>1000	0.45
Lulu	Site 1	12/28/05	12:35	0.25	15.87	8.26	214	137	10.1	122	474	11.2	0.61
Lulu	Site 1	12/28/05	12:36	0.50	15.88	8.30	214	137	9.9	119	474	10.3	0.61
Lulu	Site 1	12/28/05	12:37	1.00	15.81	8.32	213	137	9.9	119	475	10.4	0.61
Lulu	Site 1	12/28/05	12:38	1.50	15.77	8.33	214	137	9.9	119	475	10.3	0.61
Lulu	Site 1	12/28/05	12:39	2.00	15.73	8.33	214	137	9.9	119	475	10.5	0.61
Lulu	Site 1	12/28/05	12:40	2.50	15.59	8.20	214	137	9.7	116	470	11.3	0.61
Lulu	Site 1	12/28/05	12:42	2.85	15.95	7.17	382	244	0.6	7	219	>1000	0.61
Lulu	Site 2	12/28/05	12:49	0.25	16.13	8.16	215	137	9.8	118	350	10.5	0.62
Lulu	Site 2	12/28/05	12:49	0.50	16.11	8.18	215	137	9.6	116	355	10.6	0.62
Lulu	Site 2	12/28/05	12:51	1.00	16.10	8.21	215	137	9.5	115	366	10.9	0.62
Lulu	Site 2	12/28/05	12:51	1.50	16.06	8.21	215	137	9.6	116	372	10.9	0.62
Lulu	Site 2	12/28/05	12:52	2.00	16.04	8.22	215	138	9.6	116	377	11.1	0.62
Lulu	Site 2	12/28/05	12:55	2.50	16.19	7.18	422	270	0.7	8	136	>1000	0.62
Lulu	Site 2	12/28/05	12:56	2.66	16.21	7.14	419	268	0.4	5	122	>1000	0.62
Lulu	Site 2	1/3/06	9:32	0.25	19.09	7.97	218	139	9.0	116	462	11.4	0.67
Lulu	Site 2	1/3/06	9:33	0.50	19.08	8.01	218	140	9.1	116	466	11.3	0.67
Lulu	Site 2	1/3/06	9:34	1.00	19.08	8.05	218	139	8.9	114	469	11.3	0.67
Lulu	Site 2	1/3/06	9:35	1.50	19.08	8.07	218	139	8.7	112	470	11.5	0.67
Lulu	Site 2	1/3/06	9:36	2.00	19.08	8.07	218	139	8.7	111	471	11.8	0.67
Lulu	Site 2	1/3/06	9:37	2.50	19.08	8.07	218	139	8.7	112	472	11.7	0.67
Lulu	Site 2	1/3/06	9:41	2.91	18.51	6.73	493	316	0.6	7	104	>1000	0.67
Lulu	Site 1	1/3/06	9:48	0.25	18.95	7.93	218	139	8.9	113	325	10.4	0.68
Lulu	Site 1	1/3/06	9:49	0.50	18.95	7.98	218	139	8.8	112	336	10.5	0.68
Lulu	Site 1	1/3/06	9:50	1.00	18.94	7.99	218	139	8.6	111	341	10.4	0.68
Lulu	Site 1	1/3/06	9:51	1.50	18.92	7.99	217	139	8.6	109	345	10.4	0.68
Lulu	Site 1	1/3/06	9:51	2.00	18.91	7.98	218	139	8.6	109	350	10.4	0.68
Lulu	Site 1	1/3/06	9:52	2.50	18.91	7.97	218	139	8.6	110	354	10.4	0.68
Lulu	Site 1	1/3/06	9:55	3.00	18.67	7.03	312	199	0.7	9	247	>1000	0.68
Lulu	Site 1	1/3/06	9:56	3.45	18.61	7.01	350	224	0.5	6	250	>1000	0.68
Lulu	Site 3	1/3/06	10:07	0.25	18.83	7.54	218	140	7.5	96	352	10.2	0.67
Lulu	Site 3	1/3/06	10:08	0.50	18.85	7.53	218	140	7.5	96	356	10.0	0.67
Lulu	Site 3	1/3/06	10:09	1.00	18.80	7.53	218	140	7.3	93	360	10.1	0.67
Lulu	Site 3	1/3/06	10:09	1.50	18.77	7.52	218	140	7.2	92	362	10.4	0.67
Lulu	Site 3	1/3/06	10:10	2.00	18.72	7.51	218	140	7.2	92	366	10.3	0.67
Lulu	Site 3	1/3/06	10:11	2.50	18.50	7.41	218	140	5.6	71	365	10.6	0.67
Lulu	Site 3	1/3/06	10:13	2.89	17.51	7.22	219	140	3.7	46	361	14.2	0.67
Shipp	Site 3	1/3/06	11:11	0.25	19.04	8.08	201	128	9.5	121	461	19.2	0.48
Shipp	Site 3	1/3/06	11:12	0.50	19.01	8.11	201	129	9.1	116	462	18.1	0.48
Shipp	Site 3	1/3/06	11:13	1.00	19.01	8.13	201	128	8.8	112	464	18.6	0.48
Shipp	Site 3	1/3/06	11:14	1.50	18.96	8.13	201	128	8.7	111	464	18.5	0.48
Shipp	Site 3	1/3/06	11:14	2.00	18.86	8.09	201	129	8.6	110	462	18.9	0.48
Shipp	Site 3	1/3/06	11:16	2.30	18.74	7.93	201	129	8.0	102	456	29.7	0.48

Lake	Site	Date	Time	Level (m)	Temp (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (µg/l)	DO (mg/l)	DO (%Sat)	Redox (mV)	Turbidity (NTU)	Secchi (m)
Shipp	Site 2	1/3/06	11:21	0.25	19.21	8.25	200	128	9.2	118	469	19.9	0.44
Shipp	Site 2	1/3/06	11:22	0.50	19.22	8.29	200	128	9.1	117	470	17.3	0.44
Shipp	Site 2	1/3/06	11:23	1.00	19.24	8.32	200	128	9.0	115	471	17.6	0.44
Shipp	Site 2	1/3/06	11:24	1.50	19.19	8.32	201	128	8.9	114	471	17.6	0.44
Shipp	Site 2	1/3/06	11:25	2.00	19.00	8.23	201	129	8.8	113	467	17.4	0.44
Shipp	Site 2	1/3/06	11:25	2.50	18.98	8.20	201	128	8.6	110	467	17.4	0.44
Shipp	Site 2	1/3/06	11:30	3.00	18.52	7.99	200	128	7.9	100	381	23.9	0.44
Shipp	Site 2	1/3/06	11:31	3.50	17.54	7.67	201	129	5.7	70	380	24.5	0.44
Shipp	Site 2	1/3/06	11:32	4.00	17.16	7.50	201	129	4.9	60	382	22.1	0.44
Shipp	Site 2	1/3/06	11:35	4.41	17.20	6.83	258	165	0.8	10	108	>1000	0.44
Shipp	Site 1	1/3/06	11:40	0.25	19.52	8.50	200	128	9.4	122	331	21.4	0.44
Shipp	Site 1	1/3/06	11:41	0.50	19.50	8.55	200	128	9.4	122	339	18.6	0.44
Shipp	Site 1	1/3/06	11:42	1.00	19.44	8.56	200	128	9.1	118	345	18.5	0.44
Shipp	Site 1	1/3/06	11:43	1.50	19.39	8.57	200	128	9.3	120	351	18.6	0.44
Shipp	Site 1	1/3/06	11:43	2.00	19.37	8.57	200	128	9.0	117	355	18.9	0.44
Shipp	Site 1	1/3/06	11:44	2.50	19.34	8.55	200	128	9.1	118	359	19.2	0.44
Shipp	Site 1	1/3/06	11:45	3.00	19.32	8.51	200	128	9.1	117	364	23.4	0.44
Shipp	Site 1	1/3/06	11:49	3.45	18.40	6.55	552	353	0.8	10	80	>1000	0.44
May	Site 1	1/3/06	13:03	0.25	20.65	7.88	201	129	9.1	120	440	15.9	0.46
May	Site 1	1/3/06	13:04	0.50	20.64	7.86	201	129	9.0	119	441	14.9	0.46
May	Site 1	1/3/06	13:05	1.00	20.64	7.86	202	129	8.8	117	442	15.1	0.46
May	Site 1	1/3/06	13:05	1.50	20.61	7.86	201	129	8.8	117	443	15.4	0.46
May	Site 1	1/3/06	13:07	2.00	19.35	7.65	195	125	7.6	98	352	>1000	0.46
May	Site 1	1/3/06	13:09	2.11	19.56	6.88	313	200	0.7	8	170	>1000	0.46
May	Site 2	1/3/06	13:18	0.25	20.58	7.73	201	129	8.6	114	335	14.6	0.42
May	Site 2	1/3/06	13:19	0.50	20.59	7.71	201	129	8.5	113	340	14.9	0.42
May	Site 2	1/3/06	13:20	1.00	20.57	7.71	201	129	8.4	111	345	15.1	0.42
May	Site 2	1/3/06	13:21	1.50	20.55	7.70	202	129	8.3	110	350	15.2	0.42
May	Site 2	1/3/06	13:21	2.00	19.34	7.63	197	126	7.7	99	352	23.8	0.42
May	Site 2	1/3/06	13:23	2.21	19.26	7.17	300	192	0.8	11	152	>1000	0.42
Lulu	Site 2	1/12/06	8:59	0.25	17.28	7.97	220	141	8.6	107	443	9.6	0.67
Lulu	Site 2	1/12/06	9:00	0.50	17.06	7.96	220	141	8.5	105	440	9.6	0.67
Lulu	Site 2	1/12/06	9:00	1.00	16.81	8.00	220	141	8.8	108	440	10.0	0.67
Lulu	Site 2	1/12/06	9:01	1.50	16.28	7.94	220	141	8.4	102	436	11.6	0.67
Lulu	Site 2	1/12/06	9:02	2.00	16.23	7.87	220	141	8.1	98	430	13.1	0.67
Lulu	Site 2	1/12/06	9:03	2.50	16.23	7.81	220	141	7.8	95	426	14.8	0.67
Lulu	Site 2	1/12/06	9:08	3.00	17.50	7.08	367	235	1.0	12	372	>1000	0.67
Lulu	Site 1	1/12/06	9:13	0.25	17.68	8.32	220	141	9.5	118	410	9.1	0.67
Lulu	Site 1	1/12/06	9:14	0.50	17.64	8.39	220	141	9.2	115	412	8.8	0.67
Lulu	Site 1	1/12/06	9:15	1.00	17.45	8.42	220	140	9.2	114	413	8.6	0.67
Lulu	Site 1	1/12/06	9:16	1.50	17.38	8.41	219	140	9.1	112	413	8.8	0.67
Lulu	Site 1	1/12/06	9:17	2.00	16.93	8.32	220	140	9.0	110	410	9.5	0.67
Lulu	Site 1	1/12/06	9:18	2.50	16.40	8.09	220	141	7.8	95	398	11.6	0.67
Lulu	Site 1	1/12/06	9:21	3.00	16.47	7.14	272	174	0.9	10	316	>1000	0.67
Lulu	Site 1	1/12/06	9:24	3.39	16.67	7.04	345	221	0.9	11	291	>1000	0.67
Lulu	Site 3	1/12/06	9:32	0.25	17.90	8.13	220	141	8.8	110	370	8.7	0.67
Lulu	Site 3	1/12/06	9:33	0.50	17.81	8.14	220	141	8.5	107	369	8.8	0.67
Lulu	Site 3	1/12/06	9:34	1.00	17.71	8.10	220	141	8.3	104	370	8.8	0.67
Lulu	Site 3	1/12/06	9:35	1.50	17.52	7.97	220	141	7.5	94	364	9.3	0.67
Lulu	Site 3	1/12/06	9:36	2.00	17.34	7.82	220	141	6.4	79	359	10.0	0.67
Lulu	Site 3	1/12/06	9:37	2.50	16.93	7.69	221	141	5.1	63	353	13.2	0.67
Lulu	Site 3	1/12/06	9:39	2.64	16.87	7.51	221	142	4.5	55	347	178.5	0.67
Shipp	Site 3	1/12/06	10:40	0.25	17.36	8.24	202	129	8.8	109	427	16.9	0.45
Shipp	Site 3	1/12/06	10:41	0.50	17.01	8.36	203	130	8.7	107	430	16.9	0.45
Shipp	Site 3	1/12/06	10:42	1.00	16.50	8.28	201	129	8.5	103	426	17.4	0.45
Shipp	Site 3	1/12/06	10:43	1.50	16.43	8.04	202	129	6.9	84	412	19.3	0.45
Shipp	Site 3	1/12/06	10:44	2.00	16.41	7.89	202	130	6.4	77	406	21.1	0.45
Shipp	Site 3	1/12/06	10:46	2.29	16.39	7.68	203	130	6.1	74	394	40.0	0.45
Shipp	Site 2	1/12/06	10:52	0.25	18.30	8.99	202	129	10.3	130	455	16.8	0.45
Shipp	Site 2	1/12/06	10:53	0.50	18.53	9.01	201	129	10.1	129	455	16.5	0.45
Shipp	Site 2	1/12/06	10:54	1.00	18.19	9.00	201	129	10.1	127	453	16.6	0.45
Shipp	Site 2	1/12/06	10:54	1.50	17.95	8.96	201	129	9.8	123	450	16.5	0.45
Shipp	Site 2	1/12/06	10:55	2.00	17.32	8.75	202	129	9.3	115	441	16.1	0.45
Shipp	Site 2	1/12/06	10:56	2.50	16.88	8.56	202	129	8.5	104	430	16.4	0.45
Shipp	Site 2	1/12/06	10:57	3.00	16.41	8.22	201	129	6.8	82	415	17.2	0.45
Shipp	Site 2	1/12/06	10:58	3.50	16.34	7.94	202	129	5.9	72	401	18.7	0.45
Shipp	Site 2	1/12/06	10:59	4.00	16.31	7.83	202	130	5.6	68	395	21.1	0.45
Shipp	Site 2	1/12/06	11:01	4.50	16.41	7.60	205	131	4.5	55	260	>1000	0.45
Shipp	Site 2	1/12/06	11:04	4.57	16.52	7.13	205	131	1.4	17	-251	>1000	0.45

Lake	Site	Date	Time	Level (m)	Temp (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (µg/l)	DO (mg/l)	DO (%Sat)	Redox (mV)	Turbidity (NTU)	Secchi (m)
Shipp	Site 1	1/12/06	11:10	0.25	18.52	9.05	202	129	10.4	132	351	16.6	0.43
Shipp	Site 1	1/12/06	11:11	0.50	18.49	9.10	202	129	10.4	133	357	16.5	0.43
Shipp	Site 1	1/12/06	11:12	1.00	18.20	9.12	201	129	10.3	129	360	16.8	0.43
Shipp	Site 1	1/12/06	11:13	1.50	17.56	8.97	201	128	10.0	125	357	17.3	0.43
Shipp	Site 1	1/12/06	11:14	2.00	17.27	8.70	202	129	8.9	111	346	18.0	0.43
Shipp	Site 1	1/12/06	11:15	2.50	16.71	8.38	202	129	7.3	89	333	21.0	0.43
Shipp	Site 1	1/12/06	11:15	3.00	16.60	8.14	202	129	6.4	78	324	23.5	0.43
Shipp	Site 1	1/12/06	11:19	3.47	17.20	6.72	352	226	1.1	14	201	>1000	0.43
May	Site 2	1/12/06	12:08	0.25	19.17	8.00	203	130	8.6	111	365	11.9	0.58
May	Site 2	1/12/06	12:09	0.50	18.87	7.98	202	129	8.8	113	365	12.0	0.58
May	Site 2	1/12/06	12:10	1.00	18.44	8.01	203	130	8.9	112	366	11.9	0.58
May	Site 2	1/12/06	12:11	1.50	17.98	7.91	203	130	8.2	103	362	12.7	0.58
May	Site 2	1/12/06	12:12	2.00	17.55	7.83	202	130	7.5	93	358	14.9	0.58
May	Site 2	1/12/06	12:14	2.30	17.39	7.16	218	139	0.9	11	135	>1000	0.58
May	Site 1	1/12/06	12:22	0.25	19.17	7.89	204	131	8.7	112	309	12.6	0.58
May	Site 1	1/12/06	12:23	0.50	18.63	7.85	205	131	8.9	114	311	12.4	0.58
May	Site 1	1/12/06	12:24	1.00	18.32	7.88	205	131	8.8	111	317	12.4	0.58
May	Site 1	1/12/06	12:25	1.50	18.28	7.86	204	131	8.6	108	320	12.6	0.58
May	Site 1	1/12/06	12:27	2.02	17.10	7.38	240	153	0.8	9	245	>1000	0.58
Lulu	Site 1	1/23/06	9:29	0.25	19.30	7.85	224	143	8.8	113	276	10.5	0.62
Lulu	Site 1	1/23/06	9:30	0.50	19.27	7.83	224	143	8.9	115	287	10.6	0.62
Lulu	Site 1	1/23/06	9:32	1.00	19.22	7.83	224	143	9.1	117	299	10.7	0.62
Lulu	Site 1	1/23/06	9:33	1.50	19.20	7.83	224	143	8.1	104	305	10.6	0.62
Lulu	Site 1	1/23/06	9:34	2.00	19.11	7.84	224	143	8.2	105	311	10.7	0.62
Lulu	Site 1	1/23/06	9:35	2.50	19.06	7.84	224	143	9.3	119	313	10.9	0.62
Lulu	Site 1	1/23/06	9:38	2.89	18.65	6.76	324	208	0.8	11	90	>1000	0.62
Lulu	Site 2	1/23/06	9:11	0.25	19.01	7.98	224	143	9.4	121	406	11.7	0.62
Lulu	Site 2	1/23/06	9:12	0.50	19.01	7.97	224	143	9.1	117	406	12.1	0.62
Lulu	Site 2	1/23/06	9:13	1.00	18.93	7.93	223	143	9.2	117	405	11.9	0.62
Lulu	Site 2	1/23/06	9:14	1.50	18.79	7.89	224	143	9.1	116	404	11.8	0.62
Lulu	Site 2	1/23/06	9:14	2.00	18.78	7.80	224	143	8.8	112	399	12.4	0.62
Lulu	Site 2	1/23/06	9:16	2.50	18.50	7.64	225	144	8.2	103	390	14.8	0.62
Lulu	Site 2	1/23/06	9:22	2.86	18.30	6.73	439	281	0.7	9	82	>1000	0.62
Lulu	Site 3	1/23/06	9:47	0.25	19.75	7.84	224	143	8.1	105	291	11.1	0.66
Lulu	Site 3	1/23/06	9:47	0.50	19.74	7.79	224	143	8.0	104	295	11.0	0.66
Lulu	Site 3	1/23/06	9:48	1.00	19.72	7.72	224	143	7.8	101	298	11.4	0.66
Lulu	Site 3	1/23/06	9:49	1.50	19.72	7.70	224	143	7.5	97	302	11.5	0.66
Lulu	Site 3	1/23/06	9:50	2.00	19.66	7.64	224	143	7.2	94	302	11.9	0.66
Lulu	Site 3	1/23/06	9:54	2.48	19.43	7.41	225	144	4.7	61	292	>1000	0.66
Shipp	Site 3	1/23/06	10:50	0.25	19.40	7.92	206	132	8.6	111	357	18.3	0.46
Shipp	Site 3	1/23/06	10:51	0.50	19.38	7.89	206	132	8.5	109	358	18.5	0.46
Shipp	Site 3	1/23/06	10:52	1.00	19.30	7.88	206	132	8.6	111	358	18.6	0.46
Shipp	Site 3	1/23/06	10:53	1.50	19.09	7.85	205	131	7.9	102	358	18.8	0.46
Shipp	Site 3	1/23/06	10:54	2.00	18.45	7.63	206	132	6.8	86	349	27.0	0.46
Shipp	Site 3	1/23/06	10:55	2.24	18.44	7.53	206	132	7.1	89	346	36.4	0.46
Shipp	Site 2	1/23/06	11:00	0.25	19.50	8.29	206	132	8.8	114	382	17.6	0.46
Shipp	Site 2	1/23/06	11:01	0.50	19.46	8.29	206	132	9.5	122	382	17.4	0.46
Shipp	Site 2	1/23/06	11:03	1.00	19.43	8.26	206	132	8.7	113	381	17.5	0.46
Shipp	Site 2	1/23/06	11:04	1.50	19.43	8.26	206	132	8.8	113	382	17.8	0.46
Shipp	Site 2	1/23/06	11:05	2.00	19.40	8.24	206	132	8.9	115	382	18.0	0.46
Shipp	Site 2	1/23/06	11:06	2.50	19.38	8.23	206	132	8.7	113	382	17.8	0.46
Shipp	Site 2	1/23/06	11:07	3.00	19.32	8.16	205	131	8.9	115	379	17.9	0.46
Shipp	Site 2	1/23/06	11:09	3.50	19.06	7.83	206	132	8.0	102	364	23.4	0.46
Shipp	Site 2	1/23/06	11:10	4.00	18.87	7.70	206	132	7.7	99	359	26.6	0.46
Shipp	Site 2	1/23/06	11:13	4.45	18.48	7.02	228	146	0.8	10	64	>1000	0.46
Shipp	Site 1	1/23/06	11:18	0.25	19.42	8.26	206	132	9.5	123	296	17.3	0.44
Shipp	Site 1	1/23/06	11:18	0.50	19.43	8.27	206	132	9.7	125	303	17.4	0.44
Shipp	Site 1	1/23/06	11:19	1.00	19.38	8.27	206	132	9.7	126	310	17.5	0.44
Shipp	Site 1	1/23/06	11:20	1.50	19.35	8.25	206	132	9.6	124	313	17.7	0.44
Shipp	Site 1	1/23/06	11:21	2.00	19.32	8.23	206	132	9.7	126	317	18.1	0.44
Shipp	Site 1	1/23/06	11:22	2.50	19.30	8.23	206	132	8.7	113	321	17.9	0.44
Shipp	Site 1	1/23/06	11:23	3.00	19.29	8.19	206	132	8.7	112	325	18.5	0.44
Shipp	Site 1	1/23/06	11:26	3.46	18.52	6.54	356	228	0.8	11	52	>1000	0.44
May	Site 2	1/23/06	12:06	0.25	20.89	7.85	207	132	8.6	115	338	15.1	0.48
May	Site 2	1/23/06	12:07	0.50	20.83	7.76	206	132	8.6	114	337	15.3	0.48
May	Site 2	1/23/06	12:08	1.00	20.66	7.63	207	132	7.9	104	334	15.4	0.48
May	Site 2	1/23/06	12:09	1.50	20.20	7.54	207	132	7.2	95	330	16.1	0.48
May	Site 2	1/23/06	12:10	2.00	19.87	7.46	206	132	7.4	96	329	181.6	0.48
May	Site 2	1/23/06	12:13	2.08	19.73	7.21	253	162	0.8	10	169	>1000	0.48

Lake	Site	Date	Time	Level (m)	Temp (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (µg/l)	DO (mg/l)	DO (%Sat)	Redox (mV)	Turbidity (NTU)	Secchi (m)
May	Site 1	1/23/06	12:20	0.25	20.62	7.90	206	132	8.5	112	300	15.4	0.47
May	Site 1	1/23/06	12:21	0.50	20.61	7.84	206	132	8.4	111	306	15.7	0.47
May	Site 1	1/23/06	12:22	1.00	20.52	7.82	205	131	8.7	115	310	15.9	0.47
May	Site 1	1/23/06	12:23	1.50	20.45	7.78	206	132	8.4	110	313	15.9	0.47
May	Site 1	1/23/06	12:25	2.00	20.25	7.68	205	131	8.5	112	288	684.7	0.47
May	Site 1	1/23/06	12:28	2.11	19.48	7.10	246	157	0.7	9	133	>1000	0.47
Lulu	Site 2	2/16/06	8:26	0.25	14.11	7.65	223	143	6.7	77	308	11.5	0.68
Lulu	Site 2	2/16/06	8:27	0.50	14.09	7.73	223	143	6.7	78	319	12.4	0.68
Lulu	Site 2	2/16/06	8:27	1.00	14.07	7.76	223	143	6.8	79	324	12.2	0.68
Lulu	Site 2	2/16/06	8:28	1.50	14.04	7.77	223	143	6.8	79	329	11.7	0.68
Lulu	Site 2	2/16/06	8:29	2.00	14.04	7.77	223	143	6.7	78	333	11.5	0.68
Lulu	Site 2	2/16/06	8:31	2.50	13.90	7.56	224	144	5.8	67	235	>1000	0.68
Lulu	Site 2	2/16/06	8:37	2.83	14.20	6.93	315	201	0.6	7	206	>1000	0.68
Lulu	Site 1	2/16/06	8:43	0.25	14.85	8.13	223	143	6.9	81	509	11.1	0.68
Lulu	Site 1	2/16/06	8:45	0.50	14.77	8.13	223	143	7.0	83	486	11.1	0.68
Lulu	Site 1	2/16/06	8:46	1.00	14.74	8.12	223	143	7.0	81	474	10.9	0.68
Lulu	Site 1	2/16/06	8:47	1.50	14.40	8.11	223	143	7.1	82	468	11.0	0.68
Lulu	Site 1	2/16/06	8:48	2.00	14.51	8.08	223	143	7.1	82	465	10.9	0.68
Lulu	Site 1	2/16/06	8:49	2.50	14.10	8.06	222	142	6.9	80	460	10.8	0.68
Lulu	Site 1	2/16/06	8:50	3.00	13.75	7.29	300	192	4.2	49	296	>1000	0.68
Lulu	Site 1	2/16/06	8:53	3.29	14.39	6.97	344	220	0.9	11	266	>1000	0.68
Lulu	Site 3	2/16/06	9:00	0.25	15.45	8.10	223	143	6.7	80	545	11.0	0.68
Lulu	Site 3	2/16/06	9:01	0.50	15.45	8.03	223	143	6.7	80	509	11.0	0.68
Lulu	Site 3	2/16/06	9:02	1.00	15.45	7.98	223	143	6.6	79	493	10.8	0.68
Lulu	Site 3	2/16/06	9:02	1.50	15.39	7.96	223	143	6.7	80	482	10.9	0.68
Lulu	Site 3	2/16/06	9:03	2.00	15.37	7.90	223	143	6.6	79	472	10.8	0.68
Lulu	Site 3	2/16/06	9:05	2.50	15.17	7.57	225	144	4.9	58	446	29.5	0.68
Lulu	Site 3	2/16/06	9:06	2.56	15.17	7.48	225	144	4.6	55	437	915.6	0.68
Shipp	Site 3	2/16/06	10:19	0.25	15.19	8.46	206	132	7.1	85	494	18.7	0.38
Shipp	Site 3	2/16/06	10:20	0.50	15.21	8.46	206	132	7.0	83	490	18.5	0.38
Shipp	Site 3	2/16/06	10:21	1.00	15.05	8.49	205	131	7.0	83	488	18.3	0.38
Shipp	Site 3	2/16/06	10:22	1.50	14.90	8.50	206	132	7.2	84	487	18.0	0.38
Shipp	Site 3	2/16/06	10:22	2.00	14.87	8.48	205	131	7.1	83	484	18.4	0.38
Shipp	Site 3	2/16/06	10:24	2.29	14.73	8.17	206	132	6.8	80	462	35.4	0.38
Shipp	Site 2	2/16/06	10:28	0.25	15.56	8.54	206	132	7.1	84	480	17.2	0.38
Shipp	Site 2	2/16/06	10:29	0.50	15.56	8.52	206	132	7.0	84	478	17.2	0.38
Shipp	Site 2	2/16/06	10:30	1.00	15.48	8.55	206	132	7.2	86	477	17.9	0.38
Shipp	Site 2	2/16/06	10:31	1.50	15.47	8.53	206	132	7.1	85	476	18.0	0.38
Shipp	Site 2	2/16/06	10:32	2.00	15.35	8.52	206	132	7.2	85	473	18.2	0.38
Shipp	Site 2	2/16/06	10:33	2.50	15.33	8.49	206	132	7.1	84	470	17.9	0.38
Shipp	Site 2	2/16/06	10:33	3.00	15.33	8.47	206	132	7.1	84	469	17.9	0.38
Shipp	Site 2	2/16/06	10:35	3.50	14.98	8.04	206	132	6.4	75	446	21.8	0.38
Shipp	Site 2	2/16/06	10:36	4.00	14.42	7.91	206	132	6.3	73	441	21.8	0.38
Shipp	Site 2	2/16/06	10:38	4.47	14.41	7.61	208	133	5.6	66	237	>1000	0.38
Shipp	Site 1	2/16/06	10:56	0.25	15.17	8.04	206	132	6.9	82	404	17.5	0.38
Shipp	Site 1	2/16/06	10:57	0.50	15.19	8.00	206	132	6.4	75	401	17.2	0.38
Shipp	Site 1	2/16/06	10:58	1.00	15.43	8.00	206	132	6.5	77	399	17.5	0.38
Shipp	Site 1	2/16/06	10:59	1.50	15.16	8.00	206	132	6.4	76	399	17.8	0.38
Shipp	Site 1	2/16/06	11:00	2.00	15.15	8.01	206	132	6.5	77	399	18.4	0.38
Shipp	Site 1	2/16/06	11:00	2.50	14.73	7.93	206	132	6.4	75	395	18.2	0.38
Shipp	Site 1	2/16/06	11:02	3.00	14.12	7.74	206	132	5.8	67	380	24.2	0.38
Shipp	Site 1	2/16/06	11:06	3.33	15.34	6.65	314	201	1.4	17	111	>1000	0.38
May	Site 2	2/16/06	11:41	0.25	16.12	8.00	203	130	6.4	77	401	13.5	0.58
May	Site 2	2/16/06	11:42	0.50	15.88	7.91	203	130	6.3	76	393	12.8	0.58
May	Site 2	2/16/06	11:43	1.00	15.74	7.81	204	130	6.2	74	386	12.8	0.58
May	Site 2	2/16/06	11:44	1.50	15.57	7.75	204	130	6.1	72	383	13.0	0.58
May	Site 2	2/16/06	11:45	2.00	15.39	7.69	204	130	5.8	69	376	15.2	0.58
May	Site 2	2/16/06	11:49	2.19	15.32	7.21	334	214	0.8	10	154	>1000	0.58
May	Site 1	2/16/06	11:53	0.25	15.86	8.03	203	130	6.2	74	271	12.1	0.61
May	Site 1	2/16/06	11:54	0.50	15.80	7.98	203	130	6.3	76	280	12.9	0.61
May	Site 1	2/16/06	11:55	1.00	15.75	7.94	203	130	6.3	76	288	13.1	0.61
May	Site 1	2/16/06	11:56	1.50	15.41	7.88	202	129	6.3	75	294	13.3	0.61
May	Site 1	2/16/06	12:01	1.99	14.52	7.49	200	128	5.6	65	218	>1000	0.61
Lulu	Site 2	3/2/06	8:49	0.25	20.40	8.23	224	143	6.6	73	383	11.0	0.62
Lulu	Site 2	3/2/06	8:49	0.50	20.35	8.21	224	143	6.6	73	383	10.4	0.62
Lulu	Site 2	3/2/06	8:50	1.00	20.30	8.17	224	143	6.7	74	382	10.5	0.62
Lulu	Site 2	3/2/06	8:51	1.50	20.05	8.02	224	143	6.6	73	375	10.6	0.62
Lulu	Site 2	3/2/06	8:51	2.00	19.45	7.89	223	143	6.4	70	370	11.1	0.62
Lulu	Site 2	3/2/06	8:53	2.50	19.33	7.48	224	143	6.0	65	358	22.1	0.62
Lulu	Site 2	3/2/06	8:56	2.87	19.55	6.85	421	270	0.6	7	18	>1000	0.62

Lake	Site	Date	Time	Level (m)	Temp (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (µg/l)	DO (mg/l)	DO (%Sat)	Redox (mV)	Turbidity (NTU)	Secchi (m)
Lulu	Site 1	3/2/06	9:02	0.25	20.13	8.38	223	143	7.1	78	259	10.5	0.64
Lulu	Site 1	3/2/06	9:03	0.50	20.13	8.45	223	143	7.2	79	273	9.8	0.64
Lulu	Site 1	3/2/06	9:04	1.00	20.13	8.51	223	143	7.2	79	284	10.0	0.64
Lulu	Site 1	3/2/06	9:04	1.50	20.12	8.49	223	143	7.3	80	290	9.9	0.64
Lulu	Site 1	3/2/06	9:05	2.00	19.92	8.47	223	143	7.3	80	293	9.6	0.64
Lulu	Site 1	3/2/06	9:06	2.50	19.78	8.14	224	143	7.0	77	287	12.5	0.64
Lulu	Site 1	3/2/06	9:09	3.03	19.23	6.65	392	251	0.9	10	136	>1000	0.64
Lulu	Site 3	3/2/06	9:18	0.25	19.72	7.77	224	143	6.9	75	282	10.2	0.63
Lulu	Site 3	3/2/06	9:19	0.50	19.72	7.78	223	143	7.0	76	285	10.3	0.63
Lulu	Site 3	3/2/06	9:20	1.00	19.80	7.81	224	143	6.9	76	291	10.3	0.63
Lulu	Site 3	3/2/06	9:20	1.50	19.77	7.78	224	143	6.9	75	291	10.1	0.63
Lulu	Site 3	3/2/06	9:21	2.00	19.41	7.77	223	143	6.9	75	293	10.3	0.63
Lulu	Site 3	3/2/06	9:21	2.50	19.32	7.59	223	143	6.6	72	288	11.7	0.63
Lulu	Site 3	3/2/06	9:23	2.68	19.33	7.50	223	143	4.2	45	286	>1000	0.63
Shipp	Site 3	3/2/06	10:25	0.25	20.06	8.27	206	132	6.6	73	347	17.2	0.47
Shipp	Site 3	3/2/06	10:26	0.50	20.03	8.25	206	132	6.7	74	346	16.9	0.47
Shipp	Site 3	3/2/06	10:26	1.00	19.88	8.23	206	132	6.7	73	345	16.9	0.47
Shipp	Site 3	3/2/06	10:27	1.50	19.66	8.17	207	132	6.5	71	343	19.1	0.47
Shipp	Site 3	3/2/06	10:28	2.00	18.90	7.86	206	132	6.1	66	331	22.1	0.47
Shipp	Site 3	3/2/06	10:29	2.33	18.85	7.51	207	132	3.4	36	317	47.6	0.47
Shipp	Site 2	3/2/06	10:34	0.25	20.12	8.70	205	131	7.2	79	365	16.5	0.44
Shipp	Site 2	3/2/06	10:34	0.50	20.15	8.72	205	131	7.3	80	364	16.6	0.44
Shipp	Site 2	3/2/06	10:35	1.00	20.00	8.69	206	132	7.3	80	364	16.3	0.44
Shipp	Site 2	3/2/06	10:36	1.50	19.04	8.22	205	131	6.9	74	344	16.3	0.44
Shipp	Site 2	3/2/06	10:37	2.00	18.85	7.93	205	131	6.3	68	332	16.0	0.44
Shipp	Site 2	3/2/06	10:38	2.50	18.71	7.73	205	131	5.8	62	325	15.9	0.44
Shipp	Site 2	3/2/06	10:39	3.00	18.57	7.49	206	132	5.1	54	315	16.5	0.44
Shipp	Site 2	3/2/06	10:39	3.50	18.45	7.32	206	132	2.6	28	310	18.0	0.44
Shipp	Site 2	3/2/06	10:40	4.00	18.41	7.25	207	132	2.3	24	307	20.8	0.44
Shipp	Site 2	3/2/06	10:42	4.46	18.48	6.66	244	156	0.9	9	2	>1000	0.44
Shipp	Site 1	3/2/06	11:01	0.25	20.39	8.81	205	131	7.0	78	328	16.6	0.43
Shipp	Site 1	3/2/06	11:02	0.50	20.40	8.83	205	131	7.0	78	328	16.5	0.43
Shipp	Site 1	3/2/06	11:02	1.00	20.37	8.85	205	131	7.0	77	329	16.4	0.43
Shipp	Site 1	3/2/06	11:03	1.50	20.28	8.84	205	131	7.1	78	329	16.9	0.43
Shipp	Site 1	3/2/06	11:03	2.00	20.33	8.84	205	131	7.1	79	331	17.0	0.43
Shipp	Site 1	3/2/06	11:04	2.50	20.32	8.84	205	131	7.1	79	332	17.0	0.43
Shipp	Site 1	3/2/06	11:05	3.00	20.05	8.47	205	131	6.6	73	317	23.1	0.43
Shipp	Site 1	3/2/06	11:08	3.32	19.08	6.83	291	186	0.9	10	88	>1000	0.43
May	Site 1	3/2/06	12:44	0.25	21.59	7.62	205	131	6.9	78	321	13.2	0.42
May	Site 1	3/2/06	12:45	0.50	21.50	7.63	205	131	6.9	78	322	13.2	0.42
May	Site 1	3/2/06	12:46	1.00	21.50	7.66	204	131	6.9	78	324	13.0	0.42
May	Site 1	3/2/06	12:47	1.50	21.26	7.60	204	131	5.0	56	325	13.2	0.42
May	Site 1	3/2/06	12:49	2.00	21.08	7.39	205	131	1.0	11	164	>1000	0.42
May	Site 1	3/2/06	12:50	2.05	20.44	6.90	283	181	0.6	7	149	>1000	0.42
May	Site 2	3/2/06	12:57	0.25	20.90	7.41	205	131	6.7	75	266	15.6	0.41
May	Site 2	3/2/06	12:58	0.50	20.92	7.38	205	131	6.7	75	274	15.7	0.41
May	Site 2	3/2/06	12:59	1.00	20.73	7.36	205	131	6.6	74	280	17.1	0.41
May	Site 2	3/2/06	12:59	1.50	20.10	7.30	204	131	6.5	72	278	18.9	0.41
May	Site 2	3/2/06	13:02	2.00	20.00	7.10	210	134	5.4	59	271	>1000	0.41
May	Site 2	3/2/06	13:03	2.11	19.79	6.98	331	212	0.7	8	156	>1000	0.41
Lulu	Site 2	3/10/06	8:39	0.25	20.22	7.29	227	146	6.4	71	349	11.5	0.68
Lulu	Site 2	3/10/06	8:41	0.50	20.24	7.23	227	145	6.2	68	349	11.1	0.68
Lulu	Site 2	3/10/06	8:42	1.00	20.14	7.25	227	145	6.2	68	351	11.3	0.68
Lulu	Site 2	3/10/06	8:42	1.50	20.18	7.24	227	145	6.2	68	351	11.3	0.68
Lulu	Site 2	3/10/06	8:43	2.00	20.18	7.23	227	146	6.3	69	351	11.5	0.68
Lulu	Site 2	3/10/06	8:46	2.50	20.07	6.55	324	207	0.6	6	90	>1000	0.68
Lulu	Site 2	3/10/06	8:47	2.70	20.10	6.54	330	211	0.4	4	45	>1000	0.68
Lulu	Site 1	3/10/06	8:54	0.25	20.32	7.50	227	145	6.7	74	246	11.6	0.63
Lulu	Site 1	3/10/06	8:54	0.50	20.32	7.54	227	145	6.8	75	255	11.7	0.63
Lulu	Site 1	3/10/06	8:55	1.00	20.32	7.57	227	145	6.8	75	263	11.8	0.63
Lulu	Site 1	3/10/06	8:56	1.50	20.32	7.57	227	145	6.9	76	269	11.8	0.63
Lulu	Site 1	3/10/06	8:56	2.00	20.33	7.59	227	145	6.9	76	274	11.6	0.63
Lulu	Site 1	3/10/06	8:59	2.50	20.33	6.89	230	147	1.3	14	221	>1000	0.63
Lulu	Site 1	3/10/06	9:02	2.89	20.24	6.49	393	251	0.6	6	197	>1000	0.63
Lulu	Site 3	3/10/06	9:12	0.25	20.70	7.47	227	145	6.7	75	270	12.4	0.62
Lulu	Site 3	3/10/06	9:13	0.50	20.69	7.50	227	145	6.7	75	276	12.1	0.62
Lulu	Site 3	3/10/06	9:14	1.00	20.69	7.49	227	145	6.7	75	278	11.9	0.62
Lulu	Site 3	3/10/06	9:14	1.50	20.66	7.50	227	145	6.8	76	282	12.4	0.62
Lulu	Site 3	3/10/06	9:15	2.00	20.68	7.49	227	145	6.8	76	283	12.9	0.62
Lulu	Site 3	3/10/06	9:16	2.49	20.61	7.47	227	145	6.0	67	287	129.7	0.62

Lake	Site	Date	Time	Level (m)	Temp (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (µg/l)	DO (mg/l)	DO (%Sat)	Redox (mV)	Turbidity (NTU)	Secchi (m)
Shipp	Site 3	3/10/06	9:29	0.25	20.23	7.65	209	134	6.6	73	309	19.9	0.42
Shipp	Site 3	3/10/06	9:30	0.50	20.21	7.66	209	134	6.7	74	310	20.1	0.42
Shipp	Site 3	3/10/06	9:31	1.00	20.19	7.68	209	134	6.7	74	312	20.4	0.42
Shipp	Site 3	3/10/06	9:32	1.50	20.18	7.70	209	134	6.8	75	314	19.9	0.42
Shipp	Site 3	3/10/06	9:33	2.00	20.16	7.75	209	134	6.8	75	316	20.1	0.42
Shipp	Site 3	3/10/06	9:34	2.21	20.12	7.78	209	134	6.2	68	318	24.4	0.42
Shipp	Site 2	3/10/06	9:39	0.25	20.36	8.06	208	133	6.8	75	331	19.2	0.42
Shipp	Site 2	3/10/06	9:39	0.50	20.34	8.09	208	133	6.8	75	332	19.1	0.42
Shipp	Site 2	3/10/06	9:40	1.00	20.36	8.11	208	133	6.8	75	334	19.3	0.42
Shipp	Site 2	3/10/06	9:41	1.50	20.36	8.09	208	133	6.9	76	335	19.3	0.42
Shipp	Site 2	3/10/06	9:42	2.00	20.28	8.08	208	133	6.9	76	336	19.7	0.42
Shipp	Site 2	3/10/06	9:43	2.50	20.28	8.08	209	133	6.9	76	336	19.6	0.42
Shipp	Site 2	3/10/06	9:43	3.00	20.26	8.08	208	133	6.9	76	336	20.0	0.42
Shipp	Site 2	3/10/06	9:44	3.50	20.25	8.06	208	133	6.8	75	334	20.6	0.42
Shipp	Site 2	3/10/06	9:46	3.87	19.92	7.01	222	142	0.7	8	-40	>1000	0.42
Shipp	Site 1	3/10/06	9:51	0.25	20.31	8.02	209	134	6.5	72	207	20.5	0.44
Shipp	Site 1	3/10/06	9:52	0.50	20.31	8.07	209	134	6.5	72	228	20.5	0.44
Shipp	Site 1	3/10/06	9:52	1.00	20.30	8.08	209	134	6.5	72	240	20.4	0.44
Shipp	Site 1	3/10/06	9:53	1.50	20.30	8.09	209	134	6.6	73	251	20.4	0.44
Shipp	Site 1	3/10/06	9:54	2.00	20.30	8.10	208	133	6.5	72	258	20.4	0.44
Shipp	Site 1	3/10/06	9:54	2.50	20.32	8.10	209	134	6.6	73	267	20.3	0.44
Shipp	Site 1	3/10/06	9:56	3.00	20.12	6.58	236	151	0.8	9	18	>1000	0.44
Shipp	Site 1	3/10/06	9:58	3.19	20.09	6.80	248	159	0.5	6	45	>1000	0.44
May	Site 2	3/10/06	10:05	0.25	20.77	7.44	209	134	6.0	67	232	15.6	0.53
May	Site 2	3/10/06	10:06	0.50	20.77	7.45	209	134	6.0	67	242	15.7	0.53
May	Site 2	3/10/06	10:06	1.00	20.75	7.42	209	134	6.0	67	247	15.7	0.53
May	Site 2	3/10/06	10:07	1.50	20.75	7.42	209	134	6.0	67	254	16.5	0.53
May	Site 2	3/10/06	10:10	1.81	20.53	7.02	268	171	0.6	7	133	>1000	0.53
May	Site 1	3/10/06	10:14	0.25	20.51	7.45	204	131	5.9	65	227	14.4	0.53
May	Site 1	3/10/06	10:15	0.50	20.51	7.49	204	131	6.0	67	237	14.5	0.53
May	Site 1	3/10/06	10:16	1.00	20.48	7.48	204	131	6.0	67	245	14.8	0.53
May	Site 1	3/10/06	10:17	1.50	20.49	7.50	205	131	2.9	33	251	29.5	0.53
May	Site 1	3/10/06	10:22	1.74	20.47	6.90	215	137	0.6	7	203	>1000	0.53
May	Site 1	3/13/06	9:12	0.25	22.46	7.39	207	132	6.6	76	420	15.4	0.44
May	Site 1	3/13/06	9:14	0.50	22.47	7.36	207	132	6.5	75	420	15.4	0.44
May	Site 1	3/13/06	9:14	1.00	22.43	7.33	207	132	6.5	75	421	15.1	0.44
May	Site 1	3/13/06	9:15	1.50	22.36	7.32	206	132	6.6	76	421	15.0	0.44
May	Site 1	3/13/06	9:18	1.91	21.65	6.87	322	206	0.5	6	179	>1000	0.44
May	Site 2	3/13/06	9:25	0.25	22.83	7.28	209	134	6.6	77	328	16.6	0.45
May	Site 2	3/13/06	9:26	0.50	22.80	7.31	209	134	6.6	77	334	16.6	0.45
May	Site 2	3/13/06	9:27	1.00	22.80	7.31	209	134	6.6	77	339	16.5	0.45
May	Site 2	3/13/06	9:28	1.50	22.68	7.21	209	134	6.5	75	344	17.0	0.45
May	Site 2	3/13/06	9:30	1.94	22.36	6.76	291	186	0.6	7	207	>1000	0.45
Shipp	Site 1	3/13/06	9:41	0.25	22.08	8.03	210	134	6.9	79	373	19.1	0.42
Shipp	Site 1	3/13/06	9:42	0.50	22.08	8.04	210	134	6.9	79	376	18.7	0.42
Shipp	Site 1	3/13/06	9:42	1.00	22.15	8.07	210	134	7.0	80	379	18.9	0.42
Shipp	Site 1	3/13/06	9:43	1.50	22.05	8.01	210	134	7.0	80	381	19.1	0.42
Shipp	Site 1	3/13/06	9:44	2.00	22.05	8.04	210	134	6.9	79	383	19.2	0.42
Shipp	Site 1	3/13/06	9:45	2.50	22.03	8.00	210	134	6.8	78	383	19.7	0.42
Shipp	Site 1	3/13/06	9:48	3.00	22.00	6.98	231	148	0.7	8	288	>1000	0.42
Shipp	Site 1	3/13/06	9:49	3.26	21.71	6.94	232	148	0.5	6	278	>1000	0.42
Shipp	Site 2	3/13/06	9:54	0.25	22.36	8.03	210	134	6.6	76	331	19.1	0.38
Shipp	Site 2	3/13/06	9:55	0.50	22.35	8.08	210	134	6.6	76	338	19.1	0.38
Shipp	Site 2	3/13/06	9:56	1.00	22.33	8.10	210	134	6.6	76	343	19.1	0.38
Shipp	Site 2	3/13/06	9:57	1.50	22.30	8.10	210	134	6.6	76	348	18.9	0.38
Shipp	Site 2	3/13/06	9:57	2.00	22.27	8.08	210	134	6.6	76	353	19.2	0.38
Shipp	Site 2	3/13/06	9:58	2.50	22.27	8.01	210	134	6.6	76	354	19.0	0.38
Shipp	Site 2	3/13/06	9:59	3.00	22.24	8.02	210	134	6.6	76	356	19.0	0.38
Shipp	Site 2	3/13/06	10:00	3.50	21.94	7.69	210	135	6.6	75	348	22.1	0.38
Shipp	Site 2	3/13/06	10:03	3.85	21.47	6.74	223	143	0.6	6	110	>1000	0.38
Shipp	Site 3	3/13/06	10:24	0.25	22.41	7.96	210	134	6.0	69	378	19.3	0.42
Shipp	Site 3	3/13/06	10:25	0.50	22.37	7.91	210	134	6.0	69	379	20.0	0.42
Shipp	Site 3	3/13/06	10:26	1.00	22.29	7.90	210	134	6.0	69	377	20.0	0.42
Shipp	Site 3	3/13/06	10:26	1.50	22.25	7.87	210	135	6.0	69	377	20.1	0.42
Shipp	Site 3	3/13/06	10:27	2.00	21.88	7.71	210	134	5.8	66	371	25.0	0.42
Shipp	Site 3	3/13/06	10:28	2.37	21.62	7.48	211	135	2.7	30	358	263.9	0.42
Lulu	Site 3	3/13/06	10:40	0.25	22.92	7.51	229	147	5.7	66	378	12.1	0.58
Lulu	Site 3	3/13/06	10:40	0.50	22.90	7.51	229	147	5.7	66	378	12.4	0.58
Lulu	Site 3	3/13/06	10:41	1.00	22.90	7.49	229	146	5.6	65	379	12.3	0.58
Lulu	Site 3	3/13/06	10:42	1.50	22.88	7.45	229	147	5.6	65	379	12.2	0.58
Lulu	Site 3	3/13/06	10:43	2.00	22.85	7.44	229	147	5.6	65	380	13.0	0.58
Lulu	Site 3	3/13/06	10:44	2.23	22.77	7.43	229	147	2.5	28	379	31.7	0.58

Lake	Site	Date	Time	Level (m)	Temp (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (µg/l)	DO (mg/l)	DO (%Sat)	Redox (mV)	Turbidity (NTU)	Secchi (m)
Lulu	Site 1	3/13/06	10:52	0.25	22.64	7.73	229	146	5.7	66	398	11.1	0.67
Lulu	Site 1	3/13/06	10:53	0.50	22.63	7.75	228	146	5.7	66	400	11.0	0.67
Lulu	Site 1	3/13/06	10:53	1.00	22.61	7.79	229	146	5.7	66	400	11.1	0.67
Lulu	Site 1	3/13/06	10:54	1.50	22.59	7.75	228	146	5.7	66	401	11.3	0.67
Lulu	Site 1	3/13/06	10:55	2.00	22.48	7.74	229	146	5.7	66	400	11.3	0.67
Lulu	Site 1	3/13/06	10:58	2.49	22.42	7.11	265	170	0.6	7	309	>1000	0.67
Lulu	Site 2	3/13/06	11:03	0.25	22.58	7.40	229	146	6.4	74	350	11.8	0.63
Lulu	Site 2	3/13/06	11:04	0.50	22.59	7.38	229	147	6.4	74	354	12.0	0.63
Lulu	Site 2	3/13/06	11:05	1.00	22.64	7.40	229	147	6.3	73	357	11.9	0.63
Lulu	Site 2	3/13/06	11:06	1.50	22.58	7.38	229	146	6.4	74	361	12.2	0.63
Lulu	Site 2	3/13/06	11:06	2.00	22.37	7.35	229	146	6.3	72	363	15.3	0.63
Lulu	Site 2	3/13/06	11:09	2.50	21.69	6.65	458	293	0.6	7	341	>1000	0.63
May	Site 1	4/12/06	10:10	0.25	22.83	7.75	210	134	7.5	88	323	19.0	0.48
May	Site 1	4/12/06	10:11	0.50	22.84	7.74	209	134	7.5	87	323	19.1	0.48
May	Site 1	4/12/06	10:12	1.00	22.77	7.74	210	135	7.5	87	324	19.9	0.48
May	Site 1	4/12/06	10:13	1.50	22.75	7.74	210	135	7.5	86	324	21.3	0.48
May	Site 1	4/12/06	10:14	1.83	22.74	6.80	396	254	0.3	4	172	>1000	0.48
May	Site 2	4/12/06	10:22	0.25	22.52	7.70	213	136	7.3	84	262	20.1	0.45
May	Site 2	4/12/06	10:22	0.50	22.52	7.68	213	136	7.3	84	265	20.0	0.45
May	Site 2	4/12/06	10:23	1.00	22.52	7.64	213	136	6.9	79	268	20.1	0.45
May	Site 2	4/12/06	10:24	1.50	22.52	7.61	213	136	6.9	80	271	20.4	0.45
May	Site 2	4/12/06	10:26	1.94	22.58	6.92	250	160	0.3	3	163	>1000	0.45
Shipp	Site 1	4/12/06	10:32	0.25	22.94	8.24	217	139	7.4	86	224	22.8	0.41
Shipp	Site 1	4/12/06	10:33	0.50	22.95	8.26	217	139	7.3	86	227	22.8	0.41
Shipp	Site 1	4/12/06	10:34	1.00	22.94	8.27	217	139	7.3	85	231	23.1	0.41
Shipp	Site 1	4/12/06	10:35	1.50	22.93	8.28	217	139	7.2	84	233	23.4	0.41
Shipp	Site 1	4/12/06	10:35	2.00	22.92	8.28	216	138	7.2	84	237	24.1	0.41
Shipp	Site 1	4/12/06	10:36	2.50	22.91	8.28	217	139	7.2	84	240	23.5	0.41
Shipp	Site 1	4/12/06	10:39	2.94	22.86	7.37	221	141	0.5	6	38	>1000	0.41
Shipp	Site 2	4/12/06	10:45	0.25	22.74	8.55	217	139	7.9	91	205	26.4	0.40
Shipp	Site 2	4/12/06	10:46	0.50	22.73	8.56	217	139	7.8	91	210	26.1	0.40
Shipp	Site 2	4/12/06	10:47	1.00	22.74	8.56	217	139	7.9	91	214	26.1	0.40
Shipp	Site 2	4/12/06	10:47	1.50	22.75	8.57	217	139	7.9	91	217	26.5	0.40
Shipp	Site 2	4/12/06	10:48	2.00	22.74	8.57	217	139	7.8	90	220	26.5	0.40
Shipp	Site 2	4/12/06	10:49	2.50	22.77	8.56	217	139	7.7	90	222	26.9	0.40
Shipp	Site 2	4/12/06	10:49	3.00	22.76	8.56	217	139	7.7	90	225	27.0	0.40
Shipp	Site 2	4/12/06	10:50	3.50	22.75	8.57	217	139	7.8	90	228	27.0	0.40
Shipp	Site 2	4/12/06	10:51	4.00	22.75	8.55	217	139	7.6	89	206	56.9	0.40
Shipp	Site 2	4/12/06	10:53	4.16	22.76	7.29	247	158	0.3	3	69	>1000	0.40
Shipp	Site 3	4/12/06	10:59	0.25	23.02	8.65	216	138	8.2	96	214	26.3	0.40
Shipp	Site 3	4/12/06	11:00	0.50	23.01	8.66	217	139	8.1	94	217	26.1	0.40
Shipp	Site 3	4/12/06	11:00	1.00	23.03	8.68	217	139	8.2	95	218	26.5	0.40
Shipp	Site 3	4/12/06	11:01	1.50	23.01	8.68	217	139	8.2	95	220	26.8	0.40
Shipp	Site 3	4/12/06	11:02	2.00	22.97	8.65	216	138	8.0	93	224	196.0	0.40
Lulu	Site 3	4/12/06	11:14	0.25	23.06	7.84	235	151	7.1	83	264	18.2	0.45
Lulu	Site 3	4/12/06	11:16	0.50	23.05	7.75	236	151	7.0	82	270	18.4	0.45
Lulu	Site 3	4/12/06	11:17	1.00	23.02	7.70	235	151	7.0	81	273	18.9	0.45
Lulu	Site 3	4/12/06	11:18	1.50	23.00	7.68	236	151	6.9	81	276	20.7	0.45
Lulu	Site 3	4/12/06	11:20	1.94	22.94	7.61	235	151	6.5	76	276	>1000	0.45
Lulu	Site 1	4/12/06	11:28	0.25	23.55	7.98	236	151	7.3	86	273	17.4	0.47
Lulu	Site 1	4/12/06	11:29	0.50	23.45	7.99	235	150	7.4	87	275	17.4	0.47
Lulu	Site 1	4/12/06	11:30	1.00	23.26	8.11	235	150	7.9	93	275	17.2	0.47
Lulu	Site 1	4/12/06	11:31	1.50	23.23	8.14	234	150	7.8	92	275	17.2	0.47
Lulu	Site 1	4/12/06	11:31	2.00	23.12	8.13	235	150	7.7	90	276	17.3	0.47
Lulu	Site 1	4/12/06	11:34	2.42	23.14	6.91	346	222	0.3	3	138	>1000	0.47
Lulu	Site 2	4/12/06	11:39	0.25	23.39	8.02	235	150	7.7	91	232	19.3	0.45
Lulu	Site 2	4/12/06	11:40	0.50	23.38	7.98	235	150	7.7	91	237	17.9	0.45
Lulu	Site 2	4/12/06	11:41	1.00	23.33	7.95	235	151	7.6	90	242	18.5	0.45
Lulu	Site 2	4/12/06	11:41	1.50	23.31	7.92	235	151	7.5	88	246	18.6	0.45
Lulu	Site 2	4/12/06	11:42	2.00	23.17	7.84	235	151	7.3	85	250	41.3	0.45
Lulu	Site 2	4/12/06	11:43	2.41	23.20	6.94	370	236	0.2	3	149	>1000	0.45
May	Site 1	4/24/06	7:43	0.25	26.47	7.72	211	135	6.1	76	362	18.7	0.43
May	Site 1	4/24/06	7:44	0.50	26.38	7.73	211	135	6.0	74	362	16.5	0.43
May	Site 1	4/24/06	7:45	1.00	26.30	7.69	211	135	5.5	69	361	16.4	0.43
May	Site 1	4/24/06	7:46	1.50	26.13	7.64	211	135	5.1	63	359	17.6	0.43
May	Site 1	4/24/06	7:49	1.85	26.03	7.44	209	134	2.9	36	303	>1000	0.43
May	Site 2	4/24/06	7:56	0.25	26.98	7.65	213	136	6.2	78	335	22.8	0.44
May	Site 2	4/24/06	7:57	0.50	26.96	7.72	212	135	5.8	72	336	21.6	0.44
May	Site 2	4/24/06	7:57	1.00	26.88	7.69	212	135	5.8	73	337	20.9	0.44
May	Site 2	4/24/06	7:58	1.50	26.79	7.66	212	136	5.3	66	338	20.1	0.44
May	Site 2	4/24/06	8:00	2.00	26.65	7.13	237	152	0.4	5	338	>1000	0.44
May	Site 2	4/24/06	8:01	2.13	26.65	7.05	283	181	0.2	2	235	>1000	0.44

Lake	Site	Date	Time	Level (m)	Temp (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (µg/l)	DO (mg/l)	DO (%Sat)	Redox (mV)	Turbidity (NTU)	Secchi (m)
Shipp	Site 1	4/24/06	8:08	0.25	26.48	8.25	219	140	6.2	77	331	23.3	0.36
Shipp	Site 1	4/24/06	8:08	0.50	26.47	8.31	219	140	5.9	73	333	23.0	0.36
Shipp	Site 1	4/24/06	8:09	1.00	26.53	8.31	219	140	5.8	72	336	22.4	0.36
Shipp	Site 1	4/24/06	8:10	1.50	26.39	8.30	219	140	5.5	68	338	22.0	0.36
Shipp	Site 1	4/24/06	8:11	2.00	26.22	8.16	219	140	5.0	62	336	22.6	0.36
Shipp	Site 1	4/24/06	8:12	2.50	26.13	8.08	219	140	4.5	56	335	22.3	0.36
Shipp	Site 1	4/24/06	8:14	3.00	26.11	7.80	225	144	3.4	42	307	>1000	0.36
Shipp	Site 1	4/24/06	8:16	3.35	25.95	6.83	316	202	0.3	4	240	>1000	0.36
Shipp	Site 2	4/24/06	8:21	0.25	26.86	8.75	220	141	7.1	89	336	23.0	0.35
Shipp	Site 2	4/24/06	8:22	0.50	26.90	8.87	219	140	7.0	88	342	22.7	0.35
Shipp	Site 2	4/24/06	8:23	1.00	26.66	8.73	219	140	6.5	81	340	22.6	0.35
Shipp	Site 2	4/24/06	8:24	1.50	26.56	8.64	219	140	6.1	75	339	22.0	0.35
Shipp	Site 2	4/24/06	8:25	2.00	26.54	8.60	219	140	5.6	70	340	22.0	0.35
Shipp	Site 2	4/24/06	8:26	2.50	26.51	8.58	220	140	6.1	75	344	22.1	0.35
Shipp	Site 2	4/24/06	8:26	3.00	26.49	8.48	220	141	5.8	72	342	22.0	0.35
Shipp	Site 2	4/24/06	8:28	3.50	26.19	7.88	222	142	2.2	27	315	25.0	0.35
Shipp	Site 2	4/24/06	8:30	4.00	25.84	7.55	224	144	0.6	7	281	>1000	0.35
Shipp	Site 2	4/24/06	8:31	4.38	25.57	6.84	295	189	0.1	2	-1	>1000	0.35
Shipp	Site 3	4/24/06	8:50	0.25	27.12	9.01	219	140	7.7	97	325	23.3	0.34
Shipp	Site 3	4/24/06	8:51	0.50	26.88	8.97	219	140	7.9	99	326	22.8	0.34
Shipp	Site 3	4/24/06	8:52	1.00	26.78	8.90	219	140	7.9	99	327	23.5	0.34
Shipp	Site 3	4/24/06	8:53	1.50	26.56	8.62	220	141	6.6	83	319	23.0	0.34
Shipp	Site 3	4/24/06	8:54	2.00	26.48	8.20	221	141	5.3	65	304	22.8	0.34
Shipp	Site 3	4/24/06	8:55	2.05	26.47	8.04	221	142	5.0	62	302	24.7	0.34
Lulu	Site 2	4/24/06	9:46	0.25	27.60	8.50	240	153	8.1	103	349	15.1	0.46
Lulu	Site 2	4/24/06	9:47	0.50	27.64	8.49	240	153	7.8	99	348	14.9	0.46
Lulu	Site 2	4/24/06	9:48	1.00	27.29	8.54	239	153	8.3	105	353	14.9	0.46
Lulu	Site 2	4/24/06	9:48	1.50	27.31	8.51	239	153	8.3	105	355	15.3	0.46
Lulu	Site 2	4/24/06	9:51	1.93	27.02	8.34	239	153	7.7	96	348	28.8	0.46
Lulu	Site 1	4/24/06	9:56	0.25	27.46	7.88	240	153	6.8	87	329	15.0	0.46
Lulu	Site 1	4/24/06	9:57	0.50	27.57	7.87	240	153	6.9	87	328	14.5	0.46
Lulu	Site 1	4/24/06	9:58	1.00	26.77	8.01	239	153	7.3	91	339	15.2	0.46
Lulu	Site 1	4/24/06	9:59	1.50	26.57	7.81	240	153	6.3	79	331	15.2	0.46
Lulu	Site 1	4/24/06	10:00	2.00	26.44	7.65	240	154	5.8	72	325	15.1	0.46
Lulu	Site 1	4/24/06	10:00	2.50	26.29	7.56	240	153	5.3	65	320	21.9	0.46
Lulu	Site 1	4/24/06	10:02	3.00	25.96	6.62	364	233	0.2	2	122	>1000	0.46
Lulu	Site 1	4/24/06	10:02	3.26	25.97	6.62	373	239	0.1	2	121	>1000	0.46
Lulu	Site 3	4/24/06	10:10	0.25	26.56	7.41	238	152	4.3	53	253	16.0	0.43
Lulu	Site 3	4/24/06	10:10	0.50	26.53	7.34	238	152	4.0	50	255	16.1	0.43
Lulu	Site 3	4/24/06	10:11	1.00	26.58	7.28	238	152	4.1	52	258	16.0	0.43
Lulu	Site 3	4/24/06	10:12	1.50	26.24	7.20	238	152	2.6	32	257	16.5	0.43
Lulu	Site 3	4/24/06	10:13	2.00	26.12	7.15	237	152	2.4	30	257	16.8	0.43
Lulu	Site 3	4/24/06	10:14	2.46	26.05	7.08	234	150	2.0	25	243	226.9	0.43

APPENDIX B

RESULTS OF LABORATORY ANALYSES CONDUCTED ON SURFACE WATER SAMPLES COLLECTED IN LAKES MAY, SHIPP, AND LULU FROM OCTOBER 2005 – APRIL 2006

Characteristics of Surface Water Samples Collected in in Lake May from August 2005 to April 2006

Sample Description	Sample Location	Date Collected	Alkalinity	NH3	NOX	Dis Org N	Part N	TN	OP	Dis Org P	Part P	TP	Turbidity	TSS	Chl a
May	Site 1	10/6/05	47.2	582	<5	60	682	1326	<1	1	68	70	7.3	8.8	47.1
May	Site 1	10/20/05	56.2	406	<5	35	857	1300	<1	3	66	70	8.5	11.2	75.3
May	Site 1	11/7/05	47.6	280	66	363	92	801	1	12	14	27	9.1	13.0	69.1
May	Site 1	11/22/05	49.0	180	11	294	739	1224	1	1	62	64	7.9	15.0	73.3
May	Site 1	11/29/05	50.6	629	<5	642	81	1354	1	2	68	71	8.0	13.9	57.1
May	Site 1	12/14/05	48.0	474	<5	175	640	1291	<1	6	74	81	8.4	12.5	53.9
May	Site 1	12/28/05	48.4	395	<5	98	913	1408	<1	2	56	59	8.0	13.4	51.5
May	Site 1	1/3/06	50.4	67	<5	436	842	1347	<1	1	56	58	9.8	16.8	35.4
May	Site 1	1/12/06	50.2	32	<5	279	977	1290	1	3	47	51	6.6	17.2	31.5
May	Site 1	1/23/06	50.4	<5	<5	344	838	1187	<1	5	57	63	10.3	17.6	43.5
May	Site 1	2/16/06	51.8	53	106	231	633	1023	4	2	39	45	7.6	13.0	30.7
May	Site 1	3/2/06	48.0	186	<5	254	623	1065	<1	4	46	51	6.6	12.2	12.4
May	Site 1	3/10/06	51.2	16	<5	370	748	1136	<1	7	48	56	8.4	16.0	34.9
May	Site 1	3/13/06	51.0	43	<5	451	701	1197	<1	3	57	61	9.4	16.4	47.8
May	Site 1	3/27/06	52.8	136	16	354	804	1310	<1	10	70	81	10.0	12.7	44.7
May	Site 1	4/12/06	52.2	41	5	385	908	1339	1	2	81	84	9.8	20.4	52.9
May	Site 1	4/24/06	55.0	51	<5	439	985	1477	<1	2	58	61	9.3	21.3	44.0
May	Site 2	10/6/05	47.2	636	<5	25	1146	1809	1	4	47	52	5.8	6.6	50.5
May	Site 2	10/20/05	51.4	433	<5	28	979	1442	<1	2	72	75	9.3	9.6	70.5
May	Site 2	11/7/05	50.2	285	90	232	120	727	1	2	25	28	9.5	14.6	73.4
May	Site 2	11/22/05	50.2	121	13	419	785	1338	1	1	74	76	8.5	16.2	75.1
May	Site 2	11/29/05	49.8	405	14	24	859	1302	1	3	64	68	8.3	20.0	64.7
May	Site 2	12/14/05	47.0	439	<5	86	736	1263	1	5	77	83	8.3	13.4	54.6
May	Site 2	12/28/05	50.8	368	7	122	252	749	<1	2	27	30	8.3	11.4	50.4
May	Site 2	1/3/06	50.0	31	<5	434	966	1433	<1	2	56	59	9.3	27.0	33.0
May	Site 2	1/12/06	50.6	<5	<5	336	532	873	1	5	38	44	6.0	10.6	30.2
May	Site 2	1/23/06	50.2	<5	<5	353	715	1073	<1	1	53	55	9.2	16.8	39.4
May	Site 2	2/16/06	51.4	10	166	154	732	1062	8	1	39	48	7.7	13.2	29.1
May	Site 2	3/2/06	52.6	242	<5	210	791	1245	<1	1	66	68	8.6	14.7	15.0
May	Site 2	3/10/06	52.8	20	<5	401	758	1181	<1	7	53	61	9.2	16.3	44.3
May	Site 2	3/13/06	52.4	43	<5	402	744	1191	<1	4	61	66	9.7	17.8	51.2
May	Site 2	3/27/06	54.4	250	17	215	857	1339	<1	6	70	77	11.4	13.4	50.7
May	Site 2	4/12/06	53.6	39	7	374	889	1309	1	3	85	89	11.7	21.2	52.9
May	Site 2	4/24/06	55.2	16	<5	423	1174	1615	1	3	99	103	12.8	20.2	49.0

Characteristics of Surface Water Samples Collected in in Lake Shipp from August 2005 to April 2006

Sample Description	Sample Location	Date Collected	Alkalinity	NH3	NOX	Dis Org N	Part N	TN	OP	Dis Org P	Part P	TP	Turbidity	TSS	Chl a
Shipp	Site 1	10/6/05	48.2	763	<5	56	363	1184	<1	2	41	44	7.1	8.1	57.3
Shipp	Site 1	10/20/05	47.8	515	<5	271	715	1503	<1	1	53	55	7.9	12.5	72.0
Shipp	Site 1	11/7/05	47.4	302	51	143	379	875	<1	3	20	24	9.6	15.6	91.2
Shipp	Site 1	11/22/05	49.4	100	20	377	1292	1789	1	9	53	63	10.9	19.0	127.0
Shipp	Site 1	11/29/05	49.0	1084	<5	715	1186	2987	<1	3	110	114	10.6	20.8	107.0
Shipp	Site 1	12/14/05	51.4	427	<5	259	871	1559	3	3	67	73	11.0	16.4	111.0
Shipp	Site 1	12/28/05	49.8	357	<5	64	509	932	<1	1	12	14	10.2	13.8	96.5
Shipp	Site 1	1/3/06	49.4	57	<5	478	1111	1648	<1	2	57	60	11.5	25.5	58.4
Shipp	Site 1	1/12/06	51.8	132	<5	311	791	1236	<1	2	51	54	9.1	15.2	62.1
Shipp	Site 1	1/23/06	50.6	<5	<5	389	978	1372	<1	2	58	61	10.9	18.2	59.0
Shipp	Site 1	2/16/06	54.2	6	101	386	926	1419	5	6	49	60	10.6	16.0	56.2
Shipp	Site 1	3/2/06	53.4	380	<5	120	1148	1650	<1	1	65	67	10.2	13.7	54.6
Shipp	Site 1	3/10/06	53.2	9	<5	449	1136	1596	<1	10	55	66	12.2	21.2	68.6
Shipp	Site 1	3/13/06	54.0	62	<5	431	1062	1557	<1	4	55	60	10.9	19.4	77.2
Shipp	Site 1	3/27/06	57.2	118	19	379	1108	1624	<1	6	59	66	10.6	14.7	78.5
Shipp	Site 1	4/12/06	55.6	45	<5	427	1266	1740	1	3	67	71	12.9	19.4	78.9
Shipp	Site 1	4/24/06	56.2	16	<5	450	1686	2154	<1	3	58	62	13.1	25.8	70.1
Shipp	Site 2	10/6/05	48.6	565	<5	236	1033	1836	<1	2	44	47	7.3	7.5	55.9
Shipp	Site 2	10/20/05	47.6	480	<5	88	921	1491	<1	3	53	57	8.5	12.9	70.3
Shipp	Site 2	11/7/05	47.8	293	60	161	1612	2126	<1	18	68	87	8.6	14.2	82.4
Shipp	Site 2	11/22/05	49.6	169	31	292	1327	1819	1	2	62	65	10.5	18.3	124.0
Shipp	Site 2	11/29/05	48.4	273	21	355	978	1627	<1	4	51	56	10.8	22.0	104.0
Shipp	Site 2	12/14/05	49.2	438	<5	287	801	1528	<1	6	66	73	11.3	15.8	111.0
Shipp	Site 2	12/28/05	51.4	312	<5	151	797	1262	<1	2	34	37	10.6	16.6	107.0
Shipp	Site 2	1/3/06	49.8	34	<5	453	1146	1635	<1	2	58	61	12.2	22.3	60.2
Shipp	Site 2	1/12/06	51.8	97	<5	318	917	1334	1	2	59	62	8.4	14.6	66.8
Shipp	Site 2	1/23/06	52.2	<5	<5	342	996	1343	<1	1	56	58	10.2	16.6	56.7
Shipp	Site 2	2/16/06	143.0	6	122	292	984	1404	6	4	46	56	10.1	14.6	54.5
Shipp	Site 2	3/2/06	52.4	370	<5	101	1050	1523	<1	11	46	58	9.4	14.0	50.5
Shipp	Site 2	3/10/06	52.8	35	<5	411	1246	1694	<1	12	51	64	10.8	14.9	70.9
Shipp	Site 2	3/13/06	53.8	76	<5	405	1059	1542	<1	1	63	65	11.2	17.8	84.2
Shipp	Site 2	3/27/06	54.6	171	19	305	1187	1682	<1	6	66	73	11.4	16.8	79.7
Shipp	Site 2	4/12/06	56.0	44	5	444	1375	1868	1	3	74	78	13.1	24.8	79.5
Shipp	Site 2	4/24/06	58.2	5	<5	458	1707	2172	1	1	58	60	13.4	24.0	73.1
Shipp	Site 3	10/6/05	49.8	449	<5	85	1262	1798	<1	3	56	60	7.1	8.4	58.7
Shipp	Site 3	10/20/05	48.0	656	<5	26	1294	1978	<1	4	53	58	8.7	12.0	76.2
Shipp	Site 3	11/7/05	46.4	302	90	414	64	870	1	4	10	15	8.0	15.2	84.7
Shipp	Site 3	11/22/05	49.2	219	13	224	1364	1820	<1	7	69	77	11.1	21.4	115.0
Shipp	Site 3	11/29/05	50.2	561	28	152	879	1620	<1	3	44	48	9.7	15.5	110.0
Shipp	Site 3	12/14/05	49.8	701	<5	364	241	1308	<1	3	42	46	11.7	16.2	100.0
Shipp	Site 3	12/28/05	51.0	378	<5	89	431	900	<1	2	24	27	11.0	14.6	97.9
Shipp	Site 3	1/3/06	50.6	15	49	470	1143	1677	<1	3	58	62	11.7	22.5	59.8
Shipp	Site 3	1/12/06	50.6	30	<5	1125	323	1480	1	1	58	60	10.4	16.6	75.8
Shipp	Site 3	1/23/06	52.4	<5	<5	404	1031	1440	<1	6	59	66	11.4	20.4	58.6
Shipp	Site 3	2/16/06	49.8	5	73	339	990	1407	3	8	46	57	11.3	15.4	54.5
Shipp	Site 3	3/2/06	52.6	385	<5	107	1068	1562	<1	1	57	59	9.5	14.7	55.9
Shipp	Site 3	3/10/06	53.2	46	<5	400	935	1383	<1	1	52	54	11.8	19.6	68.0
Shipp	Site 3	3/13/06	54.4	49	<5	449	1029	1529	<1	3	60	64	11.2	20.4	74.8
Shipp	Site 3	3/27/06	55.2	50	16	444	1105	1615	<1	7	58	66	10.9	14.6	73.1
Shipp	Site 3	4/12/06	57.2	49	<5	424	1378	1853	1	5	69	75	15.8	25.0	86.4
Shipp	Site 3	4/24/06	58.2	<5	<5	498	1608	2111	1	1	57	59	13.9	21.0	64.9

Characteristics of Surface Water Samples Collected in in Lake Lulu from August 2005 to April 2006

Sample Description	Sample Location	Date Collected	Alkalinity	NH3	NOX	Dis Org N	Part N	TN	OP	Dis Org P	Part P	TP	Turbidity	TSS	Chl a
Lulu	Site 1	10/6/05	49.0	559	<5	22	445	1028	1	4	41	46	6.1	6.4	42.8
Lulu	Site 1	10/20/05	49.8	357	<5	92	728	1179	<1	5	47	53	6.4	9.2	43.9
Lulu	Site 1	11/7/05	48.2	274	83	116	382	855	1	9	55	65	7.5	13.4	59.6
Lulu	Site 1	11/22/05	50.2	96	21	678	706	1501	<1	1	69	71	10.6	21.3	69.8
Lulu	Site 1	11/29/05	49.0	433	14	384	313	1144	<1	8	42	51	10.3	14.5	49.5
Lulu	Site 1	12/14/05	49.8	395	<5	190	584	1171	1	9	52	62	6.3	12.6	39.5
Lulu	Site 1	12/28/05	49.2	305	<5	267	105	679	1	2	29	32	6.0	9.0	43.9
Lulu	Site 1	1/3/06	49.4	35	<5	413	668	1118	<1	3	38	42	5.4	13.8	26.7
Lulu	Site 1	1/12/06	50.6	15	<5	319	537	873	<1	2	37	40	4.4	8.8	18.9
Lulu	Site 1	1/23/06	50.4	<5	<5	375	523	903	<1	3	42	46	5.5	13.0	25.3
Lulu	Site 1	2/16/06	50.6	<5	61	318	530	911	1	1	40	42	6.1	9.0	24.3
Lulu	Site 1	3/2/06	52.2	170	<5	251	524	947	<1	2	40	43	4.5	9.5	19.0
Lulu	Site 1	3/10/06	53.2	35	<5	385	543	965	<1	9	37	47	6.0	15.7	24.1
Lulu	Site 1	3/13/06	52.8	74	5	352	578	1009	<1	20	31	52	6.6	15.2	30.8
Lulu	Site 1	3/27/06	53.4	51	25	352	622	1050	<1	5	62	68	7.3	12.6	34.2
Lulu	Site 1	4/12/06	54.8	41	<5	392	853	1288	1	4	66	71	9.4	21.2	40.5
Lulu	Site 1	4/24/06	55.4	12	7	449	842	1310	<1	3	49	53	7.8	16.8	31.5
Lulu	Site 2	10/6/05	48.0	506	<5	60	872	1440	1	5	49	55	5.8	7.8	50.2
Lulu	Site 2	10/20/05	50.6	391	5	43	783	1222	<1	8	42	51	6.0	8.0	47.5
Lulu	Site 2	11/7/05	48.2	293	58	71	858	1280	1	1	52	54	6.9	11.6	50.6
Lulu	Site 2	11/22/05	49.4	108	10	363	1034	1515	<1	1	75	77	9.9	22.0	62.6
Lulu	Site 2	11/29/05	50.2	391	11	16	745	1163	<1	5	42	48	9.5	15.5	51.3
Lulu	Site 2	12/14/05	48.6	599	<5	243	410	1254	<1	6	52	59	6.2	10.6	38.3
Lulu	Site 2	12/28/05	50.4	279	<5	74	381	736	2	1	31	34	6.3	9.6	42.2
Lulu	Site 2	1/3/06	49.2	16	<5	532	600	1150	<1	3	43	47	6.3	15.0	26.7
Lulu	Site 2	1/12/06	49.6	55	<5	363	444	864	<1	3	36	40	4.9	9.6	23.9
Lulu	Site 2	1/23/06	51.2	<5	<5	401	627	1033	<1	3	52	56	6.7	12.8	27.7
Lulu	Site 2	2/16/06	51.0	5	166	235	613	1019	11	5	29	45	6.0	9.0	23.5
Lulu	Site 2	3/2/06	51.2	7	<5	410	618	1037	<1	2	49	52	3.8	10.9	19.1
Lulu	Site 2	3/10/06	53.0	13	<5	395	678	1088	<1	2	54	57	6.9	12.8	25.8
Lulu	Site 2	3/13/06	53.0	18	3	425	605	1051	<1	3	52	56	7.2	16.6	31.0
Lulu	Site 2	3/27/06	53.0	115	17	277	745	1154	<1	4	65	70	9.6	14.6	30.3
Lulu	Site 2	4/12/06	55.8	42	14	407	859	1322	<1	5	66	72	10.1	23.0	38.5
Lulu	Site 2	4/24/06	58.2	12	309	151	735	1207	7	1	42	50	8.6	18.4	31.2
Lulu	Site 3	10/6/05	53.4	301	<5	150	571	1024	<1	7	35	43	5.8	6.4	39.0
Lulu	Site 3	10/20/05	50.2	210	<5	336	705	1253	<1	5	43	49	7.1	8.4	40.5
Lulu	Site 3	11/7/05	49.0	249	59	368	409	1085	1	5	33	39	6.5	12.0	50.4
Lulu	Site 3	11/22/05	49.6	107	9	414	778	1308	<1	7	55	63	8.7	19.0	52.9
Lulu	Site 3	11/29/05	49.8	347	26	175	624	1172	<1	7	44	52	8.2	15.3	47.7
Lulu	Site 3	12/14/05	50.0	623	<5	160	594	1379	<1	9	42	52	6.4	11.8	30.7
Lulu	Site 3	12/28/05	50.8	453	7	17	228	705	1	3	21	25	6.4	13.0	42.2
Lulu	Site 3	1/3/06	50.2	25	<5	507	597	1131	<1	3	41	45	6.9	11.5	28.7
Lulu	Site 3	1/12/06	50.0	<5	<5	342	505	852	<1	2	36	39	4.4	10.0	20.9
Lulu	Site 3	1/23/06	52.0	<5	<5	377	599	981	<1	3	49	53	7.0	15.0	23.3
Lulu	Site 3	2/16/06	51.4	7	76	277	588	948	8	9	25	42	5.9	9.8	20.4
Lulu	Site 3	3/2/06	52.4	145	<5	226	673	1046	<1	10	38	49	5.2	11.3	21.2
Lulu	Site 3	3/10/06	50.2	12	<5	427	400	845	<1	2	48	51	7.5	15.0	22.7
Lulu	Site 3	3/13/06	53.8	23	<5	417	564	1006	<1	3	48	52	6.5	15.4	30.5
Lulu	Site 3	3/27/06	54.0	47	15	380	630	1072	<1	6	53	60	7.8	13.6	28.5
Lulu	Site 3	4/12/06	57.0	91	<5	364	870	1327	<1	6	71	78	9.7	24.0	35.7
Lulu	Site 3	4/24/06	54.6	5	47	404	828	1284	4	10	56	70	9.3	20.0	35.5

Characteristics of Surface Water Samples Collected in in Lake Howard - Lake May Canal from October 2005 to April 2006

Sample Location	Date Collected	pH (s.u.)	Alkalinity (mg/l)	NH3 (µg/l)	NOX (µg/l)	Dis Org N (µg/l)	Part N (µg/l)	TN (µg/l)	SRP (µg/l)	Dis Org P (µg/l)	Part P (µg/l)	TP (µg/l)	Turbidity (mg/l)	TSS (mg/l)	Chl a (mg/m^3)
Inflow	10/6/05	7.07	49.2	474	<5	117	1110	1703	<1	2	68	71	6.5	6.8	46.7
Inflow	10/20/05	8.06	52.2	415	<5	31	749	1197	<1	2	60	63	8.3	10.5	66.0
Inflow	11/7/05	7.86	43.2	256	<5	788	669	1715	<1	8	17	26	6.3	13.4	43.9
Inflow	11/22/05	7.26	54.6	129	15	284	772	1200	<1	5	33	39	8.2	16.0	61.0
Inflow	11/29/05	7.54	48.0	352	<5	289	391	1034	<1	1	41	43	7.6	16.9	59.4
Inflow	12/14/05	7.48	47.8	363	<5	287	330	982	1	7	36	44	6.2	11.1	54.4
Inflow	12/28/05	7.12	49.2	347	<5	77	635	1061	1	1	46	48	5.9	12.7	50.2
Inflow	1/3/06	7.13	48.8	23	<5	445	747	1217	<1	1	44	46	8.2	21.6	29.8
Inflow	1/12/06	7.24	48.6	63	<5	384	1052	1501	1	1	45	47	7.1	12.6	27.7
Inflow	1/23/06	7.33	48.2	<5	<5	403	702	1110	<1	1	61	63	8.3	17.7	41.9
Inflow	2/16/06	7.53	47.0	57	137	130	646	970	10	4	26	40	6.1	11.8	26.2
Inflow	3/2/06	7.17	44.2	152	10	277	432	871	<1	4	28	33	5.4	11.3	20.9
Inflow	3/10/06	7.14	53.4	13	<5	382	800	1197	<1	8	51	60	9.3	17.7	35.5
Inflow	3/13/06	7.21	53.4	76	5	401	672	1154	1	7	64	72	10.3	20.0	46.6
Inflow	3/27/06	7.25	52.2	53	19	372	747	1191	1	35	30	66	7.5	10.8	39.2
Inflow	4/12/06	7.45	48.2	58	<5	347	685	1092	1	1	38	40	6.4	6.4	37.9
Inflow	4/24/06	7.87	49.0	68	<5	364	752	1186	<1	1	32	34	7.6	15.2	31.6
	average	7.39	49.2	171	13	316	699	1199	1	5	42	49	7.4	13.7	42.3
	min	7.07	43.2	<5	<5	31	330	871	<1	1	17	26	5.4	6.4	20.9
	max	8.06	54.6	474	137	788	1110	1715	10	35	68	72	10.3	21.6	66.0

Characteristics of Surface Water Samples Collected in in Lake Eloise - Lake Lulu Canal from October 2005 to April 2006

Sample Location	Date Collected	pH (s.u.)	Alkalinity (mg/l)	NH3 (µg/l)	NO_x (µg/l)	Dis Org N (µg/l)	Part N (µg/l)	TN (µg/l)	SRP (µg/l)	Dis Org P (µg/l)	Part P (µg/l)	TP (µg/l)	Turbidity (mg/l)	TSS (mg/l)	Chl a (mg/m^3)
Inflow	10/6/05	7.18	50.8	352	<5	112	763	1229	<1	7	46	54	5.9	6.6	66.4
Inflow	10/20/05	7.69	50.6	451	<5	130	927	1510	<1	7	63	71	9.7	9.0	62.9
Inflow	11/7/05	7.77	48.4	254	43	365	532	1194	1	11	41	53	9.6	13.2	66.2
Inflow	11/22/05	7.13	52.0	434	13	290	4013	4750	<1	1	81	83	15.3	28.0	72.6
Inflow	11/29/05	7.21	50.2	<5	<5	513	923	1441	1	8	60	69	14.7	16.5	66.2
Inflow	12/14/05	7.51	49.6	532	<5	147	519	1200	<1	4	54	59	11.3	14.8	51.6
Inflow	12/28/05	7.15	51.4	357	<5	757	420	1536	2	4	55	61	10.8	14.4	48.7
Inflow	1/3/06	7.15	49.8	199	<5	320	670	1191	<1	3	43	47	7.2	15.5	28.7
Inflow	1/12/06	7.07	51.4	48	<5	396	766	1212	<1	5	80	86	8.2	15.6	39.3
Inflow	1/23/06	7.33	52.2	<5	<5	361	719	1085	<1	2	62	65	7.4	13.4	28.7
Inflow	2/16/06	7.12	50.2	5	17	437	475	934	<1	13	27	41	6.4	11.2	22.8
Inflow	3/2/06	7.28	52.6	169	<5	303	26	500	<1	2	12	15	4.6	9.0	18.6
Inflow	3/10/06	7.26	53.4	14	<5	455	565	1036	<1	7	49	57	5.8	13.0	26.3
Inflow	3/13/06	7.26	51.8	45	5	425	637	1112	<1	5	65	71	9.0	19.2	29.7
Inflow	3/27/06	7.40	55.2	61	16	421	637	1135	<1	7	65	73	8.0	12.4	37.0
Inflow	4/12/06	7.35	55.4	187	<5	276	941	1406	<1	82	7	90	10.4	24.2	36.9
Inflow	4/24/06	7.78	55.8	41	13	405	743	1202	1	4	46	51	8.0	17.2	30.2
	average	7.33	51.8	186	8	359	840	1393	<1	10	50	62	9.0	14.9	43.1
	min	7.07	48.4	<5	<5	112	26	500	<1	1	7	15	4.6	6.6	18.6
	max	7.78	55.8	532	43	757	4013	4750	2	82	81	90	15.3	28.0	72.6

APPENDIX C

WATER LEVEL DATA IN LAKE SHIPP FROM 1984-2006

(Source: SWFWMD)

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	3/7/1984	131.68
160685	STA-392	SWFWMD_HYDRO	3/8/1984	131.68
160685	STA-392	SWFWMD_HYDRO	3/9/1984	131.5
160685	STA-392	SWFWMD_HYDRO	3/10/1984	131.6
160685	STA-392	SWFWMD_HYDRO	3/11/1984	131.6
160685	STA-392	SWFWMD_HYDRO	3/12/1984	131.6
160685	STA-392	SWFWMD_HYDRO	3/13/1984	131.68
160685	STA-392	SWFWMD_HYDRO	3/14/1984	131.68
160685	STA-392	SWFWMD_HYDRO	3/15/1984	131.66
160685	STA-392	SWFWMD_HYDRO	3/16/1984	131.66
160685	STA-392	SWFWMD_HYDRO	3/17/1984	131.66
160685	STA-392	SWFWMD_HYDRO	3/18/1984	131.64
160685	STA-392	SWFWMD_HYDRO	3/19/1984	131.64
160685	STA-392	SWFWMD_HYDRO	3/21/1984	131.62
160685	STA-392	SWFWMD_HYDRO	3/22/1984	131.6
160685	STA-392	SWFWMD_HYDRO	3/23/1984	131.6
160685	STA-392	SWFWMD_HYDRO	3/24/1984	131.58
160685	STA-392	SWFWMD_HYDRO	3/25/1984	131.58
160685	STA-392	SWFWMD_HYDRO	3/26/1984	131.58
160685	STA-392	SWFWMD_HYDRO	3/27/1984	131.58
160685	STA-392	SWFWMD_HYDRO	3/28/1984	131.56
160685	STA-392	SWFWMD_HYDRO	3/29/1984	131.56
160685	STA-392	SWFWMD_HYDRO	3/30/1984	131.56
160685	STA-392	SWFWMD_HYDRO	3/31/1984	131.54
160685	STA-392	SWFWMD_HYDRO	4/1/1984	131.54
160685	STA-392	SWFWMD_HYDRO	4/2/1984	131.52
160685	STA-392	SWFWMD_HYDRO	4/3/1984	131.5
160685	STA-392	SWFWMD_HYDRO	4/4/1984	131.5
160685	STA-392	SWFWMD_HYDRO	4/5/1984	131.52
160685	STA-392	SWFWMD_HYDRO	4/6/1984	131.52
160685	STA-392	SWFWMD_HYDRO	4/7/1984	131.5
160685	STA-392	SWFWMD_HYDRO	4/8/1984	131.48
160685	STA-392	SWFWMD_HYDRO	4/9/1984	131.48
160685	STA-392	SWFWMD_HYDRO	4/10/1984	131.48
160685	STA-392	SWFWMD_HYDRO	4/11/1984	131.46
160685	STA-392	SWFWMD_HYDRO	4/12/1984	131.44
160685	STA-392	SWFWMD_HYDRO	4/13/1984	131.42
160685	STA-392	SWFWMD_HYDRO	4/14/1984	131.42
160685	STA-392	SWFWMD_HYDRO	4/15/1984	131.44
160685	STA-392	SWFWMD_HYDRO	4/16/1984	131.46
160685	STA-392	SWFWMD_HYDRO	4/17/1984	131.46
160685	STA-392	SWFWMD_HYDRO	4/18/1984	131.4
160685	STA-392	SWFWMD_HYDRO	4/19/1984	131.4
160685	STA-392	SWFWMD_HYDRO	4/20/1984	131.4
160685	STA-392	SWFWMD_HYDRO	4/21/1984	131.38
160685	STA-392	SWFWMD_HYDRO	4/22/1984	131.38
160685	STA-392	SWFWMD_HYDRO	4/23/1984	131.38
160685	STA-392	SWFWMD_HYDRO	4/24/1984	131.36
160685	STA-392	SWFWMD_HYDRO	4/25/1984	131.34
160685	STA-392	SWFWMD_HYDRO	4/26/1984	131.32
160685	STA-392	SWFWMD_HYDRO	4/27/1984	131.3
160685	STA-392	SWFWMD_HYDRO	4/28/1984	131.28
160685	STA-392	SWFWMD_HYDRO	4/29/1984	131.26

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	4/30/1984	131.26
160685	STA-392	SWFWMD_HYDRO	5/1/1984	131.22
160685	STA-392	SWFWMD_HYDRO	5/2/1984	131.2
160685	STA-392	SWFWMD_HYDRO	5/3/1984	131.18
160685	STA-392	SWFWMD_HYDRO	5/4/1984	131.16
160685	STA-392	SWFWMD_HYDRO	5/5/1984	131.12
160685	STA-392	SWFWMD_HYDRO	5/6/1984	131.1
160685	STA-392	SWFWMD_HYDRO	5/7/1984	131.1
160685	STA-392	SWFWMD_HYDRO	5/8/1984	131.14
160685	STA-392	SWFWMD_HYDRO	5/9/1984	131.14
160685	STA-392	SWFWMD_HYDRO	5/10/1984	131.16
160685	STA-392	SWFWMD_HYDRO	5/11/1984	131.14
160685	STA-392	SWFWMD_HYDRO	5/12/1984	131.1
160685	STA-392	SWFWMD_HYDRO	5/13/1984	131.08
160685	STA-392	SWFWMD_HYDRO	5/14/1984	131.06
160685	STA-392	SWFWMD_HYDRO	5/15/1984	131.02
160685	STA-392	SWFWMD_HYDRO	5/17/1984	130.98
160685	STA-392	SWFWMD_HYDRO	5/18/1984	130.96
160685	STA-392	SWFWMD_HYDRO	5/19/1984	130.94
160685	STA-392	SWFWMD_HYDRO	5/20/1984	130.88
160685	STA-392	SWFWMD_HYDRO	5/21/1984	130.88
160685	STA-392	SWFWMD_HYDRO	5/22/1984	130.98
160685	STA-392	SWFWMD_HYDRO	5/23/1984	130.96
160685	STA-392	SWFWMD_HYDRO	5/24/1984	130.96
160685	STA-392	SWFWMD_HYDRO	5/25/1984	130.8
160685	STA-392	SWFWMD_HYDRO	5/26/1984	131
160685	STA-392	SWFWMD_HYDRO	5/27/1984	131.06
160685	STA-392	SWFWMD_HYDRO	5/28/1984	131.04
160685	STA-392	SWFWMD_HYDRO	5/29/1984	131
160685	STA-392	SWFWMD_HYDRO	5/30/1984	131
160685	STA-392	SWFWMD_HYDRO	5/31/1984	131
160685	STA-392	SWFWMD_HYDRO	6/1/1984	130.96
160685	STA-392	SWFWMD_HYDRO	6/2/1984	130.94
160685	STA-392	SWFWMD_HYDRO	6/3/1984	130.9
160685	STA-392	SWFWMD_HYDRO	6/4/1984	130.9
160685	STA-392	SWFWMD_HYDRO	6/5/1984	130.88
160685	STA-392	SWFWMD_HYDRO	6/6/1984	130.86
160685	STA-392	SWFWMD_HYDRO	6/7/1984	130.84
160685	STA-392	SWFWMD_HYDRO	6/8/1984	130.8
160685	STA-392	SWFWMD_HYDRO	6/9/1984	130.78
160685	STA-392	SWFWMD_HYDRO	6/10/1984	130.76
160685	STA-392	SWFWMD_HYDRO	6/11/1984	130.76
160685	STA-392	SWFWMD_HYDRO	6/12/1984	130.74
160685	STA-392	SWFWMD_HYDRO	6/13/1984	130.7
160685	STA-392	SWFWMD_HYDRO	6/14/1984	130.72
160685	STA-392	SWFWMD_HYDRO	6/15/1984	130.68
160685	STA-392	SWFWMD_HYDRO	6/16/1984	130.68
160685	STA-392	SWFWMD_HYDRO	6/17/1984	130.68
160685	STA-392	SWFWMD_HYDRO	6/18/1984	130.86
160685	STA-392	SWFWMD_HYDRO	6/19/1984	131.02
160685	STA-392	SWFWMD_HYDRO	6/20/1984	131
160685	STA-392	SWFWMD_HYDRO	6/21/1984	131
160685	STA-392	SWFWMD_HYDRO	6/22/1984	130.98

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	6/23/1984	131
160685	STA-392	SWFWMD_HYDRO	6/24/1984	131
160685	STA-392	SWFWMD_HYDRO	6/25/1984	131.02
160685	STA-392	SWFWMD_HYDRO	6/26/1984	130.98
160685	STA-392	SWFWMD_HYDRO	6/27/1984	130.98
160685	STA-392	SWFWMD_HYDRO	6/28/1984	130.96
160685	STA-392	SWFWMD_HYDRO	6/29/1984	131.02
160685	STA-392	SWFWMD_HYDRO	6/30/1984	131.06
160685	STA-392	SWFWMD_HYDRO	7/1/1984	131.1
160685	STA-392	SWFWMD_HYDRO	7/2/1984	131.12
160685	STA-392	SWFWMD_HYDRO	7/3/1984	131.14
160685	STA-392	SWFWMD_HYDRO	7/4/1984	131.24
160685	STA-392	SWFWMD_HYDRO	7/5/1984	131.38
160685	STA-392	SWFWMD_HYDRO	7/6/1984	131.36
160685	STA-392	SWFWMD_HYDRO	7/7/1984	131.34
160685	STA-392	SWFWMD_HYDRO	7/8/1984	131.34
160685	STA-392	SWFWMD_HYDRO	7/9/1984	131.32
160685	STA-392	SWFWMD_HYDRO	7/10/1984	131.3
160685	STA-392	SWFWMD_HYDRO	7/11/1984	131.28
160685	STA-392	SWFWMD_HYDRO	7/12/1984	131.28
160685	STA-392	SWFWMD_HYDRO	7/13/1984	131.26
160685	STA-392	SWFWMD_HYDRO	7/14/1984	131.3
160685	STA-392	SWFWMD_HYDRO	7/15/1984	131.34
160685	STA-392	SWFWMD_HYDRO	7/16/1984	131.32
160685	STA-392	SWFWMD_HYDRO	7/17/1984	131.32
160685	STA-392	SWFWMD_HYDRO	7/18/1984	131.32
160685	STA-392	SWFWMD_HYDRO	7/19/1984	131.34
160685	STA-392	SWFWMD_HYDRO	7/20/1984	131.34
160685	STA-392	SWFWMD_HYDRO	7/21/1984	131.36
160685	STA-392	SWFWMD_HYDRO	7/22/1984	131.36
160685	STA-392	SWFWMD_HYDRO	7/23/1984	131.38
160685	STA-392	SWFWMD_HYDRO	7/24/1984	131.4
160685	STA-392	SWFWMD_HYDRO	7/25/1984	131.38
160685	STA-392	SWFWMD_HYDRO	7/26/1984	131.4
160685	STA-392	SWFWMD_HYDRO	7/27/1984	131.4
160685	STA-392	SWFWMD_HYDRO	7/28/1984	131.38
160685	STA-392	SWFWMD_HYDRO	7/29/1984	131.38
160685	STA-392	SWFWMD_HYDRO	7/30/1984	131.36
160685	STA-392	SWFWMD_HYDRO	8/27/1984	131.7
160685	STA-392	SWFWMD_HYDRO	8/28/1984	131.68
160685	STA-392	SWFWMD_HYDRO	8/29/1984	131.66
160685	STA-392	SWFWMD_HYDRO	8/30/1984	131.64
160685	STA-392	SWFWMD_HYDRO	8/31/1984	131.6
160685	STA-392	SWFWMD_HYDRO	9/1/1984	131.58
160685	STA-392	SWFWMD_HYDRO	9/2/1984	131.58
160685	STA-392	SWFWMD_HYDRO	9/3/1984	131.58
160685	STA-392	SWFWMD_HYDRO	9/4/1984	131.58
160685	STA-392	SWFWMD_HYDRO	9/5/1984	131.68
160685	STA-392	SWFWMD_HYDRO	9/6/1984	131.74
160685	STA-392	SWFWMD_HYDRO	9/7/1984	131.7
160685	STA-392	SWFWMD_HYDRO	9/8/1984	131.68
160685	STA-392	SWFWMD_HYDRO	9/9/1984	131.68
160685	STA-392	SWFWMD_HYDRO	9/10/1984	131.66

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	9/11/1984	131.62
160685	STA-392	SWFWMD_HYDRO	9/12/1984	131.58
160685	STA-392	SWFWMD_HYDRO	9/13/1984	131.6
160685	STA-392	SWFWMD_HYDRO	9/14/1984	131.58
160685	STA-392	SWFWMD_HYDRO	9/15/1984	131.56
160685	STA-392	SWFWMD_HYDRO	9/16/1984	131.56
160685	STA-392	SWFWMD_HYDRO	9/17/1984	131.64
160685	STA-392	SWFWMD_HYDRO	9/18/1984	131.66
160685	STA-392	SWFWMD_HYDRO	9/19/1984	131.68
160685	STA-392	SWFWMD_HYDRO	9/20/1984	131.68
160685	STA-392	SWFWMD_HYDRO	9/21/1984	131.66
160685	STA-392	SWFWMD_HYDRO	9/22/1984	131.64
160685	STA-392	SWFWMD_HYDRO	9/23/1984	131.6
160685	STA-392	SWFWMD_HYDRO	9/24/1984	131.58
160685	STA-392	SWFWMD_HYDRO	9/25/1984	131.56
160685	STA-392	SWFWMD_HYDRO	9/26/1984	131.54
160685	STA-392	SWFWMD_HYDRO	9/27/1984	131.52
160685	STA-392	SWFWMD_HYDRO	9/28/1984	131.64
160685	STA-392	SWFWMD_HYDRO	9/29/1984	131.66
160685	STA-392	SWFWMD_HYDRO	9/30/1984	131.66
160685	STA-392	SWFWMD_HYDRO	10/1/1984	131.66
160685	STA-392	SWFWMD_HYDRO	10/2/1984	131.64
160685	STA-392	SWFWMD_HYDRO	10/3/1984	131.6
160685	STA-392	SWFWMD_HYDRO	10/4/1984	131.58
160685	STA-392	SWFWMD_HYDRO	10/5/1984	131.58
160685	STA-392	SWFWMD_HYDRO	10/6/1984	131.56
160685	STA-392	SWFWMD_HYDRO	10/7/1984	131.54
160685	STA-392	SWFWMD_HYDRO	10/8/1984	131.54
160685	STA-392	SWFWMD_HYDRO	10/9/1984	131.58
160685	STA-392	SWFWMD_HYDRO	10/10/1984	131.56
160685	STA-392	SWFWMD_HYDRO	10/11/1984	131.54
160685	STA-392	SWFWMD_HYDRO	10/12/1984	131.5
160685	STA-392	SWFWMD_HYDRO	10/13/1984	131.48
160685	STA-392	SWFWMD_HYDRO	10/14/1984	131.48
160685	STA-392	SWFWMD_HYDRO	10/15/1984	131.48
160685	STA-392	SWFWMD_HYDRO	10/16/1984	131.46
160685	STA-392	SWFWMD_HYDRO	10/17/1984	131.46
160685	STA-392	SWFWMD_HYDRO	10/18/1984	131.46
160685	STA-392	SWFWMD_HYDRO	10/19/1984	131.44
160685	STA-392	SWFWMD_HYDRO	10/20/1984	131.4
160685	STA-392	SWFWMD_HYDRO	10/21/1984	131.38
160685	STA-392	SWFWMD_HYDRO	10/22/1984	131.38
160685	STA-392	SWFWMD_HYDRO	10/23/1984	131.36
160685	STA-392	SWFWMD_HYDRO	10/24/1984	131.36
160685	STA-392	SWFWMD_HYDRO	10/27/1984	131.3
160685	STA-392	SWFWMD_HYDRO	10/30/1984	131.32
160685	STA-392	SWFWMD_HYDRO	11/2/1984	131.3
160685	STA-392	SWFWMD_HYDRO	11/5/1984	131.26
160685	STA-392	SWFWMD_HYDRO	11/7/1984	131.24
160685	STA-392	SWFWMD_HYDRO	11/9/1984	131.22
160685	STA-392	SWFWMD_HYDRO	11/12/1984	131.1
160685	STA-392	SWFWMD_HYDRO	11/18/1984	131
160685	STA-392	SWFWMD_HYDRO	11/24/1984	131.02

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	11/28/1984	131
160685	STA-392	SWFWMD_HYDRO	12/1/1984	131.02
160685	STA-392	SWFWMD_HYDRO	12/6/1984	131.02
160685	STA-392	SWFWMD_HYDRO	12/9/1984	130.98
160685	STA-392	SWFWMD_HYDRO	12/10/1984	130.96
160685	STA-392	SWFWMD_HYDRO	12/11/1984	130.96
160685	STA-392	SWFWMD_HYDRO	12/12/1984	130.94
160685	STA-392	SWFWMD_HYDRO	12/13/1984	130.92
160685	STA-392	SWFWMD_HYDRO	12/14/1984	130.92
160685	STA-392	SWFWMD_HYDRO	12/15/1984	130.9
160685	STA-392	SWFWMD_HYDRO	12/16/1984	130.9
160685	STA-392	SWFWMD_HYDRO	12/17/1984	130.9
160685	STA-392	SWFWMD_HYDRO	12/18/1984	130.9
160685	STA-392	SWFWMD_HYDRO	12/19/1984	130.9
160685	STA-392	SWFWMD_HYDRO	12/20/1984	130.88
160685	STA-392	SWFWMD_HYDRO	12/21/1984	130.88
160685	STA-392	SWFWMD_HYDRO	12/22/1984	130.86
160685	STA-392	SWFWMD_HYDRO	12/23/1984	130.86
160685	STA-392	SWFWMD_HYDRO	12/24/1984	130.86
160685	STA-392	SWFWMD_HYDRO	12/25/1984	130.86
160685	STA-392	SWFWMD_HYDRO	12/26/1984	130.86
160685	STA-392	SWFWMD_HYDRO	12/27/1984	130.85
160685	STA-392	SWFWMD_HYDRO	12/28/1984	130.84
160685	STA-392	SWFWMD_HYDRO	12/29/1984	130.82
160685	STA-392	SWFWMD_HYDRO	12/30/1984	130.82
160685	STA-392	SWFWMD_HYDRO	12/31/1984	129.8
160685	STA-392	SWFWMD_HYDRO	1/1/1985	130.8
160685	STA-392	SWFWMD_HYDRO	1/2/1985	130.8
160685	STA-392	SWFWMD_HYDRO	1/3/1985	130.82
160685	STA-392	SWFWMD_HYDRO	1/4/1985	130.8
160685	STA-392	SWFWMD_HYDRO	1/5/1985	130.8
160685	STA-392	SWFWMD_HYDRO	1/6/1985	130.78
160685	STA-392	SWFWMD_HYDRO	1/7/1985	130.78
160685	STA-392	SWFWMD_HYDRO	1/8/1985	130.76
160685	STA-392	SWFWMD_HYDRO	1/9/1985	130.74
160685	STA-392	SWFWMD_HYDRO	1/10/1985	130.72
160685	STA-392	SWFWMD_HYDRO	1/11/1985	130.7
160685	STA-392	SWFWMD_HYDRO	1/12/1985	130.66
160685	STA-392	SWFWMD_HYDRO	1/13/1985	130.64
160685	STA-392	SWFWMD_HYDRO	1/14/1985	130.66
160685	STA-392	SWFWMD_HYDRO	1/15/1985	130.66
160685	STA-392	SWFWMD_HYDRO	1/16/1985	130.64
160685	STA-392	SWFWMD_HYDRO	1/17/1985	130.64
160685	STA-392	SWFWMD_HYDRO	1/18/1985	130.66
160685	STA-392	SWFWMD_HYDRO	1/19/1985	130.66
160685	STA-392	SWFWMD_HYDRO	1/20/1985	130.64
160685	STA-392	SWFWMD_HYDRO	1/21/1985	130.62
160685	STA-392	SWFWMD_HYDRO	1/22/1985	130.6
160685	STA-392	SWFWMD_HYDRO	1/23/1985	130.58
160685	STA-392	SWFWMD_HYDRO	1/24/1985	130.58
160685	STA-392	SWFWMD_HYDRO	1/25/1985	130.58
160685	STA-392	SWFWMD_HYDRO	1/26/1985	130.56
160685	STA-392	SWFWMD_HYDRO	1/27/1985	130.54

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	1/28/1985	130.54
160685	STA-392	SWFWMD_HYDRO	1/29/1985	130.56
160685	STA-392	SWFWMD_HYDRO	1/30/1985	130.54
160685	STA-392	SWFWMD_HYDRO	1/31/1985	130.54
160685	STA-392	SWFWMD_HYDRO	2/1/1985	130.52
160685	STA-392	SWFWMD_HYDRO	2/2/1985	130.5
160685	STA-392	SWFWMD_HYDRO	2/3/1985	130.54
160685	STA-392	SWFWMD_HYDRO	2/4/1985	130.52
160685	STA-392	SWFWMD_HYDRO	2/5/1985	130.5
160685	STA-392	SWFWMD_HYDRO	2/6/1985	130.5
160685	STA-392	SWFWMD_HYDRO	2/7/1985	130.52
160685	STA-392	SWFWMD_HYDRO	2/8/1985	130.54
160685	STA-392	SWFWMD_HYDRO	2/9/1985	130.52
160685	STA-392	SWFWMD_HYDRO	2/10/1985	130.5
160685	STA-392	SWFWMD_HYDRO	2/11/1985	130.5
160685	STA-392	SWFWMD_HYDRO	2/12/1985	130.48
160685	STA-392	SWFWMD_HYDRO	2/13/1985	130.48
160685	STA-392	SWFWMD_HYDRO	2/14/1985	130.48
160685	STA-392	SWFWMD_HYDRO	2/15/1985	130.46
160685	STA-392	SWFWMD_HYDRO	2/16/1985	130.46
160685	STA-392	SWFWMD_HYDRO	2/17/1985	130.44
160685	STA-392	SWFWMD_HYDRO	2/18/1985	130.42
160685	STA-392	SWFWMD_HYDRO	2/19/1985	130.42
160685	STA-392	SWFWMD_HYDRO	2/20/1985	130.4
160685	STA-392	SWFWMD_HYDRO	2/21/1985	130.4
160685	STA-392	SWFWMD_HYDRO	2/22/1985	130.38
160685	STA-392	SWFWMD_HYDRO	2/23/1985	130.38
160685	STA-392	SWFWMD_HYDRO	2/24/1985	130.36
160685	STA-392	SWFWMD_HYDRO	2/25/1985	130.36
160685	STA-392	SWFWMD_HYDRO	2/26/1985	130.36
160685	STA-392	SWFWMD_HYDRO	2/27/1985	130.34
160685	STA-392	SWFWMD_HYDRO	2/28/1985	130.34
160685	STA-392	SWFWMD_HYDRO	3/1/1985	130.32
160685	STA-392	SWFWMD_HYDRO	3/2/1985	130.32
160685	STA-392	SWFWMD_HYDRO	3/3/1985	130.3
160685	STA-392	SWFWMD_HYDRO	3/4/1985	130.3
160685	STA-392	SWFWMD_HYDRO	3/5/1985	130.28
160685	STA-392	SWFWMD_HYDRO	3/6/1985	130.26
160685	STA-392	SWFWMD_HYDRO	3/7/1985	130.26
160685	STA-392	SWFWMD_HYDRO	3/8/1985	130.24
160685	STA-392	SWFWMD_HYDRO	3/9/1985	130.24
160685	STA-392	SWFWMD_HYDRO	3/10/1985	130.22
160685	STA-392	SWFWMD_HYDRO	3/11/1985	130.2
160685	STA-392	SWFWMD_HYDRO	3/12/1985	130.18
160685	STA-392	SWFWMD_HYDRO	3/13/1985	130.16
160685	STA-392	SWFWMD_HYDRO	3/14/1985	130.16
160685	STA-392	SWFWMD_HYDRO	3/15/1985	130.18
160685	STA-392	SWFWMD_HYDRO	3/16/1985	130.18
160685	STA-392	SWFWMD_HYDRO	3/17/1985	130.06
160685	STA-392	SWFWMD_HYDRO	3/18/1985	130.04
160685	STA-392	SWFWMD_HYDRO	3/19/1985	130.02
160685	STA-392	SWFWMD_HYDRO	3/20/1985	130.02
160685	STA-392	SWFWMD_HYDRO	3/21/1985	130.04

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	3/22/1985	130.3
160685	STA-392	SWFWMD_HYDRO	3/23/1985	130.3
160685	STA-392	SWFWMD_HYDRO	3/24/1985	130.28
160685	STA-392	SWFWMD_HYDRO	3/25/1985	130.28
160685	STA-392	SWFWMD_HYDRO	3/26/1985	130.26
160685	STA-392	SWFWMD_HYDRO	3/27/1985	130.24
160685	STA-392	SWFWMD_HYDRO	3/28/1985	130.24
160685	STA-392	SWFWMD_HYDRO	3/29/1985	130.24
160685	STA-392	SWFWMD_HYDRO	3/30/1985	130.22
160685	STA-392	SWFWMD_HYDRO	3/31/1985	130.2
160685	STA-392	SWFWMD_HYDRO	4/1/1985	130.18
160685	STA-392	SWFWMD_HYDRO	4/2/1985	130.2
160685	STA-392	SWFWMD_HYDRO	4/3/1985	130.18
160685	STA-392	SWFWMD_HYDRO	4/4/1985	130.16
160685	STA-392	SWFWMD_HYDRO	4/5/1985	130.14
160685	STA-392	SWFWMD_HYDRO	4/6/1985	130.12
160685	STA-392	SWFWMD_HYDRO	4/7/1985	130.12
160685	STA-392	SWFWMD_HYDRO	4/8/1985	130.1
160685	STA-392	SWFWMD_HYDRO	4/9/1985	130.1
160685	STA-392	SWFWMD_HYDRO	4/10/1985	130.1
160685	STA-392	SWFWMD_HYDRO	4/11/1985	130.08
160685	STA-392	SWFWMD_HYDRO	4/12/1985	130.08
160685	STA-392	SWFWMD_HYDRO	4/13/1985	130.06
160685	STA-392	SWFWMD_HYDRO	4/14/1985	130.06
160685	STA-392	SWFWMD_HYDRO	4/15/1985	130.04
160685	STA-392	SWFWMD_HYDRO	4/16/1985	130.02
160685	STA-392	SWFWMD_HYDRO	4/17/1985	130.02
160685	STA-392	SWFWMD_HYDRO	4/18/1985	130.02
160685	STA-392	SWFWMD_HYDRO	4/19/1985	130
160685	STA-392	SWFWMD_HYDRO	4/20/1985	130
160685	STA-392	SWFWMD_HYDRO	4/21/1985	130
160685	STA-392	SWFWMD_HYDRO	4/22/1985	130
160685	STA-392	SWFWMD_HYDRO	4/23/1985	129.88
160685	STA-392	SWFWMD_HYDRO	4/24/1985	129.98
160685	STA-392	SWFWMD_HYDRO	4/25/1985	129.94
160685	STA-392	SWFWMD_HYDRO	4/26/1985	129.92
160685	STA-392	SWFWMD_HYDRO	4/27/1985	129.88
160685	STA-392	SWFWMD_HYDRO	4/28/1985	129.86
160685	STA-392	SWFWMD_HYDRO	4/29/1985	129.82
160685	STA-392	SWFWMD_HYDRO	4/30/1985	129.8
160685	STA-392	SWFWMD_HYDRO	5/1/1985	129.78
160685	STA-392	SWFWMD_HYDRO	5/2/1985	129.76
160685	STA-392	SWFWMD_HYDRO	5/3/1985	129.76
160685	STA-392	SWFWMD_HYDRO	5/4/1985	129.74
160685	STA-392	SWFWMD_HYDRO	5/5/1985	129.7
160685	STA-392	SWFWMD_HYDRO	5/6/1985	129.68
160685	STA-392	SWFWMD_HYDRO	5/7/1985	129.66
160685	STA-392	SWFWMD_HYDRO	5/8/1985	129.64
160685	STA-392	SWFWMD_HYDRO	5/9/1985	129.62
160685	STA-392	SWFWMD_HYDRO	5/10/1985	129.64
160685	STA-392	SWFWMD_HYDRO	5/11/1985	129.6
160685	STA-392	SWFWMD_HYDRO	5/12/1985	129.58
160685	STA-392	SWFWMD_HYDRO	5/13/1985	129.56

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	5/14/1985	129.56
160685	STA-392	SWFWMD_HYDRO	5/15/1985	129.54
160685	STA-392	SWFWMD_HYDRO	5/16/1985	129.58
160685	STA-392	SWFWMD_HYDRO	5/17/1985	129.56
160685	STA-392	SWFWMD_HYDRO	5/18/1985	129.52
160685	STA-392	SWFWMD_HYDRO	5/19/1985	129.48
160685	STA-392	SWFWMD_HYDRO	5/20/1985	129.46
160685	STA-392	SWFWMD_HYDRO	5/21/1985	129.44
160685	STA-392	SWFWMD_HYDRO	5/22/1985	129.42
160685	STA-392	SWFWMD_HYDRO	5/23/1985	129.4
160685	STA-392	SWFWMD_HYDRO	5/24/1985	129.38
160685	STA-392	SWFWMD_HYDRO	5/25/1985	129.36
160685	STA-392	SWFWMD_HYDRO	5/26/1985	129.34
160685	STA-392	SWFWMD_HYDRO	5/27/1985	129.32
160685	STA-392	SWFWMD_HYDRO	5/28/1985	129.3
160685	STA-392	SWFWMD_HYDRO	5/29/1985	129.25
160685	STA-392	SWFWMD_HYDRO	5/30/1985	129.26
160685	STA-392	SWFWMD_HYDRO	5/31/1985	129.24
160685	STA-392	SWFWMD_HYDRO	6/1/1985	129.22
160685	STA-392	SWFWMD_HYDRO	6/2/1985	129.18
160685	STA-392	SWFWMD_HYDRO	6/3/1985	129.16
160685	STA-392	SWFWMD_HYDRO	6/4/1985	129.14
160685	STA-392	SWFWMD_HYDRO	6/5/1985	129.1
160685	STA-392	SWFWMD_HYDRO	6/6/1985	129.08
160685	STA-392	SWFWMD_HYDRO	6/7/1985	129.04
160685	STA-392	SWFWMD_HYDRO	6/8/1985	129.02
160685	STA-392	SWFWMD_HYDRO	6/9/1985	129.06
160685	STA-392	SWFWMD_HYDRO	6/10/1985	129.04
160685	STA-392	SWFWMD_HYDRO	6/11/1985	129.08
160685	STA-392	SWFWMD_HYDRO	6/12/1985	129.1
160685	STA-392	SWFWMD_HYDRO	6/13/1985	129.12
160685	STA-392	SWFWMD_HYDRO	6/14/1985	129.2
160685	STA-392	SWFWMD_HYDRO	6/15/1985	129.24
160685	STA-392	SWFWMD_HYDRO	6/16/1985	129.22
160685	STA-392	SWFWMD_HYDRO	6/17/1985	129.22
160685	STA-392	SWFWMD_HYDRO	6/18/1985	129.2
160685	STA-392	SWFWMD_HYDRO	6/19/1985	129.16
160685	STA-392	SWFWMD_HYDRO	6/20/1985	129.14
160685	STA-392	SWFWMD_HYDRO	6/21/1985	129.16
160685	STA-392	SWFWMD_HYDRO	6/22/1985	129.2
160685	STA-392	SWFWMD_HYDRO	6/23/1985	129.22
160685	STA-392	SWFWMD_HYDRO	6/24/1985	129.22
160685	STA-392	SWFWMD_HYDRO	6/25/1985	129.22
160685	STA-392	SWFWMD_HYDRO	6/26/1985	129.22
160685	STA-392	SWFWMD_HYDRO	6/27/1985	129.26
160685	STA-392	SWFWMD_HYDRO	6/28/1985	129.28
160685	STA-392	SWFWMD_HYDRO	6/29/1985	129.3
160685	STA-392	SWFWMD_HYDRO	6/30/1985	129.28
160685	STA-392	SWFWMD_HYDRO	7/1/1985	129.28
160685	STA-392	SWFWMD_HYDRO	7/2/1985	129.3
160685	STA-392	SWFWMD_HYDRO	7/3/1985	129.3
160685	STA-392	SWFWMD_HYDRO	7/4/1985	129.3
160685	STA-392	SWFWMD_HYDRO	7/5/1985	129.28

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	7/6/1985	129.28
160685	STA-392	SWFWMD_HYDRO	7/7/1985	129.3
160685	STA-392	SWFWMD_HYDRO	7/8/1985	129.3
160685	STA-392	SWFWMD_HYDRO	7/9/1985	129.3
160685	STA-392	SWFWMD_HYDRO	7/10/1985	129.28
160685	STA-392	SWFWMD_HYDRO	7/11/1985	129.26
160685	STA-392	SWFWMD_HYDRO	7/12/1985	129.24
160685	STA-392	SWFWMD_HYDRO	7/13/1985	129.42
160685	STA-392	SWFWMD_HYDRO	7/14/1985	129.42
160685	STA-392	SWFWMD_HYDRO	7/15/1985	129.54
160685	STA-392	SWFWMD_HYDRO	7/16/1985	129.54
160685	STA-392	SWFWMD_HYDRO	7/17/1985	129.56
160685	STA-392	SWFWMD_HYDRO	7/18/1985	129.6
160685	STA-392	SWFWMD_HYDRO	7/19/1985	129.68
160685	STA-392	SWFWMD_HYDRO	7/20/1985	129.7
160685	STA-392	SWFWMD_HYDRO	7/21/1985	129.72
160685	STA-392	SWFWMD_HYDRO	7/22/1985	129.7
160685	STA-392	SWFWMD_HYDRO	7/23/1985	129.7
160685	STA-392	SWFWMD_HYDRO	7/24/1985	129.68
160685	STA-392	SWFWMD_HYDRO	7/25/1985	129.7
160685	STA-392	SWFWMD_HYDRO	7/26/1985	129.76
160685	STA-392	SWFWMD_HYDRO	7/27/1985	129.74
160685	STA-392	SWFWMD_HYDRO	7/28/1985	129.72
160685	STA-392	SWFWMD_HYDRO	7/29/1985	129.7
160685	STA-392	SWFWMD_HYDRO	7/30/1985	129.68
160685	STA-392	SWFWMD_HYDRO	7/31/1985	129.66
160685	STA-392	SWFWMD_HYDRO	8/1/1985	129.76
160685	STA-392	SWFWMD_HYDRO	8/2/1985	129.74
160685	STA-392	SWFWMD_HYDRO	8/3/1985	129.72
160685	STA-392	SWFWMD_HYDRO	8/4/1985	129.78
160685	STA-392	SWFWMD_HYDRO	8/5/1985	129.76
160685	STA-392	SWFWMD_HYDRO	8/6/1985	129.74
160685	STA-392	SWFWMD_HYDRO	8/7/1985	129.88
160685	STA-392	SWFWMD_HYDRO	8/8/1985	129.9
160685	STA-392	SWFWMD_HYDRO	8/9/1985	129.9
160685	STA-392	SWFWMD_HYDRO	8/10/1985	129.92
160685	STA-392	SWFWMD_HYDRO	8/11/1985	129.94
160685	STA-392	SWFWMD_HYDRO	8/12/1985	129.96
160685	STA-392	SWFWMD_HYDRO	8/13/1985	130
160685	STA-392	SWFWMD_HYDRO	8/14/1985	130.02
160685	STA-392	SWFWMD_HYDRO	8/15/1985	130.04
160685	STA-392	SWFWMD_HYDRO	8/16/1985	130.06
160685	STA-392	SWFWMD_HYDRO	8/17/1985	130.04
160685	STA-392	SWFWMD_HYDRO	8/18/1985	130.02
160685	STA-392	SWFWMD_HYDRO	8/19/1985	130
160685	STA-392	SWFWMD_HYDRO	8/20/1985	129.96
160685	STA-392	SWFWMD_HYDRO	8/21/1985	129.94
160685	STA-392	SWFWMD_HYDRO	8/22/1985	129.94
160685	STA-392	SWFWMD_HYDRO	8/23/1985	130.04
160685	STA-392	SWFWMD_HYDRO	8/24/1985	130.04
160685	STA-392	SWFWMD_HYDRO	8/25/1985	130.06
160685	STA-392	SWFWMD_HYDRO	8/26/1985	130.1
160685	STA-392	SWFWMD_HYDRO	8/27/1985	130.12

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	8/28/1985	130.1
160685	STA-392	SWFWMD_HYDRO	8/29/1985	130.18
160685	STA-392	SWFWMD_HYDRO	8/30/1985	130.18
160685	STA-392	SWFWMD_HYDRO	8/31/1985	130.2
160685	STA-392	SWFWMD_HYDRO	9/1/1985	130.3
160685	STA-392	SWFWMD_HYDRO	9/2/1985	130.42
160685	STA-392	SWFWMD_HYDRO	9/3/1985	130.44
160685	STA-392	SWFWMD_HYDRO	9/4/1985	130.48
160685	STA-392	SWFWMD_HYDRO	9/5/1985	130.48
160685	STA-392	SWFWMD_HYDRO	9/6/1985	130.5
160685	STA-392	SWFWMD_HYDRO	9/7/1985	130.5
160685	STA-392	SWFWMD_HYDRO	9/8/1985	130.5
160685	STA-392	SWFWMD_HYDRO	9/9/1985	130.48
160685	STA-392	SWFWMD_HYDRO	9/10/1985	130.48
160685	STA-392	SWFWMD_HYDRO	9/11/1985	130.46
160685	STA-392	SWFWMD_HYDRO	9/12/1985	130.46
160685	STA-392	SWFWMD_HYDRO	9/13/1985	130.46
160685	STA-392	SWFWMD_HYDRO	9/14/1985	130.44
160685	STA-392	SWFWMD_HYDRO	9/15/1985	130.42
160685	STA-392	SWFWMD_HYDRO	9/16/1985	130.42
160685	STA-392	SWFWMD_HYDRO	9/17/1985	130.42
160685	STA-392	SWFWMD_HYDRO	9/18/1985	130.4
160685	STA-392	SWFWMD_HYDRO	9/19/1985	130.4
160685	STA-392	SWFWMD_HYDRO	9/20/1985	130.58
160685	STA-392	SWFWMD_HYDRO	9/21/1985	130.6
160685	STA-392	SWFWMD_HYDRO	9/22/1985	130.62
160685	STA-392	SWFWMD_HYDRO	9/23/1985	130.64
160685	STA-392	SWFWMD_HYDRO	9/24/1985	130.64
160685	STA-392	SWFWMD_HYDRO	9/25/1985	130.62
160685	STA-392	SWFWMD_HYDRO	9/26/1985	130.6
160685	STA-392	SWFWMD_HYDRO	9/27/1985	130.62
160685	STA-392	SWFWMD_HYDRO	9/28/1985	130.62
160685	STA-392	SWFWMD_HYDRO	9/29/1985	130.6
160685	STA-392	SWFWMD_HYDRO	9/30/1985	130.62
160685	STA-392	SWFWMD_HYDRO	10/1/1985	130.6
160685	STA-392	SWFWMD_HYDRO	10/2/1985	130.58
160685	STA-392	SWFWMD_HYDRO	10/3/1985	130.56
160685	STA-392	SWFWMD_HYDRO	10/4/1985	130.58
160685	STA-392	SWFWMD_HYDRO	10/5/1985	130.62
160685	STA-392	SWFWMD_HYDRO	10/6/1985	130.68
160685	STA-392	SWFWMD_HYDRO	10/7/1985	130.66
160685	STA-392	SWFWMD_HYDRO	10/25/1985	130.46
160685	STA-392	SWFWMD_HYDRO	10/26/1985	130.44
160685	STA-392	SWFWMD_HYDRO	10/27/1985	130.42
160685	STA-392	SWFWMD_HYDRO	10/28/1985	130.4
160685	STA-392	SWFWMD_HYDRO	10/29/1985	130.38
160685	STA-392	SWFWMD_HYDRO	10/30/1985	130.38
160685	STA-392	SWFWMD_HYDRO	10/31/1985	130.4
160685	STA-392	SWFWMD_HYDRO	11/1/1985	130.42
160685	STA-392	SWFWMD_HYDRO	11/2/1985	130.4
160685	STA-392	SWFWMD_HYDRO	11/3/1985	130.38
160685	STA-392	SWFWMD_HYDRO	11/4/1985	130.36
160685	STA-392	SWFWMD_HYDRO	11/5/1985	130.34

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	11/6/1985	130.32
160685	STA-392	SWFWMD_HYDRO	11/7/1985	130.3
160685	STA-392	SWFWMD_HYDRO	11/8/1985	130.28
160685	STA-392	SWFWMD_HYDRO	11/9/1985	130.28
160685	STA-392	SWFWMD_HYDRO	11/10/1985	130.26
160685	STA-392	SWFWMD_HYDRO	11/11/1985	130.26
160685	STA-392	SWFWMD_HYDRO	11/12/1985	130.26
160685	STA-392	SWFWMD_HYDRO	11/13/1985	130.24
160685	STA-392	SWFWMD_HYDRO	11/14/1985	130.22
160685	STA-392	SWFWMD_HYDRO	11/15/1985	130.22
160685	STA-392	SWFWMD_HYDRO	11/16/1985	130.22
160685	STA-392	SWFWMD_HYDRO	11/17/1985	130.2
160685	STA-392	SWFWMD_HYDRO	11/18/1985	130.2
160685	STA-392	SWFWMD_HYDRO	11/19/1985	130.22
160685	STA-392	SWFWMD_HYDRO	11/20/1985	130.22
160685	STA-392	SWFWMD_HYDRO	11/21/1985	130.22
160685	STA-392	SWFWMD_HYDRO	11/22/1985	130.22
160685	STA-392	SWFWMD_HYDRO	11/23/1985	130.24
160685	STA-392	SWFWMD_HYDRO	11/24/1985	130.22
160685	STA-392	SWFWMD_HYDRO	11/25/1985	130.22
160685	STA-392	SWFWMD_HYDRO	11/26/1985	130.22
160685	STA-392	SWFWMD_HYDRO	11/27/1985	130.2
160685	STA-392	SWFWMD_HYDRO	11/28/1985	130.2
160685	STA-392	SWFWMD_HYDRO	11/29/1985	130.18
160685	STA-392	SWFWMD_HYDRO	11/30/1985	130.14
160685	STA-392	SWFWMD_HYDRO	12/1/1985	130.14
160685	STA-392	SWFWMD_HYDRO	12/2/1985	130.14
160685	STA-392	SWFWMD_HYDRO	12/3/1985	130.12
160685	STA-392	SWFWMD_HYDRO	12/4/1985	130.1
160685	STA-392	SWFWMD_HYDRO	12/5/1985	130.2
160685	STA-392	SWFWMD_HYDRO	12/6/1985	130.24
160685	STA-392	SWFWMD_HYDRO	12/7/1985	130.22
160685	STA-392	SWFWMD_HYDRO	12/8/1985	130.2
160685	STA-392	SWFWMD_HYDRO	12/9/1985	130.2
160685	STA-392	SWFWMD_HYDRO	12/10/1985	130.2
160685	STA-392	SWFWMD_HYDRO	12/11/1985	130.18
160685	STA-392	SWFWMD_HYDRO	12/12/1985	130.18
160685	STA-392	SWFWMD_HYDRO	12/13/1985	130.18
160685	STA-392	SWFWMD_HYDRO	12/14/1985	130.2
160685	STA-392	SWFWMD_HYDRO	12/15/1985	130.18
160685	STA-392	SWFWMD_HYDRO	12/16/1985	130.16
160685	STA-392	SWFWMD_HYDRO	12/17/1985	130.16
160685	STA-392	SWFWMD_HYDRO	12/18/1985	130.14
160685	STA-392	SWFWMD_HYDRO	12/19/1985	130.12
160685	STA-392	SWFWMD_HYDRO	12/20/1985	130.1
160685	STA-392	SWFWMD_HYDRO	12/21/1985	130.08
160685	STA-392	SWFWMD_HYDRO	12/22/1985	130.06
160685	STA-392	SWFWMD_HYDRO	12/23/1985	130.06
160685	STA-392	SWFWMD_HYDRO	12/24/1985	130.06
160685	STA-392	SWFWMD_HYDRO	12/25/1985	130.06
160685	STA-392	SWFWMD_HYDRO	12/26/1985	130.04
160685	STA-392	SWFWMD_HYDRO	12/27/1985	130.04
160685	STA-392	SWFWMD_HYDRO	12/28/1985	130.02

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	12/29/1985	130.02
160685	STA-392	SWFWMD_HYDRO	12/31/1985	130
160685	STA-392	SWFWMD_HYDRO	1/1/1986	130.1
160685	STA-392	SWFWMD_HYDRO	1/2/1986	130.12
160685	STA-392	SWFWMD_HYDRO	1/3/1986	130.1
160685	STA-392	SWFWMD_HYDRO	1/4/1986	130.1
160685	STA-392	SWFWMD_HYDRO	1/5/1986	130.16
160685	STA-392	SWFWMD_HYDRO	1/6/1986	130.16
160685	STA-392	SWFWMD_HYDRO	1/7/1986	130.16
160685	STA-392	SWFWMD_HYDRO	1/8/1986	130.16
160685	STA-392	SWFWMD_HYDRO	1/9/1986	130.16
160685	STA-392	SWFWMD_HYDRO	1/10/1986	130.26
160685	STA-392	SWFWMD_HYDRO	1/11/1986	130.26
160685	STA-392	SWFWMD_HYDRO	1/12/1986	130.26
160685	STA-392	SWFWMD_HYDRO	1/13/1986	130.24
160685	STA-392	SWFWMD_HYDRO	1/14/1986	130.24
160685	STA-392	SWFWMD_HYDRO	1/15/1986	130.24
160685	STA-392	SWFWMD_HYDRO	1/16/1986	130.22
160685	STA-392	SWFWMD_HYDRO	1/17/1986	130.22
160685	STA-392	SWFWMD_HYDRO	1/18/1986	130.22
160685	STA-392	SWFWMD_HYDRO	1/19/1986	130.2
160685	STA-392	SWFWMD_HYDRO	1/20/1986	130.2
160685	STA-392	SWFWMD_HYDRO	1/21/1986	130.2
160685	STA-392	SWFWMD_HYDRO	1/22/1986	130.2
160685	STA-392	SWFWMD_HYDRO	1/23/1986	130.2
160685	STA-392	SWFWMD_HYDRO	1/24/1986	130.18
160685	STA-392	SWFWMD_HYDRO	1/25/1986	130.18
160685	STA-392	SWFWMD_HYDRO	1/26/1986	130.18
160685	STA-392	SWFWMD_HYDRO	1/27/1986	130.16
160685	STA-392	SWFWMD_HYDRO	1/28/1986	130.16
160685	STA-392	SWFWMD_HYDRO	1/29/1986	130.16
160685	STA-392	SWFWMD_HYDRO	1/30/1986	130.14
160685	STA-392	SWFWMD_HYDRO	1/31/1986	130.14
160685	STA-392	SWFWMD_HYDRO	2/1/1986	130.12
160685	STA-392	SWFWMD_HYDRO	2/2/1986	130.12
160685	STA-392	SWFWMD_HYDRO	2/3/1986	130.12
160685	STA-392	SWFWMD_HYDRO	2/4/1986	130.12
160685	STA-392	SWFWMD_HYDRO	2/5/1986	130.1
160685	STA-392	SWFWMD_HYDRO	2/6/1986	130.1
160685	STA-392	SWFWMD_HYDRO	2/7/1986	130.1
160685	STA-392	SWFWMD_HYDRO	2/8/1986	130.1
160685	STA-392	SWFWMD_HYDRO	2/9/1986	130.24
160685	STA-392	SWFWMD_HYDRO	2/10/1986	130.26
160685	STA-392	SWFWMD_HYDRO	2/11/1986	130.28
160685	STA-392	SWFWMD_HYDRO	2/12/1986	130.28
160685	STA-392	SWFWMD_HYDRO	2/13/1986	130.28
160685	STA-392	SWFWMD_HYDRO	2/14/1986	130.26
160685	STA-392	SWFWMD_HYDRO	2/15/1986	130.26
160685	STA-392	SWFWMD_HYDRO	2/16/1986	130.24
160685	STA-392	SWFWMD_HYDRO	2/17/1986	130.24
160685	STA-392	SWFWMD_HYDRO	2/18/1986	130.24
160685	STA-392	SWFWMD_HYDRO	2/19/1986	130.24
160685	STA-392	SWFWMD_HYDRO	2/20/1986	130.22

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	2/21/1986	130.22
160685	STA-392	SWFWMD_HYDRO	2/22/1986	130.24
160685	STA-392	SWFWMD_HYDRO	2/23/1986	130.26
160685	STA-392	SWFWMD_HYDRO	2/24/1986	130.24
160685	STA-392	SWFWMD_HYDRO	2/25/1986	130.22
160685	STA-392	SWFWMD_HYDRO	2/26/1986	130.22
160685	STA-392	SWFWMD_HYDRO	2/27/1986	130.2
160685	STA-392	SWFWMD_HYDRO	2/28/1986	130.18
160685	STA-392	SWFWMD_HYDRO	3/1/1986	130.16
160685	STA-392	SWFWMD_HYDRO	3/2/1986	130.14
160685	STA-392	SWFWMD_HYDRO	3/3/1986	130.12
160685	STA-392	SWFWMD_HYDRO	3/4/1986	130.12
160685	STA-392	SWFWMD_HYDRO	3/5/1986	130.14
160685	STA-392	SWFWMD_HYDRO	3/6/1986	130.12
160685	STA-392	SWFWMD_HYDRO	3/7/1986	130.12
160685	STA-392	SWFWMD_HYDRO	3/8/1986	130.1
160685	STA-392	SWFWMD_HYDRO	3/9/1986	130.1
160685	STA-392	SWFWMD_HYDRO	3/10/1986	130.1
160685	STA-392	SWFWMD_HYDRO	3/11/1986	130.1
160685	STA-392	SWFWMD_HYDRO	3/12/1986	130.08
160685	STA-392	SWFWMD_HYDRO	3/13/1986	130.08
160685	STA-392	SWFWMD_HYDRO	3/14/1986	130.08
160685	STA-392	SWFWMD_HYDRO	3/15/1986	130.2
160685	STA-392	SWFWMD_HYDRO	3/16/1986	130.3
160685	STA-392	SWFWMD_HYDRO	3/17/1986	130.32
160685	STA-392	SWFWMD_HYDRO	3/18/1986	130.3
160685	STA-392	SWFWMD_HYDRO	3/19/1986	130.3
160685	STA-392	SWFWMD_HYDRO	3/20/1986	130.3
160685	STA-392	SWFWMD_HYDRO	3/21/1986	130.32
160685	STA-392	SWFWMD_HYDRO	3/22/1986	130.3
160685	STA-392	SWFWMD_HYDRO	3/23/1986	130.26
160685	STA-392	SWFWMD_HYDRO	3/24/1986	130.24
160685	STA-392	SWFWMD_HYDRO	3/25/1986	130.22
160685	STA-392	SWFWMD_HYDRO	3/26/1986	130.22
160685	STA-392	SWFWMD_HYDRO	3/27/1986	130.24
160685	STA-392	SWFWMD_HYDRO	3/28/1986	130.22
160685	STA-392	SWFWMD_HYDRO	3/29/1986	130.2
160685	STA-392	SWFWMD_HYDRO	3/30/1986	130.2
160685	STA-392	SWFWMD_HYDRO	3/31/1986	130.2
160685	STA-392	SWFWMD_HYDRO	4/1/1986	130.18
160685	STA-392	SWFWMD_HYDRO	4/2/1986	130.16
160685	STA-392	SWFWMD_HYDRO	4/3/1986	130.16
160685	STA-392	SWFWMD_HYDRO	4/4/1986	130.14
160685	STA-392	SWFWMD_HYDRO	4/5/1986	130.14
160685	STA-392	SWFWMD_HYDRO	4/6/1986	130.1
160685	STA-392	SWFWMD_HYDRO	4/7/1986	130.08
160685	STA-392	SWFWMD_HYDRO	4/8/1986	130.06
160685	STA-392	SWFWMD_HYDRO	4/9/1986	130.06
160685	STA-392	SWFWMD_HYDRO	4/10/1986	130.04
160685	STA-392	SWFWMD_HYDRO	4/11/1986	130.04
160685	STA-392	SWFWMD_HYDRO	4/12/1986	130.02
160685	STA-392	SWFWMD_HYDRO	4/13/1986	130.04
160685	STA-392	SWFWMD_HYDRO	4/14/1986	130.02

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	4/15/1986	130
160685	STA-392	SWFWMD_HYDRO	4/16/1986	129.96
160685	STA-392	SWFWMD_HYDRO	4/17/1986	129.96
160685	STA-392	SWFWMD_HYDRO	4/18/1986	129.92
160685	STA-392	SWFWMD_HYDRO	4/19/1986	129.92
160685	STA-392	SWFWMD_HYDRO	4/20/1986	129.88
160685	STA-392	SWFWMD_HYDRO	4/21/1986	129.86
160685	STA-392	SWFWMD_HYDRO	4/22/1986	129.86
160685	STA-392	SWFWMD_HYDRO	4/23/1986	129.84
160685	STA-392	SWFWMD_HYDRO	4/24/1986	129.82
160685	STA-392	SWFWMD_HYDRO	4/25/1986	129.8
160685	STA-392	SWFWMD_HYDRO	4/26/1986	129.76
160685	STA-392	SWFWMD_HYDRO	4/27/1986	129.74
160685	STA-392	SWFWMD_HYDRO	4/28/1986	129.7
160685	STA-392	SWFWMD_HYDRO	4/29/1986	129.7
160685	STA-392	SWFWMD_HYDRO	4/30/1986	129.68
160685	STA-392	SWFWMD_HYDRO	5/1/1986	129.64
160685	STA-392	SWFWMD_HYDRO	5/2/1986	129.6
160685	STA-392	SWFWMD_HYDRO	5/3/1986	129.56
160685	STA-392	SWFWMD_HYDRO	5/4/1986	129.54
160685	STA-392	SWFWMD_HYDRO	5/5/1986	129.54
160685	STA-392	SWFWMD_HYDRO	5/6/1986	129.5
160685	STA-392	SWFWMD_HYDRO	5/7/1986	129.5
160685	STA-392	SWFWMD_HYDRO	5/8/1986	129.48
160685	STA-392	SWFWMD_HYDRO	5/9/1986	129.46
160685	STA-392	SWFWMD_HYDRO	5/10/1986	129.44
160685	STA-392	SWFWMD_HYDRO	5/11/1986	129.42
160685	STA-392	SWFWMD_HYDRO	5/12/1986	129.4
160685	STA-392	SWFWMD_HYDRO	5/13/1986	129.4
160685	STA-392	SWFWMD_HYDRO	5/14/1986	129.38
160685	STA-392	SWFWMD_HYDRO	5/15/1986	129.36
160685	STA-392	SWFWMD_HYDRO	5/16/1986	129.32
160685	STA-392	SWFWMD_HYDRO	5/17/1986	129.3
160685	STA-392	SWFWMD_HYDRO	5/18/1986	129.28
160685	STA-392	SWFWMD_HYDRO	5/19/1986	129.26
160685	STA-392	SWFWMD_HYDRO	5/20/1986	129.26
160685	STA-392	SWFWMD_HYDRO	5/21/1986	129.26
160685	STA-392	SWFWMD_HYDRO	5/22/1986	129.24
160685	STA-392	SWFWMD_HYDRO	5/23/1986	129.2
160685	STA-392	SWFWMD_HYDRO	5/24/1986	129.16
160685	STA-392	SWFWMD_HYDRO	5/25/1986	129.12
160685	STA-392	SWFWMD_HYDRO	5/26/1986	129.1
160685	STA-392	SWFWMD_HYDRO	5/27/1986	129.1
160685	STA-392	SWFWMD_HYDRO	5/28/1986	129.06
160685	STA-392	SWFWMD_HYDRO	5/29/1986	129.06
160685	STA-392	SWFWMD_HYDRO	5/30/1986	129.06
160685	STA-392	SWFWMD_HYDRO	5/31/1986	129.04
160685	STA-392	SWFWMD_HYDRO	6/1/1986	129
160685	STA-392	SWFWMD_HYDRO	6/2/1986	128.98
160685	STA-392	SWFWMD_HYDRO	6/3/1986	128.98
160685	STA-392	SWFWMD_HYDRO	6/4/1986	128.96
160685	STA-392	SWFWMD_HYDRO	6/5/1986	128.96
160685	STA-392	SWFWMD_HYDRO	6/6/1986	128.94

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	6/7/1986	128.92
160685	STA-392	SWFWMD_HYDRO	6/8/1986	128.94
160685	STA-392	SWFWMD_HYDRO	6/9/1986	128.94
160685	STA-392	SWFWMD_HYDRO	6/10/1986	128.94
160685	STA-392	SWFWMD_HYDRO	6/11/1986	128.9
160685	STA-392	SWFWMD_HYDRO	6/12/1986	128.96
160685	STA-392	SWFWMD_HYDRO	6/13/1986	129.12
160685	STA-392	SWFWMD_HYDRO	6/14/1986	129.1
160685	STA-392	SWFWMD_HYDRO	6/15/1986	129.12
160685	STA-392	SWFWMD_HYDRO	6/16/1986	129.22
160685	STA-392	SWFWMD_HYDRO	6/17/1986	129.22
160685	STA-392	SWFWMD_HYDRO	6/18/1986	129.24
160685	STA-392	SWFWMD_HYDRO	6/19/1986	129.3
160685	STA-392	SWFWMD_HYDRO	6/20/1986	129.3
160685	STA-392	SWFWMD_HYDRO	6/21/1986	129.34
160685	STA-392	SWFWMD_HYDRO	6/22/1986	129.56
160685	STA-392	SWFWMD_HYDRO	6/23/1986	129.56
160685	STA-392	SWFWMD_HYDRO	6/24/1986	129.56
160685	STA-392	SWFWMD_HYDRO	6/25/1986	129.6
160685	STA-392	SWFWMD_HYDRO	6/26/1986	129.62
160685	STA-392	SWFWMD_HYDRO	6/27/1986	129.6
160685	STA-392	SWFWMD_HYDRO	6/28/1986	129.58
160685	STA-392	SWFWMD_HYDRO	6/29/1986	129.6
160685	STA-392	SWFWMD_HYDRO	6/30/1986	129.58
160685	STA-392	SWFWMD_HYDRO	7/1/1986	129.56
160685	STA-392	SWFWMD_HYDRO	7/2/1986	129.58
160685	STA-392	SWFWMD_HYDRO	7/3/1986	129.58
160685	STA-392	SWFWMD_HYDRO	7/4/1986	129.58
160685	STA-392	SWFWMD_HYDRO	7/5/1986	129.56
160685	STA-392	SWFWMD_HYDRO	7/6/1986	129.56
160685	STA-392	SWFWMD_HYDRO	7/7/1986	129.54
160685	STA-392	SWFWMD_HYDRO	7/8/1986	129.54
160685	STA-392	SWFWMD_HYDRO	7/9/1986	129.54
160685	STA-392	SWFWMD_HYDRO	7/10/1986	129.54
160685	STA-392	SWFWMD_HYDRO	7/11/1986	129.58
160685	STA-392	SWFWMD_HYDRO	7/12/1986	129.56
160685	STA-392	SWFWMD_HYDRO	7/13/1986	129.54
160685	STA-392	SWFWMD_HYDRO	7/14/1986	129.52
160685	STA-392	SWFWMD_HYDRO	7/15/1986	129.5
160685	STA-392	SWFWMD_HYDRO	7/16/1986	129.5
160685	STA-392	SWFWMD_HYDRO	7/17/1986	129.5
160685	STA-392	SWFWMD_HYDRO	7/18/1986	129.48
160685	STA-392	SWFWMD_HYDRO	7/19/1986	129.48
160685	STA-392	SWFWMD_HYDRO	7/20/1986	129.46
160685	STA-392	SWFWMD_HYDRO	7/21/1986	129.44
160685	STA-392	SWFWMD_HYDRO	7/22/1986	129.42
160685	STA-392	SWFWMD_HYDRO	7/23/1986	129.4
160685	STA-392	SWFWMD_HYDRO	7/24/1986	129.4
160685	STA-392	SWFWMD_HYDRO	7/25/1986	129.4
160685	STA-392	SWFWMD_HYDRO	7/26/1986	129.38
160685	STA-392	SWFWMD_HYDRO	7/27/1986	129.36
160685	STA-392	SWFWMD_HYDRO	7/28/1986	129.38
160685	STA-392	SWFWMD_HYDRO	7/29/1986	129.36

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	7/30/1986	129.36
160685	STA-392	SWFWMD_HYDRO	7/31/1986	129.36
160685	STA-392	SWFWMD_HYDRO	8/1/1986	129.4
160685	STA-392	SWFWMD_HYDRO	8/2/1986	129.4
160685	STA-392	SWFWMD_HYDRO	8/3/1986	129.42
160685	STA-392	SWFWMD_HYDRO	8/4/1986	129.6
160685	STA-392	SWFWMD_HYDRO	8/5/1986	129.6
160685	STA-392	SWFWMD_HYDRO	8/6/1986	129.78
160685	STA-392	SWFWMD_HYDRO	8/7/1986	129.76
160685	STA-392	SWFWMD_HYDRO	8/8/1986	129.74
160685	STA-392	SWFWMD_HYDRO	8/9/1986	129.7
160685	STA-392	SWFWMD_HYDRO	8/10/1986	129.68
160685	STA-392	SWFWMD_HYDRO	8/11/1986	129.68
160685	STA-392	SWFWMD_HYDRO	8/12/1986	129.68
160685	STA-392	SWFWMD_HYDRO	8/13/1986	129.7
160685	STA-392	SWFWMD_HYDRO	8/14/1986	129.72
160685	STA-392	SWFWMD_HYDRO	8/15/1986	129.74
160685	STA-392	SWFWMD_HYDRO	8/16/1986	129.74
160685	STA-392	SWFWMD_HYDRO	8/17/1986	129.74
160685	STA-392	SWFWMD_HYDRO	8/18/1986	129.72
160685	STA-392	SWFWMD_HYDRO	8/19/1986	129.78
160685	STA-392	SWFWMD_HYDRO	8/20/1986	129.82
160685	STA-392	SWFWMD_HYDRO	8/21/1986	129.88
160685	STA-392	SWFWMD_HYDRO	8/22/1986	129.92
160685	STA-392	SWFWMD_HYDRO	8/23/1986	129.92
160685	STA-392	SWFWMD_HYDRO	8/25/1986	129.94
160685	STA-392	SWFWMD_HYDRO	8/26/1986	129.92
160685	STA-392	SWFWMD_HYDRO	8/27/1986	129.9
160685	STA-392	SWFWMD_HYDRO	8/28/1986	129.92
160685	STA-392	SWFWMD_HYDRO	8/29/1986	129.92
160685	STA-392	SWFWMD_HYDRO	8/30/1986	129.9
160685	STA-392	SWFWMD_HYDRO	8/31/1986	129.96
160685	STA-392	SWFWMD_HYDRO	9/1/1986	129.9
160685	STA-392	SWFWMD_HYDRO	9/2/1986	129.9
160685	STA-392	SWFWMD_HYDRO	9/3/1986	129.96
160685	STA-392	SWFWMD_HYDRO	9/4/1986	129.94
160685	STA-392	SWFWMD_HYDRO	9/5/1986	129.94
160685	STA-392	SWFWMD_HYDRO	9/6/1986	129.96
160685	STA-392	SWFWMD_HYDRO	9/7/1986	130
160685	STA-392	SWFWMD_HYDRO	9/8/1986	130.02
160685	STA-392	SWFWMD_HYDRO	9/9/1986	130.06
160685	STA-392	SWFWMD_HYDRO	9/10/1986	130.2
160685	STA-392	SWFWMD_HYDRO	9/11/1986	130.22
160685	STA-392	SWFWMD_HYDRO	9/12/1986	130.22
160685	STA-392	SWFWMD_HYDRO	9/13/1986	130.22
160685	STA-392	SWFWMD_HYDRO	9/14/1986	130.22
160685	STA-392	SWFWMD_HYDRO	9/15/1986	130.2
160685	STA-392	SWFWMD_HYDRO	9/16/1986	130.18
160685	STA-392	SWFWMD_HYDRO	9/17/1986	130.16
160685	STA-392	SWFWMD_HYDRO	9/24/1986	130.1
160685	STA-392	SWFWMD_HYDRO	9/25/1986	130.1
160685	STA-392	SWFWMD_HYDRO	9/26/1986	130.08
160685	STA-392	SWFWMD_HYDRO	9/27/1986	130.08

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	9/28/1986	130.06
160685	STA-392	SWFWMD_HYDRO	9/29/1986	130.06
160685	STA-392	SWFWMD_HYDRO	10/1/1986	130.06
160685	STA-392	SWFWMD_HYDRO	10/2/1986	130.04
160685	STA-392	SWFWMD_HYDRO	10/3/1986	130.02
160685	STA-392	SWFWMD_HYDRO	10/4/1986	130
160685	STA-392	SWFWMD_HYDRO	10/5/1986	129.98
160685	STA-392	SWFWMD_HYDRO	10/6/1986	129.96
160685	STA-392	SWFWMD_HYDRO	10/7/1986	129.94
160685	STA-392	SWFWMD_HYDRO	10/8/1986	130.12
160685	STA-392	SWFWMD_HYDRO	10/9/1986	130.16
160685	STA-392	SWFWMD_HYDRO	10/10/1986	130.16
160685	STA-392	SWFWMD_HYDRO	10/11/1986	130.2
160685	STA-392	SWFWMD_HYDRO	10/12/1986	130.2
160685	STA-392	SWFWMD_HYDRO	10/13/1986	130.2
160685	STA-392	SWFWMD_HYDRO	10/14/1986	130.18
160685	STA-392	SWFWMD_HYDRO	10/15/1986	130.16
160685	STA-392	SWFWMD_HYDRO	10/16/1986	130.16
160685	STA-392	SWFWMD_HYDRO	10/17/1986	130.14
160685	STA-392	SWFWMD_HYDRO	10/18/1986	130.12
160685	STA-392	SWFWMD_HYDRO	10/19/1986	130.08
160685	STA-392	SWFWMD_HYDRO	10/20/1986	130.06
160685	STA-392	SWFWMD_HYDRO	10/21/1986	130.02
160685	STA-392	SWFWMD_HYDRO	10/22/1986	130
160685	STA-392	SWFWMD_HYDRO	10/23/1986	129.98
160685	STA-392	SWFWMD_HYDRO	10/24/1986	129.96
160685	STA-392	SWFWMD_HYDRO	10/25/1986	129.04
160685	STA-392	SWFWMD_HYDRO	10/26/1986	129.02
160685	STA-392	SWFWMD_HYDRO	10/27/1986	130.12
160685	STA-392	SWFWMD_HYDRO	10/28/1986	130.12
160685	STA-392	SWFWMD_HYDRO	10/29/1986	130.12
160685	STA-392	SWFWMD_HYDRO	10/30/1986	130.14
160685	STA-392	SWFWMD_HYDRO	10/31/1986	130.14
160685	STA-392	SWFWMD_HYDRO	11/1/1986	130.24
160685	STA-392	SWFWMD_HYDRO	11/2/1986	130.26
160685	STA-392	SWFWMD_HYDRO	11/3/1986	130.28
160685	STA-392	SWFWMD_HYDRO	11/4/1986	130.3
160685	STA-392	SWFWMD_HYDRO	11/5/1986	130.3
160685	STA-392	SWFWMD_HYDRO	11/6/1986	130.2
160685	STA-392	SWFWMD_HYDRO	11/7/1986	130.18
160685	STA-392	SWFWMD_HYDRO	11/8/1986	130.18
160685	STA-392	SWFWMD_HYDRO	11/9/1986	130.18
160685	STA-392	SWFWMD_HYDRO	11/10/1986	130.16
160685	STA-392	SWFWMD_HYDRO	11/11/1986	130.16
160685	STA-392	SWFWMD_HYDRO	11/12/1986	130.16
160685	STA-392	SWFWMD_HYDRO	11/13/1986	130.16
160685	STA-392	SWFWMD_HYDRO	11/14/1986	130.18
160685	STA-392	SWFWMD_HYDRO	11/15/1986	130.16
160685	STA-392	SWFWMD_HYDRO	11/16/1986	130.14
160685	STA-392	SWFWMD_HYDRO	11/17/1986	130.12
160685	STA-392	SWFWMD_HYDRO	11/18/1986	130.1
160685	STA-392	SWFWMD_HYDRO	11/19/1986	130.08
160685	STA-392	SWFWMD_HYDRO	11/20/1986	130.08

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	11/21/1986	130.08
160685	STA-392	SWFWMD_HYDRO	11/22/1986	130.06
160685	STA-392	SWFWMD_HYDRO	11/23/1986	130.06
160685	STA-392	SWFWMD_HYDRO	11/24/1986	130.04
160685	STA-392	SWFWMD_HYDRO	11/25/1986	130.02
160685	STA-392	SWFWMD_HYDRO	11/26/1986	130
160685	STA-392	SWFWMD_HYDRO	11/27/1986	130
160685	STA-392	SWFWMD_HYDRO	11/28/1986	130
160685	STA-392	SWFWMD_HYDRO	11/29/1986	130
160685	STA-392	SWFWMD_HYDRO	11/30/1986	130.02
160685	STA-392	SWFWMD_HYDRO	12/1/1986	130.04
160685	STA-392	SWFWMD_HYDRO	12/2/1986	130.04
160685	STA-392	SWFWMD_HYDRO	12/3/1986	130.04
160685	STA-392	SWFWMD_HYDRO	12/4/1986	130.02
160685	STA-392	SWFWMD_HYDRO	12/5/1986	130
160685	STA-392	SWFWMD_HYDRO	12/6/1986	129.98
160685	STA-392	SWFWMD_HYDRO	12/7/1986	129.96
160685	STA-392	SWFWMD_HYDRO	12/8/1986	129.94
160685	STA-392	SWFWMD_HYDRO	12/9/1986	129.94
160685	STA-392	SWFWMD_HYDRO	12/10/1986	129.94
160685	STA-392	SWFWMD_HYDRO	12/11/1986	129.92
160685	STA-392	SWFWMD_HYDRO	12/12/1986	129.92
160685	STA-392	SWFWMD_HYDRO	12/13/1986	129.94
160685	STA-392	SWFWMD_HYDRO	12/14/1986	129.92
160685	STA-392	SWFWMD_HYDRO	12/15/1986	129.9
160685	STA-392	SWFWMD_HYDRO	12/16/1986	129.9
160685	STA-392	SWFWMD_HYDRO	12/17/1986	129.9
160685	STA-392	SWFWMD_HYDRO	12/18/1986	129.9
160685	STA-392	SWFWMD_HYDRO	12/19/1986	129.88
160685	STA-392	SWFWMD_HYDRO	12/20/1986	129.88
160685	STA-392	SWFWMD_HYDRO	12/21/1986	129.86
160685	STA-392	SWFWMD_HYDRO	12/22/1986	129.88
160685	STA-392	SWFWMD_HYDRO	12/23/1986	129.9
160685	STA-392	SWFWMD_HYDRO	12/24/1986	129.96
160685	STA-392	SWFWMD_HYDRO	12/25/1986	129.98
160685	STA-392	SWFWMD_HYDRO	12/26/1986	129.96
160685	STA-392	SWFWMD_HYDRO	12/27/1986	129.96
160685	STA-392	SWFWMD_HYDRO	12/28/1986	129.94
160685	STA-392	SWFWMD_HYDRO	12/29/1986	129.94
160685	STA-392	SWFWMD_HYDRO	12/30/1986	129.94
160685	STA-392	SWFWMD_HYDRO	12/31/1986	129.92
160685	STA-392	SWFWMD_HYDRO	1/1/1987	129.24
160685	STA-392	SWFWMD_HYDRO	1/2/1987	129.24
160685	STA-392	SWFWMD_HYDRO	1/3/1987	130.1
160685	STA-392	SWFWMD_HYDRO	1/4/1987	130.1
160685	STA-392	SWFWMD_HYDRO	1/5/1987	130.1
160685	STA-392	SWFWMD_HYDRO	1/6/1987	130.08
160685	STA-392	SWFWMD_HYDRO	1/7/1987	130.08
160685	STA-392	SWFWMD_HYDRO	1/8/1987	130.08
160685	STA-392	SWFWMD_HYDRO	1/9/1987	130.08
160685	STA-392	SWFWMD_HYDRO	1/10/1987	130.06
160685	STA-392	SWFWMD_HYDRO	1/11/1987	130.06
160685	STA-392	SWFWMD_HYDRO	1/12/1987	130.06

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	1/13/1987	130.04
160685	STA-392	SWFWMD_HYDRO	1/14/1987	130.04
160685	STA-392	SWFWMD_HYDRO	1/15/1987	130.02
160685	STA-392	SWFWMD_HYDRO	1/16/1987	130.02
160685	STA-392	SWFWMD_HYDRO	1/17/1987	130.08
160685	STA-392	SWFWMD_HYDRO	1/18/1987	130.08
160685	STA-392	SWFWMD_HYDRO	1/19/1987	130.06
160685	STA-392	SWFWMD_HYDRO	1/20/1987	130.06
160685	STA-392	SWFWMD_HYDRO	1/21/1987	130.04
160685	STA-392	SWFWMD_HYDRO	1/22/1987	130.02
160685	STA-392	SWFWMD_HYDRO	1/23/1987	130.08
160685	STA-392	SWFWMD_HYDRO	1/24/1987	130.08
160685	STA-392	SWFWMD_HYDRO	1/25/1987	130.08
160685	STA-392	SWFWMD_HYDRO	1/26/1987	130.06
160685	STA-392	SWFWMD_HYDRO	1/27/1987	130.04
160685	STA-392	SWFWMD_HYDRO	1/28/1987	130
160685	STA-392	SWFWMD_HYDRO	1/29/1987	130
160685	STA-392	SWFWMD_HYDRO	1/30/1987	130
160685	STA-392	SWFWMD_HYDRO	1/31/1987	130
160685	STA-392	SWFWMD_HYDRO	2/1/1987	130
160685	STA-392	SWFWMD_HYDRO	2/2/1987	129.98
160685	STA-392	SWFWMD_HYDRO	2/3/1987	129.96
160685	STA-392	SWFWMD_HYDRO	2/4/1987	129.96
160685	STA-392	SWFWMD_HYDRO	2/5/1987	129.96
160685	STA-392	SWFWMD_HYDRO	2/6/1987	129.98
160685	STA-392	SWFWMD_HYDRO	2/7/1987	130
160685	STA-392	SWFWMD_HYDRO	2/8/1987	130
160685	STA-392	SWFWMD_HYDRO	2/9/1987	130
160685	STA-392	SWFWMD_HYDRO	2/10/1987	129.98
160685	STA-392	SWFWMD_HYDRO	2/11/1987	129.96
160685	STA-392	SWFWMD_HYDRO	2/12/1987	129.94
160685	STA-392	SWFWMD_HYDRO	2/13/1987	129.92
160685	STA-392	SWFWMD_HYDRO	2/14/1987	129.9
160685	STA-392	SWFWMD_HYDRO	2/15/1987	129.9
160685	STA-392	SWFWMD_HYDRO	2/16/1987	129.96
160685	STA-392	SWFWMD_HYDRO	2/17/1987	129.96
160685	STA-392	SWFWMD_HYDRO	2/18/1987	129.98
160685	STA-392	SWFWMD_HYDRO	2/19/1987	129.98
160685	STA-392	SWFWMD_HYDRO	2/20/1987	129.98
160685	STA-392	SWFWMD_HYDRO	2/21/1987	130.02
160685	STA-392	SWFWMD_HYDRO	2/22/1987	130
160685	STA-392	SWFWMD_HYDRO	2/23/1987	130
160685	STA-392	SWFWMD_HYDRO	2/24/1987	129.98
160685	STA-392	SWFWMD_HYDRO	2/25/1987	129.98
160685	STA-392	SWFWMD_HYDRO	2/26/1987	129.98
160685	STA-392	SWFWMD_HYDRO	2/27/1987	130.02
160685	STA-392	SWFWMD_HYDRO	2/28/1987	130.02
160685	STA-392	SWFWMD_HYDRO	3/1/1987	130.02
160685	STA-392	SWFWMD_HYDRO	3/2/1987	130.02
160685	STA-392	SWFWMD_HYDRO	3/3/1987	130
160685	STA-392	SWFWMD_HYDRO	3/4/1987	129.96
160685	STA-392	SWFWMD_HYDRO	3/5/1987	129.94
160685	STA-392	SWFWMD_HYDRO	3/6/1987	129.96

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	3/7/1987	130.06
160685	STA-392	SWFWMD_HYDRO	3/8/1987	130.06
160685	STA-392	SWFWMD_HYDRO	3/9/1987	130.04
160685	STA-392	SWFWMD_HYDRO	3/10/1987	130.02
160685	STA-392	SWFWMD_HYDRO	3/11/1987	130.02
160685	STA-392	SWFWMD_HYDRO	3/12/1987	130
160685	STA-392	SWFWMD_HYDRO	3/13/1987	129.98
160685	STA-392	SWFWMD_HYDRO	3/14/1987	129.96
160685	STA-392	SWFWMD_HYDRO	3/15/1987	129.96
160685	STA-392	SWFWMD_HYDRO	3/16/1987	129.94
160685	STA-392	SWFWMD_HYDRO	3/17/1987	129.92
160685	STA-392	SWFWMD_HYDRO	3/18/1987	129.92
160685	STA-392	SWFWMD_HYDRO	3/19/1987	129.98
160685	STA-392	SWFWMD_HYDRO	3/20/1987	130
160685	STA-392	SWFWMD_HYDRO	3/21/1987	129.98
160685	STA-392	SWFWMD_HYDRO	3/22/1987	129.96
160685	STA-392	SWFWMD_HYDRO	3/23/1987	129.94
160685	STA-392	SWFWMD_HYDRO	3/24/1987	129.92
160685	STA-392	SWFWMD_HYDRO	3/25/1987	129.94
160685	STA-392	SWFWMD_HYDRO	3/26/1987	130.1
160685	STA-392	SWFWMD_HYDRO	3/27/1987	130.2
160685	STA-392	SWFWMD_HYDRO	3/28/1987	130.22
160685	STA-392	SWFWMD_HYDRO	3/29/1987	130.46
160685	STA-392	SWFWMD_HYDRO	3/30/1987	130.56
160685	STA-392	SWFWMD_HYDRO	3/31/1987	130.76
160685	STA-392	SWFWMD_HYDRO	4/1/1987	130.76
160685	STA-392	SWFWMD_HYDRO	4/2/1987	130.74
160685	STA-392	SWFWMD_HYDRO	4/3/1987	130.72
160685	STA-392	SWFWMD_HYDRO	4/4/1987	130.72
160685	STA-392	SWFWMD_HYDRO	4/5/1987	130.72
160685	STA-392	SWFWMD_HYDRO	4/6/1987	130.7
160685	STA-392	SWFWMD_HYDRO	4/7/1987	130.7
160685	STA-392	SWFWMD_HYDRO	4/8/1987	130.7
160685	STA-392	SWFWMD_HYDRO	4/9/1987	130.7
160685	STA-392	SWFWMD_HYDRO	4/10/1987	130.7
160685	STA-392	SWFWMD_HYDRO	4/11/1987	130.68
160685	STA-392	SWFWMD_HYDRO	4/12/1987	130.68
160685	STA-392	SWFWMD_HYDRO	4/13/1987	129.66
160685	STA-392	SWFWMD_HYDRO	4/14/1987	129.66
160685	STA-392	SWFWMD_HYDRO	4/15/1987	129.8
160685	STA-392	SWFWMD_HYDRO	4/16/1987	129.78
160685	STA-392	SWFWMD_HYDRO	4/17/1987	130.76
160685	STA-392	SWFWMD_HYDRO	4/18/1987	130.76
160685	STA-392	SWFWMD_HYDRO	4/19/1987	130.76
160685	STA-392	SWFWMD_HYDRO	4/20/1987	130.74
160685	STA-392	SWFWMD_HYDRO	4/21/1987	130.72
160685	STA-392	SWFWMD_HYDRO	4/22/1987	130.68
160685	STA-392	SWFWMD_HYDRO	4/23/1987	130.68
160685	STA-392	SWFWMD_HYDRO	4/24/1987	130.68
160685	STA-392	SWFWMD_HYDRO	4/25/1987	130.68
160685	STA-392	SWFWMD_HYDRO	4/26/1987	130.68
160685	STA-392	SWFWMD_HYDRO	4/27/1987	130.66
160685	STA-392	SWFWMD_HYDRO	4/28/1987	130.64

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	4/29/1987	130.62
160685	STA-392	SWFWMD_HYDRO	4/30/1987	130.6
160685	STA-392	SWFWMD_HYDRO	5/1/1987	130.6
160685	STA-392	SWFWMD_HYDRO	5/2/1987	130.56
160685	STA-392	SWFWMD_HYDRO	5/3/1987	130.54
160685	STA-392	SWFWMD_HYDRO	5/4/1987	130.52
160685	STA-392	SWFWMD_HYDRO	5/5/1987	130.5
160685	STA-392	SWFWMD_HYDRO	5/6/1987	130.56
160685	STA-392	SWFWMD_HYDRO	5/7/1987	130.54
160685	STA-392	SWFWMD_HYDRO	5/8/1987	130.54
160685	STA-392	SWFWMD_HYDRO	5/9/1987	130.52
160685	STA-392	SWFWMD_HYDRO	5/10/1987	130.52
160685	STA-392	SWFWMD_HYDRO	5/11/1987	130.54
160685	STA-392	SWFWMD_HYDRO	5/12/1987	130.56
160685	STA-392	SWFWMD_HYDRO	5/13/1987	130.54
160685	STA-392	SWFWMD_HYDRO	5/14/1987	130.52
160685	STA-392	SWFWMD_HYDRO	5/15/1987	130.52
160685	STA-392	SWFWMD_HYDRO	5/16/1987	130.5
160685	STA-392	SWFWMD_HYDRO	5/17/1987	130.5
160685	STA-392	SWFWMD_HYDRO	5/18/1987	130.5
160685	STA-392	SWFWMD_HYDRO	5/19/1987	130.52
160685	STA-392	SWFWMD_HYDRO	5/20/1987	130.5
160685	STA-392	SWFWMD_HYDRO	5/21/1987	130.46
160685	STA-392	SWFWMD_HYDRO	5/22/1987	130.44
160685	STA-392	SWFWMD_HYDRO	5/23/1987	130.42
160685	STA-392	SWFWMD_HYDRO	5/24/1987	130.4
160685	STA-392	SWFWMD_HYDRO	5/25/1987	130.4
160685	STA-392	SWFWMD_HYDRO	5/26/1987	130.38
160685	STA-392	SWFWMD_HYDRO	5/27/1987	130.36
160685	STA-392	SWFWMD_HYDRO	5/28/1987	130.34
160685	STA-392	SWFWMD_HYDRO	5/29/1987	130.3
160685	STA-392	SWFWMD_HYDRO	5/30/1987	130.28
160685	STA-392	SWFWMD_HYDRO	5/31/1987	130.26
160685	STA-392	SWFWMD_HYDRO	6/1/1987	130.26
160685	STA-392	SWFWMD_HYDRO	6/2/1987	130.24
160685	STA-392	SWFWMD_HYDRO	6/3/1987	130.22
160685	STA-392	SWFWMD_HYDRO	6/4/1987	130.2
160685	STA-392	SWFWMD_HYDRO	6/5/1987	130.18
160685	STA-392	SWFWMD_HYDRO	6/6/1987	130.18
160685	STA-392	SWFWMD_HYDRO	6/7/1987	130.2
160685	STA-392	SWFWMD_HYDRO	6/8/1987	130.16
160685	STA-392	SWFWMD_HYDRO	6/9/1987	130.1
160685	STA-392	SWFWMD_HYDRO	6/10/1987	130.06
160685	STA-392	SWFWMD_HYDRO	6/11/1987	130.04
160685	STA-392	SWFWMD_HYDRO	6/12/1987	130
160685	STA-392	SWFWMD_HYDRO	6/13/1987	129.98
160685	STA-392	SWFWMD_HYDRO	6/14/1987	129.96
160685	STA-392	SWFWMD_HYDRO	6/15/1987	129.94
160685	STA-392	SWFWMD_HYDRO	6/16/1987	129.94
160685	STA-392	SWFWMD_HYDRO	6/17/1987	129.92
160685	STA-392	SWFWMD_HYDRO	6/18/1987	130
160685	STA-392	SWFWMD_HYDRO	6/19/1987	130
160685	STA-392	SWFWMD_HYDRO	6/20/1987	130

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	6/21/1987	129.96
160685	STA-392	SWFWMD_HYDRO	6/22/1987	129.94
160685	STA-392	SWFWMD_HYDRO	6/23/1987	129.92
160685	STA-392	SWFWMD_HYDRO	6/24/1987	129.9
160685	STA-392	SWFWMD_HYDRO	6/25/1987	129.96
160685	STA-392	SWFWMD_HYDRO	6/26/1987	129.98
160685	STA-392	SWFWMD_HYDRO	6/27/1987	130
160685	STA-392	SWFWMD_HYDRO	6/28/1987	130
160685	STA-392	SWFWMD_HYDRO	6/29/1987	129.98
160685	STA-392	SWFWMD_HYDRO	6/30/1987	130.16
160685	STA-392	SWFWMD_HYDRO	7/1/1987	130.2
160685	STA-392	SWFWMD_HYDRO	7/2/1987	130.18
160685	STA-392	SWFWMD_HYDRO	7/3/1987	130.24
160685	STA-392	SWFWMD_HYDRO	7/4/1987	130.4
160685	STA-392	SWFWMD_HYDRO	7/5/1987	130.44
160685	STA-392	SWFWMD_HYDRO	7/6/1987	130.48
160685	STA-392	SWFWMD_HYDRO	7/7/1987	130.54
160685	STA-392	SWFWMD_HYDRO	7/8/1987	130.56
160685	STA-392	SWFWMD_HYDRO	7/9/1987	130.56
160685	STA-392	SWFWMD_HYDRO	7/10/1987	130.54
160685	STA-392	SWFWMD_HYDRO	7/11/1987	130.5
160685	STA-392	SWFWMD_HYDRO	7/12/1987	130.46
160685	STA-392	SWFWMD_HYDRO	7/13/1987	130.48
160685	STA-392	SWFWMD_HYDRO	7/14/1987	130.46
160685	STA-392	SWFWMD_HYDRO	7/15/1987	130.54
160685	STA-392	SWFWMD_HYDRO	7/16/1987	130.56
160685	STA-392	SWFWMD_HYDRO	7/17/1987	130.56
160685	STA-392	SWFWMD_HYDRO	7/18/1987	130.58
160685	STA-392	SWFWMD_HYDRO	7/19/1987	130.56
160685	STA-392	SWFWMD_HYDRO	7/20/1987	130.61
160685	STA-392	SWFWMD_HYDRO	7/21/1987	130.61
160685	STA-392	SWFWMD_HYDRO	7/22/1987	130.62
160685	STA-392	SWFWMD_HYDRO	7/23/1987	130.6
160685	STA-392	SWFWMD_HYDRO	7/24/1987	130.58
160685	STA-392	SWFWMD_HYDRO	7/25/1987	130.56
160685	STA-392	SWFWMD_HYDRO	7/26/1987	130.56
160685	STA-392	SWFWMD_HYDRO	7/27/1987	130.54
160685	STA-392	SWFWMD_HYDRO	7/28/1987	130.54
160685	STA-392	SWFWMD_HYDRO	8/20/1987	130.46
160685	STA-392	SWFWMD_HYDRO	8/21/1987	130.48
160685	STA-392	SWFWMD_HYDRO	8/22/1987	130.46
160685	STA-392	SWFWMD_HYDRO	8/23/1987	130.46
160685	STA-392	SWFWMD_HYDRO	8/24/1987	130.42
160685	STA-392	SWFWMD_HYDRO	8/25/1987	130.4
160685	STA-392	SWFWMD_HYDRO	8/26/1987	130.38
160685	STA-392	SWFWMD_HYDRO	8/27/1987	130.38
160685	STA-392	SWFWMD_HYDRO	8/28/1987	130.42
160685	STA-392	SWFWMD_HYDRO	8/29/1987	130.42
160685	STA-392	SWFWMD_HYDRO	8/30/1987	130.42
160685	STA-392	SWFWMD_HYDRO	8/31/1987	130.38
160685	STA-392	SWFWMD_HYDRO	9/1/1987	130.36
160685	STA-392	SWFWMD_HYDRO	9/2/1987	130.48
160685	STA-392	SWFWMD_HYDRO	9/3/1987	130.48

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	9/4/1987	130.9
160685	STA-392	SWFWMD_HYDRO	9/5/1987	131.1
160685	STA-392	SWFWMD_HYDRO	9/6/1987	130.8
160685	STA-392	SWFWMD_HYDRO	9/7/1987	130.7
160685	STA-392	SWFWMD_HYDRO	9/8/1987	130.6
160685	STA-392	SWFWMD_HYDRO	9/9/1987	130.6
160685	STA-392	SWFWMD_HYDRO	9/10/1987	130.58
160685	STA-392	SWFWMD_HYDRO	9/11/1987	130.56
160685	STA-392	SWFWMD_HYDRO	9/12/1987	130.76
160685	STA-392	SWFWMD_HYDRO	9/13/1987	130.8
160685	STA-392	SWFWMD_HYDRO	9/14/1987	130.9
160685	STA-392	SWFWMD_HYDRO	9/15/1987	130.88
160685	STA-392	SWFWMD_HYDRO	9/16/1987	130.88
160685	STA-392	SWFWMD_HYDRO	9/17/1987	130.86
160685	STA-392	SWFWMD_HYDRO	9/18/1987	130.84
160685	STA-392	SWFWMD_HYDRO	9/19/1987	130.82
160685	STA-392	SWFWMD_HYDRO	9/20/1987	130.82
160685	STA-392	SWFWMD_HYDRO	9/21/1987	130.84
160685	STA-392	SWFWMD_HYDRO	9/22/1987	130.84
160685	STA-392	SWFWMD_HYDRO	9/23/1987	130.84
160685	STA-392	SWFWMD_HYDRO	9/24/1987	130.82
160685	STA-392	SWFWMD_HYDRO	9/25/1987	130.8
160685	STA-392	SWFWMD_HYDRO	9/26/1987	130.8
160685	STA-392	SWFWMD_HYDRO	9/27/1987	130.78
160685	STA-392	SWFWMD_HYDRO	9/28/1987	130.76
160685	STA-392	SWFWMD_HYDRO	9/29/1987	130.74
160685	STA-392	SWFWMD_HYDRO	9/30/1987	130.82
160685	STA-392	SWFWMD_HYDRO	10/1/1987	130.9
160685	STA-392	SWFWMD_HYDRO	10/2/1987	130.88
160685	STA-392	SWFWMD_HYDRO	10/3/1987	130.86
160685	STA-392	SWFWMD_HYDRO	10/4/1987	130.84
160685	STA-392	SWFWMD_HYDRO	10/5/1987	130.82
160685	STA-392	SWFWMD_HYDRO	10/6/1987	130.8
160685	STA-392	SWFWMD_HYDRO	10/7/1987	130.78
160685	STA-392	SWFWMD_HYDRO	10/8/1987	130.76
160685	STA-392	SWFWMD_HYDRO	10/9/1987	130.76
160685	STA-392	SWFWMD_HYDRO	10/10/1987	130.76
160685	STA-392	SWFWMD_HYDRO	10/11/1987	130.74
160685	STA-392	SWFWMD_HYDRO	10/12/1987	130.96
160685	STA-392	SWFWMD_HYDRO	10/13/1987	130.98
160685	STA-392	SWFWMD_HYDRO	10/14/1987	130.96
160685	STA-392	SWFWMD_HYDRO	10/15/1987	130.94
160685	STA-392	SWFWMD_HYDRO	10/16/1987	130.92
160685	STA-392	SWFWMD_HYDRO	10/17/1987	130.92
160685	STA-392	SWFWMD_HYDRO	10/18/1987	130.9
160685	STA-392	SWFWMD_HYDRO	10/19/1987	130.9
160685	STA-392	SWFWMD_HYDRO	10/20/1987	130.9
160685	STA-392	SWFWMD_HYDRO	10/21/1987	130.88
160685	STA-392	SWFWMD_HYDRO	10/22/1987	130.88
160685	STA-392	SWFWMD_HYDRO	10/23/1987	130.86
160685	STA-392	SWFWMD_HYDRO	10/24/1987	130.86
160685	STA-392	SWFWMD_HYDRO	10/25/1987	130.84
160685	STA-392	SWFWMD_HYDRO	10/26/1987	130.84

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	10/27/1987	130.84
160685	STA-392	SWFWMD_HYDRO	10/28/1987	130.84
160685	STA-392	SWFWMD_HYDRO	10/29/1987	130.82
160685	STA-392	SWFWMD_HYDRO	10/30/1987	130.8
160685	STA-392	SWFWMD_HYDRO	10/31/1987	130.78
160685	STA-392	SWFWMD_HYDRO	11/1/1987	130.87
160685	STA-392	SWFWMD_HYDRO	11/2/1987	130.88
160685	STA-392	SWFWMD_HYDRO	11/3/1987	131.04
160685	STA-392	SWFWMD_HYDRO	11/4/1987	131.06
160685	STA-392	SWFWMD_HYDRO	11/5/1987	131.06
160685	STA-392	SWFWMD_HYDRO	11/6/1987	131.04
160685	STA-392	SWFWMD_HYDRO	11/7/1987	131.02
160685	STA-392	SWFWMD_HYDRO	11/8/1987	131.04
160685	STA-392	SWFWMD_HYDRO	11/9/1987	131.04
160685	STA-392	SWFWMD_HYDRO	11/10/1987	131.02
160685	STA-392	SWFWMD_HYDRO	11/11/1987	131
160685	STA-392	SWFWMD_HYDRO	11/12/1987	131
160685	STA-392	SWFWMD_HYDRO	11/13/1987	130.98
160685	STA-392	SWFWMD_HYDRO	11/14/1987	130.98
160685	STA-392	SWFWMD_HYDRO	11/15/1987	130.96
160685	STA-392	SWFWMD_HYDRO	11/16/1987	130.96
160685	STA-392	SWFWMD_HYDRO	11/17/1987	131.3
160685	STA-392	SWFWMD_HYDRO	11/18/1987	131.32
160685	STA-392	SWFWMD_HYDRO	11/19/1987	131.46
160685	STA-392	SWFWMD_HYDRO	11/20/1987	131.44
160685	STA-392	SWFWMD_HYDRO	11/21/1987	131.44
160685	STA-392	SWFWMD_HYDRO	11/22/1987	131.44
160685	STA-392	SWFWMD_HYDRO	11/23/1987	131.42
160685	STA-392	SWFWMD_HYDRO	11/24/1987	131.42
160685	STA-392	SWFWMD_HYDRO	11/25/1987	131.42
160685	STA-392	SWFWMD_HYDRO	11/26/1987	131.46
160685	STA-392	SWFWMD_HYDRO	11/27/1987	131.52
160685	STA-392	SWFWMD_HYDRO	11/28/1987	131.54
160685	STA-392	SWFWMD_HYDRO	11/29/1987	131.52
160685	STA-392	SWFWMD_HYDRO	11/30/1987	131.5
160685	STA-392	SWFWMD_HYDRO	12/1/1987	131.5
160685	STA-392	SWFWMD_HYDRO	12/2/1987	131.5
160685	STA-392	SWFWMD_HYDRO	12/3/1987	131.5
160685	STA-392	SWFWMD_HYDRO	12/4/1987	131.5
160685	STA-392	SWFWMD_HYDRO	12/5/1987	131.48
160685	STA-392	SWFWMD_HYDRO	12/6/1987	131.48
160685	STA-392	SWFWMD_HYDRO	12/7/1987	131.48
160685	STA-392	SWFWMD_HYDRO	12/8/1987	131.48
160685	STA-392	SWFWMD_HYDRO	12/9/1987	131.48
160685	STA-392	SWFWMD_HYDRO	12/10/1987	131.48
160685	STA-392	SWFWMD_HYDRO	12/11/1987	131.48
160685	STA-392	SWFWMD_HYDRO	12/12/1987	131.46
160685	STA-392	SWFWMD_HYDRO	12/13/1987	131.46
160685	STA-392	SWFWMD_HYDRO	12/14/1987	131.46
160685	STA-392	SWFWMD_HYDRO	12/15/1987	131.46
160685	STA-392	SWFWMD_HYDRO	12/16/1987	131.5
160685	STA-392	SWFWMD_HYDRO	12/17/1987	131.54
160685	STA-392	SWFWMD_HYDRO	12/18/1987	131.52

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	12/19/1987	131.5
160685	STA-392	SWFWMD_HYDRO	12/20/1987	131.48
160685	STA-392	SWFWMD_HYDRO	12/21/1987	131.46
160685	STA-392	SWFWMD_HYDRO	12/22/1987	131.46
160685	STA-392	SWFWMD_HYDRO	12/23/1987	131.5
160685	STA-392	SWFWMD_HYDRO	12/24/1987	131.52
160685	STA-392	SWFWMD_HYDRO	12/25/1987	131.5
160685	STA-392	SWFWMD_HYDRO	12/26/1987	131.48
160685	STA-392	SWFWMD_HYDRO	12/27/1987	131.48
160685	STA-392	SWFWMD_HYDRO	12/28/1987	131.46
160685	STA-392	SWFWMD_HYDRO	12/29/1987	131.44
160685	STA-392	SWFWMD_HYDRO	12/30/1987	131.42
160685	STA-392	SWFWMD_HYDRO	12/31/1987	131.4
160685	STA-392	SWFWMD_HYDRO	1/1/1988	131.4
160685	STA-392	SWFWMD_HYDRO	1/2/1988	131.4
160685	STA-392	SWFWMD_HYDRO	1/3/1988	131.4
160685	STA-392	SWFWMD_HYDRO	1/4/1988	131.42
160685	STA-392	SWFWMD_HYDRO	1/5/1988	131.4
160685	STA-392	SWFWMD_HYDRO	1/6/1988	131.4
160685	STA-392	SWFWMD_HYDRO	1/7/1988	131.4
160685	STA-392	SWFWMD_HYDRO	1/8/1988	131.38
160685	STA-392	SWFWMD_HYDRO	1/9/1988	131.38
160685	STA-392	SWFWMD_HYDRO	1/10/1988	131.38
160685	STA-392	SWFWMD_HYDRO	1/11/1988	131.4
160685	STA-392	SWFWMD_HYDRO	1/12/1988	131.4
160685	STA-392	SWFWMD_HYDRO	1/13/1988	131.42
160685	STA-392	SWFWMD_HYDRO	1/14/1988	131.4
160685	STA-392	SWFWMD_HYDRO	1/15/1988	131.4
160685	STA-392	SWFWMD_HYDRO	1/16/1988	131.38
160685	STA-392	SWFWMD_HYDRO	1/17/1988	131.38
160685	STA-392	SWFWMD_HYDRO	1/18/1988	131.38
160685	STA-392	SWFWMD_HYDRO	1/19/1988	131.36
160685	STA-392	SWFWMD_HYDRO	1/20/1988	131.36
160685	STA-392	SWFWMD_HYDRO	1/21/1988	131.46
160685	STA-392	SWFWMD_HYDRO	1/22/1988	131.46
160685	STA-392	SWFWMD_HYDRO	1/23/1988	131.44
160685	STA-392	SWFWMD_HYDRO	1/24/1988	131.44
160685	STA-392	SWFWMD_HYDRO	1/25/1988	131.44
160685	STA-392	SWFWMD_HYDRO	1/26/1988	131.44
160685	STA-392	SWFWMD_HYDRO	1/27/1988	131.48
160685	STA-392	SWFWMD_HYDRO	1/28/1988	131.46
160685	STA-392	SWFWMD_HYDRO	1/29/1988	131.46
160685	STA-392	SWFWMD_HYDRO	1/30/1988	131.44
160685	STA-392	SWFWMD_HYDRO	1/31/1988	131.44
160685	STA-392	SWFWMD_HYDRO	2/1/1988	131.46
160685	STA-392	SWFWMD_HYDRO	2/2/1988	131.46
160685	STA-392	SWFWMD_HYDRO	2/3/1988	131.44
160685	STA-392	SWFWMD_HYDRO	2/4/1988	131.44
160685	STA-392	SWFWMD_HYDRO	2/5/1988	131.4
160685	STA-392	SWFWMD_HYDRO	2/6/1988	131.44
160685	STA-392	SWFWMD_HYDRO	2/7/1988	131.44
160685	STA-392	SWFWMD_HYDRO	2/8/1988	131.48
160685	STA-392	SWFWMD_HYDRO	2/9/1988	131.48

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	2/10/1988	131.48
160685	STA-392	SWFWMD_HYDRO	2/11/1988	131.46
160685	STA-392	SWFWMD_HYDRO	2/12/1988	131.46
160685	STA-392	SWFWMD_HYDRO	2/13/1988	131.44
160685	STA-392	SWFWMD_HYDRO	2/14/1988	131.44
160685	STA-392	SWFWMD_HYDRO	2/15/1988	131.42
160685	STA-392	SWFWMD_HYDRO	2/16/1988	131.48
160685	STA-392	SWFWMD_HYDRO	2/17/1988	131.48
160685	STA-392	SWFWMD_HYDRO	2/18/1988	131.48
160685	STA-392	SWFWMD_HYDRO	2/19/1988	131.48
160685	STA-392	SWFWMD_HYDRO	2/20/1988	131.48
160685	STA-392	SWFWMD_HYDRO	2/21/1988	131.5
160685	STA-392	SWFWMD_HYDRO	2/22/1988	131.5
160685	STA-392	SWFWMD_HYDRO	2/23/1988	131.48
160685	STA-392	SWFWMD_HYDRO	2/24/1988	131.48
160685	STA-392	SWFWMD_HYDRO	2/25/1988	131.48
160685	STA-392	SWFWMD_HYDRO	2/26/1988	131.46
160685	STA-392	SWFWMD_HYDRO	2/27/1988	131.46
160685	STA-392	SWFWMD_HYDRO	2/28/1988	131.4
160685	STA-392	SWFWMD_HYDRO	2/29/1988	131.42
160685	STA-392	SWFWMD_HYDRO	3/1/1988	131.42
160685	STA-392	SWFWMD_HYDRO	3/2/1988	131.4
160685	STA-392	SWFWMD_HYDRO	3/3/1988	131.38
160685	STA-392	SWFWMD_HYDRO	3/4/1988	131.4
160685	STA-392	SWFWMD_HYDRO	3/5/1988	131.46
160685	STA-392	SWFWMD_HYDRO	3/6/1988	131.56
160685	STA-392	SWFWMD_HYDRO	3/7/1988	131.56
160685	STA-392	SWFWMD_HYDRO	3/8/1988	131.56
160685	STA-392	SWFWMD_HYDRO	3/9/1988	131.56
160685	STA-392	SWFWMD_HYDRO	3/10/1988	131.74
160685	STA-392	SWFWMD_HYDRO	3/11/1988	131.7
160685	STA-392	SWFWMD_HYDRO	3/12/1988	131.7
160685	STA-392	SWFWMD_HYDRO	3/14/1988	131.72
160685	STA-392	SWFWMD_HYDRO	3/15/1988	131.66
160685	STA-392	SWFWMD_HYDRO	3/16/1988	131.64
160685	STA-392	SWFWMD_HYDRO	3/17/1988	131.64
160685	STA-392	SWFWMD_HYDRO	3/18/1988	131.64
160685	STA-392	SWFWMD_HYDRO	3/19/1988	131.62
160685	STA-392	SWFWMD_HYDRO	3/20/1988	131.74
160685	STA-392	SWFWMD_HYDRO	3/21/1988	131.74
160685	STA-392	SWFWMD_HYDRO	3/22/1988	131.72
160685	STA-392	SWFWMD_HYDRO	3/23/1988	131.72
160685	STA-392	SWFWMD_HYDRO	3/24/1988	131.7
160685	STA-392	SWFWMD_HYDRO	3/25/1988	131.72
160685	STA-392	SWFWMD_HYDRO	3/26/1988	131.72
160685	STA-392	SWFWMD_HYDRO	3/27/1988	131.76
160685	STA-392	SWFWMD_HYDRO	3/28/1988	131.74
160685	STA-392	SWFWMD_HYDRO	3/29/1988	131.74
160685	STA-392	SWFWMD_HYDRO	3/30/1988	131.74
160685	STA-392	SWFWMD_HYDRO	3/31/1988	131.72
160685	STA-392	SWFWMD_HYDRO	4/1/1988	131.72
160685	STA-392	SWFWMD_HYDRO	4/2/1988	131.7
160685	STA-392	SWFWMD_HYDRO	4/3/1988	131.7

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	4/4/1988	131.68
160685	STA-392	SWFWMD_HYDRO	4/5/1988	131.68
160685	STA-392	SWFWMD_HYDRO	4/6/1988	131.64
160685	STA-392	SWFWMD_HYDRO	4/7/1988	131.62
160685	STA-392	SWFWMD_HYDRO	4/8/1988	131.6
160685	STA-392	SWFWMD_HYDRO	4/9/1988	131.6
160685	STA-392	SWFWMD_HYDRO	4/10/1988	131.58
160685	STA-392	SWFWMD_HYDRO	4/11/1988	131.6
160685	STA-392	SWFWMD_HYDRO	4/12/1988	131.6
160685	STA-392	SWFWMD_HYDRO	4/13/1988	131.56
160685	STA-392	SWFWMD_HYDRO	4/14/1988	131.54
160685	STA-392	SWFWMD_HYDRO	4/15/1988	131.5
160685	STA-392	SWFWMD_HYDRO	4/16/1988	131.48
160685	STA-392	SWFWMD_HYDRO	4/17/1988	131.48
160685	STA-392	SWFWMD_HYDRO	4/18/1988	131.46
160685	STA-392	SWFWMD_HYDRO	4/19/1988	131.44
160685	STA-392	SWFWMD_HYDRO	4/20/1988	131.44
160685	STA-392	SWFWMD_HYDRO	4/21/1988	131.46
160685	STA-392	SWFWMD_HYDRO	4/22/1988	131.44
160685	STA-392	SWFWMD_HYDRO	4/23/1988	131.42
160685	STA-392	SWFWMD_HYDRO	4/24/1988	131.4
160685	STA-392	SWFWMD_HYDRO	4/25/1988	131.4
160685	STA-392	SWFWMD_HYDRO	4/26/1988	131.38
160685	STA-392	SWFWMD_HYDRO	4/27/1988	131.36
160685	STA-392	SWFWMD_HYDRO	4/28/1988	131.36
160685	STA-392	SWFWMD_HYDRO	4/29/1988	131.34
160685	STA-392	SWFWMD_HYDRO	4/30/1988	131.36
160685	STA-392	SWFWMD_HYDRO	5/1/1988	131.38
160685	STA-392	SWFWMD_HYDRO	5/2/1988	131.34
160685	STA-392	SWFWMD_HYDRO	5/3/1988	131.32
160685	STA-392	SWFWMD_HYDRO	5/4/1988	131.3
160685	STA-392	SWFWMD_HYDRO	5/5/1988	131.28
160685	STA-392	SWFWMD_HYDRO	5/6/1988	131.24
160685	STA-392	SWFWMD_HYDRO	5/7/1988	131.2
160685	STA-392	SWFWMD_HYDRO	5/8/1988	131.2
160685	STA-392	SWFWMD_HYDRO	5/9/1988	131.2
160685	STA-392	SWFWMD_HYDRO	5/10/1988	131.18
160685	STA-392	SWFWMD_HYDRO	5/11/1988	131.16
160685	STA-392	SWFWMD_HYDRO	5/12/1988	131.12
160685	STA-392	SWFWMD_HYDRO	5/13/1988	131.2
160685	STA-392	SWFWMD_HYDRO	5/14/1988	131.1
160685	STA-392	SWFWMD_HYDRO	5/15/1988	131.1
160685	STA-392	SWFWMD_HYDRO	5/16/1988	131.08
160685	STA-392	SWFWMD_HYDRO	5/17/1988	131.06
160685	STA-392	SWFWMD_HYDRO	5/18/1988	131.06
160685	STA-392	SWFWMD_HYDRO	5/19/1988	131.06
160685	STA-392	SWFWMD_HYDRO	5/20/1988	131.02
160685	STA-392	SWFWMD_HYDRO	5/21/1988	131
160685	STA-392	SWFWMD_HYDRO	5/22/1988	131
160685	STA-392	SWFWMD_HYDRO	5/23/1988	130.98
160685	STA-392	SWFWMD_HYDRO	5/24/1988	130.98
160685	STA-392	SWFWMD_HYDRO	5/25/1988	131.04
160685	STA-392	SWFWMD_HYDRO	5/26/1988	131.02

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	5/27/1988	131
160685	STA-392	SWFWMD_HYDRO	5/28/1988	130.98
160685	STA-392	SWFWMD_HYDRO	5/29/1988	130.96
160685	STA-392	SWFWMD_HYDRO	5/30/1988	130.94
160685	STA-392	SWFWMD_HYDRO	5/31/1988	130.92
160685	STA-392	SWFWMD_HYDRO	6/1/1988	130.9
160685	STA-392	SWFWMD_HYDRO	6/2/1988	130.86
160685	STA-392	SWFWMD_HYDRO	6/3/1988	130.84
160685	STA-392	SWFWMD_HYDRO	6/4/1988	130.82
160685	STA-392	SWFWMD_HYDRO	6/5/1988	130.8
160685	STA-392	SWFWMD_HYDRO	6/6/1988	130.76
160685	STA-392	SWFWMD_HYDRO	6/7/1988	130.74
160685	STA-392	SWFWMD_HYDRO	6/8/1988	130.74
160685	STA-392	SWFWMD_HYDRO	6/9/1988	130.74
160685	STA-392	SWFWMD_HYDRO	6/10/1988	130.72
160685	STA-392	SWFWMD_HYDRO	6/11/1988	130.7
160685	STA-392	SWFWMD_HYDRO	6/12/1988	130.68
160685	STA-392	SWFWMD_HYDRO	6/13/1988	130.64
160685	STA-392	SWFWMD_HYDRO	6/14/1988	130.62
160685	STA-392	SWFWMD_HYDRO	6/15/1988	130.62
160685	STA-392	SWFWMD_HYDRO	6/16/1988	130.6
160685	STA-392	SWFWMD_HYDRO	6/17/1988	130.58
160685	STA-392	SWFWMD_HYDRO	6/18/1988	130.56
160685	STA-392	SWFWMD_HYDRO	6/19/1988	130.54
160685	STA-392	SWFWMD_HYDRO	6/20/1988	130.54
160685	STA-392	SWFWMD_HYDRO	6/21/1988	130.58
160685	STA-392	SWFWMD_HYDRO	6/22/1988	130.58
160685	STA-392	SWFWMD_HYDRO	6/23/1988	130.6
160685	STA-392	SWFWMD_HYDRO	6/24/1988	130.6
160685	STA-392	SWFWMD_HYDRO	6/25/1988	130.58
160685	STA-392	SWFWMD_HYDRO	6/26/1988	130.56
160685	STA-392	SWFWMD_HYDRO	6/27/1988	130.68
160685	STA-392	SWFWMD_HYDRO	6/28/1988	130.68
160685	STA-392	SWFWMD_HYDRO	6/29/1988	130.8
160685	STA-392	SWFWMD_HYDRO	6/30/1988	130.76
160685	STA-392	SWFWMD_HYDRO	7/1/1988	130.74
160685	STA-392	SWFWMD_HYDRO	7/2/1988	130.77
160685	STA-392	SWFWMD_HYDRO	7/3/1988	130.7
160685	STA-392	SWFWMD_HYDRO	7/4/1988	130.68
160685	STA-392	SWFWMD_HYDRO	7/5/1988	130.7
160685	STA-392	SWFWMD_HYDRO	7/6/1988	130.66
160685	STA-392	SWFWMD_HYDRO	7/7/1988	130.64
160685	STA-392	SWFWMD_HYDRO	7/8/1988	130.62
160685	STA-392	SWFWMD_HYDRO	7/9/1988	130.62
160685	STA-392	SWFWMD_HYDRO	7/10/1988	130.62
160685	STA-392	SWFWMD_HYDRO	7/11/1988	130.62
160685	STA-392	SWFWMD_HYDRO	7/12/1988	130.6
160685	STA-392	SWFWMD_HYDRO	7/13/1988	130.58
160685	STA-392	SWFWMD_HYDRO	7/14/1988	130.58
160685	STA-392	SWFWMD_HYDRO	7/15/1988	130.58
160685	STA-392	SWFWMD_HYDRO	7/16/1988	130.6
160685	STA-392	SWFWMD_HYDRO	7/17/1988	130.54
160685	STA-392	SWFWMD_HYDRO	7/18/1988	130.58

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	7/19/1988	130.58
160685	STA-392	SWFWMD_HYDRO	7/20/1988	130.56
160685	STA-392	SWFWMD_HYDRO	7/21/1988	130.6
160685	STA-392	SWFWMD_HYDRO	7/22/1988	130.6
160685	STA-392	SWFWMD_HYDRO	7/23/1988	130.58
160685	STA-392	SWFWMD_HYDRO	7/24/1988	130.56
160685	STA-392	SWFWMD_HYDRO	7/25/1988	130.6
160685	STA-392	SWFWMD_HYDRO	7/26/1988	130.64
160685	STA-392	SWFWMD_HYDRO	7/27/1988	130.62
160685	STA-392	SWFWMD_HYDRO	7/28/1988	130.66
160685	STA-392	SWFWMD_HYDRO	7/29/1988	130.64
160685	STA-392	SWFWMD_HYDRO	7/30/1988	130.62
160685	STA-392	SWFWMD_HYDRO	7/31/1988	130.6
160685	STA-392	SWFWMD_HYDRO	8/1/1988	130.6
160685	STA-392	SWFWMD_HYDRO	8/2/1988	130.66
160685	STA-392	SWFWMD_HYDRO	8/3/1988	130.64
160685	STA-392	SWFWMD_HYDRO	8/4/1988	130.64
160685	STA-392	SWFWMD_HYDRO	8/5/1988	130.62
160685	STA-392	SWFWMD_HYDRO	8/6/1988	130.6
160685	STA-392	SWFWMD_HYDRO	8/7/1988	130.64
160685	STA-392	SWFWMD_HYDRO	8/8/1988	130.66
160685	STA-392	SWFWMD_HYDRO	8/9/1988	130.66
160685	STA-392	SWFWMD_HYDRO	8/10/1988	130.7
160685	STA-392	SWFWMD_HYDRO	8/11/1988	130.68
160685	STA-392	SWFWMD_HYDRO	8/12/1988	130.66
160685	STA-392	SWFWMD_HYDRO	8/13/1988	130.64
160685	STA-392	SWFWMD_HYDRO	8/14/1988	130.62
160685	STA-392	SWFWMD_HYDRO	8/15/1988	130.62
160685	STA-392	SWFWMD_HYDRO	8/16/1988	130.66
160685	STA-392	SWFWMD_HYDRO	8/17/1988	130.66
160685	STA-392	SWFWMD_HYDRO	8/18/1988	130.78
160685	STA-392	SWFWMD_HYDRO	8/19/1988	130.8
160685	STA-392	SWFWMD_HYDRO	8/22/1988	130.74
160685	STA-392	SWFWMD_HYDRO	8/23/1988	130.74
160685	STA-392	SWFWMD_HYDRO	8/24/1988	130.78
160685	STA-392	SWFWMD_HYDRO	8/25/1988	130.76
160685	STA-392	SWFWMD_HYDRO	8/26/1988	130.76
160685	STA-392	SWFWMD_HYDRO	8/27/1988	130.8
160685	STA-392	SWFWMD_HYDRO	8/28/1988	130.84
160685	STA-392	SWFWMD_HYDRO	8/29/1988	130.9
160685	STA-392	SWFWMD_HYDRO	8/30/1988	130.9
160685	STA-392	SWFWMD_HYDRO	8/31/1988	130.9
160685	STA-392	SWFWMD_HYDRO	9/1/1988	130.9
160685	STA-392	SWFWMD_HYDRO	9/2/1988	130.88
160685	STA-392	SWFWMD_HYDRO	9/3/1988	130.86
160685	STA-392	SWFWMD_HYDRO	9/4/1988	130.86
160685	STA-392	SWFWMD_HYDRO	9/5/1988	130.84
160685	STA-392	SWFWMD_HYDRO	9/6/1988	131.4
160685	STA-392	SWFWMD_HYDRO	9/7/1988	131.5
160685	STA-392	SWFWMD_HYDRO	9/8/1988	131.54
160685	STA-392	SWFWMD_HYDRO	9/10/1988	131.64
160685	STA-392	SWFWMD_HYDRO	9/11/1988	131.6
160685	STA-392	SWFWMD_HYDRO	9/12/1988	131.6

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	9/13/1988	131.62
160685	STA-392	SWFWMD_HYDRO	9/14/1988	131.62
160685	STA-392	SWFWMD_HYDRO	9/15/1988	131.62
160685	STA-392	SWFWMD_HYDRO	9/16/1988	131.6
160685	STA-392	SWFWMD_HYDRO	9/17/1988	131.58
160685	STA-392	SWFWMD_HYDRO	9/18/1988	131.6
160685	STA-392	SWFWMD_HYDRO	9/19/1988	131.58
160685	STA-392	SWFWMD_HYDRO	9/20/1988	131.58
160685	STA-392	SWFWMD_HYDRO	9/21/1988	131.58
160685	STA-392	SWFWMD_HYDRO	9/22/1988	131.58
160685	STA-392	SWFWMD_HYDRO	9/23/1988	131.56
160685	STA-392	SWFWMD_HYDRO	9/24/1988	131.56
160685	STA-392	SWFWMD_HYDRO	9/25/1988	131.54
160685	STA-392	SWFWMD_HYDRO	9/26/1988	131.52
160685	STA-392	SWFWMD_HYDRO	9/27/1988	131.48
160685	STA-392	SWFWMD_HYDRO	9/28/1988	131.46
160685	STA-392	SWFWMD_HYDRO	9/29/1988	131.5
160685	STA-392	SWFWMD_HYDRO	10/1/1988	131.48
160685	STA-392	SWFWMD_HYDRO	10/2/1988	131.46
160685	STA-392	SWFWMD_HYDRO	10/3/1988	131.54
160685	STA-392	SWFWMD_HYDRO	10/4/1988	131.56
160685	STA-392	SWFWMD_HYDRO	10/5/1988	131.56
160685	STA-392	SWFWMD_HYDRO	10/6/1988	131.54
160685	STA-392	SWFWMD_HYDRO	10/7/1988	131.5
160685	STA-392	SWFWMD_HYDRO	10/8/1988	131.48
160685	STA-392	SWFWMD_HYDRO	10/9/1988	131.46
160685	STA-392	SWFWMD_HYDRO	10/10/1988	131.44
160685	STA-392	SWFWMD_HYDRO	10/11/1988	131.42
160685	STA-392	SWFWMD_HYDRO	10/12/1988	131.4
160685	STA-392	SWFWMD_HYDRO	10/13/1988	131.38
160685	STA-392	SWFWMD_HYDRO	10/14/1988	131.38
160685	STA-392	SWFWMD_HYDRO	10/15/1988	131.36
160685	STA-392	SWFWMD_HYDRO	10/16/1988	131.34
160685	STA-392	SWFWMD_HYDRO	10/17/1988	131.32
160685	STA-392	SWFWMD_HYDRO	10/18/1988	131.3
160685	STA-392	SWFWMD_HYDRO	10/19/1988	131.28
160685	STA-392	SWFWMD_HYDRO	10/20/1988	131.28
160685	STA-392	SWFWMD_HYDRO	10/21/1988	131.28
160685	STA-392	SWFWMD_HYDRO	10/22/1988	131.26
160685	STA-392	SWFWMD_HYDRO	10/23/1988	131.24
160685	STA-392	SWFWMD_HYDRO	10/24/1988	131.24
160685	STA-392	SWFWMD_HYDRO	10/25/1988	131.22
160685	STA-392	SWFWMD_HYDRO	10/26/1988	131.2
160685	STA-392	SWFWMD_HYDRO	10/27/1988	131.18
160685	STA-392	SWFWMD_HYDRO	10/28/1988	131.16
160685	STA-392	SWFWMD_HYDRO	10/29/1988	131.14
160685	STA-392	SWFWMD_HYDRO	10/30/1988	131.14
160685	STA-392	SWFWMD_HYDRO	10/31/1988	131.12
160685	STA-392	SWFWMD_HYDRO	11/1/1988	131.14
160685	STA-392	SWFWMD_HYDRO	11/2/1988	131.12
160685	STA-392	SWFWMD_HYDRO	11/3/1988	131.36
160685	STA-392	SWFWMD_HYDRO	11/4/1988	131.36
160685	STA-392	SWFWMD_HYDRO	11/5/1988	131.36

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	11/6/1988	131.38
160685	STA-392	SWFWMD_HYDRO	11/7/1988	131.38
160685	STA-392	SWFWMD_HYDRO	11/8/1988	131.36
160685	STA-392	SWFWMD_HYDRO	11/9/1988	131.36
160685	STA-392	SWFWMD_HYDRO	11/10/1988	131.36
160685	STA-392	SWFWMD_HYDRO	11/11/1988	131.34
160685	STA-392	SWFWMD_HYDRO	11/12/1988	131.32
160685	STA-392	SWFWMD_HYDRO	11/13/1988	131.3
160685	STA-392	SWFWMD_HYDRO	11/14/1988	131.3
160685	STA-392	SWFWMD_HYDRO	11/16/1988	131.28
160685	STA-392	SWFWMD_HYDRO	11/17/1988	131.28
160685	STA-392	SWFWMD_HYDRO	11/18/1988	131.28
160685	STA-392	SWFWMD_HYDRO	11/19/1988	131.26
160685	STA-392	SWFWMD_HYDRO	11/20/1988	131.26
160685	STA-392	SWFWMD_HYDRO	11/21/1988	131.26
160685	STA-392	SWFWMD_HYDRO	11/22/1988	131.26
160685	STA-392	SWFWMD_HYDRO	11/23/1988	131.66
160685	STA-392	SWFWMD_HYDRO	11/24/1988	131.68
160685	STA-392	SWFWMD_HYDRO	11/25/1988	131.66
160685	STA-392	SWFWMD_HYDRO	11/26/1988	131.64
160685	STA-392	SWFWMD_HYDRO	11/27/1988	131.62
160685	STA-392	SWFWMD_HYDRO	11/28/1988	131.6
160685	STA-392	SWFWMD_HYDRO	11/29/1988	131.58
160685	STA-392	SWFWMD_HYDRO	12/1/1988	131.58
160685	STA-392	SWFWMD_HYDRO	12/2/1988	131.6
160685	STA-392	SWFWMD_HYDRO	12/3/1988	131.56
160685	STA-392	SWFWMD_HYDRO	12/4/1988	131.54
160685	STA-392	SWFWMD_HYDRO	12/5/1988	131.52
160685	STA-392	SWFWMD_HYDRO	12/6/1988	131.54
160685	STA-392	SWFWMD_HYDRO	12/7/1988	131.54
160685	STA-392	SWFWMD_HYDRO	12/8/1988	131.54
160685	STA-392	SWFWMD_HYDRO	12/9/1988	131.54
160685	STA-392	SWFWMD_HYDRO	12/10/1988	131.54
160685	STA-392	SWFWMD_HYDRO	12/11/1988	131.6
160685	STA-392	SWFWMD_HYDRO	12/12/1988	131.64
160685	STA-392	SWFWMD_HYDRO	12/13/1988	131.64
160685	STA-392	SWFWMD_HYDRO	12/14/1988	131.62
160685	STA-392	SWFWMD_HYDRO	12/15/1988	131.6
160685	STA-392	SWFWMD_HYDRO	12/16/1988	131.6
160685	STA-392	SWFWMD_HYDRO	12/17/1988	131.58
160685	STA-392	SWFWMD_HYDRO	12/18/1988	131.56
160685	STA-392	SWFWMD_HYDRO	12/19/1988	131.54
160685	STA-392	SWFWMD_HYDRO	12/20/1988	131.52
160685	STA-392	SWFWMD_HYDRO	12/21/1988	131.5
160685	STA-392	SWFWMD_HYDRO	12/28/1988	131.54
160685	STA-392	SWFWMD_HYDRO	12/29/1988	131.54
160685	STA-392	SWFWMD_HYDRO	12/30/1988	131.52
160685	STA-392	SWFWMD_HYDRO	12/31/1988	131.52
160685	STA-392	SWFWMD_HYDRO	1/1/1989	131.52
160685	STA-392	SWFWMD_HYDRO	1/2/1989	131.52
160685	STA-392	SWFWMD_HYDRO	1/3/1989	131.5
160685	STA-392	SWFWMD_HYDRO	1/4/1989	131.5
160685	STA-392	SWFWMD_HYDRO	1/5/1989	131.48

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	1/6/1989	131.48
160685	STA-392	SWFWMD_HYDRO	1/7/1989	131.46
160685	STA-392	SWFWMD_HYDRO	1/8/1989	131.46
160685	STA-392	SWFWMD_HYDRO	1/9/1989	131.46
160685	STA-392	SWFWMD_HYDRO	1/10/1989	131.46
160685	STA-392	SWFWMD_HYDRO	1/11/1989	131.44
160685	STA-392	SWFWMD_HYDRO	1/12/1989	131.44
160685	STA-392	SWFWMD_HYDRO	1/13/1989	131.44
160685	STA-392	SWFWMD_HYDRO	1/14/1989	131.42
160685	STA-392	SWFWMD_HYDRO	1/15/1989	131.42
160685	STA-392	SWFWMD_HYDRO	1/16/1989	131.44
160685	STA-392	SWFWMD_HYDRO	1/17/1989	131.44
160685	STA-392	SWFWMD_HYDRO	1/18/1989	131.42
160685	STA-392	SWFWMD_HYDRO	1/19/1989	131.42
160685	STA-392	SWFWMD_HYDRO	1/20/1989	131.4
160685	STA-392	SWFWMD_HYDRO	1/21/1989	131.52
160685	STA-392	SWFWMD_HYDRO	1/22/1989	131.66
160685	STA-392	SWFWMD_HYDRO	1/23/1989	131.64
160685	STA-392	SWFWMD_HYDRO	1/24/1989	131.62
160685	STA-392	SWFWMD_HYDRO	1/25/1989	131.62
160685	STA-392	SWFWMD_HYDRO	1/26/1989	131.62
160685	STA-392	SWFWMD_HYDRO	1/27/1989	131.6
160685	STA-392	SWFWMD_HYDRO	1/28/1989	131.6
160685	STA-392	SWFWMD_HYDRO	1/29/1989	131.6
160685	STA-392	SWFWMD_HYDRO	1/30/1989	131.6
160685	STA-392	SWFWMD_HYDRO	1/31/1989	131.6
160685	STA-392	SWFWMD_HYDRO	2/1/1989	131.6
160685	STA-392	SWFWMD_HYDRO	2/2/1989	131.58
160685	STA-392	SWFWMD_HYDRO	2/3/1989	131.58
160685	STA-392	SWFWMD_HYDRO	2/4/1989	131.58
160685	STA-392	SWFWMD_HYDRO	2/5/1989	131.56
160685	STA-392	SWFWMD_HYDRO	2/6/1989	131.56
160685	STA-392	SWFWMD_HYDRO	2/7/1989	131.56
160685	STA-392	SWFWMD_HYDRO	2/8/1989	131.54
160685	STA-392	SWFWMD_HYDRO	2/9/1989	131.54
160685	STA-392	SWFWMD_HYDRO	2/10/1989	131.52
160685	STA-392	SWFWMD_HYDRO	2/11/1989	131.5
160685	STA-392	SWFWMD_HYDRO	2/12/1989	131.48
160685	STA-392	SWFWMD_HYDRO	2/13/1989	131.48
160685	STA-392	SWFWMD_HYDRO	2/14/1989	131.46
160685	STA-392	SWFWMD_HYDRO	2/15/1989	131.46
160685	STA-392	SWFWMD_HYDRO	2/16/1989	131.44
160685	STA-392	SWFWMD_HYDRO	2/17/1989	131.44
160685	STA-392	SWFWMD_HYDRO	2/18/1989	131.42
160685	STA-392	SWFWMD_HYDRO	2/19/1989	131.4
160685	STA-392	SWFWMD_HYDRO	2/20/1989	131.36
160685	STA-392	SWFWMD_HYDRO	2/21/1989	131.36
160685	STA-392	SWFWMD_HYDRO	2/23/1989	131.32
160685	STA-392	SWFWMD_HYDRO	2/24/1989	131.3
160685	STA-392	SWFWMD_HYDRO	2/26/1989	131.28
160685	STA-392	SWFWMD_HYDRO	2/27/1989	131.26
160685	STA-392	SWFWMD_HYDRO	2/28/1989	131.26
160685	STA-392	SWFWMD_HYDRO	3/1/1989	131.24

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	3/2/1989	131.32
160685	STA-392	SWFWMD_HYDRO	3/3/1989	131.38
160685	STA-392	SWFWMD_HYDRO	3/4/1989	131.38
160685	STA-392	SWFWMD_HYDRO	3/5/1989	131.36
160685	STA-392	SWFWMD_HYDRO	3/6/1989	131.36
160685	STA-392	SWFWMD_HYDRO	3/7/1989	131.4
160685	STA-392	SWFWMD_HYDRO	3/8/1989	131.4
160685	STA-392	SWFWMD_HYDRO	3/9/1989	131.4
160685	STA-392	SWFWMD_HYDRO	3/10/1989	131.36
160685	STA-392	SWFWMD_HYDRO	3/11/1989	131.34
160685	STA-392	SWFWMD_HYDRO	3/12/1989	131.32
160685	STA-392	SWFWMD_HYDRO	3/13/1989	131.32
160685	STA-392	SWFWMD_HYDRO	3/14/1989	131.3
160685	STA-392	SWFWMD_HYDRO	3/15/1989	131.3
160685	STA-392	SWFWMD_HYDRO	3/16/1989	131.28
160685	STA-392	SWFWMD_HYDRO	3/17/1989	131.28
160685	STA-392	SWFWMD_HYDRO	3/18/1989	131.26
160685	STA-392	SWFWMD_HYDRO	3/19/1989	131.26
160685	STA-392	SWFWMD_HYDRO	3/20/1989	131.24
160685	STA-392	SWFWMD_HYDRO	3/21/1989	131.22
160685	STA-392	SWFWMD_HYDRO	3/22/1989	131.2
160685	STA-392	SWFWMD_HYDRO	3/23/1989	131.18
160685	STA-392	SWFWMD_HYDRO	3/24/1989	131.18
160685	STA-392	SWFWMD_HYDRO	3/25/1989	131.2
160685	STA-392	SWFWMD_HYDRO	3/26/1989	131.18
160685	STA-392	SWFWMD_HYDRO	3/27/1989	131.14
160685	STA-392	SWFWMD_HYDRO	3/28/1989	131.1
160685	STA-392	SWFWMD_HYDRO	3/29/1989	131.08
160685	STA-392	SWFWMD_HYDRO	3/30/1989	131.06
160685	STA-392	SWFWMD_HYDRO	3/31/1989	131.12
160685	STA-392	SWFWMD_HYDRO	4/1/1989	131.12
160685	STA-392	SWFWMD_HYDRO	4/2/1989	131.12
160685	STA-392	SWFWMD_HYDRO	4/3/1989	131.1
160685	STA-392	SWFWMD_HYDRO	4/4/1989	131.1
160685	STA-392	SWFWMD_HYDRO	4/5/1989	131.08
160685	STA-392	SWFWMD_HYDRO	4/6/1989	131.06
160685	STA-392	SWFWMD_HYDRO	4/7/1989	131.02
160685	STA-392	SWFWMD_HYDRO	4/8/1989	131
160685	STA-392	SWFWMD_HYDRO	4/9/1989	130.98
160685	STA-392	SWFWMD_HYDRO	4/10/1989	130.96
160685	STA-392	SWFWMD_HYDRO	4/11/1989	130.96
160685	STA-392	SWFWMD_HYDRO	4/12/1989	130.96
160685	STA-392	SWFWMD_HYDRO	4/13/1989	130.94
160685	STA-392	SWFWMD_HYDRO	4/14/1989	130.94
160685	STA-392	SWFWMD_HYDRO	4/15/1989	131
160685	STA-392	SWFWMD_HYDRO	4/16/1989	131.06
160685	STA-392	SWFWMD_HYDRO	4/17/1989	131.06
160685	STA-392	SWFWMD_HYDRO	4/18/1989	131.04
160685	STA-392	SWFWMD_HYDRO	4/19/1989	131.02
160685	STA-392	SWFWMD_HYDRO	4/20/1989	131
160685	STA-392	SWFWMD_HYDRO	4/21/1989	130.98
160685	STA-392	SWFWMD_HYDRO	4/22/1989	130.96
160685	STA-392	SWFWMD_HYDRO	4/23/1989	130.94

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	4/24/1989	130.9
160685	STA-392	SWFWMD_HYDRO	4/25/1989	130.9
160685	STA-392	SWFWMD_HYDRO	4/26/1989	130.88
160685	STA-392	SWFWMD_HYDRO	4/27/1989	130.84
160685	STA-392	SWFWMD_HYDRO	4/28/1989	130.82
160685	STA-392	SWFWMD_HYDRO	4/29/1989	130.8
160685	STA-392	SWFWMD_HYDRO	5/1/1989	130.92
160685	STA-392	SWFWMD_HYDRO	5/2/1989	131.06
160685	STA-392	SWFWMD_HYDRO	5/3/1989	131.04
160685	STA-392	SWFWMD_HYDRO	5/4/1989	131.02
160685	STA-392	SWFWMD_HYDRO	5/5/1989	130.96
160685	STA-392	SWFWMD_HYDRO	5/6/1989	130.94
160685	STA-392	SWFWMD_HYDRO	5/7/1989	130.92
160685	STA-392	SWFWMD_HYDRO	5/8/1989	130.9
160685	STA-392	SWFWMD_HYDRO	5/9/1989	130.88
160685	STA-392	SWFWMD_HYDRO	5/10/1989	130.86
160685	STA-392	SWFWMD_HYDRO	5/11/1989	130.84
160685	STA-392	SWFWMD_HYDRO	5/12/1989	130.8
160685	STA-392	SWFWMD_HYDRO	5/13/1989	130.78
160685	STA-392	SWFWMD_HYDRO	5/14/1989	130.76
160685	STA-392	SWFWMD_HYDRO	5/15/1989	130.76
160685	STA-392	SWFWMD_HYDRO	5/16/1989	130.74
160685	STA-392	SWFWMD_HYDRO	5/17/1989	130.7
160685	STA-392	SWFWMD_HYDRO	5/18/1989	130.68
160685	STA-392	SWFWMD_HYDRO	5/19/1989	130.66
160685	STA-392	SWFWMD_HYDRO	5/20/1989	130.64
160685	STA-392	SWFWMD_HYDRO	5/21/1989	130.6
160685	STA-392	SWFWMD_HYDRO	5/22/1989	130.58
160685	STA-392	SWFWMD_HYDRO	5/23/1989	130.56
160685	STA-392	SWFWMD_HYDRO	5/24/1989	130.54
160685	STA-392	SWFWMD_HYDRO	5/25/1989	130.54
160685	STA-392	SWFWMD_HYDRO	5/26/1989	130.5
160685	STA-392	SWFWMD_HYDRO	5/27/1989	130.48
160685	STA-392	SWFWMD_HYDRO	5/28/1989	130.46
160685	STA-392	SWFWMD_HYDRO	5/29/1989	130.44
160685	STA-392	SWFWMD_HYDRO	5/30/1989	130.42
160685	STA-392	SWFWMD_HYDRO	5/31/1989	130.42
160685	STA-392	SWFWMD_HYDRO	6/1/1989	130.42
160685	STA-392	SWFWMD_HYDRO	6/2/1989	130.38
160685	STA-392	SWFWMD_HYDRO	6/3/1989	130.34
160685	STA-392	SWFWMD_HYDRO	6/4/1989	130.32
160685	STA-392	SWFWMD_HYDRO	6/5/1989	130.3
160685	STA-392	SWFWMD_HYDRO	6/7/1989	130.28
160685	STA-392	SWFWMD_HYDRO	6/8/1989	130.26
160685	STA-392	SWFWMD_HYDRO	6/9/1989	130.26
160685	STA-392	SWFWMD_HYDRO	6/10/1989	130.24
160685	STA-392	SWFWMD_HYDRO	6/11/1989	130.26
160685	STA-392	SWFWMD_HYDRO	6/12/1989	130.26
160685	STA-392	SWFWMD_HYDRO	6/13/1989	130.2
160685	STA-392	SWFWMD_HYDRO	6/14/1989	130.18
160685	STA-392	SWFWMD_HYDRO	6/15/1989	130.16
160685	STA-392	SWFWMD_HYDRO	6/16/1989	130.12
160685	STA-392	SWFWMD_HYDRO	6/17/1989	130.12

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	6/18/1989	130.1
160685	STA-392	SWFWMD_HYDRO	6/19/1989	130.08
160685	STA-392	SWFWMD_HYDRO	6/20/1989	130.08
160685	STA-392	SWFWMD_HYDRO	6/21/1989	130.3
160685	STA-392	SWFWMD_HYDRO	6/22/1989	130.3
160685	STA-392	SWFWMD_HYDRO	6/23/1989	130.32
160685	STA-392	SWFWMD_HYDRO	6/24/1989	130.36
160685	STA-392	SWFWMD_HYDRO	6/25/1989	130.38
160685	STA-392	SWFWMD_HYDRO	6/26/1989	130.36
160685	STA-392	SWFWMD_HYDRO	6/27/1989	130.34
160685	STA-392	SWFWMD_HYDRO	6/28/1989	130.32
160685	STA-392	SWFWMD_HYDRO	6/29/1989	130.36
160685	STA-392	SWFWMD_HYDRO	6/30/1989	130.36
160685	STA-392	SWFWMD_HYDRO	7/1/1989	130.38
160685	STA-392	SWFWMD_HYDRO	7/2/1989	130.44
160685	STA-392	SWFWMD_HYDRO	7/3/1989	130.54
160685	STA-392	SWFWMD_HYDRO	7/4/1989	130.56
160685	STA-392	SWFWMD_HYDRO	7/5/1989	130.54
160685	STA-392	SWFWMD_HYDRO	7/6/1989	130.6
160685	STA-392	SWFWMD_HYDRO	7/7/1989	130.64
160685	STA-392	SWFWMD_HYDRO	8/12/1989	130.42
160685	STA-392	SWFWMD_HYDRO	8/13/1989	130.44
160685	STA-392	SWFWMD_HYDRO	8/14/1989	130.44
160685	STA-392	SWFWMD_HYDRO	8/15/1989	130.42
160685	STA-392	SWFWMD_HYDRO	8/16/1989	130.4
160685	STA-392	SWFWMD_HYDRO	8/19/1989	130.38
160685	STA-392	SWFWMD_HYDRO	8/20/1989	130.38
160685	STA-392	SWFWMD_HYDRO	8/21/1989	130.44
160685	STA-392	SWFWMD_HYDRO	8/22/1989	130.44
160685	STA-392	SWFWMD_HYDRO	8/23/1989	130.4
160685	STA-392	SWFWMD_HYDRO	8/24/1989	130.36
160685	STA-392	SWFWMD_HYDRO	8/25/1989	130.34
160685	STA-392	SWFWMD_HYDRO	8/26/1989	130.34
160685	STA-392	SWFWMD_HYDRO	8/27/1989	130.42
160685	STA-392	SWFWMD_HYDRO	8/28/1989	130.44
160685	STA-392	SWFWMD_HYDRO	8/29/1989	130.42
160685	STA-392	SWFWMD_HYDRO	8/31/1989	130.36
160685	STA-392	SWFWMD_HYDRO	9/1/1989	130.34
160685	STA-392	SWFWMD_HYDRO	9/2/1989	130.36
160685	STA-392	SWFWMD_HYDRO	9/3/1989	130.34
160685	STA-392	SWFWMD_HYDRO	9/4/1989	130.34
160685	STA-392	SWFWMD_HYDRO	9/5/1989	130.32
160685	STA-392	SWFWMD_HYDRO	9/6/1989	130.32
160685	STA-392	SWFWMD_HYDRO	9/7/1989	130.3
160685	STA-392	SWFWMD_HYDRO	9/8/1989	130.28
160685	STA-392	SWFWMD_HYDRO	9/9/1989	130.28
160685	STA-392	SWFWMD_HYDRO	9/10/1989	130.26
160685	STA-392	SWFWMD_HYDRO	9/11/1989	130.24
160685	STA-392	SWFWMD_HYDRO	9/12/1989	130.22
160685	STA-392	SWFWMD_HYDRO	9/13/1989	130.2
160685	STA-392	SWFWMD_HYDRO	9/14/1989	130.18
160685	STA-392	SWFWMD_HYDRO	9/15/1989	130.26
160685	STA-392	SWFWMD_HYDRO	9/16/1989	130.26

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	9/17/1989	130.26
160685	STA-392	SWFWMD_HYDRO	9/18/1989	130.38
160685	STA-392	SWFWMD_HYDRO	9/19/1989	130.4
160685	STA-392	SWFWMD_HYDRO	9/20/1989	130.38
160685	STA-392	SWFWMD_HYDRO	9/21/1989	130.34
160685	STA-392	SWFWMD_HYDRO	9/22/1989	130.36
160685	STA-392	SWFWMD_HYDRO	9/23/1989	130.4
160685	STA-392	SWFWMD_HYDRO	9/24/1989	130.42
160685	STA-392	SWFWMD_HYDRO	9/25/1989	130.44
160685	STA-392	SWFWMD_HYDRO	9/26/1989	130.56
160685	STA-392	SWFWMD_HYDRO	9/27/1989	130.58
160685	STA-392	SWFWMD_HYDRO	9/28/1989	130.58
160685	STA-392	SWFWMD_HYDRO	9/29/1989	130.58
160685	STA-392	SWFWMD_HYDRO	9/30/1989	130.6
160685	STA-392	SWFWMD_HYDRO	7/10/1991	137.34
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160685	STA-392	SWFWMD_HYDRO	11/22/1994	132.17
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160685	STA-392	SWFWMD_HYDRO	12/14/1995	131.54
160685	STA-392	SWFWMD_HYDRO	1/30/1996	131.66
160685	STA-392	SWFWMD_HYDRO	2/26/1996	131.5
160685	STA-392	SWFWMD_HYDRO	3/27/1996	131.38
160685	STA-392	SWFWMD_HYDRO	4/25/1996	131.42
160685	STA-392	SWFWMD_HYDRO	5/20/1996	131.06
160685	STA-392	SWFWMD_HYDRO	6/27/1996	131.32
160685	STA-392	SWFWMD_HYDRO	7/29/1996	131.46
160685	STA-392	SWFWMD_HYDRO	8/29/1996	131.64
160685	STA-392	SWFWMD_HYDRO	9/26/1996	131.94
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160685	STA-392	SWFWMD_HYDRO	11/23/1996	131.42

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160685	STA-392	SWFWMD_HYDRO	6/4/1997	130.99
160685	STA-392	SWFWMD_HYDRO	6/27/1997	131.18
160685	STA-392	SWFWMD_HYDRO	7/31/1997	131.48
160685	STA-392	SWFWMD_HYDRO	8/28/1997	131.74
160685	STA-392	SWFWMD_HYDRO	9/30/1997	131.78
160685	STA-392	SWFWMD_HYDRO	10/29/1997	131.6
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160685	STA-392	SWFWMD_HYDRO	1/29/1998	131.98
160685	STA-392	SWFWMD_HYDRO	2/19/1998	132.26
160685	STA-392	SWFWMD_HYDRO	3/31/1998	132.18
160685	STA-392	SWFWMD_HYDRO	4/30/1998	131.56
160685	STA-392	SWFWMD_HYDRO	5/29/1998	131.3
160685	STA-392	SWFWMD_HYDRO	6/22/1998	130.88
160685	STA-392	SWFWMD_HYDRO	8/10/1998	131.48
160685	STA-392	SWFWMD_HYDRO	8/24/1998	131.36
160685	STA-392	SWFWMD_HYDRO	9/28/1998	132.16
160685	STA-392	SWFWMD_HYDRO	10/22/1998	131.74
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160685	STA-392	SWFWMD_HYDRO	8/27/1999	130.8
160685	STA-392	SWFWMD_HYDRO	9/27/1999	130.84
160685	STA-392	SWFWMD_HYDRO	10/29/1999	131.08
160685	STA-392	SWFWMD_HYDRO	11/30/1999	130.98
160685	STA-392	SWFWMD_HYDRO	12/14/1999	130.84
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160685	STA-392	SWFWMD_HYDRO	2/24/2000	130.7
160685	STA-392	SWFWMD_HYDRO	3/31/2000	130.24
160685	STA-392	SWFWMD_HYDRO	4/28/2000	129.76
160685	STA-392	SWFWMD_HYDRO	5/31/2000	128.98
160685	STA-392	SWFWMD_HYDRO	6/28/2000	128.78
160685	STA-392	SWFWMD_HYDRO	7/28/2000	129.26
160685	STA-392	SWFWMD_HYDRO	8/31/2000	129.82
160685	STA-392	SWFWMD_HYDRO	9/29/2000	129.96
160685	STA-392	SWFWMD_HYDRO	10/31/2000	129.42
160685	STA-392	SWFWMD_HYDRO	11/27/2000	129.12
160685	STA-392	SWFWMD_HYDRO	12/22/2000	128.9
160685	STA-392	SWFWMD_HYDRO	1/29/2001	128.66
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160685	STA-392	SWFWMD_HYDRO	3/23/2001	128.26

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160685	STA-392	SWFWMD_HYDRO	3/29/2002	130.4
160685	STA-392	SWFWMD_HYDRO	4/27/2002	130.02
160685	STA-392	SWFWMD_HYDRO	5/31/2002	129.44
160685	STA-392	SWFWMD_HYDRO	6/28/2002	129.8
160685	STA-392	SWFWMD_HYDRO	7/25/2002	130.32
160685	STA-392	SWFWMD_HYDRO	8/30/2002	130.66
160685	STA-392	SWFWMD_HYDRO	9/27/2002	130.9
160685	STA-392	SWFWMD_HYDRO	10/29/2002	131
160685	STA-392	SWFWMD_HYDRO	11/29/2002	131.08
160685	STA-392	SWFWMD_HYDRO	1/7/2003	132.36
160685	STA-392	SWFWMD_HYDRO	2/25/2003	131.96
160685	STA-392	SWFWMD_HYDRO	3/31/2003	131.92
160685	STA-392	SWFWMD_HYDRO	4/26/2003	131.58
160685	STA-392	SWFWMD_HYDRO	5/31/2003	131.34
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160685	STA-392	SWFWMD_HYDRO	8/27/2003	132.12
160685	STA-392	SWFWMD_HYDRO	9/30/2003	131.86
160685	STA-392	SWFWMD_HYDRO	10/30/2003	131.74
160685	STA-392	SWFWMD_HYDRO	11/28/2003	131.52
160685	STA-392	SWFWMD_HYDRO	12/31/2003	131.26
160685	STA-392	SWFWMD_HYDRO	1/30/2004	131.56
160685	STA-392	SWFWMD_HYDRO	2/27/2004	131.74
160685	STA-392	SWFWMD_HYDRO	3/18/2004	131.78
160685	STA-392	SWFWMD_HYDRO	4/30/2004	131.34
160685	STA-392	SWFWMD_HYDRO	5/27/2004	130.94
160685	STA-392	SWFWMD_HYDRO	6/25/2004	130.94
160685	STA-392	SWFWMD_HYDRO	7/29/2004	131.2
160685	STA-392	SWFWMD_HYDRO	8/27/2004	132.3
160685	STA-392	SWFWMD_HYDRO	9/7/2004	133
160685	STA-392	SWFWMD_HYDRO	9/24/2004	132.4
160685	STA-392	SWFWMD_HYDRO	10/29/2004	131.96
160685	STA-392	SWFWMD_HYDRO	11/30/2004	131.82
160685	STA-392	SWFWMD_HYDRO	12/30/2004	131.8
160685	STA-392	SWFWMD_HYDRO	1/31/2005	131.98
160685	STA-392	SWFWMD_HYDRO	2/10/2005	131.92
160685	STA-392	SWFWMD_HYDRO	3/25/2005	132
160685	STA-392	SWFWMD_HYDRO	4/29/2005	131.72
160685	STA-392	SWFWMD_HYDRO	5/24/2005	131.54
160685	STA-392	SWFWMD_HYDRO	6/24/2005	132.12
160685	STA-392	SWFWMD_HYDRO	7/28/2005	132.08
160685	STA-392	SWFWMD_HYDRO	8/26/2005	131.78
160685	STA-392	SWFWMD_HYDRO	9/29/2005	131.56
160685	STA-392	SWFWMD_HYDRO	10/25/2005	131.86

wbodyID	stationID	datasource	sample_date	level_ft
160685	STA-392	SWFWMD_HYDRO	11/30/2005	131.74
160685	STA-392	SWFWMD_HYDRO	12/20/2005	131.72
160685	STA-392	SWFWMD_HYDRO	1/24/2006	131.44
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160685	STA-392	SWFWMD_HYDRO	4/26/2006	130.68
160685	STA-392	SWFWMD_HYDRO	5/23/2006	130.28
160685	STA-392	SWFWMD_HYDRO	6/29/2006	130.2
160685	STA-392	SWFWMD_HYDRO	7/26/2006	130.4
160685	STA-392	SWFWMD_HYDRO	8/31/2006	130.35

APPENDIX D

MEAN ANNUAL HYDROLOGIC AND MASS BALANCE MODELS FOR LAKES MAY, SHIPP, AND LULU

Lake May

Watershed	Area (ac)	Flow (ac-ft/yr)	Mass Loading (kg)		
			Total-N	Total-P	TSS
May01	10.2	10.7	14.8	4.5	675
May02	25.5	36.2	27.0	2.2	335
May03	1.8	0.3	0.4	0.0	3
May04	2.6	1.0	1.4	0.4	66
May05	11.3	13.2	21.6	5.5	795
May06	18.1	10.8	17.2	3.7	555
May07	49.6	27.4	55.9	10.1	1,709
May08	2.7	4.3	6.0	0.4	45
May09	5.5	1.7	3.0	0.6	92
May10	81.1	124.7	106.4	3.4	829
May11	145.0	306.9	256.5	9.3	2,270
Stormwater	353.4	537	510.2	40.1	7,374.0
Seepage		120	641	14.3	0.0
Internal Recycling				58.4	
Direct Rainfall	50.54	214	384	14.7	5,609
Evaporation		221	0.0	0.0	0.0
Recharge		37.6	57.3	2.9	0
Retained in Sediment			544	77.0	1,492
Outflow to Lake Shipp		613	934	47.6	11,491

Lake Shipp

Watershed	Area (ac)	Flow (ac-ft/yr)	Mass Loading (kg)		
			Total-N	Total-P	TSS
Shipp01	4.8	0.7	1.1	0.2	34
Shipp02	32.3	47.8	81.7	21.3	3,029
Shipp03	12.8	16.3	28.3	3.5	1,023
Shipp04	7.0	7.6	12.9	2.4	480
Shipp05	18.4	13.3	25.7	4.8	690
Shipp06	18.2	17.3	27.3	8.2	1,269
Shipp07	43.9	64.7	88.2	38.0	5,967
Shipp08	8.3	4.6	10.2	1.2	178
Shipp09	47.4	41.9	61.0	5.4	451
Shipp10	52.3	1.6	3.4	0.3	24
Shipp11	40.6	32.0	56.8	11.3	1,858
Shipp12	126.4	69.8	143.1	19.2	2,475
Shipp13	35.4	28.2	44.3	3.0	223
Shipp14	91.9	55.0	105.5	16.4	1,782
Shipp15	15.0	11.5	24.1	4.7	690
Shipp16	8.5	7.2	12.9	2.6	406
Shipp17	12.1	10.8	19.5	4.0	613
Shipp18	4.8	5.2	9.3	1.9	292
Shipp19	2.5	3.3	6.0	1.2	188
Shipp20	19.4	11.1	19.7	3.8	588
Shipp21	27.5	20.0	32.5	2.9	252
Shipp22	40.3	33.1	52.7	4.9	558
Shipp23	1.2	2.8	6.9	1.1	114
Stormwater	671.0	506	873	162	23,184
Seepage		401	2,814	80.5	0.0
Internal Recycling				350	
Direct Rainfall	276.4	1169	2,098	80.6	30,667
Baseflow		29	88.0	3.7	1,011
Inflow from Lake May		613	934	47.6	11,491
Evaporation		1,207			
Recharge		224	439	16.3	0
Retained in Sediment			3,846	614	39,055
Outflow To Lake Lulu		1,287	2,522	93.6	27,298

Lake Lulu

Watershed	Area (ac)	Flow (ac-ft/yr)	Mass Loading (kg)		
			Total-N	Total-P	TSS
Lulu01	12.2	11.6	29.3	4.1	486
Lulu02	32.9	16.2	43.6	9.7	1,447
Lulu03	5.4	2.4	4.3	0.9	135
Lulu04	137.8	57.0	73.9	13.0	724
Lulu05	24.1	14.4	17.8	3.3	182
Lulu06	21.6	9.3	21.6	3.2	353
Lulu07	40.4	29.4	58.1	8.5	1,628
Lulu08	3.2	2.3	5.7	0.9	93
Lulu09	144.0	199.4	210.6	6.9	1,552
Lulu10	87.9	141.7	119.8	2.6	717
Lulu11	7.8	6.1	10.9	2.2	345
Lulu12	3.3	2.3	4.2	0.9	132
Lulu13	3.7	2.6	4.6	0.9	145
Lulu14	5.3	3.8	6.9	1.4	216
Lulu15	5.1	3.7	6.7	1.4	211
Lulu16	6.4	3.9	7.0	1.4	221
Lulu17	16.5	40.6	62.3	8.9	2,907
Lulu18	8.1	4.4	7.9	1.6	242
Lulu19	10.0	2.7	5.8	1.2	172
Lulu20	8.6	17.9	32.5	2.0	188
Lulu21	23.7	31.7	40.6	8.2	728
Lulu22	21.4	18.1	26.0	2.5	602
Stormwater	629.3	622	800	85.6	13,426
Seepage		393	1,668	91.7	0.0
Internal Recycling				807	
Direct Rainfall	307.0	1,299	2,331	89.6	34,074
Inflow from Lake Shipp		1,287	2522	93.6	27,298
Evaporation		1,341	0.0	0.0	0.0
Recharge		252	340	16.1	0
Retained in Sediment			4,267	1,023	41,615
Unidentified Losses		2,008	2,714	129	33,183

APPENDIX E

FIELD SEEPAGE METER MEASUREMENTS

1. Original Monitoring Period (October 2005-April 2006)
   a. Lake May
   b. Lake Shipp
   c. Lake Lulu

2. Supplemental Monitoring Period (July-December 2008)
   a. Lake May
   b. Lake Shipp
   c. Lake Lulu

1a. Original Monitoring Period (October 2005-April 2006) - Lake May

Seepage Meter Field Measurements

Location: Lake May   Site: 1

Date Installed: 10/19/05   Chamber Diameter: 0.58 m   Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
10/19/05	10:40	-----	-----	-----	-----	-----	Bags Installed
11/2/05	12:30	26.5	10/19/2005	10:40	14.1	6.97	Measured volume, no sample collected
12/14/05	12:40	-----	11/2/2005	12:30	42.0	-----	No sample collected, bag damaged, bag replaced
2/3/06	8:45	94.5	12/14/2005	12:40	50.8	6.88	Sample collected, bag replaced
2/20/06	9:55	3.5	2/3/2006	8:45	17.0	0.76	Sample collected, bag in good condition
4/3/06	12:30	134	2/20/2006	9:55	42.1	11.79	Sample collected, bag replaced
5/8/06	9:36	80.75	4/3/2006	12:30	34.9	8.57	Sample collected, bag replaced
6/5/06	11:50	9.5	5/8/2006	9:36	28.1	1.25	Sample collected, bag in good condition

Seepage Meter Field Measurements

Location: Lake May   Site: 1 Chamber

Date Installed: 11/2/05   Chamber Diameter: 0.58 m   Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
11/2/05	13:00	-----	-----	-----	-----	-----	Bags Installed
12/14/05	12:45	15.25	11/2/2005	13:00	42.0	1.35	Sample collected, bag in good condition
2/3/06	8:55	16.5	12/14/2005	12:45	50.8	1.20	Sample collected, bag replaced
2/20/06	10:02	33	2/3/2006	8:55	17.0	7.17	Sample collected, bag replaced
4/3/06	12:37	60	2/20/2006	10:02	42.1	5.28	Sample collected, bag replaced
5/8/06	9:30	106	4/3/2006	12:37	34.9	11.26	Sample collected, bag replaced
6/5/06	11:45	98	5/8/2006	9:30	28.1	12.92	Sample collected, bag replaced

Seepage Meter Field Measurements

Location: Lake May   Site: 2

Date Installed: 10/19/05   Chamber Diameter: 0.58 m   Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
10/19/05	10:52	-----	-----	-----	-----	-----	Bags Installed
11/2/05	13:13	8	10/19/2005	10:52	14.1	2.10	Measured volume, no sample collected
12/14/05	12:50	10.5	11/2/2005	13:13	42.0	0.93	Sample collected, bag in good condition
2/3/06	9:00	3.25	12/14/2005	12:50	50.8	0.24	Sample collected, bag in good condition
2/20/06	10:09	6.5	2/3/2006	9:00	17.0	1.41	Sample collected, bag in good condition
4/3/06	12:42	6.25	2/20/2006	10:09	42.1	0.55	Sample collected, bag in good condition
5/8/06	9:40	-----	4/3/2006	12:42	34.9	-----	No sample collected, bag damaged, bag replaced
6/5/06	11:52	-----	5/8/2006	9:40	28.1	-----	No sample collected, bag damaged, bag replaced

Seepage Meter Field Measurements

Location: Lake May   Site: 3

Date Installed: 10/19/05   Chamber Diameter: 0.58 m   Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
10/19/05	11:00	-----	-----	-----	-----	-----	Bags Installed
11/2/05	13:17	4.75	10/19/2005	11:00	14.1	1.25	Measured volume, no sample collected
12/14/05	12:59	86.25	11/2/2005	13:17	42.0	7.61	Sample collected, bag in good condition
2/3/06	9:05	3.75	12/14/2005	12:59	50.8	0.27	Sample collected, bag in good condition
2/20/06	10:14	6.25	2/3/2006	9:05	17.0	1.36	Sample collected, bag in good condition
4/3/06	12:50	114	2/20/2006	10:14	42.1	10.03	Sample collected, bag in good condition
5/8/06	9:44	67.5	4/3/2006	12:50	34.9	7.17	Sample collected, bag in good condition
6/5/06	11:57	24.5	5/8/2006	9:44	28.1	3.23	Sample collected, bag in good condition

Seepage Meter Field Measurements

Location: Lake May   Site: 4

Date Installed: 10/19/05   Chamber Diameter: 0.58 m   Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
10/19/05	11:10	-----	-----	-----	-----	-----	Bags Installed
11/2/05	13:21	8	10/19/2005	11:10	14.1	2.10	Measured volume, no sample collected
12/14/05	13:05	19.5	11/2/2005	13:21	42.0	1.72	Sample collected, bag in good condition
2/3/06	9:11	12	12/14/2005	13:05	50.8	0.87	Sample collected, bag in good condition
2/20/06	10:19	14.5	2/3/2006	9:11	17.0	3.15	Sample collected, bag in good condition
4/3/06	12:58	67	2/20/2006	10:19	42.1	5.89	Sample collected, bag replaced
5/8/06	9:50	33.25	4/3/2006	12:58	34.9	3.53	Sample collected, bag in good condition
6/5/06	12:00	-----	5/8/2006	9:50	28.1	-----	No sample collected, can't find meter

Seepage Meter Field Measurements

Location: Lake May   Site: 5

Date Installed: 10/20/05   Chamber Diameter: 0.58 m   Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
10/20/05	10:25	-----	-----	-----	-----	-----	Bags Installed
11/2/05	11:25	8	10/20/2005	10:25	13.0	2.27	Measured volume, no sample collected
1/5/06	12:50	9.5	11/2/2005	11:25	64.1	0.55	Sample collected, bag replaced
3/9/06	10:45	6.25	1/5/2006	12:50	62.9	0.37	Sample collected, bag replaced
4/3/06	13:07	-----	3/9/2006	10:45	25.1	-----	No sample collected, can't find meter
5/8/06	9:55	-----	4/3/2006	13:07	34.9	-----	No sample collected, can't find meter
6/5/06	12:05	-----	5/8/2006	9:55	28.1	-----	No sample collected, can't find meter

Seepage Meter Field Measurements

Location: Lake May

Site: 5 Chamber

Date Installed: 11/2/05

Chamber Diameter: 0.58 m

Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
11/2/05	12:00	-----	-----	-----	-----	-----	Bags Installed
1/5/06	12:55	-----	11/2/2005	12:00	64.0	-----	Measured volume, no sample collected
3/9/06	11:00	15.5	1/5/2006	12:55	62.9	0.91	Sample collected, bag replaced
4/3/06	13:02	1.75	3/9/2006	11:00	25.1	0.26	Sample collected, bag replaced
5/8/06	9:57	-----	4/3/2006	13:02	34.9	-----	No sample collected, can't find meter, meter replaced
6/5/06	12:07	-----	5/8/2006	9:57	28.1	-----	No sample collected, can't find meter

1b. Original Monitoring Period (October 2005-April 2006) - Lake Shipp

Seepage Meter Field Measurements

Location: Lake Shipp Site: 1

Date Installed: 10/19/05 Chamber Diameter: 0.58 m Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
10/19/05	11:25	-----	-----	-----	-----	-----	Bags Installed
11/2/05	13:28	5.5	10/19/2005	11:25	14.1	1.45	Measured volume, no sample collected
12/14/05	13:12	9.5	11/2/2005	13:28	42.0	0.84	Sample collected, bag in good condition
2/3/06	9:19	6.25	12/14/2005	13:12	50.8	0.46	Sample collected, bag in good condition
2/20/06	10:24	4.75	2/3/2006	9:19	17.0	1.03	Sample collected, bag in good condition
4/3/06	12:11	5.25	2/20/2006	10:24	42.1	0.46	Sample collected, bag in good condition
5/8/06	9:57	6.5	4/3/2006	12:11	34.9	0.69	Sample collected, bag in good condition
6/5/06	11:07	6.25	5/8/2006	9:57	28.0	0.83	Sample collected, bag in good condition

Seepage Meter Field Measurements

Location: Lake Shipp Site: 2

Date Installed: 10/19/05 Chamber Diameter: 0.58 m Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
10/19/05	11:36	-----	-----	-----	-----	-----	Bags Installed
11/2/05	15:02	35.25	10/19/2005	11:36	14.1	9.23	Measured volume, no sample collected
12/15/05	11:50	82	11/2/2005	15:02	42.9	7.08	Sample collected, bag in good condition
2/3/06	9:24	29.5	12/15/2005	11:50	49.9	2.19	Sample collected, bag in good condition
2/20/06	10:29	24.5	2/3/2006	9:24	17.0	5.32	Sample collected, bag in good condition
4/3/06	12:15	-----	2/20/2006	10:29	42.1	-----	Large alligator near meter
5/8/06	10:02	33.25	4/3/2006	12:15	77.0	1.60	Sample collected, bag replaced
6/5/06	11:12	29.5	5/8/2006	10:02	28.0	3.90	Sample collected, bag in good condition

Seepage Meter Field Measurements

Location: Lake Shipp Site: 3

Date Installed: 10/19/05 Chamber Diameter: 0.58 m Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
10/19/05	11:50	-----	-----	-----	-----	-----	Bags Installed
11/7/05	16:30	-----	10/19/2005	11:50	19.2	-----	No sample collected, bag damaged, bag replaced
12/15/05	12:02	19.5	11/7/2005	16:30	37.8	1.91	Sample collected, bag in good condition
2/3/06	9:34	19.75	12/15/2005	12:02	49.9	1.47	Sample collected, bag in good condition
2/20/06	10:38	15.75	2/3/2006	9:34	17.0	3.42	Sample collected, bag replaced
4/3/06	13:45	22.5	2/20/2006	10:38	42.1	1.98	Sample collected, bag in good condition
5/8/06	10:11	20.5	4/3/2006	13:45	34.9	2.18	Sample collected, bag in good condition
6/5/06	11:16	5.25	5/8/2006	10:11	28.0	0.69	Sample collected, bag in good condition

Seepage Meter Field Measurements

Location: Lake Shipp

Site: 3 Chamber

Date Installed: 11/2/05

Chamber Diameter: 0.58 m

Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
11/2/05	15:03	-----	-----	-----	-----	-----	Bags Installed
12/15/05	11:55	7.5	11/2/2005	15:03	42.9	0.65	Sample collected, bag in good condition
2/3/06	9:30	10.5	12/15/2005	11:55	49.9	0.78	Sample collected, bag in good condition
2/20/06	10:35	10.25	2/3/2006	9:30	17.0	2.23	Sample collected, bag in good condition
4/3/06	13:50	9.5	2/20/2006	10:35	42.1	0.84	Sample collected, bag in good condition
5/8/06	10:08	13.75	4/3/2006	13:50	34.8	1.46	Sample collected, bag replaced
6/5/06	11:18	16.5	5/8/2006	10:08	28.0	2.18	Sample collected, bag in good condition

Seepage Meter Field Measurements

Location: Lake Shipp

Site: 4

Date Installed: 10/19/05

Chamber Diameter: 0.58 m

Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
10/19/05	12:00	-----	-----	-----	-----	-----	Bags Installed
11/2/05	13:50	8	10/19/2005	12:00	14.1	2.10	Measured volume, no sample collected
12/15/05	12:08	22.5	11/2/2005	13:50	42.9	1.94	Sample collected, bag in good condition
2/3/06	9:39	22.25	12/15/2005	12:08	49.9	1.65	Sample collected, bag in good condition
2/20/06	10:41	18.75	2/3/2006	9:39	17.0	4.07	Sample collected, bag replaced
4/3/06	11:49	11.25	2/20/2006	10:41	42.0	0.99	Sample collected, bag in good condition
5/8/06	10:15	8.25	4/3/2006	11:49	34.9	0.87	Sample collected, bag in good condition
6/5/06	10:48	-----	5/8/2006	10:15	28.0	-----	No sample collected, bag damaged, bag replaced

Seepage Meter Field Measurements

Location: Lake Shipp

Site: 5

Date Installed: 10/19/05

Chamber Diameter: 0.58 m

Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
10/19/05	12:10	-----	-----	-----	-----	-----	Bags Installed
11/2/05	13:47	-----	10/19/2005	12:10	14.1	-----	No sample collected, bag missing, bag replaced
12/15/05	12:15	10.5	11/2/2005	13:47	42.9	0.91	Sample collected, bag in good condition
2/3/06	10:45	31.5	12/15/2005	12:15	49.9	2.34	Sample collected, bag in good condition
2/20/06	10:48	19.5	2/3/2006	10:45	17.0	4.25	Sample collected, bag in good condition
4/3/06	13:54	13.5	2/20/2006	10:48	42.1	1.19	Sample collected, bag in good condition
5/8/06	10:21	22.5	4/3/2006	13:54	34.9	2.39	Sample collected, bag replaced
6/5/06	10:55	-----	5/8/2006	10:21	28.0	-----	No sample collected, bag damaged, bag replaced

Seepage Meter Field Measurements

Location: Lake Shipp   Site: 6

Date Installed: 10/19/05   Chamber Diameter: 0.58 m   Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
10/19/05	12:22	-----	-----	-----	-----	-----	Bags Installed
11/2/05	13:34	25	10/19/2005	12:22	14.1	6.59	Sample collected, bag in good condition
12/15/05	12:25	47	11/2/2005	13:34	43.0	4.05	Sample collected, bag in good condition
2/3/06	10:51	68	12/15/2005	12:25	49.9	5.04	Sample collected, bag replaced
2/20/06	10:53	8.75	2/3/2006	10:51	17.0	1.91	Sample collected, bag in good condition
4/3/06	12:00	24.25	2/20/2006	10:53	42.0	2.14	Sample collected, bag replaced
5/8/06	10:26	36.5	4/3/2006	12:00	34.9	3.87	Sample collected, bag replaced
6/5/06	10:59	-----	5/8/2006	10:26	28.0	-----	No sample collected, bag damaged, bag replaced

Seepage Meter Field Measurements

Location: Lake Shipp   Site: 7

Date Installed: 10/19/05   Chamber Diameter: 0.58 m   Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
10/19/05	12:31	-----	-----	-----	-----	-----	Bags Installed
11/2/05	13:31	6.75	10/19/2005	12:31	14.0	1.78	Measured volume, no sample collected
12/15/05	12:30	13	11/2/2005	13:31	43.0	1.12	Sample collected, bag in good condition
2/3/06	10:56	12.25	12/15/2005	12:30	49.9	0.91	Sample collected, bag in good condition
2/20/06	10:57	13.25	2/3/2006	10:56	17.0	2.89	Sample collected, bag in good condition
4/3/06	12:05	21.25	2/20/2006	10:57	42.0	1.87	Sample collected, bag replaced
5/8/06	10:30	19.5	4/3/2006	12:05	34.9	2.07	Sample collected, bag in good condition
6/5/06	11:04	31.25	5/8/2006	10:30	28.0	4.13	Sample collected, bag replaced

Seepage Meter Field Measurements

Location: Lake Shipp   Site: 8

Date Installed: 10/20/05   Chamber Diameter: 0.58 m   Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
10/20/05	10:45	-----	-----	-----	-----	-----	Bags Installed
11/2/05	15:25	41.5	10/20/2005	10:45	13.2	11.65	Measured volume, no sample collected
1/5/06	12:37	14.5	11/2/2005	15:25	63.9	0.84	Sample collected, bag replaced
3/9/06	11:45	10.25	1/5/2006	12:37	63.0	0.60	Sample collected, bag replaced
4/3/06	12:15	5.25	3/9/2006	11:45	25.0	0.78	Sample collected, bag replaced
6/5/06	14:37	12.5	4/3/2006	12:15	63.1	0.73	Sample collected, bag replaced

Seepage Meter Field Measurements

Location: Lake Shipp — Site: 8 Chamber

Date Installed: 11/7/05 — Chamber Diameter: 0.58 m — Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
11/7/05	16:40	-----	-----	-----	-----	-----	Bags Installed
1/5/06	12:40	3.25	11/7/2005	16:40	58.8	0.20	Sample collected, bag replaced
3/9/06	11:55	1.5	1/5/2006	12:40	63.0	0.09	Sample collected, bag replaced
4/3/06	12:20	0.7	3/9/2006	11:55	25.0	0.10	Sample collected, bag replaced
6/5/06	11:33	1.5	4/3/2006	12:20	63.0	0.09	Sample collected, bag replaced

Seepage Meter Field Measurements

Location: Lake Shipp — Site: 9

Date Installed: 10/20/05 — Chamber Diameter: 0.58 m — Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
10/20/05	11:05	-----	-----	-----	-----	-----	Bags Installed
11/2/05	16:43	5	10/20/2005	11:05	13.2	1.40	Measured volume, no sample collected
1/5/06	12:26	11.5	11/2/2005	16:43	63.8	0.67	Sample collected, bag replaced
3/9/06	12:04	-----	1/5/2006	12:26	63.0	-----	No sample collected, bag damaged, bag replaced
4/3/06	11:25	9.5	3/9/2006	12:04	25.0	1.41	Sample collected, bag replaced
6/5/06	11:29	-----	4/3/2006	11:25	63.0	-----	No sample collected, meter flipped, meter replaced

Seepage Meter Field Measurements

Location: Lake Shipp — Site: 10

Date Installed: 10/20/05 — Chamber Diameter: 0.58 m — Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
10/20/05	10:55	-----	-----	-----	-----	-----	Bags Installed
11/2/05	16:33	5.75	10/20/2005	10:55	13.2	1.61	Measured volume, no sample collected
1/5/06	12:22	11.5	11/2/2005	16:33	63.8	0.67	Sample collected, bag replaced
3/9/06	12:15	16.25	1/5/2006	12:22	63.0	0.96	Sample collected, bag replaced
4/3/06	11:20	10.25	3/9/2006	12:15	25.0	1.52	Sample collected, bag replaced
6/5/06	11:23	-----	4/3/2006	11:20	63.0	-----	No sample collected, meter flipped, meter replaced

1c. Original Monitoring Period (October 2005-April 2006) - Lake Lulu

Seepage Meter Field Measurements

Location: Lake Lulu   Site: 1

Date Installed: 10/19/05   Chamber Diameter: 0.58 m   Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
10/19/05	12:55	-----	-----	-----	-----	-----	Bags Installed
11/7/05	16:11	10.75	10/19/2005	12:55	19.1	2.08	Measured volume, no sample collected
12/14/05	11:40	14	11/7/2005	16:11	36.8	1.41	Sample collected, bag in good condition
2/3/06	11:08	12.5	12/14/2005	11:40	51.0	0.91	Sample collected, bag in good condition
2/20/06	11:08	8.5	2/3/2006	11:08	17.0	1.85	Sample collected, bag in good condition
4/3/06	10:33	9.25	2/20/2006	11:08	42.0	0.82	Sample collected, bag in good condition
5/8/06	10:47	14.25	4/3/2006	10:33	35.0	1.51	Sample collected, bag in good condition
6/5/06	9:49	-----	5/8/2006	10:47	28.0	-----	No sample collected, bag damaged, bag replaced

Seepage Meter Field Measurements

Location: Lake Lulu   Site: 1 Chamber

Date Installed: 11/7/05   Chamber Diameter: 0.58 m   Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
11/7/05	16:09	-----	-----	-----	-----	-----	Bags Installed
12/14/05	11:45	0.7	11/7/2005	16:09	36.8	0.07	Sample collected, bag in good condition
2/3/06	11:12	0.8	12/14/2005	11:45	51.0	0.06	Sample collected, bag in good condition
2/20/06	11:11	0.6	2/3/2006	11:12	17.0	0.13	Sample collected, bag in good condition
4/3/06	10:30	1.75	2/20/2006	11:11	42.0	0.15	Sample collected, bag in good condition
5/8/06	10:43	9.75	4/3/2006	10:30	35.0	1.03	Sample collected, bag in good condition
6/5/06	9:45	8.5	5/8/2006	10:43	28.0	1.13	Sample collected, bag in good condition

Seepage Meter Field Measurements

Location: Lake Lulu   Site: 2

Date Installed: 10/19/05   Chamber Diameter: 0.58 m   Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
10/19/05	13:02	-----	-----	-----	-----	-----	Bags Installed
11/7/05	16:06	79.25	10/19/2005	13:02	19.1	15.35	Measured volume, no sample collected
12/14/05	11:55	62	11/7/2005	16:06	36.8	6.24	Sample collected, bag in good condition
2/3/06	11:22	40.25	12/14/2005	11:55	51.0	2.92	Sample collected, bag in good condition
2/20/06	11:16	15.75	2/3/2006	11:22	17.0	3.43	Sample collected, bag in good condition
4/3/06	10:40	-----	2/20/2006	11:16	42.0	-----	No sample collected, bag damaged, bag replaced
5/8/06	10:53	23.5	4/3/2006	10:40	35.0	2.49	Sample collected, bag in good condition
6/5/06	9:55	31.5	5/8/2006	10:53	28.0	4.17	Sample collected, bag in good condition

Seepage Meter Field Measurements

Location: Lake Lulu　　Site: 3

Date Installed: 10/19/05　　Chamber Diameter: 0.58 m　　Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
10/19/05	13:15	-----	-----	-----	-----	-----	Bags Installed
11/7/05	15:20	20.5	10/19/2005	13:15	19.1	3.98	Measured volume, no sample collected
12/14/05	12:01	11.5	11/7/2005	15:20	36.9	1.16	Sample collected, bag in good condition
2/3/06	11:27	9.75	12/14/2005	12:01	51.0	0.71	Sample collected, bag in good condition
2/20/06	11:21	9.5	2/3/2006	11:27	17.0	2.07	Sample collected, bag in good condition
4/3/06	10:45	18.25	2/20/2006	11:21	42.0	1.61	Sample collected, bag in good condition
5/8/06	10:58	13.75	4/3/2006	10:45	35.0	1.45	Sample collected, bag in good condition
6/5/06	10:00	21.25	5/8/2006	10:58	28.0	2.81	Sample collected, bag in good condition

Seepage Meter Field Measurements

Location: Lake Lulu　　Site: 4

Date Installed: 10/19/05　　Chamber Diameter: 0.58 m　　Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
10/19/05	13:22	-----	-----	-----	-----	-----	Bags Installed
11/7/05	15:24	8.25	10/19/2005	13:22	19.1	1.60	Measured volume, no sample collected
12/14/05	12:07	7.5	11/7/2005	15:24	36.9	0.75	Sample collected, bag in good condition
2/3/06	11:30	6.25	12/14/2005	12:07	51.0	0.45	Sample collected, bag in good condition
2/20/06	11:26	8.25	2/3/2006	11:30	17.0	1.80	Sample collected, bag in good condition
4/3/06	10:48	-----	2/20/2006	11:26	42.0	-----	No sample collected, bag damaged, bag replaced
5/8/06	11:03	9.5	4/3/2006	10:48	35.0	1.00	Sample collected, bag in good condition
6/5/06	10:05	9.25	5/8/2006	11:03	28.0	1.23	Sample collected, bag in good condition

Seepage Meter Field Measurements

Location: Lake Lulu　　Site: 5

Date Installed: 10/19/05　　Chamber Diameter: 0.58 m　　Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
10/19/05	13:33	-----	-----	-----	-----	-----	Bags Installed
11/7/05	15:26	5.75	10/19/2005	13:33	19.1	1.12	Measured volume, no sample collected
12/14/05	12:11	8.25	11/7/2005	15:26	36.9	0.83	Sample collected, bag in good condition
2/3/06	11:35	7.75	12/14/2005	12:11	51.0	0.56	Sample collected, bag in good condition
2/20/06	11:30	6.25	2/3/2006	11:35	17.0	1.36	Sample collected, bag in good condition
4/3/06	10:53	9.25	2/20/2006	11:30	42.0	0.82	Sample collected, bag in good condition
5/8/06	11:09	-----	4/3/2006	10:53	35.0	-----	No sample collected, bag missing, bag replaced
6/5/06	10:09	7.25	5/8/2006	11:09	28.0	0.96	Sample collected, bag in good condition

Seepage Meter Field Measurements

Location: Lake Lulu   Site: 6

Date Installed: 10/19/05   Chamber Diameter: 0.58 m   Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
10/19/05	13:41	-----	-----	-----	-----	-----	Bags Installed
11/7/05	15:32	11.25	10/19/2005	13:41	19.1	2.18	Measured volume, no sample collected
12/14/05	12:16	6.25	11/7/2005	15:32	36.9	0.63	Sample collected, bag in good condition
2/3/06	11:40	-----	12/14/2005	12:16	51.0	-----	No sample collected, bag damaged, bag replaced
2/20/06	11:36	-----	2/3/2006	11:40	17.0	-----	No sample collected, bag damaged, bag replaced
4/3/06	10:58	-----	2/20/2006	11:36	42.0	-----	No sample collected, bag damaged, bag replaced
5/8/06	11:15	8.75	4/3/2006	10:58	35.0	0.93	Sample collected, bag in good condition
6/5/06	10:14	6.5	5/8/2006	11:15	28.0	0.86	Sample collected, bag in good condition

Seepage Meter Field Measurements

Location: Lake Lulu   Site: 7

Date Installed: 10/19/05   Chamber Diameter: 0.58 m   Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
10/19/05	13:48	-----	-----	-----	-----	-----	Bags Installed
11/7/05	16:15	5.25	10/19/2005	13:48	19.1	1.02	Measured volume, no sample collected
12/14/05	12:21	-----	11/7/2005	16:15	36.8	-----	No sample collected, bag damaged, bag replaced
2/3/06	11:44	5	12/14/2005	12:21	51.0	0.36	Sample collected, bag in good condition
2/20/06	11:38	9.25	2/3/2006	11:44	17.0	2.02	Sample collected, bag in good condition
4/3/06	11:06	-----	2/20/2006	11:38	42.0	-----	No sample collected, bag damaged, bag replaced
5/8/06	11:21	8.5	4/3/2006	11:06	35.0	0.90	Sample collected, bag replaced
6/5/06	10:19	8.25	5/8/2006	11:21	28.0	1.09	Sample collected, bag in good condition

Seepage Meter Field Measurements

Location: Lake Lulu   Site: 8

Date Installed: 10/20/05   Chamber Diameter: 0.58 m   Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
10/20/05	11:22	-----	-----	-----	-----	-----	Bags Installed
11/7/05	15:55	6.25	10/20/2005	11:22	18.2	1.27	Measured volume, no sample collected
12/14/05	12:25	-----	11/7/2005	15:55	36.9	-----	No sample collected, can't find meter, meter replaced
1/5/06	11:45	-----	12/14/2005	12:25	22.0	-----	No sample collected, can't find meter, meter replaced
2/3/06	11:50	-----	1/5/2006	11:45	29.0	-----	No sample collected, can't find meter
3/9/06	12:30	-----	2/3/2006	11:50	34.0	-----	No sample collected, can't find meter
4/3/06	11:10	-----	3/9/2006	12:30	24.9	-----	No sample collected, can't find meter, meter replaced
5/8/06	11:25	-----	4/3/2006	11:10	35.0	-----	No sample collected, can't find meter
6/5/06	10:27	91	5/8/2006	11:25	63.0	5.35	Sample collected, bag replaced

Seepage Meter Field Measurements

Location: Lake Lulu   Site: 9

Date Installed: 10/20/05   Chamber Diameter: 0.58 m   Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
10/20/05	11:35	-----	-----	-----	-----	-----	Bags Installed
11/7/05	15:45	23	10/20/2005	11:35	18.2	4.69	Sample collected, bag in good condition
12/14/05	12:27	-----	11/7/2005	15:45	36.9	-----	No sample collected, can't find meter, meter replaced
1/5/06	11:50	7.25	12/14/2005	12:27	22.0	1.22	Sample collected, bag in good condition
2/3/06	11:55	-----	1/5/2006	11:50	29.0	-----	No sample collected, can't find meter
3/9/06	12:33	-----	2/3/2006	11:55	34.0	-----	No sample collected, can't find meter, meter replaced
4/3/06	11:12	-----	3/9/2006	12:33	24.9	-----	No sample collected, can't find meter, meter replaced
5/8/06	11:27	-----	4/3/2006	11:12	35.0	-----	No sample collected, can't find meter
6/5/06	10:33	8.25	5/8/2006	11:27	63.0	0.49	Sample collected, bag in good condition

Seepage Meter Field Measurements

Location: Lake Lulu   Site: 10

Date Installed: 10/20/05   Chamber Diameter: 0.58 m   Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
10/20/05	11:55	-----	-----	-----	-----	-----	Bags Installed
11/7/05	15:34	5.25	10/20/2005	11:55	18.2	1.07	Measured volume, no sample collected
12/14/05	12:29	-----	11/7/2005	15:34	36.9	-----	No sample collected, can't find meter
1/5/06	12:09	4.25	12/14/2005	12:29	58.9	0.27	Sample collected, bag in good condition
2/3/06	11:57	-----	1/5/2006	12:09	29.0	-----	No sample collected, can't find meter, meter replaced
3/9/06	12:35	-----	2/3/2006	11:57	34.0	-----	No sample collected, can't find meter
4/3/06	11:15	-----	3/9/2006	12:35	24.9	-----	No sample collected, can't find meter, meter replaced
5/8/06	11:29	-----	4/3/2006	11:15	35.0	-----	No sample collected, can't find meter
6/5/06	10:35	-----	5/8/2006	11:29	28.0	-----	No sample collected, can't find meter

Seepage Meter Field Measurements

Location: Lake Lulu   Site: 11

Date Installed: 10/20/05   Chamber Diameter: 0.58 m   Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
10/20/05	11:45	-----	-----	-----	-----	-----	Bags Installed
11/7/05	15:10	40.25	10/20/2005	11:45	18.1	8.22	Measured volume, no sample collected
12/14/05	12:30	-----	11/7/2005	15:10	36.9	-----	No sample collected, can't find meter
1/5/06	12:00	11	12/14/2005	12:30	58.9	0.69	Sample collected, bag in good condition
2/3/06	11:59	-----	1/5/2006	12:00	29.0	-----	No sample collected, can't find meter, meter replaced
3/9/06	12:37	-----	2/3/2006	11:59	34.0	-----	No sample collected, can't find meter
4/3/06	11:16	-----	3/9/2006	12:37	24.9	-----	No sample collected, can't find meter, meter replaced
5/8/06	11:30	-----	4/3/2006	11:16	35.0	-----	No sample collected, can't find meter
6/5/06	10:37	-----	5/8/2006	11:30	28.0	-----	No sample collected, can't find meter

Seepage Meter Field Measurements

Location: Lake Lulu

Site: 11 Chamber

Date Installed: 11/7/05

Chamber Diameter: 0.58 m

Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
11/7/05	15:05	-----	-----	-----	-----	-----	Bags Installed
12/14/05	12:31	-----	11/7/2005	15:05	36.9	-----	No sample collected, can't find meter
1/5/06	12:02	-----	12/14/2005	12:31	22.0	-----	Sample collected, bag in good condition
2/3/06	12:00	-----	1/5/2006	12:02	29.0	-----	No sample collected, can't find meter, meter replaced
3/9/06	12:38	-----	2/3/2006	12:00	34.0	-----	No sample collected, can't find meter
4/3/06	11:17	-----	3/9/2006	12:38	24.9	-----	No sample collected, can't find meter, meter replaced
5/8/06	11:31	-----	4/3/2006	11:17	35.0	-----	No sample collected, can't find meter
6/5/06	10:38	-----	5/8/2006	11:31	28.0	-----	No sample collected, can't find meter

2a. Supplemental Monitoring Period (July-December 2008) - Lake May

Seepage Meter Field Measurements

Location: Lake May Site: 1

Date Installed: 7/11/08 Chamber Diameter: 0.58 m Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
7/11/08	11:00	-----	-----	-----	-----	-----	Bags Installed
8/15/08	8:12	6.5	7/11/2008	11:00	34.9	0.69	Measured volume, no sample collected
9/12/08	9:25	4.25	8/15/2008	8:12	28.1	0.56	Sample collected, bag in good condition
11/6/08	9:00	6.5	9/12/2008	9:25	55.0	0.44	Sample collected, bag in good condition
12/8/08	11:07	4.75	11/6/2008	9:00	32.1	0.55	Sample collected, bag in good condition

Seepage Meter Field Measurements

Location: Lake May Site: 2

Date Installed: 7/11/08 Chamber Diameter: 0.58 m Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
7/11/08	10:51	-----	-----	-----	-----	-----	Bags Installed
8/15/08	8:09	5.5	7/11/2008	10:51	34.9	0.58	Measured volume, no sample collected
9/12/08	9:21	8.75	8/15/2008	8:09	28.0	1.16	Sample collected, bag in good condition
11/6/08	9:08	21.25	9/12/2008	9:21	55.0	1.43	Sample collected, bag in good condition
12/8/08	11:03	5.25	11/6/2008	9:08	32.1	0.61	Sample collected, bag in good condition

Seepage Meter Field Measurements

Location: Lake May Site: 3

Date Installed: 7/11/08 Chamber Diameter: 0.58 m Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
7/11/08	10:45	-----	-----	-----	-----	-----	Bags Installed
8/15/08	8:05	3.5	7/11/2008	10:45	34.9	0.37	Measured volume, no sample collected
9/12/08	9:15	7.25	8/15/2008	8:05	28.0	0.96	Sample collected, bag in good condition
11/6/08	9:12	3.25	9/12/2008	9:15	55.0	0.22	Sample collected, bag in good condition
12/8/08	10:58	2.25	11/6/2008	9:12	32.1	0.26	Sample collected, bag in good condition

Seepage Meter Field Measurements

Location: Lake May Site: 4

Date Installed: 7/11/08 Chamber Diameter: 0.58 m Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
7/11/08	11:10	-----	-----	-----	-----	-----	Bags Installed
8/15/08	8:20	-----	7/11/2008	11:10	34.9	-----	No sample collected, bag damaged, bag replaced
9/12/08	9:30	6.75	8/15/2008	8:20	28.0	0.89	Sample collected, bag in good condition
11/6/08	9:16	12.5	9/12/2008	9:30	55.0	0.84	Sample collected, bag in good condition
12/8/08	11:10	9.5	11/6/2008	9:16	32.1	1.10	Sample collected, bag in good condition

Seepage Meter Field Measurements

Location: Lake May Site: 5

Date Installed: 7/11/08 Chamber Diameter: 0.58 m Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
7/11/08	11:20	-----	-----	-----	-----	-----	Bags Installed
8/15/08	8:25	-----	7/11/2008	11:20	34.9	-----	No sample collected, can't find meter, meter replaced
9/12/08	9:40	-----	8/15/2008	8:25	28.1	-----	No sample collected, can't find meter, meter replaced
11/6/08	9:18	-----	9/12/2008	9:40	55.0	-----	No sample collected, can't find meter, meter replaced
12/8/08	11:12	-----	11/6/2008	9:18	32.1	-----	No sample collected, can't find meter

2b. Supplemental Monitoring Period (July-December 2008) - Lake Shipp

Seepage Meter Field Measurements

Location: Lake Shipp — Site: 1

Date Installed: 7/11/08 — Chamber Diameter: 0.58 m — Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
7/11/08	10:35	-----	-----	-----	-----	-----	Bags Installed
8/15/08	8:30	10.25	7/11/2008	10:35	34.9	1.09	Measured volume, no sample collected
9/12/08	9:50	13.5	8/15/2008	8:30	28.1	1.78	Sample collected, bag in good condition
11/6/08	9:20	6.5	9/12/2008	9:50	55.0	0.44	Sample collected, bag in good condition
12/8/08	11:15	15.5	11/6/2008	9:20	32.1	1.79	Sample collected, bag in good condition

Seepage Meter Field Measurements

Location: Lake Shipp — Site: 2

Date Installed: 7/11/08 — Chamber Diameter: 0.58 m — Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
7/11/08	10:22	-----	-----	-----	-----	-----	Bags Installed
8/15/08	8:55	36.25	7/11/2008	10:22	34.9	3.84	Measured volume, no sample collected
9/12/08	10:19	43.5	8/15/2008	8:55	28.1	5.74	Sample collected, bag in good condition
11/6/08	9:50	19.25	9/12/2008	10:19	55.0	1.30	Sample collected, bag in good condition
12/8/08	11:20	23.5	11/6/2008	9:50	32.1	2.71	Sample collected, bag in good condition

Seepage Meter Field Measurements

Location: Lake Shipp — Site: 3

Date Installed: 7/11/08 — Chamber Diameter: 0.58 m — Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
7/11/08	10:10	-----	-----	-----	-----	-----	Bags Installed
8/15/08	8:50	8.5	7/11/2008	10:10	34.9	0.90	No sample collected, bag damaged, bag replaced
9/12/08	10:10	4.5	8/15/2008	8:50	28.1	0.59	Sample collected, bag in good condition
11/6/08	9:42	5.5	9/12/2008	10:10	55.0	0.37	Sample collected, bag in good condition
12/8/08	11:25	5.75	11/6/2008	9:42	32.1	0.66	Sample collected, bag in good condition

Seepage Meter Field Measurements

Location: Lake Shipp　　　　Site: 4

Date Installed: 7/11/08　　　　Chamber Diameter: 0.58 m　　　　Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
7/11/08	12:05	-----	-----	-----	-----	-----	Bags Installed
8/15/08	8:46	9.75	7/11/2008	12:05	34.9	1.04	Measured volume, no sample collected
9/12/08	10:05	21.25	8/15/2008	8:46	28.1	2.81	Sample collected, bag in good condition
11/6/08	9:38	10.5	9/12/2008	10:05	55.0	0.71	Sample collected, bag in good condition
12/8/08	11:38	12.5	11/6/2008	9:38	32.1	1.44	Sample collected, bag in good condition

Seepage Meter Field Measurements

Location: Lake Shipp　　　　Site: 5

Date Installed: 7/11/08　　　　Chamber Diameter: 0.58 m　　　　Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
7/11/08	11:50	-----	-----	-----	-----	-----	Bags Installed
8/15/08	8:43	10.75	7/11/2008	11:50	34.9	1.14	No sample collected, bag missing, bag replaced
9/12/08	10:01	-----	8/15/2008	8:43	28.1	-----	No sample collected, bag damaged, bag replaced
11/6/08	9:33	15.5	9/12/2008	10:01	55.0	1.04	Sample collected, bag in good condition
12/8/08	11:43	8.25	11/6/2008	9:33	32.1	0.95	Sample collected, bag in good condition

Seepage Meter Field Measurements

Location: Lake Shipp　　　　Site: 6

Date Installed: 7/11/08　　　　Chamber Diameter: 0.58 m　　　　Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
7/11/08	11:40	-----	-----	-----	-----	-----	Bags Installed
8/15/08	8:40	47.5	7/11/2008	11:40	34.9	5.04	Sample collected, bag in good condition
9/12/08	9:57	30.5	8/15/2008	8:40	28.1	4.03	Sample collected, bag in good condition
11/6/08	9:29	80.25	9/12/2008	9:57	55.0	5.41	Sample collected, bag replaced
12/8/08	11:17	15.25	11/6/2008	9:29	32.1	1.76	Sample collected, bag in good condition

Seepage Meter Field Measurements

Location: Lake Shipp | Site: 7

Date Installed: 7/11/08 | Chamber Diameter: 0.58 m | Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
7/11/08	11:30	-----	-----	-----	-----	-----	Bags Installed
8/15/08	8:35	2.5	7/11/2008	11:30	34.9	0.27	Measured volume, no sample collected
9/12/08	9:53	6.5	8/15/2008	8:35	28.1	0.86	Sample collected, bag in good condition
11/6/08	9:24	10.5	9/12/2008	9:53	55.0	0.71	Sample collected, bag in good condition
12/8/08	11:51	8.5	11/6/2008	9:24	32.1	0.98	Sample collected, bag in good condition

Seepage Meter Field Measurements

Location: Lake Shipp | Site: 8

Date Installed: 7/11/08 | Chamber Diameter: 0.58 m | Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
7/11/08	12:40	-----	-----	-----	-----	-----	Bags Installed
8/15/08	9:00	4.5	7/11/2008	12:40	34.8	0.48	Measured volume, no sample collected
9/12/08	9:55	-----	8/15/2008	9:00	28.0	-----	No sample collected, can't find meter, meter replaced
11/6/08	9:26	-----	9/12/2008	9:55	55.0	-----	No sample collected, can't find meter, meter replaced
12/8/08	11:48	-----	11/6/2008	9:26	32.1	-----	No sample collected, can't find meter

Seepage Meter Field Measurements

Location: Lake Shipp | Site: 9

Date Installed: 7/11/08 | Chamber Diameter: 0.58 m | Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
7/11/08	12:15	-----	-----	-----	-----	-----	Bags Installed
8/15/08	9:05	9.75	7/11/2008	12:15	34.9	1.04	Measured volume, no sample collected
9/12/08	10:21	6.5	8/15/2008	9:05	28.1	0.86	Sample collected, bag in good condition
11/6/08	9:55	10.5	9/12/2008	10:21	55.0	0.71	Sample collected, bag in good condition
12/8/08	12:00	10.25	11/6/2008	9:55	32.1	1.18	Sample collected, bag in good condition

Seepage Meter Field Measurements

Location: Lake Shipp Site: 10

Date Installed: 7/11/08 Chamber Diameter: 0.58 m Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
7/11/08	12:25	-----	-----	-----	-----	-----	Bags Installed
8/15/08	9:10	11.5	7/11/2008	12:25	34.9	1.22	Measured volume, no sample collected
9/12/08	10:30	6.5	8/15/2008	9:10	28.1	0.86	Sample collected, bag in good condition
11/6/08	10:05	-----	9/12/2008	10:30	55.0	-----	No sample collected, bag damaged, bag replaced
12/8/08	12:15	18.5	11/6/2008	10:05	32.1	2.14	Sample collected, bag in good condition

2c. Supplemental Monitoring Period (July-December 2008) - Lake Lulu

Seepage Meter Field Measurements

Location: Lake Lulu   Site: 1

Date Installed: 7/18/08   Chamber Diameter: 0.58 m   Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
7/18/08	10:20	-----	-----	-----	-----	-----	Bags Installed
8/15/08	9:20	8.5	7/18/2008	10:20	28.0	1.13	Measured volume, no sample collected
9/12/08	10:45	7.25	8/15/2008	9:20	28.1	0.96	Sample collected, bag in good condition
11/6/08	10:15	12.5	9/12/2008	10:45	55.0	0.84	Sample collected, bag in good condition
12/18/08	12:50	5.5	11/6/2008	10:15	42.1	0.48	Sample collected, bag in good condition

Seepage Meter Field Measurements

Location: Lake Lulu   Site: 2

Date Installed: 7/18/08   Chamber Diameter: 0.58 m   Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
7/18/08	10:32	-----	-----	-----	-----	-----	Bags Installed
8/15/08	9:25	55.5	7/18/2008	10:32	28.0	7.35	Measured volume, no sample collected
9/12/08	10:50	21.5	8/15/2008	9:25	28.1	2.84	Sample collected, bag in good condition
11/6/08	10:20	12.25	9/12/2008	10:50	55.0	0.83	Sample collected, bag in good condition
12/18/08	12:55	15.25	11/6/2008	10:20	42.1	1.34	Sample collected, bag in good condition

Seepage Meter Field Measurements

Location: Lake Lulu   Site: 3

Date Installed: 7/18/08   Chamber Diameter: 0.58 m   Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
7/18/08	10:40	-----	-----	-----	-----	-----	Bags Installed
8/15/08	9:28	6.5	7/18/2008	10:40	27.9	0.86	Measured volume, no sample collected
9/12/08	10:55	19.75	8/15/2008	9:28	28.1	2.61	Sample collected, bag in good condition
11/6/08	10:24	7.25	9/12/2008	10:55	55.0	0.49	Sample collected, bag in good condition
12/18/08	12:59	4.75	11/6/2008	10:24	42.1	0.42	Sample collected, bag in good condition

Seepage Meter Field Measurements

Location: Lake Lulu — Site: 4

Date Installed: 7/18/08 — Chamber Diameter: 0.58 m — Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
7/18/08	10:50	-----	-----	-----	-----	-----	Bags Installed
8/15/08	9:31	5.25	7/18/2008	10:50	27.9	0.70	Measured volume, no sample collected
9/12/08	10:59	5.25	8/15/2008	9:31	28.1	0.69	Sample collected, bag in good condition
11/6/08	10:29	10.5	9/12/2008	10:59	55.0	0.71	Sample collected, bag in good condition
12/18/08	13:00	-----	11/6/2008	10:29	42.1	-----	No sample collected, bag damaged, bag replaced

Seepage Meter Field Measurements

Location: Lake Lulu — Site: 5

Date Installed: 7/18/08 — Chamber Diameter: 0.58 m — Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
7/18/08	11:04	-----	-----	-----	-----	-----	Bags Installed
8/15/08	9:35	3.5	7/18/2008	11:04	27.9	0.46	Measured volume, no sample collected
9/12/08	11:03	3.5	8/15/2008	9:35	28.1	0.46	Sample collected, bag in good condition
11/6/08	10:33	5.25	9/12/2008	11:03	55.0	0.35	Sample collected, bag in good condition
12/18/08	13:03	-----	11/6/2008	10:33	42.1	-----	No sample collected, bag missing, bag replaced

Seepage Meter Field Measurements

Location: Lake Lulu — Site: 6

Date Installed: 7/18/08 — Chamber Diameter: 0.58 m — Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
7/18/08	11:11	-----	-----	-----	-----	-----	Bags Installed
8/15/08	9:38	4.5	7/18/2008	11:11	27.9	0.60	Measured volume, no sample collected
9/12/08	11:10	-----	8/15/2008	9:38	28.1	-----	No sample collected, can't find meter
11/6/08	10:36	-----	9/12/2008	11:10	55.0	-----	No sample collected, bag missing, bag replaced
12/18/08	13:05	-----	11/6/2008	10:36	42.1	-----	No sample collected, bag damaged, bag replaced

Seepage Meter Field Measurements

Location: Lake Lulu Site: 7

Date Installed: 7/18/08 Chamber Diameter: 0.58 m Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
7/18/08	11:20	-----	-----	-----	-----	-----	Bags Installed
8/15/08	9:41	5.25	7/18/2008	11:20	27.9	0.70	Measured volume, no sample collected
9/12/08	11:15	8.5	8/15/2008	9:41	28.1	1.12	Sample collected, bag in good condition
11/6/08	10:40	7.5	9/12/2008	11:15	55.0	0.51	Sample collected, bag in good condition
12/18/08	13:08	-----	11/6/2008	10:40	42.1	-----	No sample collected, bag missing, bag replaced

Seepage Meter Field Measurements

Location: Lake Lulu Site: 8

Date Installed: 7/18/08 Chamber Diameter: 0.58 m Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
7/18/08	11:35	-----	-----	-----	-----	-----	Bags Installed
8/15/08	9:45	6.5	7/18/2008	11:35	27.9	0.86	Measured volume, no sample collected
9/12/08	11:21	5.25	8/15/2008	9:45	28.1	0.69	Sample collected, bag in good condition
11/6/08	10:44	-----	9/12/2008	11:21	55.0	-----	No sample collected, bag damaged, bag replaced
12/18/08	13:11	-----	11/6/2008	10:44	42.1	-----	No sample collected, bag missing, bag replaced

Seepage Meter Field Measurements

Location: Lake Lulu Site: 9

Date Installed: 7/18/08 Chamber Diameter: 0.58 m Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
7/18/08	11:42	-----	-----	-----	-----	-----	Bags Installed
8/15/08	9:50	13.5	7/18/2008	11:42	27.9	1.79	Sample collected, bag in good condition
9/12/08	11:29	4.5	8/15/2008	9:50	28.1	0.59	Sample collected, bag in good condition
11/6/08	11:00	2.5	9/12/2008	11:29	55.0	0.17	Sample collected, bag in good condition
12/18/08	13:25	10.5	11/6/2008	11:00	42.1	0.92	Sample collected, bag in good condition

Seepage Meter Field Measurements

Location: Lake Lulu   Site: 10

Date Installed: 7/18/08   Chamber Diameter: 0.58 m   Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
7/18/08	11:55	-----	-----	-----	-----	-----	Bags Installed
8/15/08	9:55	2.25	7/18/2008	11:55	27.9	0.30	Measured volume, no sample collected
9/12/08	11:35	10.5	8/15/2008	9:55	28.1	1.39	Sample collected, bag in good condition
11/6/08	10:55	7.5	9/12/2008	11:35	83.0	0.33	Sample collected, bag in good condition
12/18/08	13:19	7.5	11/6/2008	10:55	42.1	0.66	Sample collected, bag in good condition

Seepage Meter Field Measurements

Location: Lake Lulu   Site: 11

Date Installed: 7/18/08   Chamber Diameter: 0.58 m   Sediment Area Covered: 0.27 m2

Date	Time Collected	Volume Collected (liters)	Previous Collection Event		Seepage Time (days)	Seepage (liters/m2-day)	Comments / Observations
			Date	Time			
7/18/08	12:05	-----	-----	-----	-----	-----	Bags Installed
8/15/08	10:00	2.25	7/18/2008	12:05	27.9	0.30	Measured volume, no sample collected
9/12/08	11:40	11.75	8/15/2008	10:00	28.1	1.55	Sample collected, bag in good condition
11/6/08	11:03	-----	9/12/2008	11:40	83.0	-----	No sample collected, can't find meter
12/18/08	13:31	-----	11/6/2008	11:03	42.1	-----	No sample collected, bag damaged, bag replaced

APPENDIX F

CHARACTERISTICS OF BULK PRECIPITATION SAMPLES COLLECTED AT THE CHAIN-OF-LAKES COMPLEX FROM OCTOBER 2005-APRIL 2006

Characteristics of Bulk Precipitation Collected Adjacent to Lake Lulu from October 2005 - May 2006

Date Collected	pH (s.u.)	Alkalinity (mg/l)	Cond (µmho/cm)	NH3 (µg/l)	NO_x (µg/l)	Org N (µg/l)	TN (µg/l)	SRP (µg/l)	TP (µg/l)	TSS (mg/l)
10/13/05	5.07	20.6	60	422	343	344	1109	<1	20	15.6
11/7/05	6.88	47.6	57	40	396	579	1015	40	64	4.6
11/29/05	6.93	49.2	55	184	311	152	647	4	47	7.6
12/14/05	7.28	51.2	63	197	289	155	641	<1	21	2.5
1/5/06	8.11	124	307	18	933	489	1440	6	42	4.3
2/3/06	6.32	7.4	36	172	208	228	608	10	49	12.8
2/16/06	6.57	24.2	61	90	137	2826	3053	3	28	3.3
2/26/06	7.25	52.0	126	469	483	574	1526	45	58	78.6
3/27/06	6.93	39.2	161	566	1322	1478	3366	48	93	84.0
4/12/06	7.39	58.8	152	452	440	264	1156	28	94	24.5
4/24/06	7.50	86.2	213	186	379	1423	1988	50	93	9.9
5/19/06	6.48	40.4	100	253	379	306	938	8	61	8.3
mean	6.89	50.1	116	254	468	735	1457	20	56	21.3
min	5.07	7.4	36	18	137	152	608	<1	20	2.5
max	8.11	124	307	566	1322	2826	3366	50	94	84.0

APPENDIX G

CHEMICAL CHARACTERISTICS OF STORMWATER AND BASEFLOW SAMPLES COLLECTED IN THE LAKE SHIPP DRAINAGE BASIN FROM OCTOBER 2005-MAY 2006

Characteristics of Storm Water and Baseflow Samples Collected in Winter Haven from October 2005 to May 2006

Sample Description	Type	Date Collected	pH (s.u.)	Alkalinity (mg/l)	Cond (µmho/cm)	NH3 (µg/l)	NO_X (µg/l)	Dis Org N (µg/l)	Part N (µg/l)	TN (µg/l)	SRP (µg/l)	Dis Org P (µg/l)	Part P (µg/l)	TP (µg/l)	Turbidity (NTU)	TSS (mg/l)	BOD (mg/l)
Shipp 12 / 13	Baseflow	10/25/05	7.28	47.2	266	646	1037	496	346	2525	2	11	37	50	3.1	4.7	3.1
Shipp 12 / 13	Baseflow	11/8/05	7.52	79.4	271	692	2831	112	1626	5261	19	5	4	28	0.9	1.0	7.8
Shipp 12 / 13	Baseflow	11/28/05	7.28	93.4	204	142	336	43	3360	3881	2	1	14	17	2.3	4.8	6.7
Shipp 12 / 13	Baseflow	12/27/05	7.01	69.6	250	127	556	82	621	1386	2	2	248	252	39.5	127.0	24.5
Shipp 12 / 13	Baseflow	3/13/06	7.54	100.0	284	380	69	113	274	836	22	4	124	150	7.4	23.6	4.7
Shipp 12 / 13	Baseflow	4/8/06	7.47	85.8	242	144	86	457	214	901	37	9	74	120	2.9	8.8	2.6
		average	**7.35**	**79.2**	**253**	**355**	**819**	**217**	**1074**	**2465**	**14**	**5**	**84**	**103**	**9.4**	**28.3**	**8.2**
		min	**7.01**	**47.2**	**204**	**127**	**69**	**43**	**214**	**836**	**2**	**1**	**4**	**17**	**0.9**	**1.0**	**2.6**
		max	**7.54**	**100.0**	**284**	**692**	**2831**	**496**	**3360**	**5261**	**37**	**11**	**248**	**252**	**39.5**	**127.0**	**24.5**
Shipp 12 / 13	Stormwater	10/4/05	7.60	69.6	211	111	1316	473	294	2194	59	10	65	134	6.2	21.3	<2.0
Shipp 12 / 13	Stormwater	2/3/06	6.93	35.2	117	119	497	435	287	1338	259	55	130	444	13.9	29.0	4.2
Shipp 12 / 13	Stormwater	2/26/06	6.99	66.2	210	609	355	196	224	1384	18	57	108	183	2.4	10.2	3.1
Shipp 12 / 13	Stormwater	4/9/06	7.05	67.6	177	240	184	532	376	1332	116	35	110	261	7.3	24.0	5.8
Shipp 12 / 13	Stormwater	4/23/06	7.59	81.6	230	195	441	186	226	1048	58	10	173	241	3.5	42.8	2.2
Shipp 12 / 13	Stormwater	5/9/06	7.19	44.2	131	250	1083	53	763	2149	182	7	320	509	23.7	76.3	4.2
Shipp 12 / 13	Stormwater	5/11/06	7.34	68.2	175	148	385	218	538	1289	71	61	208	340	24.6	94.6	4.5
Shipp 12 / 13	Stormwater	5/16/06	7.09	46.4	108	174	306	208	264	952	99	7	171	277	13.1	69.8	8.8
		average	**7.22**	**59.9**	**170**	**231**	**571**	**288**	**372**	**1461**	**108**	**30**	**161**	**299**	**11.8**	**46.0**	**4.7**
		min	**6.93**	**35.2**	**108**	**111**	**184**	**53**	**224**	**952**	**18**	**7**	**65**	**134**	**2.4**	**10.2**	**2.2**
		max	**7.60**	**81.6**	**230**	**609**	**1316**	**532**	**763**	**2194**	**259**	**61**	**320**	**509**	**24.6**	**94.6**	**8.8**
Shipp 7	Stormwater	10/4/05	7.67	42.0	90	173	147	64	443	827	44	18	164	226	13.3	44.8	<2.0
Shipp 7	Stormwater	10/7/05	7.37	48.2	91	523	141	42	306	1012	57	32	318	407	62.6	17.4	7.6
Shipp 7	Stormwater	10/8/05	7.22	45.8	103	217	356	46	263	882	196	30	127	353	17.6	37.9	4.1
Shipp 7	Stormwater	10/23/05	7.20	47.0	124	236	226	101	302	865	109	19	41	169	6.3	11.6	2.5
Shipp 7	Stormwater	11/1/05	6.89	37.6	96	312	313	20	344	989	59	6	112	177	16.2	49.7	2.0
Shipp 7	Stormwater	12/7/05	6.98	29.6	85	108	70	25	38	241	22	30	76	128	12.1	20.4	<2.0
Shipp 7	Stormwater	1/18/06	7.10	43.6	100	162	339	220	546	1267	113	17	254	384	29.9	87.9	4.7
Shipp 7	Stormwater	2/3/06	7.27	57.4	126	186	251	64	728	1229	335	112	981	1428	48.6	137.0	4.1
Shipp 7	Stormwater	2/26/06	6.89	37.6	119	12	239	454	516	1221	222	31	380	633	24.4	113.8	4.5
Shipp 7	Stormwater	3/23/06	6.90	70.6	169	398	319	519	1244	2480	208	67	696	971	101.0	236.0	12.5
		average	**7.15**	**45.9**	**110**	**233**	**240**	**156**	**473**	**1101**	**137**	**36**	**315**	**488**	**33.2**	**75.7**	**5.3**
		min	**6.89**	**29.6**	**85**	**12**	**70**	**20**	**38**	**241**	**22**	**6**	**41**	**128**	**6.3**	**11.6**	**2.0**
		max	**7.67**	**70.6**	**169**	**523**	**356**	**519**	**1244**	**2480**	**335**	**112**	**981**	**1428**	**101.0**	**236.0**	**12.5**

APPENDIX H

RESULTS OF LABORATORY ANALYSES CONDUCTED ON GROUNDWATER SEEPAGE SAMPLES COLLECTED FROM LAKES MAY, SHIPP, AND LULU

1. **Seepage Samples Collected from October 2005-April 2006**

2. **Seepage Samples Collected from July-December 2008**

3. **Summary of Seepage Samples Used for Quantification of Nutrient Influx from October 2005-April 2006**

4. **Summary of Seepage Samples Used for Quantification of Nutrient Influx from July-December 2008**

1. Seepage Samples Collected from October 2005-April 2006

Winter Haven Seepage

Sample Description	Sample Location	Type	Date Collected	pH (s.u.)	Alkalinity (mg/l)	Cond (µmho/cm)	TN (µg/l)	TP (µg/l)
May	Site 1	Seepage	2/3/06	6.24	30.2	170	2044	96
May	Site 1	Seepage	2/20/06	7.45	85.0	258	2795	66
May	Site 1	Seepage	4/3/06	6.76	36.2	154	3907	185
May	Site 1	Seepage	5/8/06	6.34	36.0	195	1653	131
May	Site 1	Seepage	6/5/06	5.84	19.0	173	1295	147
			average	6.53	41.3	190	2339	125
			min	5.84	19.0	154	1295	66
			max	7.45	85.0	258	3907	185
May	Site 2	Seepage	12/14/05	7.41	194	529	3123	94
May	Site 2	Seepage	2/3/06	7.51	236	581	8003	65
May	Site 2	Seepage	2/20/06	7.52	209	609	12678	10
May	Site 2	Seepage	4/3/06	6.79	219	598	9579	115
			average	7.31	215	579	8346	71
			min	6.79	194	529	3123	10
			max	7.52	236	609	12678	115
May	Site 3	Seepage	12/14/05	7.15	90.2	258	3118	94
May	Site 3	Seepage	2/3/06	7.21	59.2	211	3079	134
May	Site 3	Seepage	2/20/06	7.15	55.2	223	3813	35
May	Site 3	Seepage	4/3/06	7.04	61.6	225	1577	60
May	Site 3	Seepage	5/8/06	6.73	66.2	229	1523	73
May	Site 3	Seepage	6/5/06	6.72	72.2	175	1738	106
			average	7.00	67.4	220	2475	84
			min	6.72	55.2	175	1523	35
			max	7.21	90.2	258	3813	134
May	Site 4	Seepage	12/14/05	7.58	104	289	5087	91
May	Site 4	Seepage	2/3/06	7.62	129	317	3446	106
May	Site 4	Seepage	2/20/06	7.67	146	369	3486	83
May	Site 4	Seepage	4/3/06	7.28	119	317	2332	61
May	Site 4	Seepage	5/8/06	7.11	117	335	2427	43
			average	7.45	123	325	3356	77
			min	7.11	104	289	2332	43
			max	7.67	146	369	5087	106
May	Site 5	Seepage	1/5/06	7.48	149	461	8294	15
May	Site 5	Seepage	3/9/06	7.40	175	414	14368	20
			average	7.44	162	438	11331	18
			min	7.40	149	414	8294	15
			max	7.48	175	461	14368	20

Winter Haven Seepage

Sample Description	Sample Location	Type	Date Collected	pH (s.u.)	Alkalinity (mg/l)	Cond (µmho/cm)	TN (µg/l)	TP (µg/l)
Shipp	Site 1	Seepage	12/14/05	7.61	202	490	11251	303
Shipp	Site 1	Seepage	2/3/06	7.64	292	628	8403	352
Shipp	Site 1	Seepage	2/20/06	7.85	280	665	7443	206
Shipp	Site 1	Seepage	4/3/06	7.80	238	584	7225	253
Shipp	Site 1	Seepage	5/8/06	7.75	278	680	9370	406
Shipp	Site 1	Seepage	6/5/06	7.73	212	475	8465	411
			average	7.73	250	587	8693	322
			min	7.61	202	475	7225	206
			max	7.85	292	680	11251	411
Shipp	Site 2	Seepage	12/15/05	7.19	110	361	5366	725
Shipp	Site 2	Seepage	2/3/06	7.33	118	312	2878	663
Shipp	Site 2	Seepage	2/20/06	7.49	117	335	1555	469
Shipp	Site 2	Seepage	5/8/06	7.51	95.0	313	2054	132
Shipp	Site 2	Seepage	6/5/06	7.34	99.6	250	1987	228
			average	7.37	108	314	2768	443
			min	7.19	95.0	250	1555	132
			max	7.51	118	361	5366	725
Shipp	Site 3	Seepage	12/15/05	7.38	103	303	1882	148
Shipp	Site 3	Seepage	2/3/06	7.14	77.2	252	3016	67
Shipp	Site 3	Seepage	2/20/06	7.29	72.4	282	2676	48
Shipp	Site 3	Seepage	4/3/06	7.32	76.6	284	1861	40
Shipp	Site 3	Seepage	5/8/06	7.28	81.2	282	1860	87
Shipp	Site 3	Seepage	6/5/06	7.15	66.4	224	1683	90
			average	7.26	79.5	271	2163	80
			min	7.14	66.4	224	1683	40
			max	7.38	103	303	3016	148
Shipp	Site 4	Seepage	12/15/05	7.67	136	350	5005	172
Shipp	Site 4	Seepage	2/3/06	7.48	139	332	2376	206
Shipp	Site 4	Seepage	2/20/06	7.59	103	310	1404	260
Shipp	Site 4	Seepage	4/3/06	7.67	143	379	3777	182
Shipp	Site 4	Seepage	5/8/06	7.40	107	326	2788	154
			average	7.56	126	339	3070	195
			min	7.40	103	310	1404	154
			max	7.67	143	379	5005	260
Shipp	Site 5	Seepage	12/15/05	7.86	108	323	1482	91
Shipp	Site 5	Seepage	2/3/06	7.71	139	342	2294	31
Shipp	Site 5	Seepage	2/20/06	7.39	61.2	235	1759	23
Shipp	Site 5	Seepage	4/3/06	7.36	65.4	243	1377	15
Shipp	Site 5	Seepage	5/8/06	7.36	65.0	278	1524	21
			average	7.54	88	284	1687	36
			min	7.36	61	235	1377	15
			max	7.86	139	342	2294	91
Shipp	Site 6	Seepage	12/15/05	6.73	54.6	292	2345	20
Shipp	Site 6	Seepage	2/3/06	6.68	38.8	261	1717	63
Shipp	Site 6	Seepage	2/20/06	7.03	37.2	286	2044	46
Shipp	Site 6	Seepage	4/3/06	6.96	51.4	243	1647	37
Shipp	Site 6	Seepage	5/8/06	7.03	50.8	266	1120	46
			average	6.89	47	270	1775	42
			min	6.68	37	243	1120	20
			max	7.03	55	292	2345	63

Winter Haven Seepage

Sample Description	Sample Location	Type	Date Collected	pH (s.u.)	Alkalinity (mg/l)	Cond (µmho/cm)	TN (µg/l)	TP (µg/l)
Shipp	Site 7	Seepage	12/15/05	7.60	85.4	293	3087	125
Shipp	Site 7	Seepage	2/3/06	7.58	76.4	259	1996	160
Shipp	Site 7	Seepage	2/20/06	7.47	73.6	278	8251	286
Shipp	Site 7	Seepage	4/3/06	7.65	80.2	299	1914	77
Shipp	Site 7	Seepage	5/8/06	7.39	88.6	322	2219	23
Shipp	Site 7	Seepage	6/5/06	7.15	76.8	233	2440	116
			average	7.47	80.2	281	3318	131
			min	7.15	73.6	233	1914	23
			max	7.65	88.6	322	8251	286
Shipp	Site 8	Seepage	1/5/06	7.19	45.4	234	4497	115
Shipp	Site 8	Seepage	3/9/06	6.70	45.4	211	7517	382
Shipp	Site 8	Seepage	4/3/06	7.13	49.4	322	9418	347
Shipp	Site 8	Seepage	6/5/06	6.73	49.4	245	2000	380
			average	6.94	47.4	253	5858	306
			min	6.70	45.4	211	2000	115
			max	7.19	49.4	322	9418	382
Shipp	Site 9	Seepage	1/5/06	7.16	62.4	243	4376	12
Shipp	Site 9	Seepage	4/3/06	7.09	59.2	267	6602	16
			average	7.13	60.8	255	5489	14
			min	7.09	59.2	243	4376	12
			max	7.16	62.4	267	6602	16
Shipp	Site 10	Seepage	1/5/06	7.31	50.6	225	5168	14
Shipp	Site 10	Seepage	3/9/06	7.07	59.4	209	9334	22
Shipp	Site 10	Seepage	4/3/06	7.66	92.8	298	5683	14
			average	7.35	67.6	244	6728	17
			min	7.07	50.6	209	5168	14
			max	7.66	92.8	298	9334	22

Winter Haven Seepage

Sample Description	Sample Location	Type	Date Collected	pH (s.u.)	Alkalinity (mg/l)	Cond (µmho/cm)	TN (µg/l)	TP (µg/l)
Lulu	Site 1	Seepage	12/14/05	7.50	140	452	7217	346
Lulu	Site 1	Seepage	2/3/06	7.81	195	479	8449	424
Lulu	Site 1	Seepage	2/20/06	7.94	242	576	8753	435
Lulu	Site 1	Seepage	4/3/06	7.86	201	557	8804	472
Lulu	Site 1	Seepage	5/8/06	7.69	218	572	8023	398
			average	7.76	199	527	8249	415
			min	7.50	140	452	7217	346
			max	7.94	242	576	8804	472
Lulu	Site 2	Seepage	12/14/05	7.68	163	445	4904	501
Lulu	Site 2	Seepage	2/3/06	7.71	174	432	2119	113
Lulu	Site 2	Seepage	2/20/06	7.89	176	464	3933	315
Lulu	Site 2	Seepage	5/8/06	7.30	105	388	382	40
Lulu	Site 2	Seepage	6/5/06	7.43	93.0	279	630	8
			average	7.60	142	402	2394	195
			min	7.30	93	279	382	8
			max	7.89	176	464	4904	501
Lulu	Site 3	Seepage	12/14/05	7.85	137	408	7810	824
Lulu	Site 3	Seepage	2/3/06	7.69	178	453	4015	417
Lulu	Site 3	Seepage	2/20/06	8.11	184	497	3952	416
Lulu	Site 3	Seepage	4/3/06	8.12	198	510	3322	389
Lulu	Site 3	Seepage	5/8/06	7.82	203	516	3346	403
Lulu	Site 3	Seepage	6/5/06	7.84	196	418	3753	427
			average	7.91	183	467	4366	479
			min	7.69	137	408	3322	389
			max	8.12	203	516	7810	824
Lulu	Site 4	Seepage	12/14/05	8.01	118	392	6200	366
Lulu	Site 4	Seepage	2/3/06	7.78	146	410	6335	229
Lulu	Site 4	Seepage	2/20/06	7.78	121	377	5048	196
Lulu	Site 4	Seepage	5/8/06	7.72	125	385	4913	209
Lulu	Site 4	Seepage	6/5/06	7.79	130	322	5977	171
			average	7.82	128	377	5695	234
			min	7.72	118	322	4913	171
			max	8.01	146	410	6335	366
Lulu	Site 5	Seepage	12/14/05	7.89	128	393	944	38
Lulu	Site 5	Seepage	2/3/06	7.25	55.2	230	1610	89
Lulu	Site 5	Seepage	2/20/06	7.63	146	416	1491	48
Lulu	Site 5	Seepage	4/3/06	8.04	103	339	3366	48
Lulu	Site 5	Seepage	6/5/06	7.21	97.8	269	2940	96
			average	7.60	106	329	2070	64
			min	7.21	55.2	230	944	38
			max	8.04	146	416	3366	96
Lulu	Site 6	Seepage	12/14/05	7.41	60.2	224	810	24
Lulu	Site 6	Seepage	5/8/06	7.47	67.4	283	1634	42
Lulu	Site 6	Seepage	6/5/06	7.03	82.4	247	1403	53
			average	7.30	70.0	251	1282	40
			min	7.03	60.2	224	810	24
			max	7.47	82.4	283	1634	53

Winter Haven Seepage

Sample Description	Sample Location	Type	Date Collected	pH (s.u.)	Alkalinity (mg/l)	Cond (µmho/cm)	TN (µg/l)	TP (µg/l)
Lulu	Site 7	Seepage	2/3/06	7.23	96.8	275	2980	266
Lulu	Site 7	Seepage	2/20/06	7.27	74.4	261	6304	280
Lulu	Site 7	Seepage	5/8/06	7.35	62.4	283	5442	258
Lulu	Site 7	Seepage	6/5/06	8.04	130	300	4638	320
			average	7.47	90.9	280	4841	281
			min	7.23	62.4	261	2980	258
			max	8.04	130	300	6304	320
Lulu	Site 8	Seepage	6/5/06	6.84	58.2	228	1956	100
			average	6.84	58.2	228	1956	100
			min	6.84	58.2	228	1956	100
			max	6.84	58.2	228	1956	100
Lulu	Site 9	Seepage	1/5/06	6.94	87.8	384	4436	1935
Lulu	Site 9	Seepage	6/5/06	6.99	84.2	289	5748	1633
			average	6.97	86.0	337	5092	1784
			min	6.94	84.2	289	4436	1633
			max	6.99	87.8	384	5748	1935
Lulu	Site 10	Seepage	1/5/06	7.23	57.0	266	4500	294
			average	7.23	57.0	266	4500	294
			min	7.23	57.0	266	4500	294
			max	7.23	57.0	266	4500	294
Lulu	Site 11	Seepage	1/5/06	7.26	48.8	226	878	28
			average	7.26	48.8	226	878	28
			min	7.26	48.8	226	878	28
			max	7.26	48.8	226	878	28

2. Seepage Samples Collected from July-December 2008

Winter Haven Seepage

Sample Description	Sample Location	Date Collected	pH (s.u.)	Alkalinity (mg/l)	Cond (µmho/cm)	TN (µg/l)	TP (µg/l)
May	Site 1	9/12/08	6.23	56.8	597	883	382
May	Site 1	11/6/08	7.94	129	406	5154	211
May	Site 1	12/18/08	6.37	41.8	203	616	233
		average	6.85	75.9	402	2218	275
		min	6.23	41.8	203	616	211
		max	7.94	129	597	5154	382
May	Site 2	9/12/08	6.99	61.2	256	807	102
May	Site 2	11/6/08	7.45	58.6	254	897	115
May	Site 2	12/18/08	7.10	76.6	287	757	256
		average	7.18	65.5	266	820	158
		min	6.99	58.6	254	757	102
		max	7.45	76.6	287	897	256
May	Site 3	9/12/08	7.43	82.4	297	1911	81
May	Site 3	11/6/08	4.51	0.0	414	4449	196
May	Site 3	12/18/08	7.76	219	525	9237	155
		average	6.57	100	412	5199	144
		min	4.51	0.0	297	1911	81
		max	7.76	219	525	9237	196
May	Site 4	9/12/08	6.69	52.2	250	2037	74
May	Site 4	11/6/08	7.58	72.2	294	2883	66
May	Site 4	12/18/08	7.07	62.2	276	3718	277
		average	7.11	62.2	273	2879	139
		min	6.69	52.2	250	2037	66
		max	7.58	72.2	294	3718	277

Winter Haven Seepage

Sample Description	Sample Location	Date Collected	pH (s.u.)	Alkalinity (mg/l)	Cond (µmho/cm)	TN (µg/l)	TP (µg/l)
Shipp	Site 1	9/12/08	6.86	52.4	298	731	13
Shipp	Site 1	11/6/08	7.42	58.2	249	1300	55
Shipp	Site 1	12/18/08	7.29	166	447	7593	317
		average	7.19	92.2	331	3208	128
		min	6.86	52.4	249	731	13
		max	7.42	166	447	7593	317
Shipp	Site 2	9/12/08	6.97	66.0	233	2662	51
Shipp	Site 2	11/6/08	7.52	60.2	236	1215	13
Shipp	Site 2	12/18/08	6.94	54.6	223	1316	191
		average	7.14	60.3	231	1731	85
		min	6.94	54.6	223	1215	13
		max	7.52	66.0	236	2662	191
Shipp	Site 3	9/12/08	6.19	25.8	205	1796	36
Shipp	Site 3	11/6/08	6.97	21.0	194	1660	20
Shipp	Site 3	12/18/08	6.83	28.6	219	966	191
		average	6.66	25.1	206	1474	82
		min	6.19	21.0	194	966	20
		max	6.97	28.6	219	1796	191
Shipp	Site 4	9/12/08	6.84	86.0	344	3947	70
Shipp	Site 4	11/6/08	7.84	86.4	315	2436	15
Shipp	Site 4	12/18/08	7.43	88.0	284	698	142
		average	7.37	86.8	314	2360	76
		min	6.84	86.0	284	698	15
		max	7.84	88.0	344	3947	142
Shipp	Site 5	11/6/08	7.63	62.4	254	1254	6
Shipp	Site 5	12/18/08	7.96	126	339	2102	183
		average	7.80	94.2	297	1678	95
		min	7.63	62.4	254	1254	6
		max	7.96	126	339	2102	183
Shipp	Site 6	9/12/08	6.69	60.8	259	968	25
Shipp	Site 6	11/6/08	8.05	57.2	263	585	47
Shipp	Site 6	12/18/08	6.80	52.0	241	863	403
		average	7.18	56.7	254	805	158
		min	6.69	52.0	241	585	25
		max	8.05	60.8	263	968	403

Winter Haven Seepage

Sample Description	Sample Location	Date Collected	pH (s.u.)	Alkalinity (mg/l)	Cond (µmho/cm)	TN (µg/l)	TP (µg/l)
Shipp	Site 7	9/12/08	7.18	48.4	244	1660	6
Shipp	Site 7	11/6/08	7.84	61.8	308	1125	7
Shipp	Site 7	12/18/08	7.37	64.2	247	1431	147
		average	7.46	58.1	266	1405	53
		min	7.18	48.4	244	1125	6
		max	7.84	64.2	308	1660	147
Shipp	Site 9	9/12/08	6.89	52.0	224	1375	10
Shipp	Site 9	11/6/08	6.68	18.2	322	7804	73
Shipp	Site 9	12/18/08	6.77	65.2	256	2909	175
		average	6.78	45.1	267	4029	86
		min	6.68	18.2	224	1375	10
		max	6.89	65.2	322	7804	175
Shipp	Site 10	9/12/08	6.93	67.0	395	8891	22
Shipp	Site 10	12/18/08	7.05	55.6	324	13238	0
		average	6.99	61.3	360	11065	11
		min	6.93	55.6	324	8891	0
		max	7.05	67.0	395	13238	22

Winter Haven Seepage

Sample Description	Sample Location	Date Collected	pH (s.u.)	Alkalinity (mg/l)	Cond (µmho/cm)	TN (µg/l)	TP (µg/l)
Lulu	Site 1	9/12/08	6.90	88.6	416	2165	17
Lulu	Site 1	11/6/08	7.38	58.8	268	772	11
Lulu	Site 1	12/18/08	7.46	78.2	273	624	4
		average	7.25	75.2	319	1187	11
		min	6.90	58.8	268	624	4
		max	7.46	88.6	416	2165	17
Lulu	Site 2	9/12/08	6.49	34.6	194	1213	1
Lulu	Site 2	11/6/08	6.97	49.8	235	8089	6
Lulu	Site 2	12/18/08	6.79	54.2	226	1430	3
		average	6.75	46.2	218	3577	3
		min	6.49	34.6	194	1213	1
		max	6.97	54.2	235	8089	6
Lulu	Site 3	9/12/08	6.78	56.0	266	1440	35
Lulu	Site 3	11/6/08	7.56	63.2	297	2246	146
Lulu	Site 3	12/18/08	7.22	67.2	266	1704	56
		average	7.19	62.1	276	1797	79
		min	6.78	56.0	266	1440	35
		max	7.56	67.2	297	2246	146
Lulu	Site 4	9/12/08	7.36	95.8	374	3379	42
Lulu	Site 4	11/6/08	7.86	71.4	297	1561	9
		average	7.61	83.6	336	2470	26
		min	7.36	71.4	297	1561	9
		max	7.86	95.8	374	3379	42
Lulu	Site 5	9/12/08	7.03	42.2	264	1013	17
Lulu	Site 5	11/6/08	7.79	80.2	306	1286	13
		average	7.41	61.2	285	1150	15
		min	7.03	42.2	264	1013	13
		max	7.79	80.2	306	1286	17
Lulu	Site 7	9/12/08	7.11	78.0	316	1705	10
Lulu	Site 7	11/6/08	8.05	85.2	315	2463	61
		average	7.58	81.6	316	2084	36
		min	7.11	78.0	315	1705	10
		max	8.05	85.2	316	2463	61

Winter Haven Seepage

Sample Description	Sample Location	Date Collected	pH (s.u.)	Alkalinity (mg/l)	Cond (µmho/cm)	TN (µg/l)	TP (µg/l)
Lulu	Site 8	9/12/08	7.42	67.8	293	2322	55
		average	7.42	67.8	293	2322	55
		min	7.42	67.8	293	2322	55
		max	7.42	67.8	293	2322	55
Lulu	Site 9	9/12/08	7.09	101	394	3122	125
Lulu	Site 9	11/6/08	7.08	91.8	673	50375	287
Lulu	Site 9	12/18/08	6.55	42.4	336	1859	324
		average	6.91	78.4	468	18452	245
		min	6.55	42.4	336	1859	125
		max	7.09	101	673	50375	324
Lulu	Site 10	9/12/08	7.11	63.4	319	3020	128
Lulu	Site 10	11/6/08	7.78	42.0	297	2745	131
Lulu	Site 10	12/18/08	7.50	65.8	269	1396	56
		average	7.46	57.1	295	2387	105
		min	7.11	42.0	269	1396	56
		max	7.78	65.8	319	3020	131
Lulu	Site 11	9/12/08	7.26	64.0	262	1142	18
		average	7.26	64.0	262	1142	18
		min	7.26	64.0	262	1142	18
		max	7.26	64.0	262	1142	18

3. Summary of Seepage Samples Used for Quantification of Nutrient Influx from October 2005-April 2006

Winter Haven Seepage - Oct. 2005 to April 2006

Lake	Site	Date	Percent of Purge Volume	pH	Alkalinity (mg/l)	Cond (µmho/cm)	Total N (µg/l)	Total P (µg/l)
May	1	11/02/05	---	---	---	---	---	---
May	1	02/03/06	588	6.24	30.2	170	2044	96
May	1	02/20/06	605	7.45	85	258	2795	66
May	1	04/03/06	1256	6.76	36.2	154	3907	185
May	1	05/08/06	1649	6.34	36	195	1653	131
May	1	06/05/06	1695	5.84	19	173	1295	147
May	2	11/02/05	---	---	---	---	---	---
May	2	12/14/05	---	---	---	---	---	---
May	2	02/03/06	106	7.51	236	581	8003	65
May	2	02/20/06	137	7.52	209	609	12678	10
May	2	04/03/06	168	6.79	219	598	9579	115
May	3	11/02/05	---	---	---	---	---	---
May	3	12/14/05	442	7.15	90.2	258	3118	94
May	3	02/03/06	461	7.21	59.2	211	3079	134
May	3	02/20/06	491	7.15	55.2	223	3813	35
May	3	04/03/06	1045	7.04	61.6	225	1577	60
May	3	05/08/06	1373	6.73	66.2	229	1523	73
May	3	06/05/06	1492	6.72	72.2	175	1738	106
May	4	11/02/05	---	---	---	---	---	---
May	4	12/14/05	134	7.58	104	289	5087	91
May	4	02/03/06	192	7.62	129	317	3446	106
May	4	02/20/06	262	7.67	146	369	3486	83
May	4	04/03/06	588	7.28	119	317	2332	61
May	4	05/08/06	750	7.11	117	335	2427	43
May	5	11/02/05	---	---	---	---	---	---
May	5	01/05/06	---	---	---	---	---	---
May	5	03/09/06	115	7.4	175	414	14368	20
Lulu	1	11/07/05	---	---	---	---	---	---
Lulu	1	12/14/05	120	7.5	140	452	7217	346
Lulu	1	02/03/06	181	7.81	195	479	8449	424
Lulu	1	02/20/06	222	7.94	242	576	8753	435
Lulu	1	04/03/06	267	7.86	201	557	8804	472
Lulu	1	05/08/06	337	7.69	218	572	8023	398
Lulu	2	11/07/05	---	---	---	---	---	---
Lulu	2	12/14/05	687	7.68	163	445	4904	501
Lulu	2	02/03/06	882	7.71	174	432	2119	113
Lulu	2	02/20/06	959	7.89	176	464	3933	315
Lulu	2	05/08/06	1073	7.3	105	388	382	40
Lulu	2	06/05/06	1226	7.43	93	279	630	8
Lulu	3	11/07/05	---	---	---	---	---	---
Lulu	3	12/14/05	156	7.85	137	408	7810	824
Lulu	3	02/03/06	203	7.69	178	453	4015	417
Lulu	3	02/20/06	249	8.11	184	497	3952	416
Lulu	3	04/03/06	338	8.12	198	510	3322	389
Lulu	3	05/08/06	405	7.82	203	516	3346	403
Lulu	3	06/05/06	508	7.84	196	418	3753	427
Lulu	4	11/07/05	---	---	---	---	---	---
Lulu	4	12/14/05	---	---	---	---	---	---
Lulu	4	02/03/06	107	7.78	146	410	6335	229
Lulu	4	02/20/06	147	7.78	121	377	5048	196
Lulu	4	05/08/06	193	7.72	125	385	4913	209
Lulu	4	06/05/06	238	7.79	130	322	5977	171

Winter Haven Seepage - Oct. 2005 to April 2006

Lake	Site	Date	Percent of Purge Volume	pH	Alkalinity (mg/l)	Cond (µmho/cm)	Total N (µg/l)	Total P (µg/l)
Lulu	5	11/07/05	---	---	---	---	---	---
Lulu	5	12/14/05	---	---	---	---	---	---
Lulu	5	02/03/06	106	7.25	55.2	230	1610	89
Lulu	5	02/20/06	136	7.63	146	416	1491	48
Lulu	5	04/03/06	181	8.04	103	339	3366	48
Lulu	5	06/05/06	216	7.21	97.8	269	2940	96
Lulu	6	11/07/05	---	---	---	---	---	---
Lulu	6	12/14/05	---	---	---	---	---	---
Lulu	6	05/08/06	128	7.47	67.4	283	1634	42
Lulu	6	06/05/06	159	7.03	82.4	247	1403	53
Lulu	7	11/07/05	---	---	---	---	---	---
Lulu	7	02/03/06	---	---	---	---	---	---
Lulu	7	02/20/06	---	---	---	---	---	---
Lulu	7	05/08/06	136	7.35	62.4	283	5442	258
Lulu	7	06/05/06	176	8.04	130	300	4638	320
Lulu	8	11/07/05	---	---	---	---	---	---
Lulu	8	06/05/06	473	6.84	58.2	228	1956	100
Lulu	9	11/07/05	---	---	---	---	---	---
Lulu	9	01/05/06	147	6.94	87.8	384	4436	1935
Lulu	9	06/05/06	187	6.99	84.2	289	5748	1633
Lulu	10	11/07/05	---	---	---	---	---	---
Lulu	10	01/05/06	46	7.23	57	266	4500	294
Lulu	11	11/07/05	---	---	---	---	---	---
Lulu	11	01/05/06	249	7.26	48.8	226	878	28
Shipp	1	11/02/05	---	---	---	---	---	---
Shipp	1	12/14/05	---	---	---	---	---	---
Shipp	1	02/03/06	103	7.64	292	628	8403	352
Shipp	1	02/20/06	126	7.85	280	665	7443	206
Shipp	1	04/03/06	152	7.8	238	584	7225	253
Shipp	1	05/08/06	183	7.75	278	680	9370	406
Shipp	1	06/05/06	214	7.73	212	475	8465	411
Shipp	2	11/02/05	---	---	---	---	---	---
Shipp	2	12/15/05	570	7.19	110	361	5366	725
Shipp	2	02/03/06	713	7.33	118	312	2878	663
Shipp	2	02/20/06	832	7.49	117	335	1555	469
Shipp	2	05/08/06	994	7.51	95	313	2054	132
Shipp	2	06/05/06	1137	7.34	99.6	250	1987	228
Shipp	3	12/15/05	---	---	---	---	---	---
Shipp	3	02/03/06	191	7.14	77.2	252	3016	67
Shipp	3	02/20/06	267	7.29	72.4	282	2676	48
Shipp	3	04/03/06	377	7.32	76.6	284	1861	40
Shipp	3	05/08/06	476	7.28	81.2	282	1860	87
Shipp	3	06/05/06	502	7.15	66.4	224	1683	90
Shipp	4	11/02/05	---	---	---	---	---	---
Shipp	4	12/15/05	148	7.67	136	350	5005	172
Shipp	4	02/03/06	256	7.48	139	332	2376	206
Shipp	4	02/20/06	348	7.59	103	310	1404	260
Shipp	4	04/03/06	402	7.67	143	379	3777	182
Shipp	4	05/08/06	442	7.4	107	326	2788	154

Winter Haven Seepage - Oct. 2005 to April 2006

Lake	Site	Date	Percent of Purge Volume	pH	Alkalinity (mg/l)	Cond (µmho/cm)	Total N (µg/l)	Total P (µg/l)
Shipp	5	12/15/05	---	---	---	---	---	---
Shipp	5	02/03/06	204	7.71	139	342	2294	31
Shipp	5	02/20/06	299	7.39	61.2	235	1759	23
Shipp	5	04/03/06	365	7.36	65.4	243	1377	15
Shipp	5	05/08/06	474	7.36	65	278	1524	21
Shipp	6	11/02/05	---	---	---	---	---	---
Shipp	6	12/15/05	350	6.73	54.6	292	2345	20
Shipp	6	02/03/06	680	6.68	38.8	261	1717	63
Shipp	6	02/20/06	723	7.03	37.2	286	2044	46
Shipp	6	04/03/06	841	6.96	51.4	243	1647	37
Shipp	6	05/08/06	1018	7.03	50.8	266	1120	46
Shipp	7	11/02/05	---	---	---	---	---	---
Shipp	7	12/15/05	---	---	---	---	---	---
Shipp	7	02/03/06	156	7.58	76.4	259	1996	160
Shipp	7	02/20/06	220	7.47	73.6	278	8251	286
Shipp	7	04/03/06	323	7.65	80.2	299	1914	77
Shipp	7	05/08/06	418	7.39	88.6	322	2219	23
Shipp	7	06/05/06	570	7.15	76.8	233	2440	116
Shipp	8	11/02/05	---	---	---	---	---	---
Shipp	8	01/05/06	272	7.19	45.4	234	4497	115
Shipp	8	03/09/06	322	6.7	45.4	211	7517	382
Shipp	8	04/03/06	348	7.13	49.4	322	9418	347
Shipp	8	06/05/06	408	6.73	49.4	245	2000	380
Shipp	9	11/02/05	---	---	---	---	---	---
Shipp	9	01/05/06	---	---	---	---	---	---
Shipp	9	04/03/06	126	7.09	59.2	267	6602	16
Shipp	10	11/02/05	---	---	---	---	---	---
Shipp	10	01/05/06	---	---	---	---	---	---
Shipp	10	03/09/06	163	7.07	59.4	209	9334	22
Shipp	10	04/03/06	213	7.66	92.8	298	5683	14

4. Summary of Seepage Samples Used for Quantification of Nutrient Influx from July-December 2008

Winter Haven Seepage - July to December 2008

Lake	Site	Date	Percent of Purge Volume	pH	Alkalinity (mg/l)	Cond (µmho/cm)	Total N (µg/l)	Total P (µg/l)
May	1	08/15/08						
May	1	09/12/08	---	---	---	---	---	---
May	1	11/06/08	---	---	---	---	---	---
May	1	12/08/08	107	6.37	41.8	203	616	233
May	2	08/15/08	---	---	---	---	---	---
May	2	09/12/08	---	---	---	---	---	---
May	2	11/06/08	173	7.45	58.6	254	897	115
May	2	12/08/08	198	7.1	76.6	287	757	256
May	3	08/15/08	---	---	---	---	---	---
May	3	09/12/08	---	---	---	---	---	---
May	3	11/06/08	---	---	---	---	---	---
May	3	12/08/08	79	7.76	219	525	9237	255
May	4	08/15/08	---	---	---	---	---	---
May	4	09/12/08	---	---	---	---	---	---
May	4	11/06/08	---	---	---	---	---	---
May	4	12/08/08	140	7.07	62.2	276	3718	277
May	5	08/15/08	---	---	---	---	---	---
May	5	09/12/08	---	---	---	---	---	---
May	5	11/06/08	---	---	---	---	---	---
May	5	12/08/08	---	---	---	---	---	---
Lulu	1	08/15/08	---	---	---	---	---	---
Lulu	1	09/12/08	---	---	---	---	---	---
Lulu	1	11/06/08	137	7.38	58.8	268	772	11
Lulu	1	12/18/08	164	7.46	78.2	273	624	4
Lulu	2	08/15/08	---	---	---	---	---	---
Lulu	2	09/12/08	374	6.49	34.6	194	1213	1
Lulu	2	11/06/08	434	6.97	49.8	235	1809	6
Lulu	2	12/18/08	508	6.79	54.2	226	1430	3
Lulu	3	08/15/08	---	---	---	---	---	---
Lulu	3	09/12/08	128	6.78	56	266	1440	35
Lulu	3	11/06/08	163	7.56	63.2	297	2246	146
Lulu	3	12/18/08	186	7.22	67.2	266	1704	56
Lulu	4	08/15/08	---	---	---	---	---	---
Lulu	4	09/12/08	---	---	---	---	---	---
Lulu	4	11/06/08	102	7.86	71.4	297	1561	9
Lulu	4	12/18/08	---	---	---	---	---	---
Lulu	5	08/15/08	---	---	---	---	---	---
Lulu	5	09/12/08	---	---	---	---	---	---
Lulu	5	11/06/08	60	7.79	80.2	306	1286	13
Lulu	5	12/18/08	---	---	---	---	---	---
Lulu	6	08/15/08	---	---	---	---	---	---
Lulu	6	09/12/08	---	---	---	---	---	---
Lulu	6	11/06/08	---	---	---	---	---	---
Lulu	6	12/18/08	---	---	---	---	---	---
Lulu	7	08/15/08	---	---	---	---	---	---
Lulu	7	09/12/08	---	---	---	---	---	---
Lulu	7	11/06/08	103	8.05	85.2	315	2463	61
Lulu	7	12/18/08	---	---	---	---	---	---
Lulu	8	08/15/08	---	---	---	---	---	---
Lulu	8	09/12/08	57	7.42	67.8	293	2322	55
Lulu	8	11/06/08	---	---	---	---	---	---
Lulu	8	12/18/08	---	---	---	---	---	---

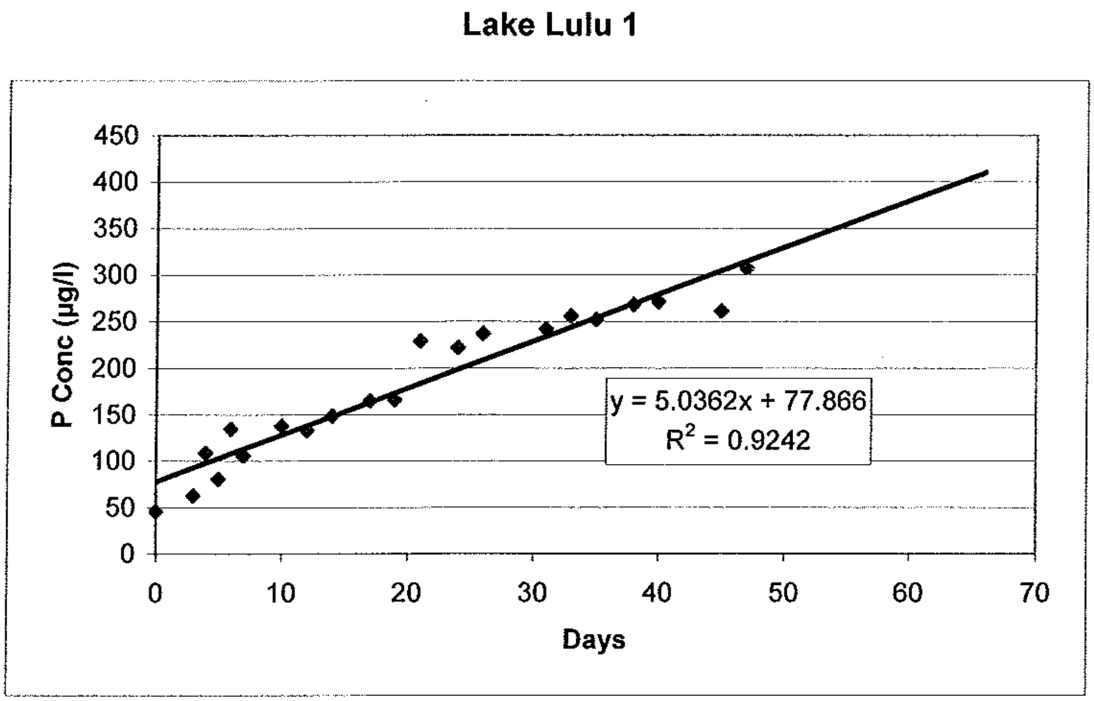
Winter Haven Seepage - July to December 2008

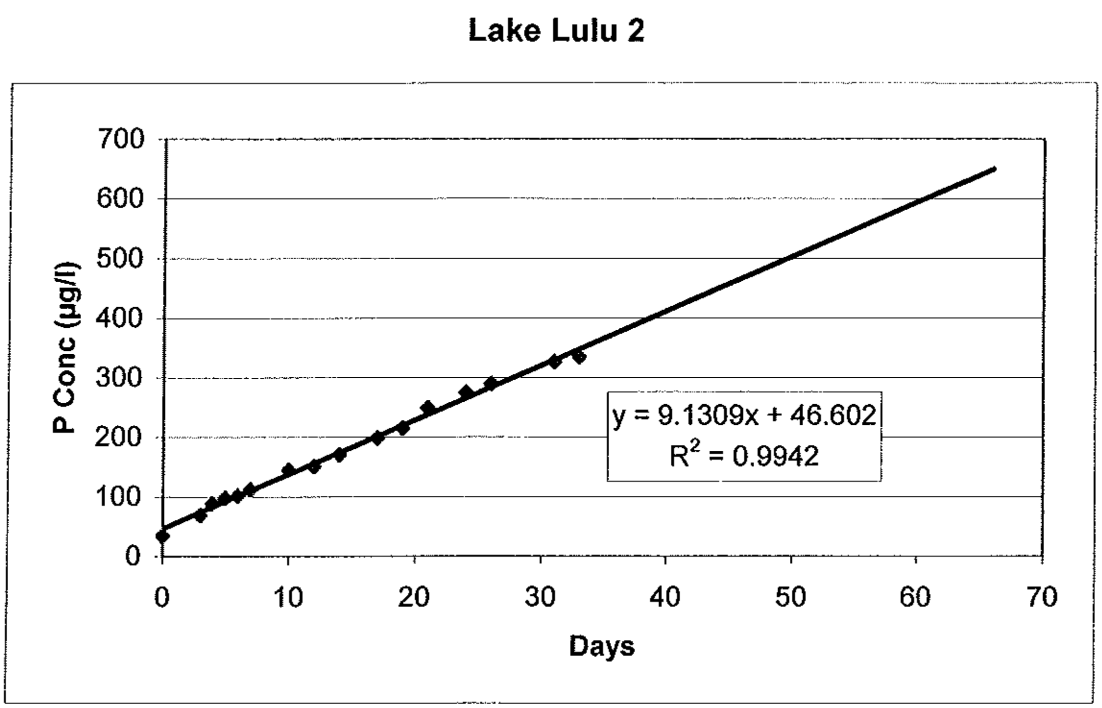
Lake	Site	Date	Percent of Purge Volume	pH	Alkalinity (mg/l)	Cond (µmho/cm)	Total N (µg/l)	Total P (µg/l)
Lulu	9	08/15/08	---	---	---	---	---	---
Lulu	9	09/12/08	---	---	---	---	---	---
Lulu	9	11/06/08	---	---	---	---	---	---
Lulu	9	12/18/08	151	6.55	42.4	336	1859	324
Lulu	10	08/15/08	---	---	---	---	---	---
Lulu	10	09/12/08	---	---	---	---	---	---
Lulu	10	11/06/08	---	---	---	---	---	---
Lulu	10	12/18/08	135	7.5	65.8	269	1396	56
Lulu	11	08/15/08	---	---	---	---	---	---
Lulu	11	09/12/08	68	7.26	64	262	1142	18
Lulu	11	11/06/08	---	---	---	---	---	---
Lulu	11	12/18/08	---	---	---	---	---	---
Shipp	1	08/15/08	---	---	---	---	---	---
Shipp	1	09/12/08	115	6.86	52.4	298	731	13
Shipp	1	11/06/08	147	7.42	58.2	249	1300	55
Shipp	1	12/08/08	222	7.29	166	447	7593	317
Shipp	2	08/15/08						
Shipp	2	09/12/08	388	6.97	66	233	2662	51
Shipp	2	11/06/08	481	7.52	60.2	236	1215	13
Shipp	2	12/08/08	595	6.94	54.6	223	1316	191
Shipp	3	08/15/08	---	---	---	---	---	---
Shipp	3	09/12/08	---	---	---	---	---	---
Shipp	3	11/06/08	---	---	---	---	---	---
Shipp	3	12/08/08	118	6.83	28.6	219	966	191
Shipp	4	08/15/08	---	---	---	---	---	---
Shipp	4	09/12/08	151	6.84	86	344	3947	70
Shipp	4	11/06/08	202	7.84	86.4	315	2436	15
Shipp	4	12/08/08	262	7.43	88	284	698	142
Shipp	5	08/15/08	---	---	---	---	---	---
Shipp	5	09/12/08	---	---	---	---	---	---
Shipp	5	11/06/08	128	7.63	62.4	254	1254	6
Shipp	5	12/08/08	168	7.96	126	339	2102	183
Shipp	6	08/15/08	---	---	---	---	---	---
Shipp	6	09/12/08	379	6.69	60.8	259	968	25
Shipp	6	11/06/08	769	8.05	57.2	263	585	47
Shipp	6	12/08/08	843	6.8	52	241	863	403
Shipp	7	08/15/08	---	---	---	---	---	---
Shipp	7	09/12/08	---	---	---	---	---	---
Shipp	7	11/06/08	---	---	---	---	---	---
Shipp	7	12/08/08	136	7.37	64.2	247	1431	147
Shipp	8	08/15/08	---	---	---	---	---	---
Shipp	8	09/12/08	---	---	---	---	---	---
Shipp	8	11/06/08	---	---	---	---	---	---
Shipp	8	12/08/08	---	---	---	---	---	---
Shipp	9	08/15/08	---	---	---	---	---	---
Shipp	9	09/12/08	---	---	---	---	---	---
Shipp	9	11/06/08	130	6.68	18.2	322	7804	73
Shipp	9	12/08/08	180	6.77	65.2	256	2909	175
Shipp	10	08/15/08	---	---	---	---	---	---
Shipp	10	09/12/08	---	---	---	---	---	---
Shipp	10	11/06/08	87	7.05	55.6	324	13238	221
Shipp	10	12/08/08	177	---	---	---	---	---

APPENDIX I

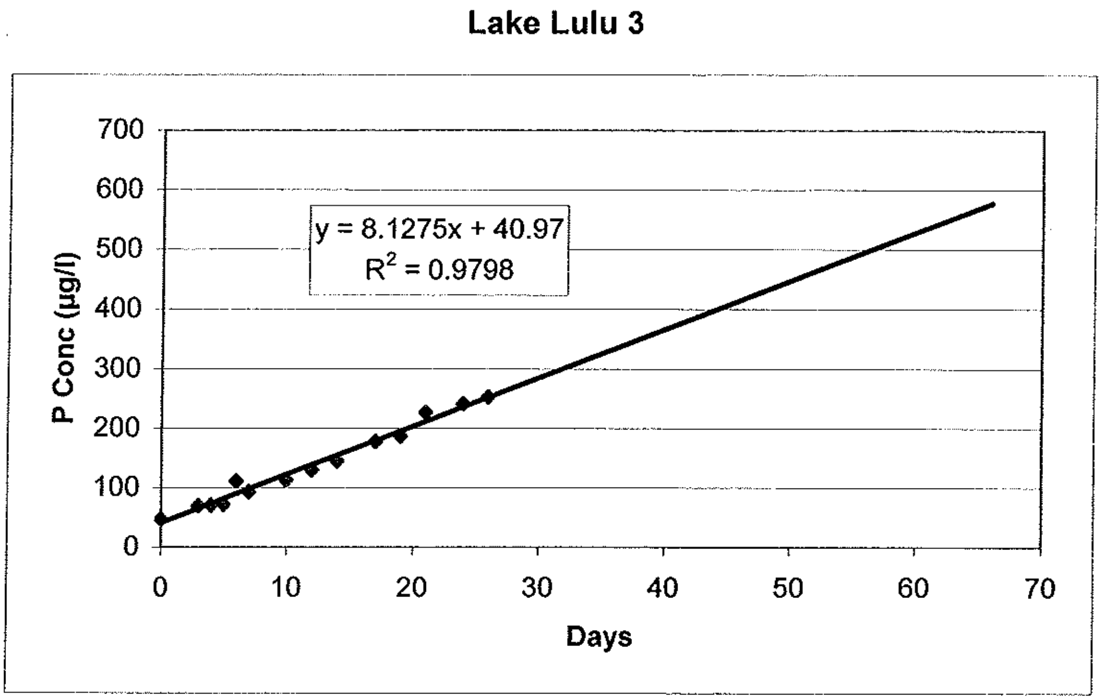
REGRESSION RELATIONSHIPS FOR ESTIMATION OF SEDIMENT PHOSPHORUS RELEASE RATES IN THE INCUBATION EXPERIMENTS

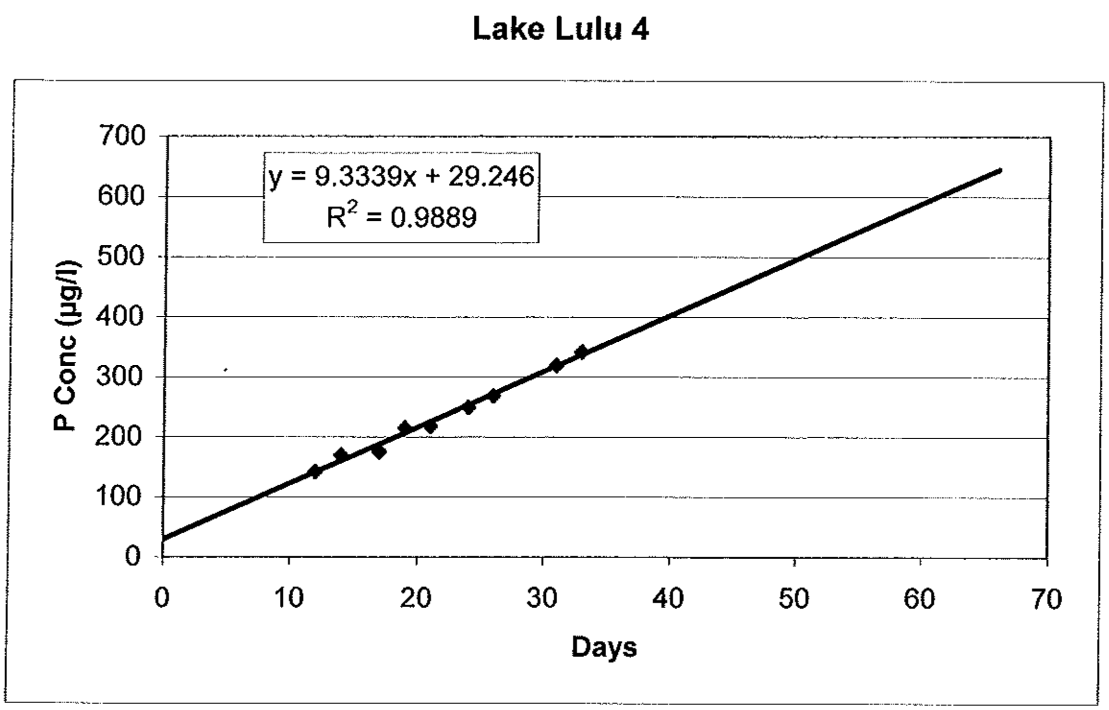
Anoxic Conditions





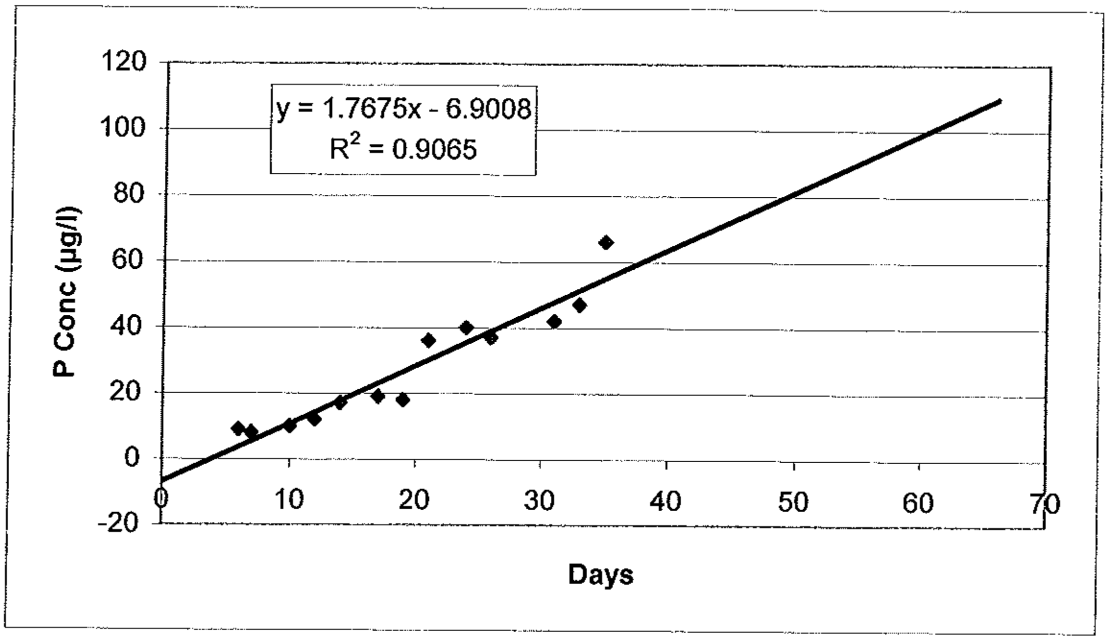
Anoxic Conditions



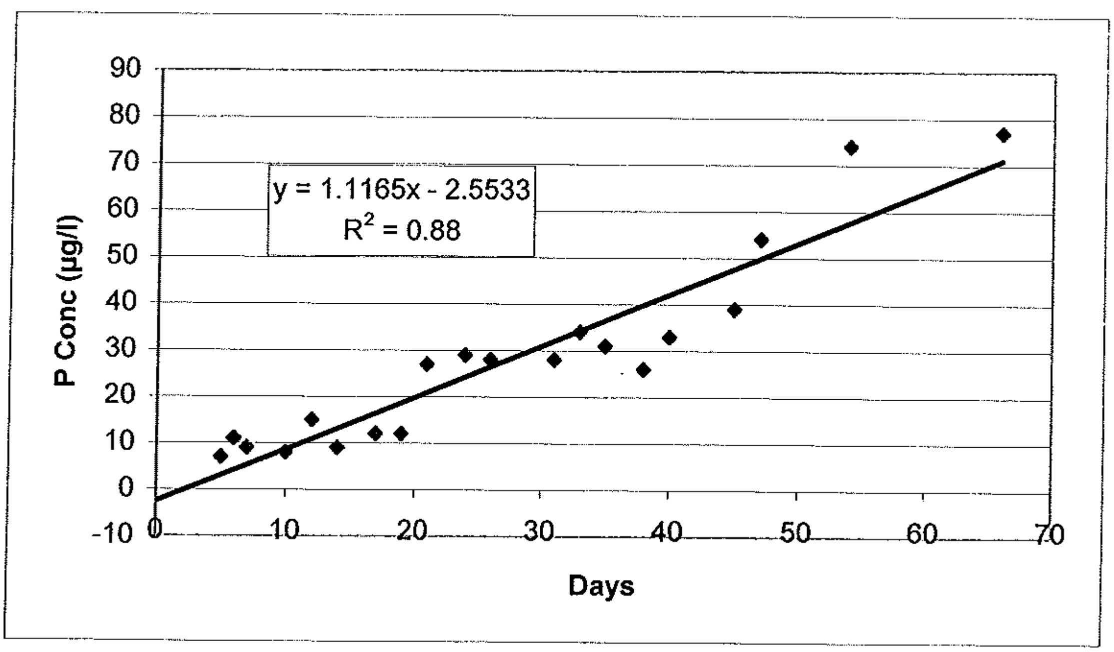


Anoxic Conditions

Lake May Deep

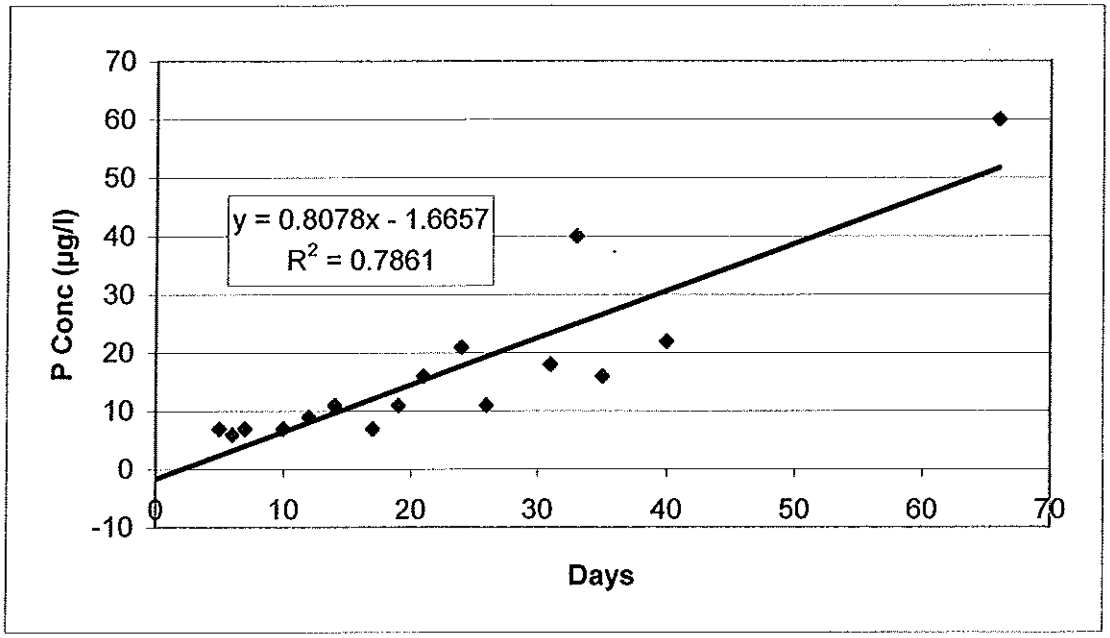


Lake May Shallow

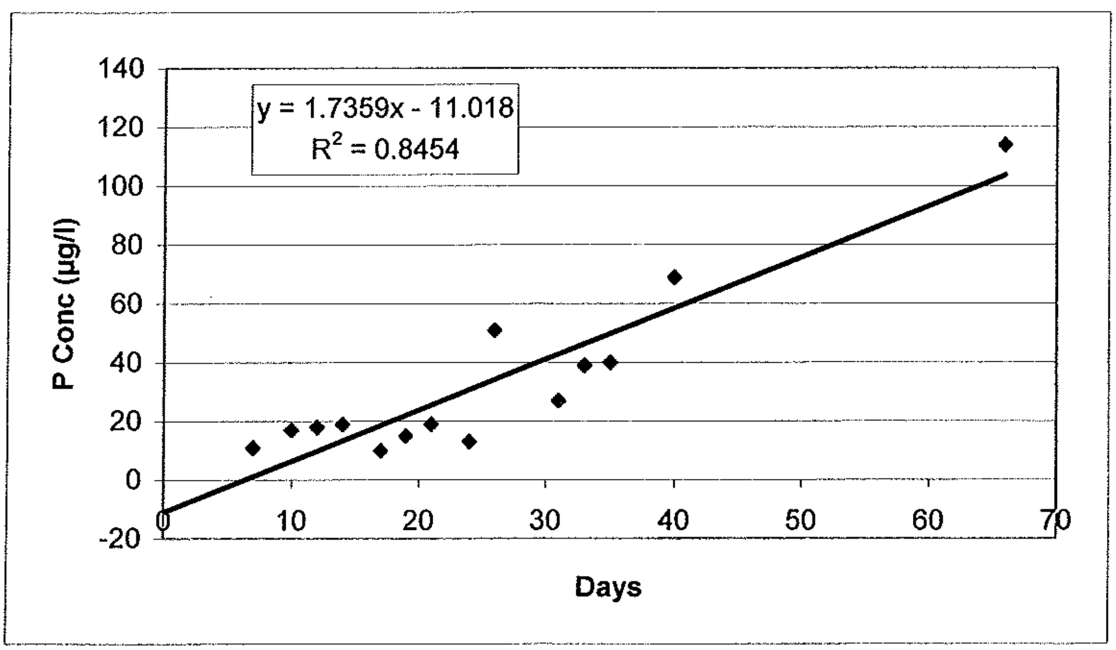


Anoxic Conditions

Lake Shipp 1

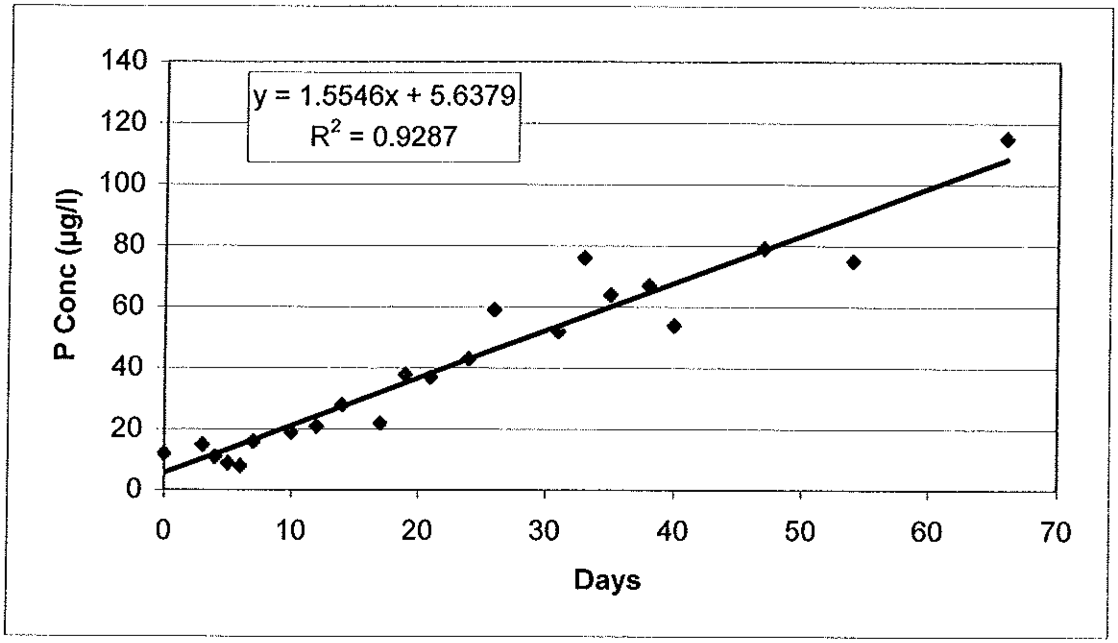


Lake Shipp 2

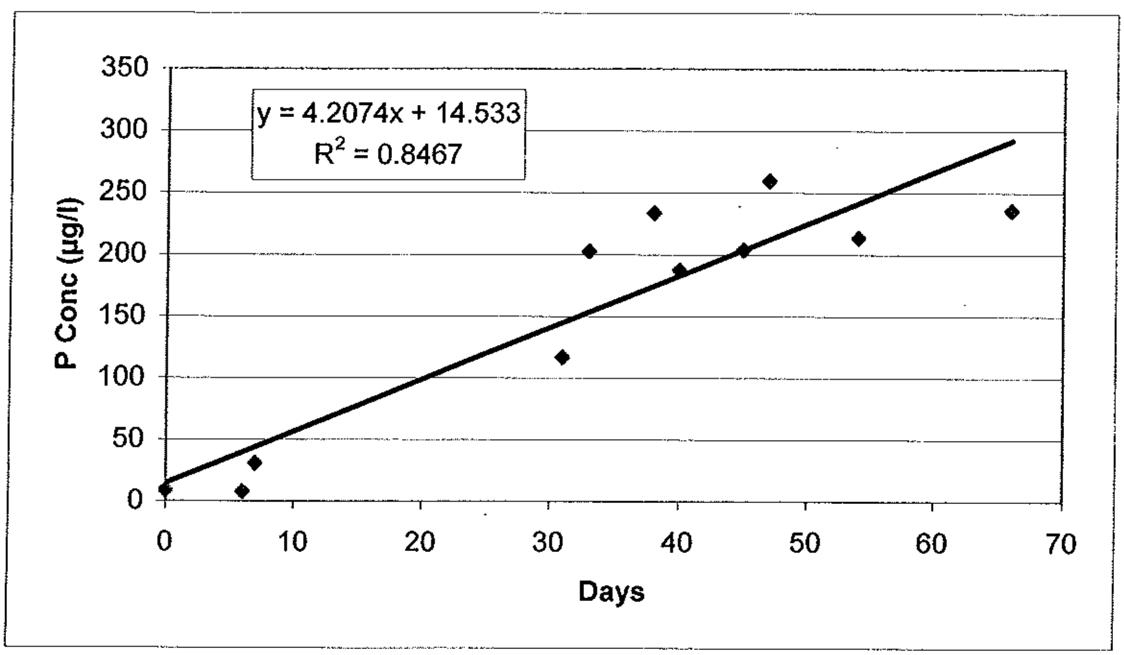


Anoxic Conditions

Lake Shipp 3

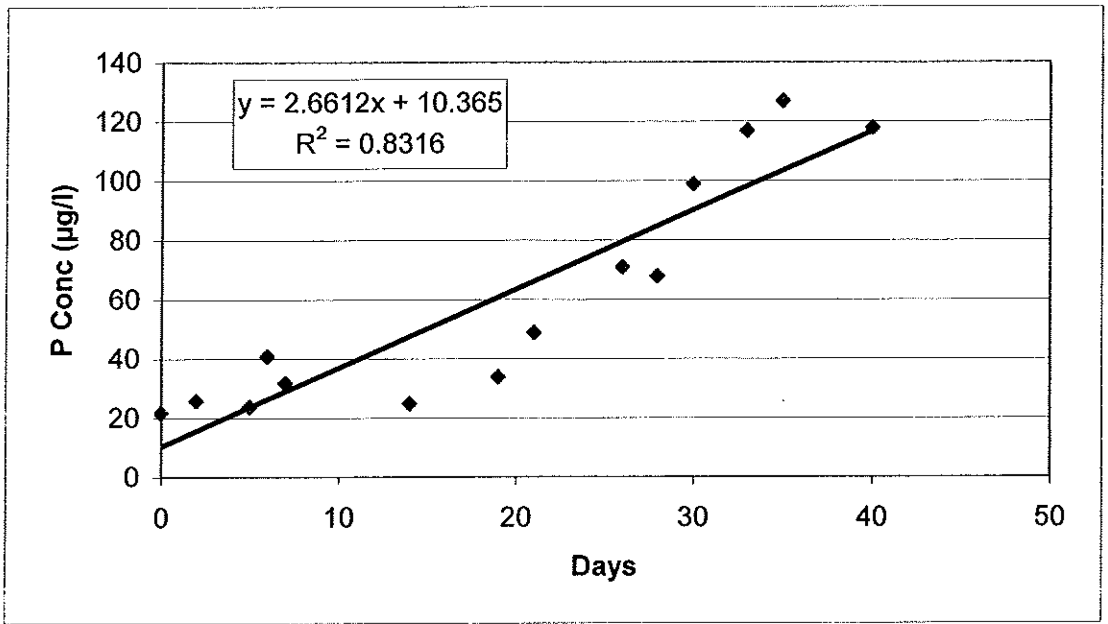


Lake Shipp 4

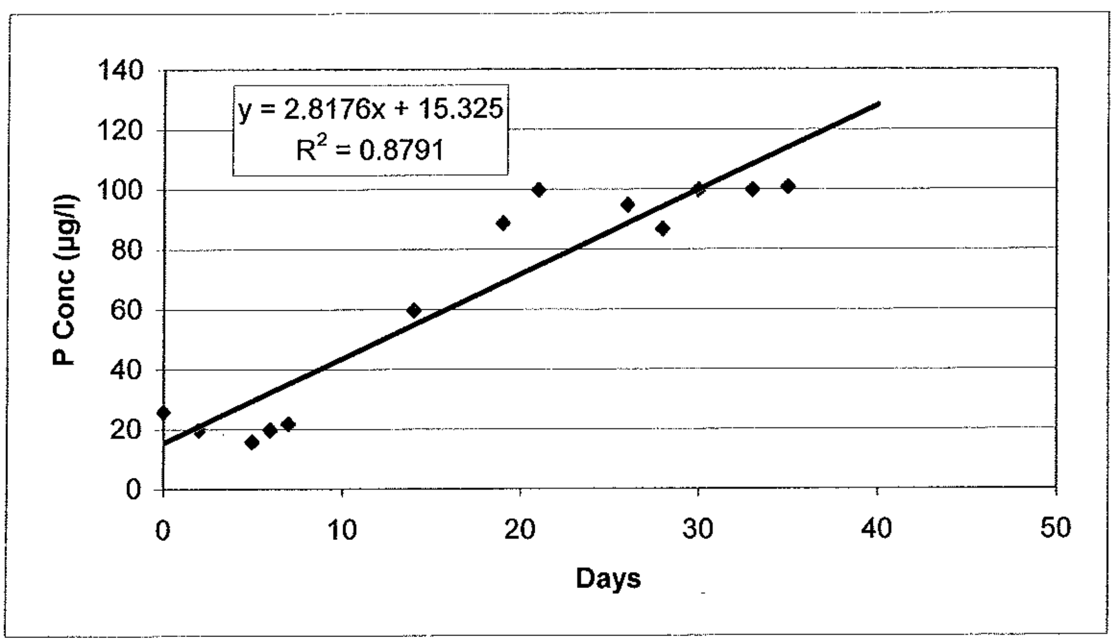


Aerobic Conditions

Lake Lulu 1

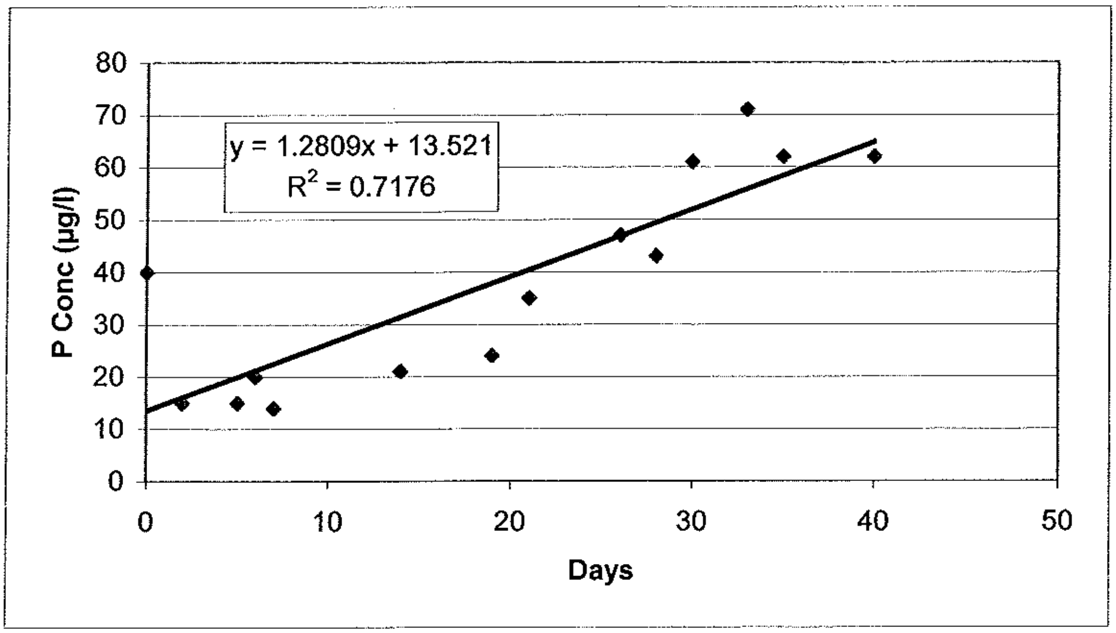


Lake Lulu 2

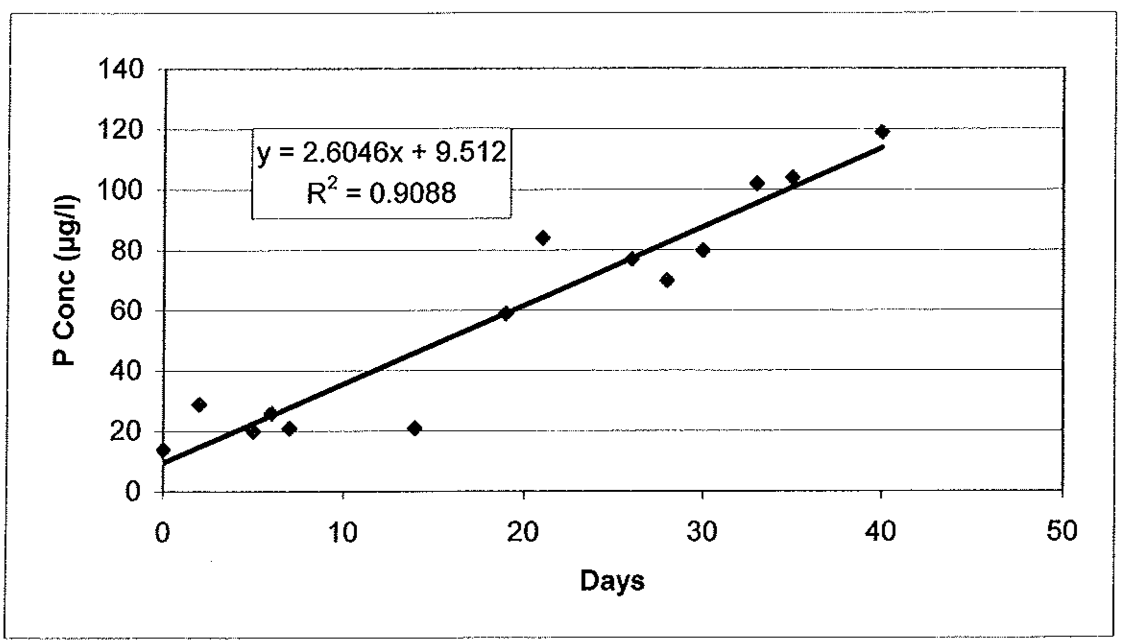


Aerobic Conditions

Lake Lulu 3

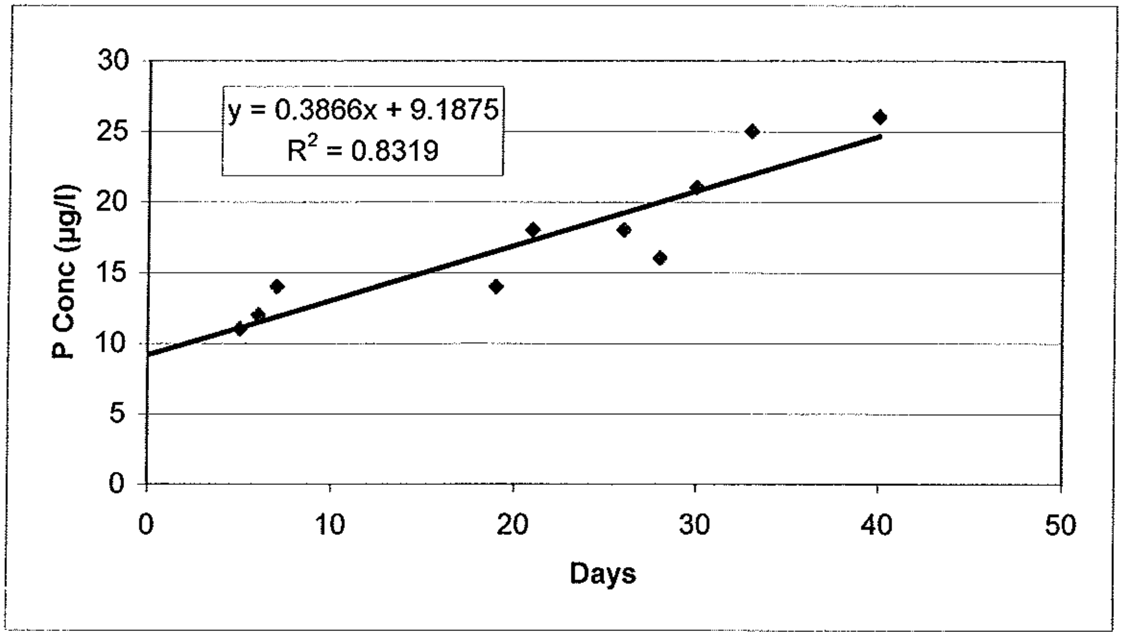


Lake Lulu 4

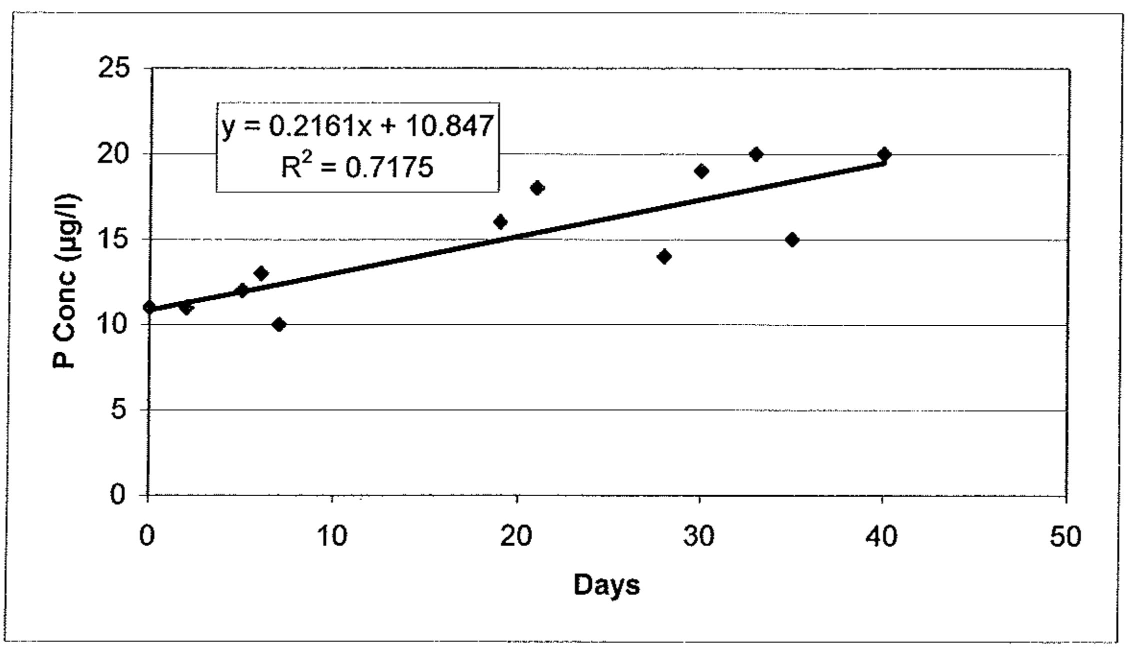


Aerobic Conditions

Lake May Deep

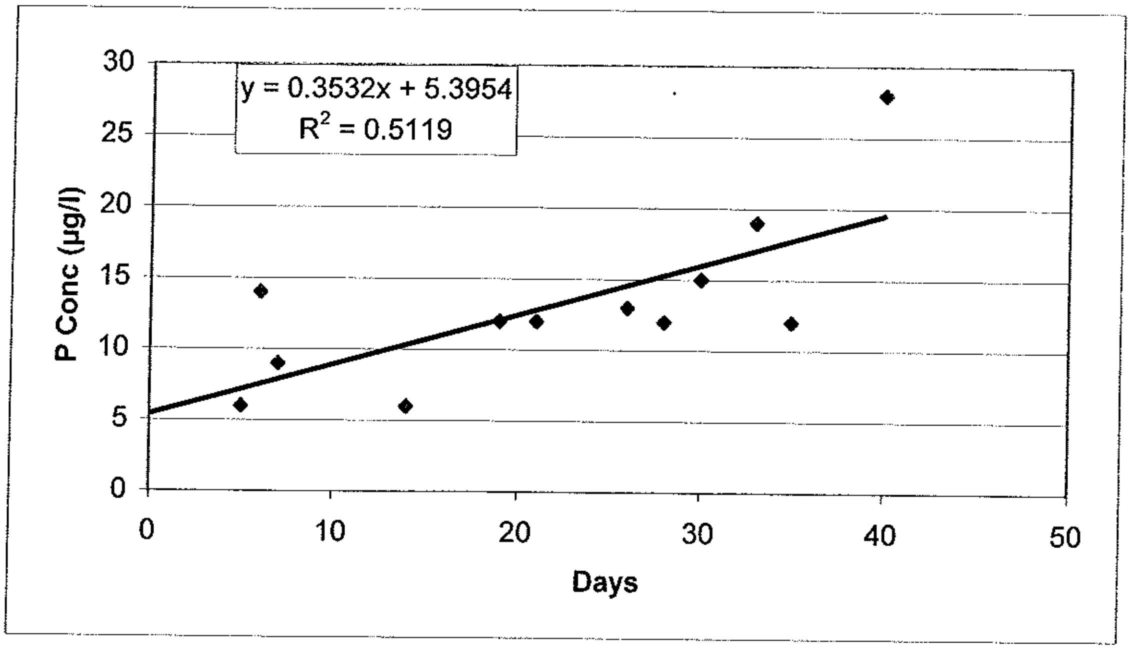


Lake May Shallow

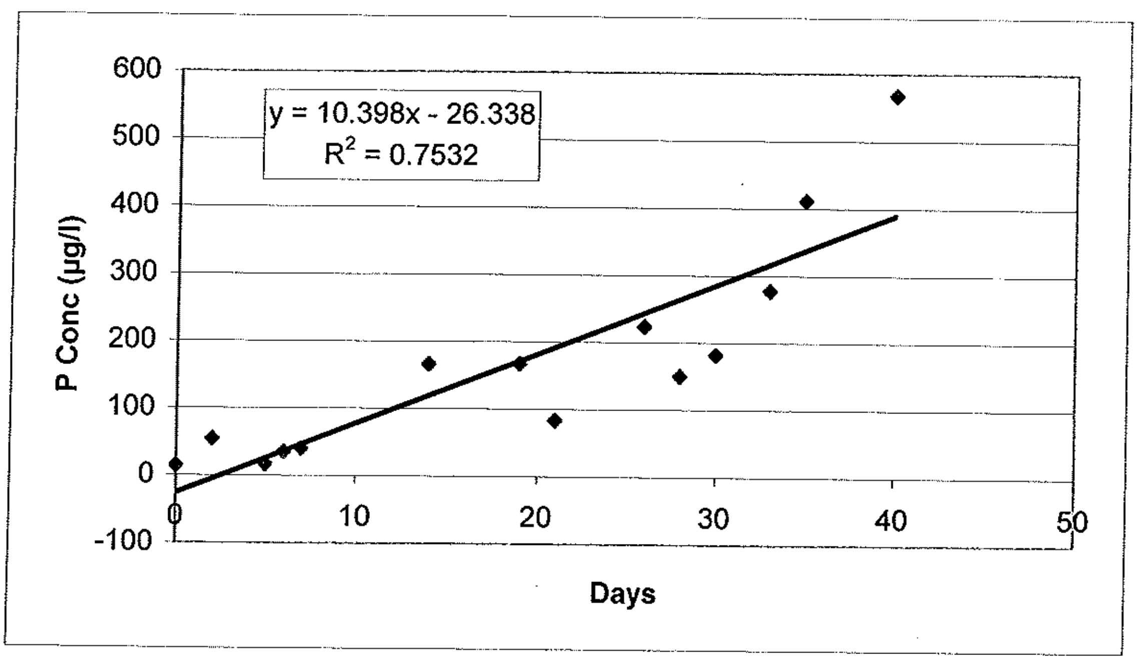


Aerobic Conditions

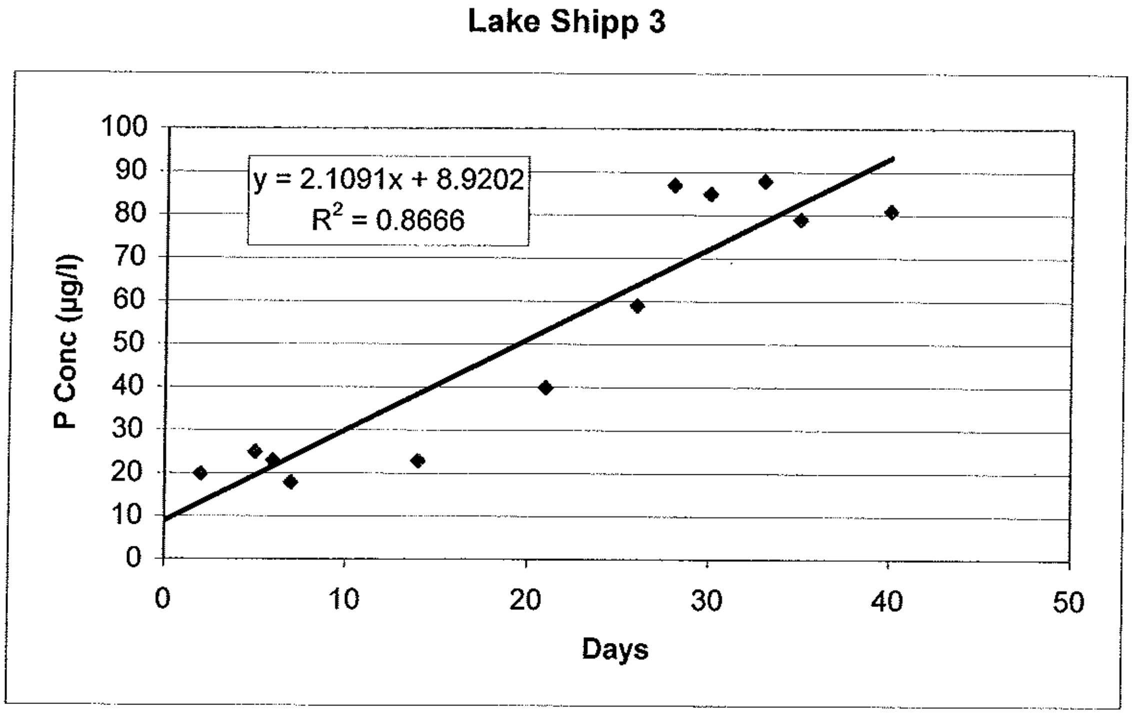
Lake Shipp 1

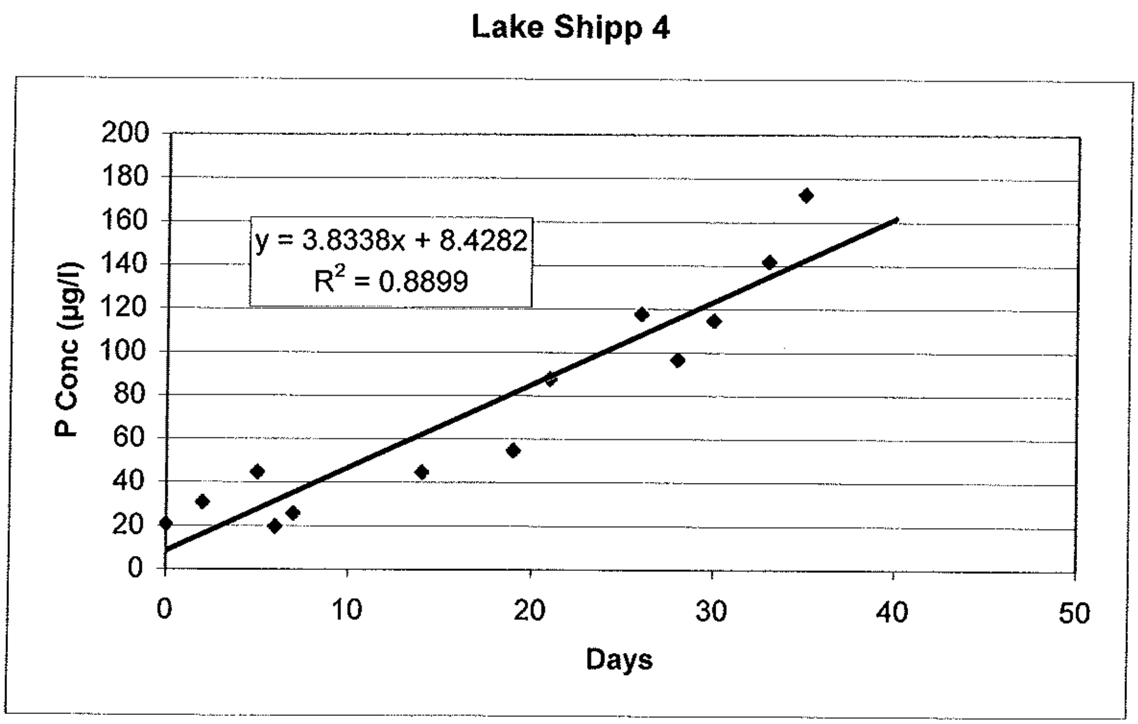


Lake Shipp 2



Aerobic Conditions





APPENDIX J

RESULTS OF ISOLATION CHAMBER EXPERIMENTS

1. **Field Data**
   a. **Original Program**
   b. **Supplemental Program**

2. **Lab Analyses**
   a. **Original Program**
   b. **Supplemental Program**

1a. Field Data - Original Program

Field Data for Wet Season Isolation Chamber Experiments in Lakes May and Shipp

Lake	Location	Date	Time	Depth (meters)	'emperatur (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (mg/l)	DO (mg/l)	DO% (Sat)	ORP (mv)
May	Lake	7/27/09	9:24	0.25	29.63	7.39	251	161	5.1	67	291
May	Lake	7/27/09	9:25	0.50	29.65	7.37	250	160	5.0	66	298
May	Lake	7/27/09	9:26	1.00	29.49	7.10	253	162	3.5	46	294
May	Lake	7/27/09	9:27	1.10	29.42	6.97	253	162	1.6	21	199
May	1W	7/27/09	9:29	0.25	29.60	7.08	256	164	2.5	32	256
May	1W	7/27/09	9:30	0.50	29.66	7.10	256	164	2.1	28	264
May	1W	7/27/09	9:31	0.99	29.63	6.87	260	166	1.3	17	44
May	2W	7/27/09	9:19	0.25	29.41	7.28	252	162	4.0	52	462
May	2W	7/27/09	9:20	0.50	29.49	7.25	252	161	3.9	51	449
May	2W	7/27/09	9:22	0.97	29.51	7.09	257	164	2.2	29	253
May	3W	7/27/09	9:33	0.25	29.70	7.45	251	161	4.7	61	214
May	3W	7/27/09	9:34	0.50	29.70	7.45	251	161	5.0	66	245
May	3W	7/27/09	9:36	0.98	29.68	7.33	251	161	2.8	37	115
May	4WO	7/27/09	9:51	0.25	29.71	7.23	255	163	3.9	51	277
May	4WO	7/27/09	9:52	0.50	29.77	7.20	254	163	4.5	59	276
May	4WO	7/27/09	9:54	1.00	29.77	7.16	254	163	4.3	56	275
May	4WO	7/27/09	9:55	1.50	29.77	7.09	254	163	4.2	55	265
May	4WO	7/27/09	9:56	1.88	28.56	6.19	346	221	0.4	5	-51
May	5WO	7/27/09	9:58	0.25	29.57	7.50	254	163	4.1	54	201
May	5WO	7/27/09	9:59	0.50	29.56	7.51	254	163	3.8	50	229
May	5WO	7/27/09	10:01	1.00	29.56	7.46	254	162	4.3	56	249
May	5WO	7/27/09	10:02	1.46	29.63	6.74	288	184	0.2	3	24
May	6WO	7/27/09	10:04	0.25	29.86	7.11	253	162	3.8	50	166
May	6WO	7/27/09	10:05	0.50	29.86	7.11	253	162	3.9	51	200
May	6WO	7/27/09	10:06	1.00	29.85	7.07	253	162	3.6	47	217
May	6WO	7/27/09	10:07	1.50	29.83	6.95	254	162	3.2	42	220
May	6WO	7/27/09	10:08	1.95	28.62	6.30	414	265	0.2	3	-69

Field Data for Wet Season Isolation Chamber Experiments in Lakes May and Shipp

Lake	Location	Date	Time	Depth (meters)	'emperatur (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (mg/l)	DO (mg/l)	DO% (Sat)	ORP (mv)
May	Lake	8/17/09	9:09	0.25	29.16	7.32	237	152	5.5	72	291
May	Lake	8/17/09	9:10	0.50	29.16	7.32	237	152	5.7	75	302
May	Lake	8/17/09	9:11	1.00	29.15	7.16	237	152	5.0	66	298
May	Lake	8/17/09	9:13	1.15	29.15	7.14	237	152	4.8	62	199
May	1W	8/17/09	9:20	0.25	29.11	8.12	231	148	5.3	70	275
May	1W	8/17/09	9:21	0.50	29.12	8.10	230	147	5.4	70	289
May	1W	8/17/09	9:24	0.99	29.18	6.93	232	149	0.8	10	176
May	2W	8/17/09	9:15	0.25	29.04	7.04	222	142	4.5	58	247
May	2W	8/17/09	9:15	0.50	29.04	7.02	222	142	4.4	57	258
May	2W	8/17/09	9:18	0.98	29.09	6.98	241	154	0.9	12	194
May	3W	8/17/09	9:04	0.25	29.08	7.97	229	146	6.4	84	356
May	3W	8/17/09	9:05	0.50	29.10	7.95	229	147	6.2	81	355
May	3W	8/17/09	9:07	0.99	29.12	7.85	229	147	5.9	77	286
May	4WO	8/17/09	9:52	0.25	29.32	6.61	255	163	4.5	59	160
May	4WO	8/17/09	9:53	0.50	29.31	6.59	254	163	4.2	55	194
May	4WO	8/17/09	9:54	1.00	29.30	6.58	254	163	3.8	50	210
May	4WO	8/17/09	9:55	1.50	29.29	6.57	254	163	3.7	48	218
May	4WO	8/17/09	9:56	1.92	29.01	6.09	337	215	0.6	8	1
May	5WO	8/17/09	9:46	0.25	29.13	7.34	232	149	5.4	71	194
May	5WO	8/17/09	9:47	0.50	29.12	7.34	232	149	5.4	70	222
May	5WO	8/17/09	9:48	1.00	29.11	7.32	232	149	5.3	70	242
May	5WO	8/17/09	9:49	1.50	29.39	6.34	340	217	0.3	3	28
May	5WO	8/17/09	9:50	1.84	29.51	6.32	367	235	0.2	3	16
May	6WO	8/17/09	9:40	0.25	29.37	6.77	259	166	4.9	64	272
May	6WO	8/17/09	9:41	0.50	29.36	6.74	260	166	4.5	60	272
May	6WO	8/17/09	9:42	1.00	29.36	6.72	260	166	4.5	59	274
May	6WO	8/17/09	9:43	1.50	29.35	6.67	260	167	4.2	55	174
May	6WO	8/17/09	9:45	1.89	29.13	6.16	371	237	1.2	15	8

Field Data for Wet Season Isolation Chamber Experiments in Lakes May and Shipp

Lake	Location	Date	Time	Depth (meters)	'emperatur (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (mg/l)	DO (mg/l)	DO% (Sat)	ORP (mv)
May	Lake	9/3/09	8:38	0.25	28.65	7.16	250	160	4.1	53	368
May	Lake	9/3/09	8:39	0.50	28.66	7.12	250	160	4.1	52	384
May	Lake	9/3/09	8:41	0.99	28.64	7.10	250	160	3.9	50	401
May	1w	9/3/09	8:42	0.25	28.66	8.43	233	149	4.9	63	457
May	1w	9/3/09	8:44	0.50	28.65	8.41	233	149	4.9	63	458
May	1w	9/3/09	8:45	0.97	28.70	7.10	246	158	2.1	27	272
May	2w	9/3/09	8:47	0.25	28.50	7.16	220	141	4.6	60	344
May	2w	9/3/09	8:48	0.50	28.50	7.15	220	141	4.7	61	365
May	2w	9/3/09	8:52	0.99	28.58	7.09	240	153	1.8	23	343
May	3w	9/3/09	8:33	0.25	28.66	8.31	225	144	5.7	73	490
May	3w	9/3/09	8:34	0.50	28.65	8.30	226	144	5.6	72	488
May	3w	9/3/09	8:36	1.00	28.69	7.78	228	146	4.7	61	306
May	4wo	9/3/09	9:18	0.25	28.80	6.66	258	165	0.8	11	244
May	4wo	9/3/09	9:19	0.50	28.80	6.66	258	165	0.6	8	246
May	4wo	9/3/09	9:20	1.00	28.80	6.65	258	165	0.6	8	249
May	4wo	9/3/09	9:21	1.50	28.80	6.64	258	165	0.7	9	250
May	4wo	9/3/09	9:22	1.72	28.80	6.60	258	165	0.6	8	174
May	5wo	9/3/09	9:10	0.25	28.66	8.01	229	146	5.2	67	273
May	5wo	9/3/09	9:11	0.50	28.66	8.01	228	146	5.3	68	303
May	5wo	9/3/09	9:12	1.00	28.65	7.96	229	146	5.3	68	316
May	5wo	9/3/09	9:15	1.33	28.74	6.90	246	157	0.7	9	219
May	6wo	9/3/09	9:03	0.25	28.96	7.01	259	166	2.4	32	375
May	6wo	9/3/09	9:04	0.50	28.96	6.97	259	166	2.2	29	372
May	6wo	9/3/09	9:05	1.00	28.96	6.92	260	166	2.2	28	317
May	6wo	9/3/09	9:06	1.50	28.95	6.69	265	170	2.0	25	112
May	6wo	9/3/09	9:08	1.78	28.81	6.26	308	197	1.3	16	28

Field Data for Wet Season Isolation Chamber Experiments in Lakes May and Shipp

Lake	Location	Date	Time	Depth (meters)	'emperatur (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (mg/l)	DO (mg/l)	DO% (Sat)	ORP (mv)
May	Lake	9/17/09	8:38	0.25	29.56	7.60	247	158	5.5	72	208
May	Lake	9/17/09	8:38	0.50	29.56	7.52	247	158	5.3	69	234
May	Lake	9/17/09	8:40	1.00	29.56	7.50	247	158	5.2	69	249
May	Lake	9/17/09	8:42	1.14	29.56	7.46	246	157	3.3	43	197
May	1w	9/17/09	8:43	0.25	29.60	8.90	235	150	5.7	74	279
May	1w	9/17/09	8:44	0.50	29.60	8.91	235	150	5.6	74	285
May	1w	9/17/09	8:46	1.00	29.61	8.20	238	152	4.8	64	159
May	1w	9/17/09	8:47	1.07	29.62	6.72	281	180	0.4	5	64
May	2w	9/17/09	8:24	0.25	29.45	7.21	215	137	4.7	62	304
May	2w	9/17/09	8:25	0.50	29.46	7.15	215	137	4.1	54	302
May	2w	9/17/09	8:27	0.98	29.50	6.84	271	174	0.3	4	170
May	3w	9/17/09	8:31	0.25	29.52	8.61	222	142	4.7	62	286
May	3w	9/17/09	8:32	0.50	29.61	8.63	222	142	5.0	65	292
May	3w	9/17/09	8:35	1.00	29.57	7.69	222	142	3.2	42	193
May	4wo	9/17/09	9:12	0.25	29.56	7.63	250	160	8.1	107	208
May	4wo	9/17/09	9:14	0.50	29.57	7.60	250	160	8.0	106	233
May	4wo	9/17/09	9:15	1.00	29.55	7.60	250	160	8.1	107	244
May	4wo	9/17/09	9:16	1.50	28.45	6.50	261	167	0.3	4	-72
May	4wo	9/17/09	9:17	1.90	28.14	6.09	304	194	0.2	2	-107
May	5w	9/17/09	8:57	0.25	29.35	8.44	230	147	6.2	81	295
May	5w	9/17/09	8:59	0.50	29.35	8.47	230	147	6.0	79	294
May	5w	9/17/09	9:00	1.00	29.36	8.37	230	147	6.0	78	292
May	5w	9/17/09	9:03	1.25	29.36	8.13	230	147	5.7	74	245
May	6wo	9/17/09	9:05	0.25	29.60	7.61	262	168	7.4	97	249
May	6wo	9/17/09	9:06	0.50	29.60	7.59	262	168	7.4	97	254
May	6wo	9/17/09	9:08	1.00	29.57	7.50	263	168	6.7	89	254
May	6wo	9/17/09	9:09	1.50	28.43	6.55	276	177	0.5	6	-63
May	6wo	9/17/09	9:10	1.94	28.24	6.19	304	194	0.2	2	-100

Field Data for Wet Season Isolation Chamber Experiments in Lakes May and Shipp

Lake	Location	Date	Time	Depth (meters)	'emperatur (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (mg/l)	DO (mg/l)	DO% (Sat)	ORP (mv)
May	Lake	10/1/09	8:44	0.25	24.96	7.38	262	168	6.2	76	344
May	Lake	10/1/09	8:45	0.50	24.99	7.35	262	167	6.3	76	339
May	Lake	10/1/09	8:47	1.00	25.01	7.31	261	167	6.1	74	316
May	1w	10/1/09	8:49	0.25	25.42	8.68	243	156	6.5	79	342
May	1w	10/1/09	8:50	0.50	25.42	8.68	243	156	6.6	80	341
May	1w	10/1/09	8:53	1.00	25.64	6.94	270	173	1.1	14	250
May	2w	10/1/09	8:55	0.25	25.39	8.68	228	146	7.0	85	300
May	2w	10/1/09	8:56	0.50	25.40	8.67	228	146	7.1	86	304
May	2w	10/1/09	8:59	1.00	25.42	8.30	228	146	5.8	71	236
May	3w	10/1/09	9:01	0.25	25.33	7.11	223	143	5.9	72	268
May	3w	10/1/09	9:02	0.50	25.32	7.09	223	143	5.9	72	274
May	3w	10/1/09	9:03	0.96	25.46	7.04	232	149	5.0	61	204
May	4wo	10/1/09	9:21	0.25	26.18	6.73	270	173	0.5	6	220
May	4wo	10/1/09	9:22	0.50	26.18	6.72	271	173	0.3	4	211
May	4wo	10/1/09	9:23	1.00	26.20	6.71	271	173	0.3	3	206
May	4wo	10/1/09	9:24	1.50	26.20	6.70	271	173	0.2	2	199
May	4wo	10/1/09	9:25	1.84	26.24	6.42	273	175	0.2	3	-54
May	5wo	10/1/09	9:27	0.25	25.19	8.36	241	154	7.1	86	252
May	5wo	10/1/09	9:28	0.50	25.20	8.38	241	154	7.1	86	271
May	5wo	10/1/09	9:29	1.00	25.19	8.38	241	154	7.1	86	280
May	5wo	10/1/09	9:30	1.31	25.48	6.65	293	187	0.4	5	8
May	6wo	10/1/09	9:32	0.25	26.26	6.84	276	177	0.5	6	102
May	6wo	10/1/09	9:33	0.50	26.26	6.83	276	177	0.3	4	110
May	6wo	10/1/09	9:33	1.00	26.26	6.82	276	177	0.3	4	118
May	6wo	10/1/09	9:34	1.50	26.26	6.82	276	177	0.3	4	123
May	6wo	10/1/09	9:35	1.86	26.44	6.37	306	196	0.1	2	-56

Field Data for Wet Season Isolation Chamber Experiments in Lakes May and Shipp

Lake	Location	Date	Time	Depth (meters)	'emperatur (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (mg/l)	DO (mg/l)	DO% (Sat)	ORP (mv)
May	Lake	10/15/09	8:30	0.25	29.42	7.38	270	173	5.8	76	343
May	Lake	10/15/09	8:31	0.50	29.36	7.32	271	173	5.3	69	339
May	Lake	10/15/09	8:32	0.90	29.31	7.20	272	174	4.4	58	320
May	1w	10/15/09	8:34	0.25	29.40	8.52	254	163	5.4	71	339
May	1w	10/15/09	8:35	0.50	29.44	8.51	254	163	5.2	68	336
May	1w	10/15/09	8:37	0.90	29.44	6.93	277	177	0.6	8	281
May	2w	10/15/09	8:39	0.25	29.41	6.95	228	146	5.1	66	285
May	2w	10/15/09	8:40	0.50	29.42	6.94	228	146	5.0	65	287
May	2w	10/15/09	8:42	0.87	29.46	6.86	271	173	0.7	9	249
May	3w	10/15/09	8:44	0.25	29.47	8.80	238	152	6.3	83	297
May	3w	10/15/09	8:45	0.50	29.47	8.80	238	152	6.4	84	299
May	3w	10/15/09	8:48	0.88	29.49	8.66	238	152	5.9	77	254
May	4wo	10/15/09	8:54	0.25	29.51	7.30	265	170	3.1	40	257
May	4wo	10/15/09	8:55	0.50	29.51	7.28	265	170	3.0	39	259
May	4wo	10/15/09	8:56	1.00	29.52	7.26	265	170	2.8	37	259
May	4wo	10/15/09	8:57	1.50	28.98	6.37	289	185	0.6	7	-125
May	4wo	10/15/09	8:57	1.73	28.40	6.23	333	213	0.3	4	-137
May	5wo	10/15/09	8:59	0.25	29.25	7.91	253	162	5.7	75	212
May	5wo	10/15/09	9:00	0.50	29.24	7.92	253	162	5.7	75	232
May	5wo	10/15/09	9:01	1.00	29.24	7.91	253	162	5.7	74	243
May	5wo	10/15/09	9:03	1.13	29.26	6.86	265	169	0.7	9	99
May	6wo	10/15/09	9:05	0.25	29.56	7.62	268	171	3.7	49	186
May	6wo	10/15/09	9:06	0.50	29.56	7.63	268	171	3.8	50	202
May	6wo	10/15/09	9:07	1.00	29.57	7.62	268	172	3.6	47	209
May	6wo	10/15/09	9:08	1.50	29.04	6.54	298	190	0.4	5	-105
May	6wo	10/15/09	9:09	1.79	28.63	6.35	372	238	0.2	3	-132

Field Data for Wet Season Isolation Chamber Experiments in Lakes May and Shipp

Lake	Location	Date	Time	Depth (meters)	'emperatur (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (mg/l)	DO (mg/l)	DO% (Sat)	ORP (mv)
Shipp	Lake	7/27/09	10:36	0.25	30.36	8.43	246	157	5.5	74	246
Shipp	Lake	7/27/09	10:37	0.50	30.33	8.42	245	157	5.7	76	262
Shipp	Lake	7/27/09	10:38	1.00	30.23	8.36	246	157	5.5	74	271
Shipp	Lake	7/27/09	10:39	1.34	30.13	8.23	246	157	4.4	58	271
Shipp	1W	7/27/09	11:13	0.25	30.45	7.21	251	161	3.3	43	267
Shipp	1W	7/27/09	11:14	0.50	30.35	7.20	252	161	3.0	40	265
Shipp	1W	7/27/09	11:15	1.00	30.19	7.17	253	162	2.8	37	263
Shipp	1W	7/27/09	11:16	1.22	30.16	7.15	253	162	2.0	27	261
Shipp	2W	7/27/09	11:23	0.25	30.43	7.18	255	163	2.7	37	253
Shipp	2W	7/27/09	11:24	0.50	30.41	7.19	255	163	2.5	34	252
Shipp	2W	7/27/09	11:25	1.00	30.21	7.14	254	163	2.2	29	252
Shipp	2W	7/27/09	11:27	1.29	30.16	7.11	254	163	1.7	23	250
Shipp	3W	7/27/09	11:18	0.25	30.37	7.17	254	163	2.3	30	257
Shipp	3W	7/27/09	11:19	0.50	30.29	7.15	254	163	2.3	30	255
Shipp	3W	7/27/09	11:20	1.00	30.09	7.12	254	163	1.7	23	252
Shipp	3W	7/27/09	11:21	1.15	30.08	7.12	254	163	1.5	20	251
Shipp	4WO	7/27/09	10:50	0.25	30.12	7.11	256	164	2.3	30	258
Shipp	4WO	7/27/09	10:51	0.50	30.09	7.14	256	164	1.9	26	256
Shipp	4WO	7/27/09	10:52	1.00	29.99	7.07	256	164	1.8	24	254
Shipp	4WO	7/27/09	10:53	1.50	29.96	7.06	255	163	1.7	23	251
Shipp	4WO	7/27/09	10:54	1.58	29.96	7.02	255	163	1.5	20	152
Shipp	5WO	7/27/09	10:30	0.25	30.12	7.00	260	166	1.5	20	320
Shipp	5WO	7/27/09	10:32	0.50	30.12	6.99	260	166	1.3	17	314
Shipp	5WO	7/27/09	10:32	1.00	30.11	6.98	260	166	1.3	17	308
Shipp	5WO	7/27/09	10:33	1.50	30.08	6.97	260	166	1.0	14	302
Shipp	5WO	7/27/09	10:35	1.72	30.07	6.93	260	166	1.0	13	104
Shipp	6WO	7/27/09	10:41	0.25	30.24	7.38	251	161	2.9	39	251
Shipp	6WO	7/27/09	10:43	0.50	30.22	7.36	251	161	3.2	42	255
Shipp	6WO	7/27/09	10:44	1.00	30.17	7.31	251	161	2.9	39	256
Shipp	6WO	7/27/09	10:46	1.47	30.15	7.29	251	160	2.6	35	256

Field Data for Wet Season Isolation Chamber Experiments in Lakes May and Shipp

Lake	Location	Date	Time	Depth (meters)	'emperatur (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (mg/l)	DO (mg/l)	DO% (Sat)	ORP (mv)
Shipp	Lake	8/17/09	10:30	0.25	29.75	8.30	237	152	6.9	91	242
Shipp	Lake	8/17/09	10:31	0.50	29.71	8.22	237	151	6.7	88	266
Shipp	Lake	8/17/09	10:32	1.00	29.61	8.07	237	151	6.4	84	275
Shipp	Lake	8/17/09	10:33	1.34	29.55	7.71	237	152	5.6	74	266
Shipp	1W	8/17/09	11:12	0.25	30.04	8.45	229	146	7.0	92	317
Shipp	1W	8/17/09	11:13	0.50	29.76	8.18	229	146	6.0	80	309
Shipp	1W	8/17/09	11:15	1.00	29.60	7.71	229	146	4.8	63	300
Shipp	1W	8/17/09	11:16	1.23	29.57	7.53	229	147	4.5	59	297
Shipp	2W	8/17/09	11:07	0.25	29.99	9.05	231	148	7.2	96	333
Shipp	2W	8/17/09	11:08	0.50	29.77	8.93	231	148	5.9	78	328
Shipp	2W	8/17/09	11:09	1.00	29.63	8.72	231	148	5.0	66	322
Shipp	2W	8/17/09	11:10	1.27	29.60	8.63	232	148	4.7	62	321
Shipp	3W	8/17/09	11:02	0.25	29.98	8.71	229	146	7.1	94	325
Shipp	3W	8/17/09	11:03	0.50	29.71	8.69	229	146	6.6	87	325
Shipp	3W	8/17/09	11:04	1.00	29.55	8.33	229	147	5.1	66	314
Shipp	3W	8/17/09	11:05	1.17	29.55	8.20	230	147	5.0	65	303
Shipp	4WO	8/17/09	10:42	0.25	29.83	7.23	236	151	4.4	58	259
Shipp	4WO	8/17/09	10:43	0.50	29.71	7.20	236	151	4.0	53	263
Shipp	4WO	8/17/09	10:44	1.00	29.58	7.11	237	151	3.5	46	263
Shipp	4WO	8/17/09	10:45	1.50	29.54	7.06	237	152	3.1	41	262
Shipp	4WO	8/17/09	10:46	1.59	29.54	7.05	237	152	3.1	41	255
Shipp	5WO	8/17/09	10:24	0.25	29.87	7.22	250	160	5.3	70	270
Shipp	5WO	8/17/09	10:25	0.50	29.81	7.17	250	160	4.5	59	271
Shipp	5WO	8/17/09	10:26	1.00	29.69	7.04	250	160	3.4	45	267
Shipp	5WO	8/17/09	10:27	1.50	29.66	7.01	250	160	3.0	40	256
Shipp	5WO	8/17/09	10:28	1.75	29.66	6.98	251	161	2.9	39	83
Shipp	6WO	8/17/09	10:35	0.25	29.90	8.77	235	150	6.3	84	308
Shipp	6WO	8/17/09	10:36	0.50	29.79	8.77	234	150	6.1	81	308
Shipp	6WO	8/17/09	10:37	1.00	29.69	8.58	234	150	5.4	72	305
Shipp	6WO	8/17/09	10:38	1.50	29.66	8.48	235	150	5.1	68	303
Shipp	6WO	8/17/09	10:39	1.58	29.66	8.45	235	150	5.1	67	288

Field Data for Wet Season Isolation Chamber Experiments in Lakes May and Shipp

Lake	Location	Date	Time	Depth (meters)	'emperatur (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (mg/l)	DO (mg/l)	DO% (Sat)	ORP (mv)
Shipp	Lake	9/3/09	9:56	0.25	28.92	8.19	239	153	6.1	79	309
Shipp	Lake	9/3/09	9:57	0.50	28.93	8.17	239	153	6.1	80	331
Shipp	Lake	9/3/09	9:58	1.00	28.87	8.10	239	153	6.1	79	347
Shipp	Lake	9/3/09	9:59	1.27	28.70	7.69	239	153	5.4	70	340
Shipp	1w	9/3/09	10:34	0.25	28.83	7.53	234	150	5.1	66	366
Shipp	1w	9/3/09	10:35	0.50	28.83	7.49	234	150	5.0	64	371
Shipp	1w	9/3/09	10:36	1.00	28.80	7.41	234	150	4.7	61	374
Shipp	1w	9/3/09	10:37	1.20	28.79	7.41	234	150	4.8	62	368
Shipp	2w	9/3/09	10:29	0.25	28.85	8.59	240	153	5.3	69	387
Shipp	2w	9/3/09	10:30	0.50	28.85	8.57	240	153	5.2	68	390
Shipp	2w	9/3/09	10:31	1.00	28.80	8.38	240	154	4.9	63	391
Shipp	2w	9/3/09	10:32	1.27	28.80	8.39	240	154	4.7	62	392
Shipp	3w	9/3/09	10:23	0.25	28.72	8.70	236	151	5.7	73	385
Shipp	3w	9/3/09	10:24	0.50	28.73	8.68	236	151	5.5	71	385
Shipp	3w	9/3/09	10:25	1.00	28.71	8.54	236	151	5.3	68	385
Shipp	3w	9/3/09	10:27	1.15	28.72	8.54	236	151	5.2	67	382
Shipp	4wo	9/3/09	10:02	0.25	28.80	7.33	232	149	4.6	60	353
Shipp	4wo	9/3/09	10:03	0.50	28.80	7.29	232	149	4.5	58	363
Shipp	4wo	9/3/09	10:04	1.00	28.78	7.26	232	149	4.4	57	371
Shipp	4wo	9/3/09	10:05	1.50	28.78	7.21	233	149	4.2	55	212
Shipp	4wo	9/3/09	10:07	1.56	28.79	7.23	232	149	4.2	55	235
Shipp	5wo	9/3/09	9:44	0.25	28.89	8.93	232	149	5.4	70	413
Shipp	5wo	9/3/09	9:45	0.50	28.89	8.99	232	149	5.3	69	412
Shipp	5wo	9/3/09	9:46	1.00	28.90	8.91	232	149	5.3	69	416
Shipp	5wo	9/3/09	9:47	1.50	28.90	8.88	232	149	5.2	68	351
Shipp	5wo	9/3/09	9:48	1.73	28.91	8.68	233	149	5.0	65	231
Shipp	6wo	9/3/09	9:49	0.25	28.95	8.06	237	152	4.9	64	309
Shipp	6wo	9/3/09	9:50	0.50	28.95	8.01	237	152	4.9	64	335
Shipp	6wo	9/3/09	9:51	1.00	28.94	8.00	237	152	4.9	63	355
Shipp	6wo	9/3/09	9:53	1.50	28.94	7.98	237	152	4.9	63	324
Shipp	6wo	9/3/09	9:55	1.64	28.94	7.78	237	152	4.8	62	232

Field Data for Wet Season Isolation Chamber Experiments in Lakes May and Shipp

Lake	Location	Date	Time	Depth (meters)	'emperatur (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (mg/l)	DO (mg/l)	DO% (Sat)	ORP (mv)
Shipp	Lake	9/17/09	9:45	0.25	29.29	8.36	238	152	6.0	78	269
Shipp	Lake	9/17/09	9:46	0.50	29.28	8.33	238	152	6.0	78	275
Shipp	Lake	9/17/09	9:47	1.00	29.19	7.91	238	152	5.4	70	254
Shipp	Lake	9/17/09	9:49	1.20	29.17	7.64	238	152	4.9	64	225
Shipp	1w	9/17/09	10:01	0.25	29.15	8.54	231	148	6.2	81	288
Shipp	1w	9/17/09	10:02	0.50	29.15	8.54	230	147	6.2	81	290
Shipp	1w	9/17/09	10:03	1.00	29.14	8.37	230	147	6.1	80	287
Shipp	1w	9/17/09	10:04	1.24	29.12	8.14	231	148	5.8	76	172
Shipp	2w	9/17/09	9:51	0.25	29.17	9.02	235	151	6.4	83	291
Shipp	2w	9/17/09	9:52	0.50	29.17	9.00	235	151	6.3	82	294
Shipp	2w	9/17/09	9:53	1.00	29.16	8.98	236	151	6.3	83	296
Shipp	2w	9/17/09	9:55	1.28	29.16	8.97	235	151	6.1	80	288
Shipp	3w	9/17/09	9:40	0.25	29.09	8.84	233	149	6.1	80	284
Shipp	3w	9/17/09	9:41	0.50	29.10	8.82	232	149	6.1	78	287
Shipp	3w	9/17/09	9:42	1.00	29.10	8.74	233	149	6.0	78	289
Shipp	3w	9/17/09	9:43	1.16	29.11	8.74	233	149	5.9	77	255
Shipp	4wo	9/17/09	10:30	0.25	29.15	7.78	230	147	6.1	79	208
Shipp	4wo	9/17/09	10:32	0.50	29.11	7.72	229	147	5.8	76	226
Shipp	4wo	9/17/09	10:33	1.00	29.08	7.58	229	147	5.6	73	235
Shipp	4wo	9/17/09	10:34	1.50	28.98	6.81	231	148	4.5	59	8
Shipp	4wo	9/17/09	10:36	1.55	28.86	6.63	233	149	0.9	12	-22
Shipp	5wo	9/17/09	10:23	0.25	29.31	9.22	218	139	6.5	86	262
Shipp	5wo	9/17/09	10:24	0.50	29.29	9.19	218	140	6.6	86	276
Shipp	5wo	9/17/09	10:25	1.00	29.24	9.02	218	139	5.5	72	277
Shipp	5wo	9/17/09	10:27	1.50	29.02	7.07	224	143	0.8	10	-9
Shipp	5wo	9/17/09	10:27	1.71	28.95	6.75	228	146	0.4	6	-59
Shipp	6wo	9/17/09	10:16	0.25	29.33	8.36	232	149	6.3	83	275
Shipp	6wo	9/17/09	10:17	0.50	29.33	8.32	232	149	6.2	81	279
Shipp	6wo	9/17/09	10:18	1.00	29.28	8.05	233	149	5.6	74	271
Shipp	6wo	9/17/09	10:19	1.50	29.08	7.00	235	150	1.4	19	173
Shipp	6wo	9/17/09	10:20	1.69	29.06	6.90	235	150	1.3	16	13

Field Data for Wet Season Isolation Chamber Experiments in Lakes May and Shipp

Lake	Location	Date	Time	Depth (meters)	'emperatur (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (mg/l)	DO (mg/l)	DO% (Sat)	ORP (mv)
Shipp	Lake	10/1/09	10:20	0.25	26.75	8.05	248	159	7.3	91	291
Shipp	Lake	10/1/09	10:21	0.50	26.75	8.05	249	159	7.2	90	295
Shipp	Lake	10/1/09	10:22	1.00	26.72	8.06	249	159	7.2	90	295
Shipp	Lake	10/1/09	10:23	1.16	26.63	7.82	249	159	6.2	77	287
Shipp	1w	10/1/09	10:25	0.25	26.60	8.71	240	153	7.2	89	311
Shipp	1w	10/1/09	10:26	0.50	26.61	8.70	240	153	7.2	90	310
Shipp	1w	10/1/09	10:27	1.00	26.60	8.70	240	153	7.2	90	311
Shipp	1w	10/1/09	10:28	1.19	26.60	8.70	240	153	7.2	90	309
Shipp	2w	10/1/09	10:10	0.25	26.64	8.69	241	154	6.3	79	311
Shipp	2w	10/1/09	10:11	0.50	26.64	8.67	241	154	6.2	77	309
Shipp	2w	10/1/09	10:13	1.00	26.64	8.67	241	154	6.2	77	309
Shipp	2w	10/1/09	10:14	1.25	26.64	8.65	242	155	6.0	75	306
Shipp	3w	10/1/09	10:16	0.25	26.49	8.49	243	156	6.6	82	306
Shipp	3w	10/1/09	10:17	0.50	26.49	8.49	243	156	6.6	82	307
Shipp	3w	10/1/09	10:18	1.00	26.49	8.48	243	156	6.5	81	309
Shipp	3w	10/1/09	10:19	1.13	26.49	8.48	244	156	6.6	82	282
Shipp	4wo	10/1/09	10:33	0.25	26.73	7.18	241	154	5.4	67	277
Shipp	4wo	10/1/09	10:34	0.50	26.75	7.15	241	154	5.1	64	276
Shipp	4wo	10/1/09	10:35	1.00	26.75	7.13	241	154	5.2	65	276
Shipp	4wo	10/1/09	10:36	1.52	26.75	7.11	242	155	5.2	65	243
Shipp	5wo	10/1/09	10:38	0.25	27.04	7.19	245	157	5.4	68	261
Shipp	5wo	10/1/09	10:39	0.50	27.05	7.19	245	157	5.3	66	263
Shipp	5wo	10/1/09	10:40	1.00	27.05	7.18	245	157	5.4	68	265
Shipp	5wo	10/1/09	10:40	1.50	27.06	7.17	246	157	5.3	66	265
Shipp	5wo	10/1/09	10:42	1.67	27.06	7.16	245	157	4.9	62	161
Shipp	6wo	10/1/09	10:43	0.25	26.98	8.03	243	155	6.5	82	252
Shipp	6wo	10/1/09	10:44	0.50	26.99	8.04	243	156	6.4	81	261
Shipp	6wo	10/1/09	10:46	1.00	26.98	8.02	243	156	6.4	81	266
Shipp	6wo	10/1/09	10:46	1.50	26.98	8.00	243	156	6.3	79	245
Shipp	6wo	10/1/09	10:47	1.60	26.99	7.96	243	156	6.3	80	220

Field Data for Wet Season Isolation Chamber Experiments in Lakes May and Shipp

Lake	Location	Date	Time	Depth (meters)	'emperatur (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (mg/l)	DO (mg/l)	DO% (Sat)	ORP (mv)
Shipp	Lake	10/15/09	9:54	0.25	29.80	8.14	250	160	7.0	92	291
Shipp	Lake	10/15/09	9:55	0.50	29.81	8.13	250	160	7.1	94	288
Shipp	Lake	10/15/09	9:56	1.00	29.75	7.79	250	160	5.9	77	264
Shipp	Lake	10/15/09	9:57	1.08	29.67	7.48	250	160	4.9	65	227
Shipp	1w	10/15/09	9:59	0.25	29.86	7.72	243	155	5.6	74	255
Shipp	1w	10/15/09	10:00	0.50	29.86	7.73	243	155	5.6	74	259
Shipp	1w	10/15/09	10:01	1.00	29.85	7.71	243	155	5.5	73	260
Shipp	1w	10/15/09	10:02	1.08	29.86	7.70	243	155	5.5	73	246
Shipp	2w	10/15/09	10:09	0.25	29.90	8.60	243	156	5.5	73	287
Shipp	2w	10/15/09	10:10	0.50	29.90	8.57	243	156	5.6	73	287
Shipp	2w	10/15/09	10:11	1.00	29.90	8.57	243	156	5.5	73	287
Shipp	2w	10/15/09	10:12	1.16	29.89	8.56	243	156	5.3	71	279
Shipp	3w	10/15/09	10:04	0.25	29.81	8.63	241	154	6.9	91	284
Shipp	3w	10/15/09	10:05	0.50	29.81	8.63	241	154	6.8	89	287
Shipp	3w	10/15/09	10:06	0.98	29.81	8.63	241	154	6.9	91	289
Shipp	4wo	10/15/09	10:17	0.25	29.68	7.09	241	154	5.1	67	281
Shipp	4wo	10/15/09	10:18	0.50	29.69	7.05	241	154	4.8	63	275
Shipp	4wo	10/15/09	10:19	1.00	29.69	7.04	241	154	4.6	61	267
Shipp	4wo	10/15/09	10:21	1.49	29.22	6.68	242	155	1.5	19	-68
Shipp	5wo	10/15/09	10:23	0.25	29.90	7.48	239	153	5.0	66	193
Shipp	5wo	10/15/09	10:24	0.50	29.91	7.48	239	153	5.0	66	208
Shipp	5wo	10/15/09	10:25	1.00	29.90	7.42	239	153	4.8	64	215
Shipp	5wo	10/15/09	10:26	1.50	29.76	7.07	240	154	2.3	30	23
Shipp	5wo	10/15/09	10:28	1.56	29.70	6.98	241	154	1.8	24	5
Shipp	6wo	10/15/09	10:30	0.25	29.97	8.23	240	154	5.8	76	209
Shipp	6wo	10/15/09	10:31	0.50	29.97	8.23	240	153	5.7	75	229
Shipp	6wo	10/15/09	10:32	1.00	29.96	8.16	240	153	5.6	74	236
Shipp	6wo	10/15/09	10:33	1.49	29.82	7.36	242	155	3.3	44	33

1b. Field Data - Supplemental Program

Field Data for Dry Season Isolation Chamber Experiments in Lakes May and Shipp

Lake	Location	Date	Time	Depth (meters)	Temperature (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (mg/l)	DO (mg/l)	DO% (Sat)	ORP (mv)
May	Lake	12/18/08	15:05	0.25	21.40	8.07	239	153	10.2	116	510
May	Lake	12/18/08	15:06	0.50	20.90	8.12	239	153	9.9	111	505
May	Lake	12/18/08	15:07	0.96	20.28	8.11	238	153	8.0	88	496
May	Lake	12/30/08	12:06	0.25	20.61	8.70	247	158	8.4	93	398
May	Lake	12/30/08	12:08	0.50	20.57	8.72	247	158	8.5	94	406
May	Lake	12/30/08	12:13	1.00	20.50	8.28	259	166	1.5	16	358
May	Lake	1/15/09	12:44	0.25	15.51	8.19	242	155	8.3	84	509
May	Lake	1/15/09	12:45	0.50	15.51	8.20	242	155	8.3	84	515
May	Lake	1/15/09	12:48	0.99	15.54	8.19	242	155	7.8	78	464
May	Lake	1/26/09	12:28	0.25	16.31	9.32	243	156	8.6	88	430
May	Lake	1/26/09	12:29	0.50	15.47	9.08	244	156	7.8	78	441
May	Lake	1/26/09	12:34	0.95	15.16	8.96	243	156	6.8	68	454
May	Lake	2/11/09	12:59	0.25	17.78	9.60	244	156	9.4	99	478
May	Lake	2/11/09	13:00	0.50	17.69	9.63	244	156	9.3	98	477
May	Lake	2/11/09	13:06	0.87	17.64	9.61	244	156	6.1	65	432
May	Lake	3/19/09	10:23	0.25	22.33	7.64	260	166	7.8	90	290
May	Lake	3/19/09	10:24	0.50	22.31	7.62	260	166	6.6	76	309
May	Lake	3/19/09	10:27	0.90	22.28	7.19	259	166	4.6	53	234
May	Lake	4/9/09	9:58	0.25	19.16	8.05	266	170	8.6	93	365
May	Lake	4/9/09	10:00	0.50	18.87	7.86	267	171	8.0	86	361
May	Lake	4/9/09	10:01	0.79	18.71	7.63	266	170	6.7	72	348
May	1W	12/18/08	15:13	0.25	20.81	9.19	239	153	10.8	121	533
May	1W	12/18/08	15:13	0.50	20.74	9.23	238	153	11.1	124	532
May	1W	12/18/08	15:14	0.98	20.30	8.85	238	152	10.0	111	444
May	1W	12/30/08	12:14	0.25	20.38	9.27	247	158	8.6	95	414
May	1W	12/30/08	12:16	0.50	20.37	9.30	246	158	8.6	96	421
May	1W	12/30/08	12:20	1.00	20.38	8.31	247	158	1.3	14	318
May	1W	1/15/09	12:58	0.25	15.50	7.98	249	159	5.8	61	449
May	1W	1/15/09	12:59	0.50	15.50	7.98	249	159	5.9	59	456
May	1W	1/15/09	13:02	1.00	15.52	7.99	249	159	5.6	56	424
May	1W	1/26/09	12:36	0.25	15.59	9.11	249	159	7.1	71	449
May	1W	1/26/09	12:37	0.50	15.30	9.07	248	159	6.6	66	452
May	1W	1/26/09	12:41	0.99	15.05	8.88	248	159	4.6	46	453
May	1W	2/11/09	13:21	0.25	17.97	9.37	248	158	7.7	81	403
May	1W	2/11/09	13:23	0.50	17.35	9.26	247	158	7.5	78	415
May	1W	2/11/09	13:30	0.87	17.28	8.96	262	168	1.7	17	360
May	1W	3/19/09	10:16	0.25	22.15	7.47	264	169	5.2	60	304
May	1W	3/19/09	10:17	0.50	22.14	7.45	263	169	4.6	53	317
May	1W	3/19/09	10:21	0.91	22.16	7.28	271	174	0.9	10	198
May	1W	4/9/09	10:03	0.25	18.59	7.40	271	174	5.8	62	341
May	1W	4/9/09	10:04	0.50	18.59	7.38	271	174	5.5	59	342
May	1W	4/9/09	10:09	0.83	18.67	7.31	282	180	0.9	9	142

Field Data for Dry Season Isolation Chamber Experiments in Lakes May and Shipp

Lake	Location	Date	Time	Depth (meters)	Temperature (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (mg/l)	DO (mg/l)	DO% (Sat)	ORP (mv)
May	2W	12/18/08	15:16	0.25	20.92	9.32	241	154	9.8	110	456
May	2W	12/18/08	15:16	0.50	20.93	9.34	240	154	9.9	111	461
May	2W	12/18/08	15:17	1.00	20.08	8.99	241	154	8.9	99	445
May	2W	12/30/08	11:50	0.25	20.36	8.38	256	164	8.1	90	487
May	2W	12/30/08	11:51	0.50	20.29	8.44	256	164	7.7	85	487
May	2W	12/30/08	12:02	0.98	20.34	8.38	266	170	2.7	30	348
May	2W	1/15/09	12:51	0.25	15.47	8.70	254	163	7.3	73	488
May	2W	1/15/09	12:52	0.50	15.47	8.71	254	163	7.1	72	491
May	2W	1/15/09	12:55	1.00	15.64	8.23	261	167	5.0	50	440
May	2W	1/26/09	12:19	0.25	15.60	10.19	254	162	9.3	94	498
May	2W	1/26/09	12:20	0.50	15.33	10.06	254	163	9.0	90	497
May	2W	1/26/09	12:26	0.98	15.06	9.43	260	167	3.9	39	410
May	2W	2/11/09	13:10	0.25	17.59	11.22	250	160	9.7	102	381
May	2W	2/11/09	13:11	0.50	17.33	11.11	250	160	9.4	100	384
May	2W	2/11/09	13:18	0.92	17.19	9.01	273	175	0.7	7	399
May	2W	3/19/09	10:08	0.25	22.17	7.49	276	177	5.6	65	397
May	2W	3/19/09	10:09	0.50	22.16	7.48	276	177	5.4	62	401
May	2W	3/19/09	10:13	0.85	22.20	7.13	282	180	3.2	36	206
May	2W	4/9/09	10:11	0.25	18.61	8.23	286	183	7.8	84	250
May	2W	4/9/09	10:13	0.50	18.57	8.15	286	183	7.4	79	274
May	2W	4/9/09	10:15	0.81	18.55	7.94	286	183	6.4	69	231
May	3W	12/18/08	15:34	0.25	21.19	9.75	239	153	10.2	115	524
May	3W	12/18/08	15:35	0.50	20.74	9.75	238	152	10.0	112	523
May	3W	12/18/08	15:36	0.97	20.09	9.74	237	152	10.4	115	521
May	3W	12/30/08	12:23	0.25	20.36	8.65	246	157	7.2	79	371
May	3W	12/30/08	12:24	0.50	20.35	8.64	246	157	7.1	79	383
May	3W	12/30/08	12:29	1.00	20.34	8.25	255	163	1.4	15	336
May	3W	1/15/09	12:36	0.25	15.53	7.71	249	159	7.9	79	534
May	3W	1/15/09	12:37	0.50	15.54	7.77	249	159	7.7	77	536
May	3W	1/15/09	12:42	0.97	15.57	8.06	249	159	7.3	73	495
May	3W	1/26/09	12:43	0.25	15.72	9.36	252	161	7.6	77	444
May	3W	1/26/09	12:45	0.50	15.30	9.39	250	160	7.5	75	444
May	3W	1/26/09	12:50	1.01	15.04	8.90	252	161	2.9	29	430
May	3W	2/11/09	13:33	0.25	17.82	9.58	258	165	8.3	88	371
May	3W	2/11/09	13:34	0.50	17.29	9.50	257	165	8.3	87	382
May	3W	2/11/09	13:44	0.86	17.24	9.30	257	165	5.8	60	360
May	3W	3/19/09	10:01	0.25	22.16	7.57	283	181	6.3	73	458
May	3W	3/19/09	10:03	0.50	22.15	7.55	283	181	5.7	66	457
May	3W	3/19/09	10:06	0.86	22.17	7.40	283	181	4.3	50	378
May	3W	4/9/09	10:16	0.25	18.65	7.52	288	184	7.6	82	238
May	3W	4/9/09	10:17	0.50	18.53	7.46	290	185	5.4	58	209
May	3W	4/9/09	10:20	0.79	18.57	7.24	291	186	3.6	38	113

Field Data for Dry Season Isolation Chamber Experiments in Lakes May and Shipp

Lake	Location	Date	Time	Depth (meters)	Temperature (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (mg/l)	DO (mg/l)	DO% (Sat)	ORP (mv)
May	4WO	12/18/08	15:47	0.25	21.38	8.63	236	151	10.2	115	488
May	4WO	12/18/08	15:48	0.50	19.98	8.30	234	150	9.4	104	474
May	4WO	12/18/08	15:49	1.00	19.49	7.91	234	150	6.6	72	461
May	4WO	12/18/08	15:50	1.50	18.99	7.77	235	150	5.1	55	457
May	4WO	12/18/08	15:50	1.97	18.99	7.60	237	151	4.1	44	443
May	4WO	12/30/08	12:44	0.25	20.26	8.24	239	153	7.7	85	386
May	4WO	12/30/08	12:45	0.50	20.26	8.34	239	153	8.4	93	395
May	4WO	12/30/08	12:46	1.00	20.20	8.30	239	153	8.1	90	395
May	4WO	12/30/08	12:47	1.50	20.06	8.01	239	153	6.5	71	384
May	4WO	12/30/08	12:52	1.81	20.03	7.42	240	154	3.2	36	316
May	4WO	1/15/09	13:15	0.25	16.27	7.73	240	154	5.4	55	437
May	4WO	1/15/09	13:16	0.50	16.28	7.71	240	153	5.4	55	444
May	4WO	1/15/09	13:18	1.00	16.27	7.72	240	153	5.3	54	451
May	4WO	1/15/09	13:19	1.50	16.28	7.73	240	153	5.3	54	426
May	4WO	1/15/09	13:21	1.84	16.32	7.73	239	153	5.0	51	369
May	4WO	1/26/09	13:07	0.25	15.62	9.32	238	152	10.7	107	425
May	4WO	1/26/09	13:08	0.50	15.30	9.24	237	152	8.7	87	430
May	4WO	1/26/09	13:09	1.00	14.29	8.87	237	151	6.8	65	442
May	4WO	1/26/09	13:12	1.47	13.84	8.73	235	150	5.4	52	451
May	4WO	2/11/09	14:00	0.25	17.60	10.93	235	150	9.6	100	335
May	4WO	2/11/09	14:02	0.50	17.25	10.69	235	150	8.9	92	352
May	4WO	2/11/09	14:04	1.00	15.82	9.77	235	150	8.3	84	371
May	4WO	2/11/09	14:12	1.48	14.74	8.93	233	149	4.8	47	429
May	4WO	3/19/09	10:59	0.25	22.30	8.61	245	157	7.6	88	291
May	4WO	3/19/09	11:00	0.50	22.26	8.60	245	157	7.6	87	298
May	4WO	3/19/09	11:01	1.00	22.21	8.56	245	157	7.0	81	304
May	4WO	3/19/09	11:03	1.50	21.41	6.70	246	157	2.7	30	67
May	4WO	3/19/09	11:04	1.73	21.12	6.55	248	159	1.3	15	35
May	4WO	4/9/09	10:38	0.25	19.36	8.47	250	160	7.4	81	332
May	4WO	4/9/09	10:39	0.50	19.32	8.44	251	160	7.5	81	334
May	4WO	4/9/09	10:40	1.00	19.27	8.37	251	160	6.9	75	332
May	4WO	4/9/09	10:43	1.50	19.22	8.30	251	161	7.2	78	236
May	4WO	4/9/09	10:45	1.62	19.22	8.29	251	161	7.2	78	225

Field Data for Dry Season Isolation Chamber Experiments in Lakes May and Shipp

Lake	Location	Date	Time	Depth (meters)	Temperature (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (mg/l)	DO (mg/l)	DO% (Sat)	ORP (mv)
May	5WO	12/18/08	15:53	1.00	19.78	8.52	239	153	8.4	92	479
May	5WO	12/18/08	15:54	1.20	19.12	8.01	243	155	3.0	32	457
May	5WO	12/30/08	12:34	0.25	20.39	9.65	246	158	9.6	106	426
May	5WO	12/30/08	12:35	0.50	20.34	9.66	246	158	9.3	103	431
May	5WO	12/30/08	12:37	1.00	20.27	9.57	246	157	9.5	105	431
May	5WO	12/30/08	12:41	1.27	20.28	8.17	248	159	3.3	36	368
May	5WO	1/15/09	13:08	0.25	15.62	8.03	249	159	6.2	62	448
May	5WO	1/15/09	13:10	0.50	15.63	7.95	249	159	6.2	62	454
May	5WO	1/15/09	13:11	1.00	15.64	7.99	249	159	6.0	60	461
May	5WO	1/15/09	13:13	1.24	15.67	7.94	249	159	5.8	58	413
May	5WO	1/26/09	12:56	0.25	15.88	10.21	250	160	10.6	107	409
May	5WO	1/26/09	12:58	0.50	15.33	10.02	250	160	9.8	98	413
May	5WO	1/26/09	13:00	1.00	14.53	9.37	252	161	8.5	83	426
May	5WO	1/26/09	13:03	1.23	14.47	9.04	250	160	5.6	55	430
May	5WO	2/11/09	13:51	0.25	17.74	11.60	247	158	11.9	125	323
May	5WO	2/11/09	13:53	0.50	17.28	11.57	247	158	11.2	117	326
May	5WO	2/11/09	13:55	1.00	16.41	10.85	248	159	8.0	81	321
May	5WO	2/11/09	13:58	1.11	16.45	9.72	246	157	3.2	33	334
May	5WO	3/19/09	10:49	0.25	22.25	8.44	268	172	6.2	71	256
May	5WO	3/19/09	10:50	0.50	22.23	8.44	268	171	5.8	67	282
May	5WO	3/19/09	10:51	1.00	22.18	8.08	268	172	5.1	58	260
May	5WO	3/19/09	10:56	1.18	22.19	7.11	272	174	0.2	3	194
May	5WO	4/9/09	10:56	0.25	18.75	8.53	273	175	7.5	81	220
May	5WO	4/9/09	10:57	0.50	18.69	8.48	274	175	7.3	78	238
May	5WO	4/9/09	10:58	1.00	18.64	8.39	274	175	7.2	77	248
May	5WO	4/9/09	11:01	1.18	18.88	6.86	274	175	2.6	28	139

Field Data for Dry Season Isolation Chamber Experiments in Lakes May and Shipp

Lake	Location	Date	Time	Depth (meters)	Temperature (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (mg/l)	DO (mg/l)	DO% (Sat)	ORP (mv)
May	6WO	12/18/08	16:19	0.25	21.58	9.34	238	153	9.9	112	530
May	6WO	12/18/08	16:20	0.50	20.51	8.84	235	150	10.2	113	507
May	6WO	12/18/08	16:22	1.00	19.21	8.02	235	150	6.8	73	475
May	6WO	12/18/08	16:22	1.50	18.92	7.88	235	150	5.3	57	471
May	6WO	12/18/08	16:23	1.75	18.93	7.83	235	151	4.4	47	470
May	6WO	12/30/08	12:54	0.25	20.29	9.55	241	154	9.0	100	426
May	6WO	12/30/08	12:55	0.50	20.26	9.42	241	154	8.7	97	424
May	6WO	12/30/08	12:56	1.00	20.09	8.98	241	154	8.3	91	408
May	6WO	12/30/08	12:58	1.50	19.85	8.34	242	155	6.5	71	387
May	6WO	12/30/08	13:02	1.89	19.75	7.37	259	165	1.0	11	248
May	6WO	1/15/09	13:23	0.25	16.16	7.96	243	155	6.3	64	424
May	6WO	1/15/09	13:24	0.50	16.16	7.97	243	155	6.1	62	433
May	6WO	1/15/09	13:25	1.00	16.16	7.99	243	155	6.0	61	439
May	6WO	1/15/09	13:26	1.50	16.17	8.00	243	155	6.0	61	445
May	6WO	1/15/09	13:29	1.84	16.29	7.78	243	156	5.3	54	273
May	6WO	1/26/09	13:14	0.25	15.80	9.79	244	156	9.4	95	426
May	6WO	1/26/09	13:16	0.50	15.30	9.55	244	156	8.9	89	431
May	6WO	1/26/09	13:17	1.00	13.93	9.13	242	155	7.2	70	441
May	6WO	1/26/09	13:18	1.50	13.48	9.03	242	155	6.4	62	442
May	6WO	1/26/09	13:21	1.74	13.49	8.84	239	153	5.1	49	393
May	6WO	2/11/09	14:15	0.25	17.68	11.18	240	154	9.8	102	364
May	6WO	2/11/09	14:17	0.50	17.21	11.03	241	154	9.6	100	366
May	6WO	2/11/09	14:19	1.00	15.47	9.90	241	154	7.8	79	386
May	6WO	2/11/09	14:20	1.50	14.48	9.38	241	154	6.3	62	413
May	6WO	2/11/09	14:23	1.64	14.43	9.12	240	153	3.8	37	383
May	6WO	3/19/09	10:41	0.25	22.41	8.85	256	164	8.4	97	368
May	6WO	3/19/09	10:43	0.50	22.37	8.83	255	163	7.2	82	370
May	6WO	3/19/09	10:44	1.00	22.35	8.77	256	164	7.5	86	372
May	6WO	3/19/09	10:46	1.50	21.15	6.87	256	164	3.2	36	127
May	6WO	3/19/09	10:47	1.85	20.57	6.57	275	176	0.5	5	39
May	6WO	4/9/09	10:48	0.25	19.36	7.49	265	170	5.8	63	245
May	6WO	4/9/09	10:50	0.50	19.30	7.46	265	170	5.7	61	259
May	6WO	4/9/09	10:51	1.00	19.26	7.40	265	170	5.6	61	264
May	6WO	4/9/09	10:52	1.50	19.24	7.37	265	170	5.5	60	269
May	6WO	4/9/09	10:54	1.66	19.26	7.28	265	169	4.9	54	107

Field Data for Dry Season Isolation Chamber Experiments in Lakes May and Shipp

Lake	Location	Date	Time	Depth (meters)	Temperature (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (mg/l)	DO (mg/l)	DO% (Sat)	ORP (mv)
Shipp	Lake	12/19/08	10:27	0.25	19.86	8.91	241	154	12.0	131	556
Shipp	Lake	12/19/08	10:28	0.50	19.80	9.05	241	154	11.3	124	557
Shipp	Lake	12/19/08	10:28	1.00	19.58	9.10	241	154	11.1	121	556
Shipp	Lake	12/30/08	11:04	0.25	20.62	9.62	245	157	9.5	106	557
Shipp	Lake	12/30/08	11:05	0.50	20.62	9.64	245	157	9.4	105	556
Shipp	Lake	12/30/08	11:06	1.00	20.62	9.69	245	157	9.3	103	557
Shipp	Lake	12/30/08	11:08	1.32	20.60	9.60	245	157	8.5	95	487
Shipp	Lake	1/15/09	10:48	0.25	16.66	8.40	245	157	7.9	81	549
Shipp	Lake	1/15/09	10:49	0.50	16.64	8.42	244	156	7.8	80	550
Shipp	Lake	1/15/09	10:50	1.00	16.52	8.37	244	156	7.5	77	549
Shipp	Lake	1/15/09	10:52	1.13	16.21	7.94	240	154	5.4	55	535
Shipp	Lake	1/26/09	10:57	0.25	15.52	9.05	244	156	9.2	92	640
Shipp	Lake	1/26/09	10:58	0.50	15.25	9.01	243	156	8.5	85	626
Shipp	Lake	1/26/09	11:00	1.00	14.52	9.20	242	155	8.6	85	613
Shipp	Lake	1/26/09	11:02	1.10	14.30	9.33	243	155	8.1	79	595
Shipp	Lake	2/11/09	11:32	0.25	16.42	8.04	248	159	8.8	90	545
Shipp	Lake	2/11/09	11:33	0.50	16.33	8.50	248	159	8.8	90	527
Shipp	Lake	2/11/09	11:34	1.00	16.30	8.78	248	159	8.2	84	515
Shipp	Lake	2/11/09	11:35	1.02	16.26	8.79	248	158	8.5	86	515
Shipp	Lake	3/19/09	11:29	0.25	22.76	8.39	266	170	8.5	98	354
Shipp	Lake	3/19/09	11:30	0.50	22.65	8.35	266	170	7.8	90	349
Shipp	Lake	3/19/09	11:31	1.00	22.58	8.14	266	170	7.2	83	344
Shipp	Lake	3/19/09	11:33	1.13	22.59	8.03	265	170	5.8	67	343
Shipp	Lake	4/9/09	11:34	0.25	21.32	8.88	274	175	9.6	108	352
Shipp	Lake	4/9/09	11:35	0.50	21.13	8.88	273	175	9.4	106	354
Shipp	Lake	4/9/09	11:37	0.99	20.88	8.77	273	175	9.0	101	355
Shipp	1W	12/19/08	11:46	0.25	19.83	9.52	243	155	11.8	129	571
Shipp	1W	12/19/08	11:46	0.50	19.48	9.56	242	155	10.8	118	570
Shipp	1W	12/19/08	11:47	1.00	19.32	9.54	242	155	10.5	114	567
Shipp	1W	12/19/08	11:48	1.25	19.21	9.38	243	155	10.1	110	549
Shipp	1W	12/30/08	10:15	0.25	20.77	7.86	249	159	8.7	97	548
Shipp	1W	12/30/08	10:16	0.50	20.75	8.32	249	159	8.5	94	554
Shipp	1W	12/30/08	10:18	1.00	20.78	8.66	249	159	8.3	92	557
Shipp	1W	12/30/08	10:20	1.20	20.72	8.97	249	159	7.7	86	555
Shipp	1W	1/15/09	10:34	0.25	16.15	7.20	251	160	5.0	51	524
Shipp	1W	1/15/09	10:36	0.50	16.26	7.29	252	161	4.7	48	527
Shipp	1W	1/15/09	10:37	1.00	16.36	7.42	252	161	4.8	49	528
Shipp	1W	1/15/09	10:39	1.18	16.26	7.58	252	161	4.4	45	531
Shipp	1W	1/26/09	11:09	0.25	15.51	9.36	252	162	7.5	76	557
Shipp	1W	1/26/09	11:10	0.50	15.37	9.31	253	162	7.7	77	556
Shipp	1W	1/26/09	11:12	1.00	14.47	9.09	253	162	6.6	65	559
Shipp	1W	1/26/09	11:13	1.13	14.44	9.07	252	161	6.1	60	558
Shipp	1W	2/11/09	11:48	0.25	16.84	9.92	252	161	9.3	95	474
Shipp	1W	2/11/09	11:50	0.50	16.68	9.85	252	161	9.1	94	474
Shipp	1W	2/11/09	11:51	1.00	16.27	9.62	252	161	8.9	90	479
Shipp	1W	3/19/09	12:20	0.25	22.99	7.98	267	171	6.2	73	332
Shipp	1W	3/19/09	12:21	0.50	22.79	7.92	267	171	6.4	75	331
Shipp	1W	3/19/09	12:24	0.96	22.44	7.64	267	171	4.7	55	323
Shipp	1W	4/9/09	11:49	0.25	20.92	8.50	276	176	7.4	83	349
Shipp	1W	4/9/09	11:51	0.50	20.34	8.18	276	177	6.4	71	340
Shipp	1W	4/9/09	11:52	1.00	20.16	7.99	276	177	6.3	70	334

Field Data for Dry Season Isolation Chamber Experiments in Lakes May and Shipp

Lake	Location	Date	Time	Depth (meters)	Temperature (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (mg/l)	DO (mg/l)	DO% (Sat)	ORP (mv)
Shipp	2W	12/19/08	11:49	0.25	19.56	9.82	242	155	11.5	125	567
Shipp	2W	12/19/08	11:49	0.50	19.48	9.86	242	155	11.3	123	567
Shipp	2W	12/19/08	11:50	1.00	19.33	9.82	242	155	11.1	121	566
Shipp	2W	12/19/08	11:50	1.31	19.24	9.80	242	155	11.1	120	563
Shipp	2W	12/30/08	10:23	0.25	20.74	9.63	246	158	9.0	100	572
Shipp	2W	12/30/08	10:24	0.50	20.75	9.69	246	158	8.6	96	571
Shipp	2W	12/30/08	10:26	1.00	20.76	9.76	247	158	8.6	96	570
Shipp	2W	12/30/08	10:28	1.27	20.77	9.83	246	158	8.7	98	568
Shipp	2W	1/15/09	11:16	0.25	16.49	7.89	246	158	6.8	70	537
Shipp	2W	1/15/09	11:17	0.50	16.48	7.84	246	157	5.9	60	538
Shipp	2W	1/15/09	11:18	1.00	16.50	7.86	246	158	6.2	63	539
Shipp	2W	1/15/09	11:20	1.26	16.44	7.97	246	158	5.4	56	539
Shipp	2W	1/26/09	11:16	0.25	15.54	9.23	250	160	7.2	72	545
Shipp	2W	1/26/09	11:17	0.50	15.39	9.21	250	160	7.3	73	544
Shipp	2W	1/26/09	11:18	1.00	14.78	9.13	249	159	6.5	64	544
Shipp	2W	1/26/09	11:20	1.25	14.40	9.04	249	159	5.9	58	545
Shipp	2W	2/11/09	11:42	0.25	16.59	9.39	252	161	8.8	90	490
Shipp	2W	2/11/09	11:44	0.50	16.35	9.36	251	161	8.0	82	491
Shipp	2W	2/11/09	11:46	0.99	16.26	9.28	251	160	7.3	75	493
Shipp	2W	3/19/09	12:06	0.25	23.11	7.47	269	172	5.4	63	307
Shipp	2W	3/19/09	12:07	0.50	22.74	7.43	271	174	5.2	60	306
Shipp	2W	3/19/09	12:09	1.14	22.42	7.30	272	174	4.1	48	300
Shipp	2W	4/9/09	11:44	0.25	20.68	8.18	278	178	7.6	85	327
Shipp	2W	4/9/09	11:45	0.50	20.39	8.09	278	178	7.3	81	329
Shipp	2W	4/9/09	11:46	0.99	20.12	7.87	278	178	6.7	74	324
Shipp	3W	12/19/08	11:55	0.25	20.13	9.61	239	153	10.4	115	548
Shipp	3W	12/19/08	11:55	0.50	19.47	9.68	238	152	10.6	116	550
Shipp	3W	12/19/08	11:56	1.00	19.24	9.68	239	153	10.9	118	549
Shipp	3W	12/19/08	11:56	1.15	19.22	9.58	239	153	10.4	113	546
Shipp	3W	12/30/08	10:34	0.25	20.66	9.52	246	157	8.3	93	552
Shipp	3W	12/30/08	10:35	0.50	20.69	9.52	247	158	8.4	94	551
Shipp	3W	12/30/08	10:37	1.00	20.68	9.54	247	158	8.5	95	551
Shipp	3W	12/30/08	10:41	1.10	20.70	9.56	247	158	8.3	93	551
Shipp	3W	1/15/09	10:41	0.25	16.38	8.46	246	157	6.9	70	554
Shipp	3W	1/15/09	10:42	0.50	16.37	8.62	246	158	6.7	69	556
Shipp	3W	1/15/09	10:44	1.00	16.40	8.68	246	157	7.0	72	556
Shipp	3W	1/15/09	10:46	1.14	16.39	8.75	247	158	6.6	67	559
Shipp	3W	1/26/09	11:03	0.25	15.48	9.93	248	159	9.8	99	570
Shipp	3W	1/26/09	11:05	0.50	15.40	9.90	247	158	9.0	90	565
Shipp	3W	1/26/09	11:06	1.00	14.69	9.48	246	158	8.6	85	569
Shipp	3W	1/26/09	11:08	1.10	14.54	9.39	246	157	7.4	72	567
Shipp	3W	2/11/09	11:37	0.25	16.54	9.24	252	161	8.3	85	499
Shipp	3W	2/11/09	11:38	0.50	16.39	9.26	251	161	7.8	80	498
Shipp	3W	2/11/09	11:40	1.00	16.23	9.22	251	161	7.3	75	496
Shipp	3W	3/19/09	12:11	0.25	22.87	8.19	272	174	7.8	91	328
Shipp	3W	3/19/09	12:13	0.50	22.64	8.16	271	173	7.0	81	330
Shipp	3W	3/19/09	12:16	0.99	22.42	7.94	271	173	5.6	65	328
Shipp	3W	4/9/09	11:39	0.25	20.55	8.26	279	178	7.7	86	338
Shipp	3W	4/9/09	11:40	0.50	20.24	8.19	279	178	7.6	84	338
Shipp	3W	4/9/09	11:42	0.98	20.01	8.01	279	178	6.9	76	316

Field Data for Dry Season Isolation Chamber Experiments in Lakes May and Shipp

Lake	Location	Date	Time	Depth (meters)	Temperature (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (mg/l)	DO (mg/l)	DO% (Sat)	ORP (mv)
Shipp	4WO	12/19/08	11:40	0.25	19.94	8.34	235	151	10.2	112	519
Shipp	4WO	12/19/08	11:41	0.50	19.92	8.27	228	146	9.8	107	516
Shipp	4WO	12/19/08	11:41	1.00	19.34	7.78	216	138	7.8	84	496
Shipp	4WO	12/19/08	11:42	1.50	19.25	7.59	213	136	6.6	71	491
Shipp	4WO	12/19/08	11:43	1.56	19.25	7.56	213	136	6.4	69	490
Shipp	4WO	12/30/08	11:23	0.25	20.78	8.25	231	148	7.1	79	460
Shipp	4WO	12/30/08	11:24	0.50	20.79	8.22	231	148	6.8	76	462
Shipp	4WO	12/30/08	11:25	1.00	20.77	8.21	231	148	6.5	72	464
Shipp	4WO	12/30/08	11:28	1.50	20.45	7.99	229	146	5.0	55	460
Shipp	4WO	1/15/09	11:24	0.25	16.70	7.93	235	150	6.4	66	534
Shipp	4WO	1/15/09	11:25	0.50	16.74	7.93	234	150	5.9	61	535
Shipp	4WO	1/15/09	11:26	1.00	16.76	7.93	234	150	5.9	60	536
Shipp	4WO	1/15/09	11:27	1.50	16.77	7.95	234	150	6.1	62	535
Shipp	4WO	1/15/09	11:28	1.53	16.76	7.96	234	150	5.6	58	534
Shipp	4WO	1/26/09	11:33	0.25	15.71	8.74	243	155	8.7	87	700
Shipp	4WO	1/26/09	11:34	0.50	15.45	8.83	243	155	8.6	86	681
Shipp	4WO	1/26/09	11:35	1.00	14.72	8.71	241	154	7.6	75	673
Shipp	4WO	1/26/09	11:37	1.50	14.70	8.78	241	154	7.1	70	661
Shipp	4WO	1/26/09	11:38	1.56	14.72	8.84	240	154	6.6	65	651
Shipp	4WO	2/11/09	12:20	0.25	16.60	9.32	249	159	8.0	82	469
Shipp	4WO	2/11/09	12:21	0.50	16.55	9.29	248	159	8.0	82	472
Shipp	4WO	2/11/09	12:23	1.00	16.19	9.21	247	158	7.4	75	475
Shipp	4WO	2/11/09	12:24	1.47	15.78	9.14	246	158	6.8	69	474
Shipp	4WO	3/19/09	11:42	0.25	22.78	7.50	266	170	5.6	65	281
Shipp	4WO	3/19/09	11:43	0.50	22.63	7.45	266	170	5.5	63	283
Shipp	4WO	3/19/09	11:44	1.00	22.35	7.37	266	170	4.9	56	286
Shipp	4WO	3/19/09	11:46	1.47	22.30	7.30	266	170	4.2	48	278
Shipp	4WO	4/9/09	12:21	0.25	21.11	8.77	274	175	8.8	99	315
Shipp	4WO	4/9/09	12:22	0.50	20.51	8.77	273	175	8.9	99	325
Shipp	4WO	4/9/09	12:23	1.00	20.19	8.50	274	175	7.8	86	323
Shipp	4WO	4/9/09	12:25	1.31	20.12	8.40	274	175	7.6	84	303

Field Data for Dry Season Isolation Chamber Experiments in Lakes May and Shipp

Lake	Location	Date	Time	Depth (meters)	Temperature (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (mg/l)	DO (mg/l)	DO% (Sat)	ORP (mv)
Shipp	5WO	12/19/08	11:10	0.25	19.87	8.78	240	154	11.0	121	545
Shipp	5WO	12/19/08	11:10	0.50	19.86	8.83	240	153	11.0	121	545
Shipp	5WO	12/19/08	11:11	1.00	19.81	8.73	239	153	11.2	123	538
Shipp	5WO	12/19/08	11:12	1.50	19.74	8.65	239	153	10.4	113	534
Shipp	5WO	12/19/08	11:12	1.75	19.73	8.54	238	152	10.2	112	526
Shipp	5WO	12/30/08	10:53	0.25	20.73	8.67	242	155	8.7	98	518
Shipp	5WO	12/30/08	10:55	0.50	20.76	8.70	242	155	8.4	94	521
Shipp	5WO	12/30/08	10:56	1.00	20.77	8.76	242	155	8.5	95	521
Shipp	5WO	12/30/08	10:58	1.50	20.76	8.84	242	155	7.9	88	524
Shipp	5WO	12/30/08	11:02	1.68	20.73	8.80	242	155	7.9	88	521
Shipp	5WO	1/15/09	11:50	0.25	16.77	8.28	240	153	7.8	80	548
Shipp	5WO	1/15/09	11:51	0.50	16.77	8.30	240	153	7.8	80	550
Shipp	5WO	1/15/09	11:53	1.00	16.77	8.34	240	153	7.7	80	551
Shipp	5WO	1/15/09	11:54	1.50	16.77	8.37	240	153	7.5	78	551
Shipp	5WO	1/15/09	11:55	1.72	16.74	8.37	240	154	6.6	68	549
Shipp	5WO	1/26/09	11:42	0.25	15.63	9.54	243	156	9.1	92	606
Shipp	5WO	1/26/09	11:43	0.50	15.47	9.55	243	156	8.8	88	599
Shipp	5WO	1/26/09	11:44	1.00	14.65	9.27	242	155	8.3	82	600
Shipp	5WO	1/26/09	11:45	1.50	14.46	9.19	241	154	7.8	77	601
Shipp	5WO	1/26/09	11:47	1.66	14.47	9.18	241	154	7.3	71	598
Shipp	5WO	2/11/09	12:06	0.25	16.70	8.71	248	159	8.1	83	475
Shipp	5WO	2/11/09	12:08	0.50	16.39	8.93	248	159	7.7	79	469
Shipp	5WO	2/11/09	12:09	1.00	16.25	9.05	248	159	7.6	78	468
Shipp	5WO	2/11/09	12:11	1.49	15.80	9.01	247	158	6.2	63	471
Shipp	5WO	3/19/09	11:36	0.25	22.80	7.45	267	171	5.0	58	320
Shipp	5WO	3/19/09	11:37	0.50	22.66	7.42	268	171	5.2	60	315
Shipp	5WO	3/19/09	11:38	1.00	22.42	7.34	268	171	4.9	56	310
Shipp	5WO	3/19/09	11:39	1.57	22.37	7.25	267	171	3.7	42	238
Shipp	5WO	4/9/09	12:06	0.25	21.02	8.66	274	176	8.7	97	358
Shipp	5WO	4/9/09	12:07	0.50	20.63	8.54	275	176	8.2	91	356
Shipp	5WO	4/9/09	12:08	1.00	20.32	8.53	274	176	8.3	92	359
Shipp	5WO	4/9/09	12:10	1.50	20.25	8.39	275	176	7.6	84	352
Shipp	5WO	4/9/09	12:11	1.53	20.24	8.32	275	176	7.4	82	279

Field Data for Dry Season Isolation Chamber Experiments in Lakes May and Shipp

Lake	Location	Date	Time	Depth (meters)	Temperature (oC)	pH (s.u.)	SpCond (µmho/cm)	TDS (mg/l)	DO (mg/l)	DO% (Sat)	ORP (mv)
Shipp	6WO	12/19/08	10:41	0.25	19.87	9.48	241	154	11.1	122	566
Shipp	6WO	12/19/08	10:41	0.50	19.86	9.47	241	154	11.6	127	563
Shipp	6WO	12/19/08	10:42	1.00	19.54	8.61	232	148	9.8	106	523
Shipp	6WO	12/19/08	10:43	1.50	19.11	7.81	221	142	7.0	76	495
Shipp	6WO	12/30/08	11:12	0.25	20.84	8.75	240	154	8.3	93	451
Shipp	6WO	12/30/08	11:13	0.50	20.83	8.74	240	154	8.2	91	457
Shipp	6WO	12/30/08	11:15	1.00	20.82	8.75	240	154	7.5	84	465
Shipp	6WO	12/30/08	11:18	1.52	20.74	8.40	239	153	6.5	73	453
Shipp	6WO	1/15/09	11:44	0.25	16.77	8.24	239	153	7.8	81	548
Shipp	6WO	1/15/09	11:45	0.50	16.74	8.24	239	153	8.0	82	550
Shipp	6WO	1/15/09	11:47	1.00	16.78	8.29	239	153	7.5	77	551
Shipp	6WO	1/15/09	11:48	1.55	16.77	8.35	239	153	7.1	73	548
Shipp	6WO	1/26/09	11:49	0.25	15.77	9.76	243	155	8.6	87	575
Shipp	6WO	1/26/09	11:50	0.50	15.51	9.76	243	155	8.6	87	570
Shipp	6WO	1/26/09	11:51	1.00	14.62	9.43	242	155	8.4	82	575
Shipp	6WO	1/26/09	11:53	1.48	14.45	9.35	241	154	7.7	75	575
Shipp	6WO	2/11/09	12:13	0.25	16.59	9.35	248	158	7.7	79	463
Shipp	6WO	2/11/09	12:15	0.50	16.42	9.29	247	158	7.3	74	467
Shipp	6WO	2/11/09	12:16	1.00	16.30	9.26	247	158	7.1	72	470
Shipp	6WO	2/11/09	12:17	1.38	16.13	9.15	246	158	6.8	69	474
Shipp	6WO	3/19/09	11:50	0.25	22.98	7.92	262	168	7.9	92	307
Shipp	6WO	3/19/09	11:50	0.50	22.81	7.83	262	167	7.5	87	307
Shipp	6WO	3/19/09	11:52	1.00	22.48	7.67	262	168	7.0	81	307
Shipp	6WO	3/19/09	11:55	1.50	22.43	7.46	261	167	5.7	66	220
Shipp	6WO	4/9/09	12:14	0.25	21.85	8.92	274	175	9.2	105	325
Shipp	6WO	4/9/09	12:15	0.50	21.38	8.88	273	175	9.3	105	334
Shipp	6WO	4/9/09	12:16	1.00	20.39	8.59	274	175	7.8	87	331
Shipp	6WO	4/9/09	12:19	1.45	20.29	8.45	273	175	7.5	83	281

2a. Lab Analyses - Original Program

Results of Isolation Chamber Experiments Conducted in Lakes May and Shipp Under Wet Season Conditions

Lake	Site	Date	Alkalinity (mg/l)	NH3 (µg/l)	NOX (µg/l)	Dis Org N (µg/l)	Part N (µg/l)	TN (µg/l)	OP (µg/l)	Dis Org P (µg/l)	Part P (µg/l)	TP (µg/l)	TSS (mg/l)	Chl a (mg/m^3)	Turbidity (NTU)
May	Lake	7/27/09	66.0	65	2.5	700	660	1427	1	8	5	14	15.4	30.7	10.2
May	Lake	8/17/09	62.0	36	2.5	475	1082	1595	0.5	4	36	40	15.4	38.3	14.6
May	Lake	9/3/09	62.0	68	2.5	1286	30	1386	0.5	16	20	36	15.2	68.6	9.4
May	Lake	9/17/09	59.4	195	2.5	335	806	1338	1	8	24	33	13.8	46.4	11.7
May	Lake	10/1/09	61.8	336	2.5	195	1056	1589	3	9	23	35	13.4	48.6	14.1
May	Lake	10/15/09	65.8	73	2.5	448	977	1500	0.5	4	39	43	13.4	76.4	13.7
May	1W	7/27/09	63.8	191	10	599	1583	2383	0.5	9	12	21	10.8	18.1	7.9
May	1W	8/17/09	58.4	51	5	694	1732	2482	3	12	37	52	36.8	112.0	24.0
May	1W	9/3/09	62.8	89	2.5	606	1621	2318	0.5	12	92	104	43.5	101.0	13.5
May	1W	9/17/09	57.2	279	2.5	636	1064	1981	0.5	7	68	75	28.0	73.7	15.1
May	1W	10/1/09	60.6	410	2.5	224	2008	2644	2	5	30	37	36.5	133.0	21.2
May	1W	10/15/09	62.4	264	2.5	346	2019	2631	0.5	9	78	87	42.0	116.0	19.1
May	2W	7/27/09	62.0	17	2.5	607	1815	2441	0.5	9	6	15	13.0	22.5	9.5
May	2W	8/17/09	50.8	39	2.5	608	1663	2312	0.5	11	13	24	11.2	69.2	8.4
May	2W	9/3/09	50.0	68	2.5	629	1773	2472	0.5	13	70	83	24.4	87.3	19.3
May	2W	9/17/09	49.2	93	2.5	933	1508	2536	0.5	8	53	61	18.5	76.4	14.5
May	2W	10/1/09	59.6	432	2.5	590	1598	2622	3	9	63	75	40.0	156.0	19.4
May	2W	10/15/09	49.8	451	2.5	497	1007	1957	0.5	4	67	71	18.8	50.8	16.7
May	3W	7/27/09	63.0	10	2.5	1261	626	1899	1	8	7	16	15.0	24.9	9.5
May	3W	8/17/09	58.8	73	2.5	1168	1123	2366	0.5	8	15	23	14.4	126.0	9.5
May	3W	9/3/09	53.6	57	2.5	1557	847	2463	0.5	6	56	62	22.0	70.7	11.6
May	3W	9/17/09	60.8	127	2.5	555	2070	2754	2	5	51	58	13.0	76.8	12.4
May	3W	10/1/09	50.8	264	2.5	1389	1021	2676	1	6	48	55	14.3	79.7	10.2
May	3W	10/15/09	56.0	986	2.5	637	759	2384	0.5	5	62	67	21.8	95.3	10.0

Results of Isolation Chamber Experiments Conducted in Lakes May and Shipp Under Wet Season Conditions

Lake	Site	Date	Alkalinity (mg/l)	NH3 (µg/l)	NOX (µg/l)	Dis Org N (µg/l)	Part N (µg/l)	TN (µg/l)	OP (µg/l)	Dis Org P (µg/l)	Part P (µg/l)	TP (µg/l)	TSS (mg/l)	Chl a (mg/m^3)	Turbidity (NTU)
May	4WO	7/27/09	63.8	17	2.5	719	699	1437	1	5	6	12	7.4	16.0	7.8
May	4WO	8/17/09	73.4	86	2.5	544	1959	2591	1	4	40	45	12.2	104.0	19.5
May	4WO	9/3/09	80.0	91	2.5	529	1499	2121	2	3	38	43	14.6	61.0	10.8
May	4WO	9/17/09	82.8	94	2.5	1458	495	2049	1	4	53	58	7.5	46.5	4.4
May	4WO	10/1/09	89.4	84	2.5	967	845	1898	9	6	28	43	8.0	66.4	10.9
May	4WO	10/15/09	83.8	67	2.5	1438	412	1919	3	2	47	52	5.9	73.0	12.2
May	5WO	7/27/09	65.0	15	2.5	680	678	1375	2	3	10	15	13.0	22.8	9.5
May	5WO	8/17/09	62.2	39	2.5	729	833	1603	0.5	7	16	23	14.2	94.8	10.0
May	5WO	9/3/09	63.6	75	2.5	679	948	1704	0.5	7	35	42	22.5	68.0	14.0
May	5WO	9/17/09	58.0	95	2.5	577	1082	1756	2	5	39	46	16.0	35.9	10.6
May	5WO	10/1/09	58.6	104	2.5	767	408	1281	2	3	29	34	21.8	45.0	17.3
May	5WO	10/15/09	63.6	98	2.5	844	431	1375	0.5	6	60	66	22.0	91.4	18.1
May	6WO	7/27/09	62.8	13	2.5	677	645	1337	2	2	14	18	12.6	38.7	9.2
May	6WO	8/17/09	77.4	97	2.5	901	2291	3291	1	3	32	36	11.4	50.1	15.5
May	6WO	9/3/09	77.4	72	2.5	486	2737	3297	1	2	35	38	17.6	95.0	13.1
May	6WO	9/17/09	86.0	80	2.5	1024	2056	3162	2	3	39	44	5.0	67.0	5.1
May	6WO	10/1/09	88.0	58	2.5	387	1952	2399	7	3	32	42	7.3	94.2	13.5
May	6WO	10/15/09	83.8	43	2.5	519	2560	3124	1	4	35	40	12.0	21.9	12.7
May - Wet	**Lake**	**average**	**62.8**	**129**	**<5**	**572.7**	**768.5**	**1472.5**	**1.1**	**7.9**	**24.5**	**33.5**	**14.4**	**51.5**	**12.3**
May - Wet	**With**	**average**	**57.2**	**217**	**<5**	**752**	**1435**	**2407**	**1**	**8**	**46**	**55**	**23.6**	**82.7**	**14.0**
May - Wet	**Without**	**average**	**73.3**	**68**	**<5**	**773**	**1252**	**2096**	**2**	**4**	**33**	**39**	**12.8**	**60.6**	**11.9**

Results of Isolation Chamber Experiments Conducted in Lakes May and Shipp Under Wet Season Conditions

Lake	Site	Date	Alkalinity (mg/l)	NH3 (µg/l)	NOX (µg/l)	Dis Org N (µg/l)	Part N (µg/l)	TN (µg/l)	OP (µg/l)	Dis Org P (µg/l)	Part P (µg/l)	TP (µg/l)	TSS (mg/l)	Chl a (mg/m^3)	Turbidity (NTU)
Shipp	Lake	7/27/09	60.6	13	2.5	680	720	1415	1	12	4	17	8.4	31.3	8.8
Shipp	Lake	8/17/09	59.2	27	2.5	636	994	1659	0.5	14	5	19	12.0	26.7	9.3
Shipp	Lake	9/3/09	58.6	66	2.5	599	749	1416	0.5	13	10	23	16.0	2.9	13.1
Shipp	Lake	9/17/09	66.2	228	2.5	960	286	1476	1	17	7	25	6.0	33.0	6.6
Shipp	Lake	10/1/09	57.6	83	2.5	750	843	1678	2	6	7	15	11.3	41.8	11.3
Shipp	Lake	10/15/09	60.6	45	2.5	668	907	1622	0.5	13	13	26	12.3	22.9	12.2
Shipp	1W	7/27/09	60.4	304	25	198	850	1377	1	4	21	26	7.6	32.0	9.3
Shipp	1W	8/17/09	58.0	29	2.5	721	1141	1893	2	2	28	32	18.3	59.1	23.1
Shipp	1W	9/3/09	56.2	70	2.5	711	1191	1974	0.5	4	55	59	14.6	8.0	5.8
Shipp	1W	9/17/09	55.2	299	2.5	335	2040	2676	4	1	41	46	12.0	95.7	9.8
Shipp	1W	10/1/09	52.4	323	2.5	275	2109	2709	2	1	36	39	18.0	102.0	14.2
Shipp	1W	10/15/09	56.8	76	2.5	497	2210	2785	0.5	2	64	66	14.6	117.0	14.1
Shipp	2W	7/27/09	59.6	313	33	201	1579	2126	0.5	4	23	27	9.6	12.5	6.0
Shipp	2W	8/17/09	60.4	37	2.5	474	1650	2163	2	0	45	47	21.8	135.0	24.3
Shipp	2W	9/3/09	61.6	68	2.5	463	1538	2071	0.5	3	88	91	28.5	25.6	13.1
Shipp	2W	9/17/09	60.8	254	2.5	577	1995	2828	1	4	42	47	16.0	57.4	19.4
Shipp	2W	10/1/09	52.8	348	2.5	600	1846	2796	2	2	23	26	14.5	90.6	14.0
Shipp	2W	10/15/09	60.0	64	2.5	1528	690	2284	0.5	3	71	74	23.0	79.7	19.5
Shipp	3W	7/27/09	63.2	250	44	352	1166	1812	1	2	24	27	6.2	13.8	4.7
Shipp	3W	8/17/09	59.8	34	2.5	477	1297	1810	1	4	34	39	35.0	92.3	23.4
Shipp	3W	9/3/09	60.6	72	2.5	851	1642	2567	0.5	7	62	69	37.5	49.4	15.2
Shipp	3W	9/17/09	62.0	67	2.5	642	1518	2229	0.5	7	32	39	28.4	27.2	9.9
Shipp	3W	10/1/09	56.8	329	2.5	298	2123	2752	0.5	3	26	29	21.5	80.1	12.7
Shipp	3W	10/15/09	56.2	58	2.5	625	1822	2507	0.5	4	41	45	19.7	70.7	11.7

Results of Isolation Chamber Experiments Conducted in Lakes May and Shipp Under Wet Season Conditions

Lake	Site	Date	Alkalinity (mg/l)	NH3 (µg/l)	NOX (µg/l)	Dis Org N (µg/l)	Part N (µg/l)	TN (µg/l)	OP (µg/l)	Dis Org P (µg/l)	Part P (µg/l)	TP (µg/l)	TSS (mg/l)	Chl a (mg/m^3)	Turbidity (NTU)
Shipp	4WO	7/27/09	59.2	213	2.5	331	1838	2384	1	3	11	15	6.8	7.5	6.2
Shipp	4WO	8/17/09	56.6	270	12	268	1562	2112	0.5	4	19	23	9.4	29.3	11.3
Shipp	4WO	9/3/09	53.2	106	5	527	1068	1706	0.5	17	24	41	11.4	78.5	20.4
Shipp	4WO	9/17/09	56.2	23	4	685	645	1357	0.5	8	17	25	1.3	38.9	14.4
Shipp	4WO	10/1/09	50.4	333	22	306	1131	1792	1	4	10	15	4.4	38.3	7.4
Shipp	4WO	10/15/09	51.8	262	32	517	831	1642	0.5	6	32	38	7.4	13.1	8.0
Shipp	5WO	7/27/09	63.2	470	2.5	356	1404	2232	0.5	14	12	26	4.6	11.0	4.6
Shipp	5WO	8/17/09	64.0	617	10	197	1215	2039	0.5	13	25	38	11.8	27.0	12.5
Shipp	5WO	9/3/09	53.8	148	13	419	1150	1730	0.5	9	39	48	19.8	28.1	23.3
Shipp	5WO	9/17/09	46.8	34	2.5	611	1117	1764	0.5	6	20	26	4.7	14.1	5.8
Shipp	5WO	10/1/09	52.2	257	31	437	731	1456	2	0	24	26	5.5	42.8	8.8
Shipp	5WO	10/15/09	51.6	281	111	314	1397	2103	0.5	3	38	41	10.6	55.9	8.2
Shipp	6WO	7/27/09	64.2	17	2.5	609	1361	1989	1	3	16	20	9.8	11.9	6.8
Shipp	6WO	8/17/09	64.4	29	2.5	1303	240	1574	0.5	5	25	30	10.0	43.5	14.3
Shipp	6WO	9/3/09	59.0	17	2.5	849	511	1379	0.5	4	36	40	8.0	52.0	9.9
Shipp	6WO	9/17/09	57.4	102	2.5	932	276	1312	0.5	4	23	27	5.0	23.0	6.4
Shipp	6WO	10/1/09	55.8	255	11	684	853	1803	1	4	13	18	9.0	75.0	11.3
Shipp	6WO	10/15/09	54.4	159	7	798	904	1868	1	11	29	41	10.0	68.0	11.2
Shipp - Wet	**Lake**	**average**	**60.5**	**77.0**	**<5**	**715**	**750**	**1544**	**1**	**12**	**8**	**21**	**11.0**	**26.4**	**10.2**
Shipp - Wet	**With**	**average**	**58.5**	**166**	**8**	**545**	**1578**	**2298**	**1**	**3**	**42**	**46**	**19.3**	**63.8**	**13.9**
Shipp - Wet	**Without**	**average**	**56.3**	**200**	**15**	**563**	**1013**	**1791**	**1**	**6**	**23**	**30**	**8.3**	**36.6**	**10.6**

2b. Lab Analyses - Supplemental Program

Results of Isolation Chamber Experiments Conducted in Lakes May and Shipp Under Dry Season Conditions

Lake	Site	Date	Alkalinity (mg/l)	NH3 (µg/l)	NOX (µg/l)	Dis Org N (µg/l)	Part N (µg/l)	TN (µg/l)	SRP (µg/l)	Dis Org P (µg/l)	Part P (µg/l)	TP (µg/l)	TSS (mg/l)	Chl a (mg/m³)	Turbidity (NTU)
May	Lake	12/18/08	58.0	31	3	862	502	1398	3	4	29	36	19.5	46.7	11.3
May	Lake	12/30/08	54.0	22	3	455	1104	1584	1	14	41	56	18.9	42.2	8.5
May	Lake	1/15/09	62.2	28	5	560	863	1456	1	20	44	65	25.4	12.7	14.6
May	Lake	1/26/09	60.4	27	2.5	889	549	1768	0.5	4	75	79	19.7	27.7	9.4
May	Lake	2/11/09	60.4	18	2.5	487	1033	1541	0.5	2	80	82	26.9	16.9	12.0
May	Lake	3/3/09	63.2	12	2.5	830	704	1549	0.5	4	52	56	23.0	71.5	15.5
May	Lake	3/19/09	63.2	39	2.5	402	826	1270	0.5	18	34	52	24.8	39.3	14.8
May	Lake	4/9/09	67.4	71	2.5	427	1086	1587	0.5	4	71	76	27.0	30.9	15.0
		average	**61.1**	**31**	**3**	**614**	**833**	**1519**	**1**	**9**	**53**	**63**	**23.2**	**36.0**	**12.6**
May	1W	12/18/08	63.8	27	2.5	561	671	1262	1	1	33	35	19.5	38.9	10.8
May	1W	12/30/08	58.0	26	2.5	462	983	1474	1	17	31	49	18.9	39.9	6.4
May	1W	1/15/09	65.4	338	7	530	762	1637	0.5	11	81	92	12.7	37.0	8.6
May	1W	1/26/09	63.4	372	6	1035	589	2002	1	14	33	48	14.0	35.3	5.8
May	1W	2/11/09	62.2	303	10	454	898	1665	1	7	53	61	10.0	10.1	5.0
May	1W	3/3/09	63.2	44	2.5	597	860	1504	0.5	10	41	51	15.6	33.0	11.5
May	1W	3/19/09	66.2	98	2.5	495	589	1185	0.5	1	50	51	14.5	23.6	13.5
May	1W	4/9/09	79.2	359	23	528	637	1547	0.5	2	69	71	8.5	19.6	13.9
		average	**65.2**	**196**	**7**	**583**	**749**	**1535**	**1**	**8**	**49**	**57**	**14.2**	**29.7**	**9.4**
May	2W	12/18/08	59.0	35	2.5	488	849	1375	1	1	42	44	20.0	36.5	11.5
May	2W	12/30/08	68.0	178	2.5	1347	1533	3061	0.5	26	20	46	15.0	41.4	7.2
May	2W	1/15/09	67.8	259	9	616	1150	2034	7	23	17	47	16.3	39.1	10.8
May	2W	1/26/09	68.2	301	18	1048	374	1741	31	12	75	118	12.7	21.5	10.0
May	2W	2/11/09	64.2	303	8	476	421	1208	1	1	86	88	11.6	18.4	4.4
May	2W	3/3/09	66.2	22	2.5	782	745	1552	0.5	6	73	79	8.5	18.8	8.4
May	2W	3/19/09	72.0	80	2.5	753	415	1251	3	2	56	61	9.5	44.7	8.1
May	2W	4/9/09	76.2	281	9	731	575	1596	3	6	74	83	9.5	13.2	8.8
		average	**67.7**	**182**	**7**	**780**	**758**	**1727**	**6**	**10**	**55**	**71**	**12.9**	**29.2**	**8.7**
May	3W	12/18/08	59.2	34	2.5	480	676	1193	1	1	41	43	14.3	29.9	9.2
May	3W	12/30/08	60.0	24	2.5	463	818	1308	2	9	35	46	10.8	22.7	3.8
May	3W	1/15/09	63.8	293	8	487	519	1307	1	3	49	53	11.7	10.6	4.8
May	3W	1/26/09	64.4	249	31	679	310	1269	1	8	21	30	13.3	14.8	3.8
May	3W	2/11/09	63.8	163	98	526	419	1206	1	8	45	54	16.6	17.2	3.9
May	3W	3/3/09	69.6	38	43	524	696	1301	0.5	2	41	43	13.8	11.6	5.6
May	3W	3/19/09	74.2	68	5	770	184	1027	0.5	3	35	38	12.8	10.6	8.9
May	3W	4/9/09	77.2	73	9	604	485	1171	0.5	3	50	53	9.0	8.7	9.0
		average	**66.5**	**118**	**25**	**567**	**513**	**1223**	**1**	**4**	**40**	**45**	**12.8**	**15.8**	**6.1**

Results of Isolation Chamber Experiments Conducted in Lakes May and Shipp Under Dry Season Conditions

Lake	Site	Date	Alkalinity (mg/l)	NH3 (µg/l)	NOX (µg/l)	Dis Org N (µg/l)	Part N (µg/l)	TN (µg/l)	SRP (µg/l)	Dis Org P (µg/l)	Part P (µg/l)	TP (µg/l)	TSS (mg/l)	Chl a (mg/m³)	Turbidity (NTU)
May	4WO	12/18/08	58.0	30	106	428	866	1430	4	6	39	49	20.3	25.6	13.8
May	4WO	12/30/08	62.0	27	2.5	569	894	1493	1	22	31	54	8.0	39.9	4.7
May	4WO	1/15/09	60.6	746	18	504	520	1788	1	4	9	14	5.7	5.1	5.2
May	4WO	1/26/09	59.0	517	351	529	297	1694	0.5	3	17	20	1.3	7.8	4.2
May	4WO	2/11/09	52.6	41	369	523	332	1265	1	8	11	20	3.4	3.0	2.0
May	4WO	3/3/09	55.4	27	9	704	157	897	0.5	3	14	17	1.5	6.1	2.3
May	4WO	3/19/09	58.2	35	2.5	459	176	673	0.5	1	11	12	4.0	2.5	2.1
May	4WO	4/9/09	68.4	110	12	586	216	924	0.5	5	14	19	4.0	4.0	1.7
		average	**59.3**	**192**	**109**	**538**	**432**	**1271**	**1**	**6**	**18**	**26**	**6.0**	**11.8**	**4.5**
May	5WO	12/18/08	59.4	36	2.5	451	1065	1555	1	0.5	65	66	26.5	55.3	19.2
May	5WO	12/30/08	48.0	93	2.5	511	857	1464	0.5	26	17	43	12.8	31.1	8.5
May	5WO	1/15/09	65.2	483	31	509	525	1548	4	3	41	48	8.0	9.8	8.3
May	5WO	1/26/09	66.0	276	152	718	492	1638	5	6	34	45	2.4	12.6	5.1
May	5WO	2/11/09	60.8	35	25	721	476	1257	3	2	35	40	1.0	5.4	2.3
May	5WO	3/3/09	64.8	14	2.5	796	290	1103	0.5	10	24	34	2.8	8.2	5.1
May	5WO	3/19/09	66.2	39	2.5	711	208	961	1	4	22	27	5.3	3.1	4.4
May	5WO	4/9/09	67.8	71	2.5	715	91	880	1	10	12	23	6.8	4.3	4.8
		average	**62.3**	**131**	**28**	**642**	**501**	**1301**	**2**	**8**	**31**	**41**	**8.2**	**16.2**	**7.2**
May	6WO	12/18/08	59.4	38	2.5	462	902	1405	1	1	50	52	19.3	45.7	12.1
May	6WO	12/30/08	54.0	25	2.5	479	901	1408	1	16	16	33	10.5	39.9	6.3
May	6WO	1/15/09	43.6	391	27	573	489	1480	4	2	24	30	10.0	13.3	6.0
May	6WO	1/26/09	63.4	431	131	742	466	1770	6	0.5	21	27	12.0	1.0	5.3
May	6WO	2/11/09	59.8	68	247	706	187	1208	2	5	30	37	8.8	7.8	2.6
May	6WO	3/3/09	58.6	15	2.5	569	617	1204	4	3	28	35	5.8	10.8	3.4
May	6WO	3/19/09	65.8	50	2.5	454	561	1068	1	0.5	24	25	6.8	12.2	3.5
May	6WO	4/9/09	64.4	134	2.5	712	40	889	1	0.5	16	18	4.5	21.6	3.2
		average	**58.6**	**144**	**52**	**587**	**520**	**1304**	**3**	**4**	**26**	**32**	**9.7**	**19.0**	**5.3**
May - Dry	**Lake**	**average**	**61.1**	**31**	**3**	**614**	**833**	**1519**	**1**	**9**	**53**	**63**	**23.2**	**36.0**	**12.6**
May - Dry	**With**	**average**	**66.5**	**165**	**13**	**643**	**673**	**1495**	**3**	**7**	**48**	**58**	**13.3**	**24.9**	**8.1**
May - Dry	**Without**	**average**	**60.1**	**156**	**63**	**589**	**484**	**1292**	**2**	**6**	**25**	**33**	**8.0**	**15.7**	**5.7**

Results of Isolation Chamber Experiments Conducted in Lakes May and Shipp Under Dry Season Conditions

Lake	Site	Date	Alkalinity (mg/l)	NH3 (µg/l)	NOX (µg/l)	Dis Org N (µg/l)	Part N (µg/l)	TN (µg/l)	SRP (µg/l)	Dis Org P (µg/l)	Part P (µg/l)	TP (µg/l)	TSS (mg/l)	Chl a (mg/m³)	Turbidity (NTU)
Shipp	Lake	12/19/08	61.8	36	145	486	812	1479	4	6	30	40	17.8	36.3	9.4
Shipp	Lake	12/30/08	64.0	23	2.5	519	1096	1641	0.5	20	28	48	16.8	40.4	7.8
Shipp	Lake	1/15/09	64.6	10	10	469	1037	1526	0.5	16	11	27	19.4	62.7	11.2
Shipp	Lake	1/26/09	72.2	38	2.5	551	1519	2111	0.5	5	28	33	15.7	14.6	7.2
Shipp	Lake	2/11/09	66.4	22	8	488	1141	1659	0.5	6	58	64	18.0	18.1	8.8
Shipp	Lake	3/3/09	66.8	12	2.5	729	1077	1821	0.5	38	15	53	22.3	21.5	12.6
Shipp	Lake	3/19/09	68.2	40	2.5	379	1043	1465	0.5	1	39	40	25.0	59.2	14.7
Shipp	Lake	4/9/09	68.0	76	2.5	487	1173	1739	0.5	-1	43	43	23.3	73.7	16.0
		average	**66.5**	**32**	**22**	**514**	**1112**	**1680**	**1**	**11**	**32**	**44**	**19.8**	**40.8**	**11.0**
Shipp	1W	12/19/08	62.2	36	2.5	472	906	1417	1	2	40	43	18.5	45.5	8.6
Shipp	1W	12/30/08	64.0	22	2.5	779	667	1471	0.5	15	20	35	13.0	18.0	5.2
Shipp	1W	1/15/09	66.4	367	12	725	615	1719	0.5	16	9	25	15.4	14.7	5.6
Shipp	1W	1/26/09	67.0	471	13	507	904	1895	0.5	2	60	62	10.7	13.5	6.4
Shipp	1W	2/11/09	66.8	110	18	523	995	1646	1	9	133	143	14.0	27.5	6.8
Shipp	1W	3/3/09	66.6	87	2.5	892	787	1769	0.5	6	67	73	20.0	61.5	13.2
Shipp	1W	3/19/09	70.4	38	2.5	464	852	1357	0.5	1	37	38	18.0	40.6	10.7
Shipp	1W	4/9/09	69.6	74	2.5	521	964	1562	0.5	-1	48	48	21.5	73.5	11.0
		average	**66.6**	**151**	**7**	**610**	**836**	**1605**	**1**	**6**	**52**	**58**	**16.4**	**36.9**	**8.4**
Shipp	2W	12/19/08	61.6	31	2.5	505	799	1338	1	6	35	42	18.8	43.2	8.4
Shipp	2W	12/30/08	72.0	21	2.5	621	816	1461	0.5	11	21	32	13.3	29.1	5.6
Shipp	2W	1/15/09	65.8	95	6	540	914	1555	1	15	22	38	11.3	23.1	7.5
Shipp	2W	1/26/09	67.6	293	11	577	606	1487	1	2	41	44	11.7	23.9	7.0
Shipp	2W	2/11/09	67.2	195	19	480	810	1504	0.5	7	48	55	12.0	10.9	6.2
Shipp	2W	3/3/09	67.0	92	33	886	783	1794	0.5	2	76	78	16.3	55.5	12.0
Shipp	2W	3/19/09	72.0	124	40	560	473	1197	0.5	3	30	33	19.8	33.0	5.8
Shipp	2W	4/9/09	71.2	75	2.5	505	1172	1755	0.5	-1	53	53	19.0	47.7	5.9
		average	**68.1**	**116**	**15**	**584**	**797**	**1511**	**1**	**5**	**41**	**47**	**15.3**	**33.3**	**7.3**
Shipp	3W	12/19/08	62.8	17	2.5	529	610	1159	2	6	34	42	16.5	38.1	8.9
Shipp	3W	12/30/08	62.0	26	2.5	647	870	1546	0.5	16	27	43	13.5	31.5	6.3
Shipp	3W	1/15/09	65.8	14	5	480	988	1487	0.5	18	28	46	18.3	40.1	8.2
Shipp	3W	1/26/09	66.6	35	2.5	500	898	1436	0.5	3	38	41	13.7	25.7	7.6
Shipp	3W	2/11/09	66.8	57	2.5	502	760	1322	0.5	17	31	48	15.8	15.8	6.5
Shipp	3W	3/3/09	68.2	98	12	583	878	1571	0.5	4	56	60	17.0	26.6	12.0
Shipp	3W	3/19/09	70.0	77	31	513	632	1253	0.5	2	33	35	18.0	36.0	8.8
Shipp	3W	4/9/09	70.6	78	2.5	514	957	1552	0.5	2	43	45	17.8	42.2	9.3
		average	**66.6**	**50**	**8**	**534**	**824**	**1416**	**1**	**8**	**36**	**45**	**16.3**	**32.0**	**8.5**

Results of Isolation Chamber Experiments Conducted in Lakes May and Shipp Under Dry Season Conditions

Lake	Site	Date	Alkalinity (mg/l)	NH3 (µg/l)	NOX (µg/l)	Dis Org N (µg/l)	Part N (µg/l)	TN (µg/l)	SRP (µg/l)	Dis Org P (µg/l)	Part P (µg/l)	TP (µg/l)	TSS (mg/l)	Chl a (mg/m^3)	Turbidity (NTU)
Shipp	4WO	12/19/08	61.4	96	2.5	431	942	1472	1	1	62	64	22.0	23.2	14.3
Shipp	4WO	12/30/08	40.0	27	2.5	482	640	1152	1	11	29	41	10.3	36.7	9.6
Shipp	4WO	1/15/09	58.4	69	5	453	633	1160	0.5	16	21	37	9.7	18.8	7.7
Shipp	4WO	1/26/09	61.4	194	10	521	666	1391	0.5	3	50	53	12.0	9.3	8.3
Shipp	4WO	2/11/09	62.8	181	6	492	917	1596	1	3	82	86	8.2	16.3	5.8
Shipp	4WO	3/3/09	65.8	11	28	622	1057	1718	1	0	56	57	17.8	21.0	13.6
Shipp	4WO	3/19/09	70.0	77	2.5	421	697	1198	0.5	1	37	38	14.0	13.3	8.2
Shipp	4WO	4/9/09	71.2	76	2.5	461	1224	1764	0.5	-1	39	39	10.5	10.9	9.0
		average	**61.4**	**91**	**7**	**485**	**847**	**1431**	**1**	**4**	**47**	**52**	**13.1**	**18.7**	**9.6**
Shipp	5WO	12/19/08	61.0	45	2.5	525	751	1324	0.5	4	36	40	28.0	19.0	15.5
Shipp	5WO	12/30/08	62.0	26	2.5	559	682	1270	0.5	12	22	34	13.0	41.7	5.5
Shipp	5WO	1/15/09	61.8	13	5	456	838	1312	0.5	15	7	22	14.4	42.2	7.4
Shipp	5WO	1/26/09	62.4	42	2.5	489	773	1307	0.5	2	33	35	17.4	17.6	7.7
Shipp	5WO	2/11/09	66.2	204	8	522	1045	1779	1	3	99	103	10.4	21.7	5.3
Shipp	5WO	3/3/09	66.4	9	2.5	606	1110	1728	0.5	4	51	55	18.3	26.9	11.5
Shipp	5WO	3/19/09	69.8	157	2.5	375	650	1185	0.5	1	23	24	13.0	16.4	8.2
Shipp	5WO	4/9/09	68.6	78	2.5	672	915	1668	0.5	1	39	40	13.3	40.9	8.5
		average	**64.8**	**72**	**4**	**526**	**846**	**1447**	**1**	**5**	**39**	**44**	**16.0**	**28.3**	**8.7**
Shipp	6WO	12/19/08	65.8	40	2.5	495	879	1417	3	0.5	31	34	18.8	56.5	10.5
Shipp	6WO	12/30/08	62.0	19	2.5	508	726	1256	1	11	26	38	8.8	26.6	7.0
Shipp	6WO	1/15/09	62.4	18	5	457	864	1344	0.5	16	42	58	14.7	37.5	8.5
Shipp	6WO	1/26/09	65.2	40	2.5	509	796	1348	0.5	2	63	65	14.0	22.3	7.6
Shipp	6WO	2/11/09	64.6	195	8	461	1056	1720	0.5	1	94	95	8.0	13.1	5.4
Shipp	6WO	3/3/09	65.6	187	29	649	981	1846	0.5	9	58	67	12.3	14.0	10.6
Shipp	6WO	3/19/09	66.0	96	32	469	380	977	0.5	1	24	25	9.7	19.3	6.4
Shipp	6WO	4/9/09	65.4	62	<5	475	1114	1654	0.5	9	32	41	23.5	18.9	6.2
		average	**64.6**	**82**	**12**	**503**	**850**	**1445**	**1**	**6**	**46**	**53**	**13.7**	**26.0**	**7.8**
Shipp - Dry	**Lake**	**average**	**66.5**	**32**	**22**	**514**	**1112**	**1680**	**1**	**11**	**32**	**44**	**19.8**	**40.8**	**11.0**
Shipp - Dry	**With**	**average**	**67.1**	**106**	**10**	**576**	**819**	**1511**	**1**	**7**	**43**	**50**	**16.0**	**34.1**	**8.1**
Shipp - Dry	**Without**	**average**	**63.6**	**82**	**8**	**505**	**847**	**1441**	**1**	**5**	**44**	**50**	**14.3**	**24.3**	**8.7**

APPENDIX K

RESULTS OF WATER QUALITY MODELS FOR LAKES MAY, SHIPP, AND LULU

1. **Calibrated Models Under Existing Conditions**

2. **Anticipated Water Quality with Hydraulic Dredging of Organic Sediments**

3. **Anticipated Water Quality with Sediment Inactivation**

1. CALIBRATED MODELS UNDER EXISTING CONDITIONS

Modified Vollenweider Mass Balance Phosphorus Limitation Model for Lake May - Calibration

Initial P Conc. (mg/l)	Hydrologic and Mass Inputs: Direct Precipitation			Stormwater		G.W. Seepage		Dry Weather Baseflow		Internal Recycling	Total Inputs		
	(in)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)	(kg)	(ac-ft)	(kg)	(mg/l)
0.063	50.77	214	14.77	537	40.20	120.0	14.30	0.0	0.00	58.4	871	127.7	0.119

Hydrologic and Mass Losses: Evaporation		Outflow to Howard		Outflow to Shipp		Deep Recharge		Total Losses		Detention Time (days)	P Ret. Coeff.	Areal P Loading (g/m2)	Final P Conc. (mg/l)	Chyl-a Conc. (mg/m3)	Secchi Disk Depth (m)	Florida TSI Value
(in)	(ac-ft)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)							
52.40	221	209	16.2	405.0	31.5	37.0	2.9	872	50.6	132	0.469	0.624	0.063	48.2	0.72	80

Calibration Numerator Coefficient: 2.7

Calibration Denominator Coefficient: 2.7

Modified Vollenweider Mass Balance Phosphorus Limitation Model for Lake Shipp - Calibration

Initial P Conc. (mg/l)	Hydrologic and Mass Inputs														
	Direct Precipitation			Stormwater		G.W. Seepage		Dry Weather Baseflow		May Inflow		Internal Recycling	Total Inputs		
	(in)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)	(kg)	(ac-ft)	(kg)	(mg/l)
0.059	50.77	1169	80.8	506	162.0	401	80.5	29.0	3.7	613	47.6	350	2718	724.6	0.216

Hydrologic and Mass Losses								Detention Time (days)	P Ret. Coeff.	Areal P Loading (g/m2)	Final P Conc. (mg/l)	Chyl-a Conc. (mg/m3)	Secchi Disk Depth (m)	Florida TSI Value
Evaporation		Outflow to Lulu		Deep Recharge		Total Losses								
(in)	(ac-ft)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)							
52.40	1207	1085	79.4	252	18.4	2544	97.8	348	0.725	0.647	0.059	77.9	0.57	84

Calibration Numerator Coefficient: 4.6

Calibration Denominator Coefficient: 4.6

Modified Vollenweider Mass Balance Phosphorus Limitation Model for Lake Lulu - Calibration

Initial P Conc. (mg/l)	Hydrologic and Mass Inputs													
	Direct Precipitation			Stormwater		G.W. Seepage		Dry Weather Baseflow		Shipp Inflow		Internal Recycling	Total Inputs		
	(in)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)	(kg)	(ac-ft)	(kg)	(mg/l)
0.052	50.77	1299	89.7	622	85.6	393	91.7	0.0	0.0	1287	94.1	807	3601	1168	0.263

Hydrologic and Mass Losses										Detention Time (days)	P Ret. Coeff.	Areal P Loading (g/m2)	Final P Conc. (mg/l)	Chyl-a Conc. (mg/m3)	Secchi Disk Depth (m)	Florida TSI Value
Evaporation		Outfall Canal		Outflow to Eloise		Deep Recharge		Total Losses								
(in)	(ac-ft)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)							
52.40	1341	770	49	209	13	252	16	2572	79.1	280	0.802	0.940	0.052	35.6	0.84	76

Calibration Numerator Coefficient: 8.4

Calibration Denominator Coefficient: 8.4

2. ANTICIPATED WATER QUALITY WITH HYDRAULIC DREDGING OF ORGANIC SEDIMENTS

Modified Vollenweider Mass Balance Phosphorus Limitation Model for Lake May - Whole Lake Dredging

Initial P Conc. (mg/l)	Hydrologic and Mass Inputs												
	Direct Precipitation			Stormwater		G.W. Seepage		Dry Weather Baseflow		Internal Recycling	Total Inputs		
	(in)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)	(kg)	(ac-ft)	(kg)	(mg/l)
0.040	50.77	214	14.77	537	40.20	120.0	14.30	0.0	0.00	11.7	871	80.9	0.075

Hydrologic and Mass Losses										Detention Time (days)	P Ret. Coeff.	Areal P Loading (g/m2)	Final P Conc. (mg/l)	Chyl-a Conc. (mg/m3)	Secchi Disk Depth (m)	Florida TSI Value
Evaporation		Outflow to Howard		Outflow to Shipp		Deep Recharge		Total Losses								
(in)	(ac-ft)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)							
52.40	221	209	10.3	405.0	20.0	37.0	1.8	872	32.1	259	0.469	0.396	0.040	29.7	0.93	72

Calibration Numerator Coefficient: 2.7

Calibration Denominator Coefficient: 2.7

Modified Vollenweider Mass Balance Phosphorus Limitation Model for Lake Shipp - Whole Lake Dredging

Initial P Conc. (mg/l)	Hydrologic and Mass Inputs														
	Direct Precipitation			Stormwater		G.W. Seepage		Dry Weather Baseflow		May Inflow		Internal Recycling	Total Inputs		
	(in)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)	(kg)	(ac-ft)	(kg)	(mg/l)
0.035	50.77	1169	80.8	506	162.0	401	80.5	29.0	3.7	613	30.2	70	2718	427.2	0.127

Hydrologic and Mass Losses								Detention Time (days)	P Ret. Coeff.	Areal P Loading (g/m2)	Final P Conc. (mg/l)	Chyl-a Conc. (mg/m3)	Secchi Disk Depth (m)	Florida TSI Value
Evaporation		Outflow to Lulu		Deep Recharge		Total Losses								
(in)	(ac-ft)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)							
52.40	1207	1085	46.8	252	10.9	2544	57.6	431	0.725	0.382	0.035	44.5	0.75	75

Calibration Numerator Coefficient: 4.6

Calibration Denominator Coefficient: 4.6

Modified Vollenweider Mass Balance Phosphorus Limitation Model for Lake Lulu - Whole Lake Dredging

Initial P Conc. (mg/l)	Hydrologic and Mass Inputs														
	Direct Precipitation			Stormwater		G.W. Seepage		Dry Weather Baseflow		Shipp Inflow		Internal Recycling	Total Inputs		
	(in)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)	(kg)	(ac-ft)	(kg)	(mg/l)
0.022	50.77	1299	89.7	622	85.6	393	91.7	0.0	0.0	1287	55.5	161	3601	484	0.109

Hydrologic and Mass Losses										Detention Time (days)	P Ret. Coeff.	Areal P Loading (g/m2)	Final P Conc. (mg/l)	Chyl-a Conc. (mg/m3)	Secchi Disk Depth (m)	Florida TSI Value
Evaporation		Outfall Canal		Outflow to Eloise		Deep Recharge		Total Losses								
(in)	(ac-ft)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)							
52.40	1341	770	20	209	6	252	7	2572	32.8	366	0.802	0.389	0.022	14.0	1.42	59

Calibration Numerator Coefficient: 8.4

Calibration Denominator Coefficient: 8.4

3. ANTICIPATED WATER QUALITY WITH SEDIMENT INACTIVATION

Modified Vollenweider Mass Balance Phosphorus Limitation Model for Lake May - Alum Inactivation

Initial P Conc. (mg/l)	Hydrologic and Mass Inputs												
	Direct Precipitation			Stormwater		G.W. Seepage		Dry Weather Baseflow		Internal Recycling	Total Inputs		
	(in)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)	(kg)	(ac-ft)	(kg)	(mg/l)
0.063	50.77	214	14.77	537	40.20	120.0	14.30	0.0	0.00	58.4	871	127.7	0.119

Hydrologic and Mass Losses										Detention Time (days)	P Ret. Coeff.	Areal P Loading (g/m2)	Final P Conc. (mg/l)	Chyl-a Conc. (mg/m3)	Secchi Disk Depth (m)	Florida TSI Value
Evaporation		Outflow to Howard		Outflow to Shipp		Deep Recharge		Total Losses								
(in)	(ac-ft)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)							
52.40	221	209	16.2	405.0	31.5	37.0	2.9	872	50.6	132	0.469	0.624	0.063	48.2	0.72	80

Calibration Numerator Coefficient: 2.7

Calibration Denominator Coefficient: 2.7

Modified Vollenweider Mass Balance Phosphorus Limitation Model for Lake Shipp - Alum Inactivation

Initial P Conc. (mg/l)	Hydrologic and Mass Inputs														
	Direct Precipitation			Stormwater		G.W. Seepage		Dry Weather Baseflow		May Inflow		Internal Recycling	Total Inputs		
	(in)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)	(kg)	(ac-ft)	(kg)	(mg/l)
0.031	50.77	1169	80.8	506	162.0	401	16.1	29.0	3.7	613	47.6	70	2718	380.2	0.113

Hydrologic and Mass Losses								Detention Time (days)	P Ret. Coeff.	Areal P Loading (g/m2)	Final P Conc. (mg/l)	Chyl-a Conc. (mg/m3)	Secchi Disk Depth (m)	Florida TSI Value
Evaporation		Outflow to Lulu		Deep Recharge		Total Losses								
(in)	(ac-ft)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)							
52.40	1207	1085	41.6	252	9.7	2544	51.3	348	0.725	0.340	0.031	39.4	0.80	73

Calibration Numerator Coefficient: 4.6

Calibration Denominator Coefficient: 4.6

Modified Vollenweider Mass Balance Phosphorus Limitation Model for Lake Lulu - Alum Inactivation

Initial P Conc. (mg/l)	Hydrologic and Mass Inputs														
	Direct Precipitation			Stormwater		G.W. Seepage		Dry Weather Baseflow		Shipp Inflow		Internal Recycling	Total Inputs		
	(in)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)	(kg)	(ac-ft)	(kg)	(mg/l)
0.018	50.77	1299	89.7	622	85.6	393	18.3	0.0	0.0	1287	49.4	161	3601	404	0.091

Hydrologic and Mass Losses										Detention Time (days)	P Ret. Coeff.	Areal P Loading (g/m2)	Final P Conc. (mg/l)	Chyl-a Conc. (mg/m3)	Secchi Disk Depth (m)	Florida TSI Value
Evaporation		Outfall Canal		Outflow to Eloise		Deep Recharge		Total Losses								
(in)	(ac-ft)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)	(ac-ft)	(kg)							
52.40	1341	770	17	209	5	252	6	2572	27.4	280	0.802	0.325	0.018	11.6	1.57	56

Calibration Numerator Coefficient: 8.4

Calibration Denominator Coefficient: 8.4

APPENDIX L

EVALUATION OF VERTICAL VARIABILITY IN PHYSICAL-CHEMICAL CHARACTERISTICS OF SEDIMENT SAMPLES COLLECTED IN LAKES MAY, SHIPP, AND LULU

Evaluation of Vertical Variability in Sediment Samples Collected in Lakes May, Shipp and Lulu

Lake	Site	Depth	Date	pH (s.u.)	Moisture (%)	Organic (%)	Density (g/cm3)	TN (µg/cm3)	TP (µg/cm3)
May	Site 1	0-12"	6/5/06	6.37	83.2	31.2	1.17	19903	2770
May	Site 2	0-12"	6/5/06	6.35	90.9	48.6	1.07	19878	1892
May	Site 3	0-12"	6/5/06	6.5	92.5	48.8	1.06	14997	1335
May	Site 4	0-12"	6/5/06	6.42	91.6	47.1	1.07	14401	1460
May	Site 5	0-12"	6/5/06	6.38	89.3	58.6	1.07	17139	1253
			average	6.40	89.5	46.9	1.09	17263	1742
			min	6.35	83.2	31.2	1.06	14401	1253
			max	6.50	92.5	58.6	1.17	19903	2770
May	Site 1	12-24"	6/5/06	6.13	85.7	49.1	1.11	20595	1833
May	Site 2	12-24"	6/5/06	6.27	85.5	37.1	1.14	19648	2935
May	Site 3	12-24"	6/5/06	6.29	84.5	40.5	1.14	19898	2022
May	Site 4	12-24"	6/5/06	6.19	86.9	42.4	1.11	20269	2077
May	Site 5	12-24"	6/5/06	5.34	90.1	66.5	1.05	14687	422
			average	6.04	86.6	47.1	1.11	19019	1858
			min	5.34	84.5	37.1	1.05	14687	422
			max	6.29	90.1	66.5	1.14	20595	2935
May	Site 2	24-36"	6/5/06	5.87	91.1	69.8	1.04	17060	270
May	Site 3	24-36"	6/5/06	5.76	89.5	66.1	1.05	17486	337
May	Site 4	24-36"	6/5/06	5.69	88.6	53.9	1.08	18506	406
May	Site 5	24-36"	6/5/06	5.28	87.8	40.8	1.11	19003	609
			average	5.65	89.3	57.7	1.07	18014	405
			min	5.28	87.8	40.8	1.04	17060	270
			max	5.87	91.1	69.8	1.11	19003	609
May	Site 2	36-48"	6/5/06	5.54	88.9	46.8	1.09	16763	397
			average	5.54	88.9	46.8	1.09	16763	397
			min	5.54	88.9	46.8	1.09	16763	397
			max	5.54	88.9	46.8	1.09	16763	397
Lulu	Site 1	0-12"	8/16/06	6.39	87.1	40.9	1.11	16787	241
Lulu	Site 2	0-12"	8/16/06	6.79	33.8	1.2	1.98	9916	548
Lulu	Site 3	0-12"	8/16/06	6.58	30.2	1.3	2.03	7079	463
Lulu	Site 4	0-12"	8/16/06	6.4	88.6	54.6	1.08	25581	1393
Lulu	Site 5	0-12"	8/16/06	6.35	91.8	58.4	1.05	21740	1337
Lulu	Site 6	0-12"	8/16/06	6.7	90.5	38.0	1.09	15590	317
Lulu	Site 7	0-12"	8/16/06	6.4	90.8	60.7	1.05	16645	173
Lulu	Site 8	0-12"	8/16/06	6.33	89.5	61.3	1.06	22916	1465
Lulu	Site 9	0-12"	8/16/06	6.49	88.3	54.7	1.08	21932	1506
Lulu	Site 10	0-12"	8/16/06	6.22	89.4	57.4	1.07	18340	1319
			average	6.47	78.0	42.8	1.26	17653	876
			min	6.22	30.2	1.2	1.05	7079	173
			max	6.79	91.8	61.3	2.03	25581	1506
Lulu	Site 1	12-24"	8/16/06	6.16	47.5	7.3	1.73	22796	520
Lulu	Site 4	12-24"	8/16/06	6.24	29.1	3.9	2.02	12630	1402
Lulu	Site 5	12-24"	8/16/06	6.45	78.6	36.9	1.20	26685	1853
Lulu	Site 6	12-24"	8/16/06	5.76	70.1	11.1	1.40	11267	112
Lulu	Site 7	12-24"	8/16/06	5.85	93.6	97.4	1.00	19129	56
Lulu	Site 8	12-24"	8/16/06	6.72	45.5	8.3	1.75	26074	1547
Lulu	Site 9	12-24"	8/16/06	6.49	81.5	46.8	1.15	27596	704
Lulu	Site 10	12-24"	8/16/06	6.45	93.5	95.7	1.00	21293	143
			average	6.27	67.4	38.4	1.41	20934	792
			min	5.76	29.1	3.9	1.00	11267	56
			max	6.72	93.6	97.4	2.02	27596	1853

Evaluation of Vertical Variability in Sediment Samples Collected in Lakes May, Shipp and Lulu

Lake	Site	Depth	Date	pH (s.u.)	Moisture (%)	Organic (%)	Density (g/cm3)	TN (µg/cm3)	TP (µg/cm3)
Lulu	Site 5	24-36"	8/16/06	5.99	41.5	7.6	1.81	49175	2009
Lulu	Site 6	24-36"	8/16/06	6.51	22.4	0.8	2.15	3496	204
Lulu	Site 7	24-36"	8/16/06	5.47	92.4	95.9	1.00	17787	98
			average	5.99	52.1	34.8	1.66	23486	770
			min	5.47	22.4	0.8	1.00	3496	98
			max	6.51	92.4	95.9	2.15	49175	2009
Shipp	Site 1	0-12"	8/16/06	6.76	74.9	12.4	1.33	26708	2664
Shipp	Site 2	0-12"	8/16/06	7.09	24.8	0.3	2.12	3991	298
Shipp	Site 3	0-12"	8/16/06	6.88	33.0	0.6	2.00	5315	447
Shipp	Site 4	0-12"	8/16/06	6.65	23.2	0.6	2.15	3357	198
Shipp	Site 5	0-12"	8/16/06	6.13	25.2	2.0	2.10	6299	1170
Shipp	Site 6	0-12"	8/16/06	6.3	31.2	3.7	1.99	11260	7315
Shipp	Site 7	0-12"	8/16/06	6.27	88.7	37.6	1.11	21678	303
Shipp	Site 8	0-12"	8/16/06	6.05	89.6	38.5	1.10	19559	3073
Shipp	Site 9	0-12"	8/16/06	6.73	25.7	1.6	2.10	7594	1390
Shipp	Site 10	0-12"	8/16/06	6.62	25.1	1.5	2.11	4886	988
			average	6.55	44.1	9.9	1.81	11065	1785
			min	6.05	23.2	0.3	1.10	3357	198
			max	7.09	89.6	38.5	2.15	26708	7315
Shipp	Site 1	12-24"	8/16/06	7.15	52.3	7.5	1.66	24011	6621
Shipp	Site 5	12-24"	8/16/06	5.46	23.4	1.1	2.14	2942	405
Shipp	Site 6	12-24"	8/16/06	6.07	21.7	1.7	2.16	4697	2324
Shipp	Site 7	12-24"	8/16/06	6.32	80.9	47.1	1.15	26916	940
Shipp	Site 8	12-24"	8/16/06	6.07	78.3	35.8	1.21	28647	1708
Shipp	Site 9	12-24"	8/16/06	6.47	21.9	1.4	2.15	7111	2591
			average	6.26	46.4	15.8	1.74	15721	2432
			min	5.46	21.7	1.1	1.15	2942	405
			max	7.15	80.9	47.1	2.16	28647	6621
Shipp	Site 7	24-36"	8/16/06	5.82	55.4	12.6	1.58	16431	1146
Shipp	Site 8	24-36"	8/16/06	5.94	88.0	56.4	1.08	20907	180
Shipp	Site 10	24-36"	8/16/06	6.24	90.8	95.8	1.01	20744	138
			average	6.00	78.1	54.9	1.22	19361	488
			min	5.82	55.4	12.6	1.01	16431	138
			max	6.24	90.8	95.8	1.58	20907	1146