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Investigation of the Effect of Alum Treatment on Benthic Invertebrate Communities of Florida Lakes

Prepared for

St. Johns River Water Management District
Highway 100 West
Palatka, Florida 32177

Prepared by

Water & Air Research, Inc.
6821 S.W. Archer Road
Gainesville, Florida 32608

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1 Background

1.1 Rationale for Alum Treatment in Lakes

Aluminum sulfate (alum) has been used successfully to improve the quality of surface waters by removing phosphorus and suspended particulates. Alum stormwater treatment systems have been installed in more than a dozen Florida urban lakes to reduce trophic state and increase water clarity. Although alum treatment may produce the intended results, treatment also introduces the potential for deleterious effects on aquatic biota.

1.2 Evidence of Biological Effects

Reduction in benthic invertebrate densities and number of taxa have been observed in streams and rivers in association with both alum treatment of surface waters (Barbiero et al. 1988) and the discharge of alum-treated wastewater (Lin 1988, George et al. 1989, George et al. 1996). Effect of alum sludge discharge on aquatic biota in lotic systems may depend in part on flow rate, with high flow systems exhibiting little or no biological impacts due to constant inflow (George et al. 1989).

Previous investigations in lakes indicate varying biological responses to alum treatment, depending on organism type, lake water pH, and other variables. Narf (1985) observed a decline in bluegreen algae and an increase in small green algae. He hypothesized that a concurrent increase in copepods was in response to an increase in small green algae, a favorable food resource. Connor and Martin (1989) reported a decline in algal populations and cladocerans in response to alum treatment. Some lake studies have shown no effect of alum treatment on benthic invertebrate communities (Havas and Likens 1985, Narf 1990). Other lake studies have demonstrated an increase (Narf 1985, Narf 1990, Harper 1990) or decrease (Smeltzer 1990) in benthic invertebrate density or species diversity. Havas and Likens (1985) only observed alum-related effects in crustaceans and insect larvae when pH was less than 5.

Biological effects of alum treatment may be less noticeable in lakes high in iron or dissolved organic carbon. Iron and dissolved organic carbon can bind aluminum, reducing the amount of inorganic aluminum available to interact with biological membranes. Conversely, low pH can enhance biological effects by making inorganic aluminum more available (Gensemer and Playle 1998).

Invertebrates appear to be less sensitive to aluminum than fish. Mechanisms of invertebrate aluminum toxicity are believed to be primarily ionoregulatory rather than respiratory in nature. Gills of invertebrates generally do not release ammonia, so aluminum precipitate and polymerization does not usually occur around the gills. Dragonfly nymphs, which have internal gill chambers, may be an exception (Gensemer and Playle 1998).

1.3 Permitting Guidelines for Installation of Alum Stormwater Treatment Systems

Alum-treated lakes in Florida were typically mesotrophic to hypereutrophic prior to receiving treatment. The St. Johns River Water Management District has made an effort to define conditions under which alum treatment is an appropriate alternative. Interim review guidelines have been developed for permit applicants seeking to install direct discharge alum stormwater injection systems (Fall and Dewey 1995). The guidelines are designed to limit use of alum stormwater injection systems to hypereutrophic lakes, maintaining the following characteristics:

- Trophic State Index greater than 70
- An annual average chlorophyll a concentration greater than 40 μg/L
- An annual average secchi depth less than 0.7 meters
- An annual average total phosphorus concentration greater than 0.12 mg/L

Injection system installation is discouraged in lakes with an average annual alkalinity less than 100 mg/L because enhanced aluminum toxicity has been demonstrated in fish under slightly acidic conditions (pH < 6.0).

1.4 Purpose and Description of the Current Investigation

The overall purpose of this investigation is to quantify the effects of small, continuous doses of alum on benthic invertebrate communities in Florida urban lakes. Due to funding limitations, the study was limited to evaluation of existing benthic macroinvertebrate data and the collection and analysis of supplemental data. A more detailed evaluation of sediment characteristics, water quality, and other factors was not within the scope of this study. Data were collected in December 1998 and June 1999 in accordance with an approved sampling plan submitted to the St. Johns River Water Management District (Water & Air Research 1998). The sampling plan was designed to address the following key questions:

1. Are there differences between pre- and post-treatment benthic invertebrate community structure in lakes that have received continuous alum treatment over a long time period?
2. Are there statistically significant differences between current benthic communities in treated lakes and benthic communities in untreated lakes with environmental conditions resembling pre-treatment conditions in the treated lakes?

Project tasks were divided into two phases as follows:

Phase I

Data Compilation
Data Review and Sufficiency Evaluation
Development of Supplemental Data Sampling Plan

Phase II

Supplemental Data Collection
Data Evaluation and Analysis
Final Report of Findings

The first step (Phase I) in this investigation was to compile existing data and evaluate their usefulness in addressing Question 1. Findings indicated that data existing prior to the current investigation were insufficient to address the first question; consequently, Phase II was implemented. This document summarizes the findings of the initial evaluation of existing data

(Phase I), describes the methods and results of supplemental data collection (Phase II), and provides recommendations for further inquiry.

2 Compilation of Existing Data

St. Johns River Water Management District provided unpublished historical water quality and biological data for alum-treated lakes (Fall 1998). The following people also were contacted to obtain data relevant to the project.

Lucee Price – City of Maitland
Kevin McCann – City of Orlando Stormwater Utility Bureau
Rodney Cassidy – City of Tallahassee
Eric Kitchen - City of Tallahassee
Curtis Watkins – City of Tallahassee
Mike Britt – City of Winter Haven
Tim Egan – City of Winter Park
Lynn Denahan – Orange County Environmental Health Department
Joe King – Polk County Natural Resources and Drainage Division
Michelle Medani – Polk County Natural Resources and Drainage Division
Jeff Spence – Polk County Natural Resources and Drainage Division
David Carr – SWFWMD, Brooksville
Craig Dye – SWFWMD, Brooksville
Marty Kelly – SWFWMD, Tampa
Russ Frydenborg - FDEP, Tallahassee
Robert Rutter – FDEP, Fort Myers
Randall Payne - FDEP, Pensacola
Eric Pluchino - FDEP, Orlando
Jim Hulbert – FDEP, Orlando

A wide variety of information on Tallahassee and Orlando/Winter Park lakes was obtained, including water quality and benthic invertebrate data. Kevin McCann provided water quality and benthic invertebrate data on Orlando lakes and assisted with the selection of candidate control lakes. Curtis Watkins provided historical information on Lake Ella and assisted with the selection of candidate control lakes. Rodney Cassidy and Eric Kitchen provided water quality data and descriptive information on select Tallahassee lakes. Tim Egan provided historical water quality data and other useful information on Lake Osceola. Lynn Denahan sent additional water quality and benthic invertebrate data for select lakes in the Orlando vicinity. Joe King, Michelle Medani, and Jeff Spence provided water quality and benthic invertebrate data for Lake Cannon. David Carr provided useful literature regarding a variety of topics related to alum treatment. Russ Frydenborg, Robert Rutter, Randall Payne, and Eric Pluchino provided benthic invertebrate data for reference lakes monitored by FDEP. Jim Hulbert, Curtis Watkins, and Kevin McCann assisted with the selection of candidate control lakes.

3 Evaluation of Compiled Data

Benthic invertebrate data are available for the treated lakes listed in Table 1. We reviewed benthic invertebrate monitoring data provided by the St. Johns River Water Management District, Orange County Environmental Health Department, the City of Orlando, the City of Tallahassee, and the Florida Department of Environmental Protection. Most of the existing benthic invertebrate data were collected to fulfill requirements of various agency construction permits for the alum injection systems. A detailed statistical analysis of the data is unwarranted because inferences that can be drawn from the data are limited by inconsistencies in:

- Sampling techniques
- Timing, frequency, and duration of sample collection
- Taxonomic level and accuracy of organism identification
- Statistics (i.e. taxa richness, Shannon-Weaver diversity Index)

Sediment metal concentrations are reported only for Lake Dot (SJRWMD, unpublished data). Sediment data for other alum-treated lakes were not identified.

Benthic invertebrate communities have been characterized to some extent in all of the alum-treated lakes, but sampling frequency and duration vary considerably among the lakes. Although historical benthic invertebrate data collected prior to alum treatment are available for all alum-treated lakes, the data are not sufficient to adequately address the effect of alum treatment on benthic invertebrate communities in Florida lakes. Due to inconsistencies in the data, comparisons of pre- and post-treatment conditions in treated lakes are limited to descriptive techniques.

4 Collection of Supplemental Data

4.1 Approach and Rationale

Supplemental data were collected to augment historical data. Since it was no longer possible to collect pre-treatment data in the alum-treated lakes, other methods were used to supplement the database for pre- and post-treatment comparisons. Non-treated urban lakes representative of pre-treatment conditions in the alum-treated lakes were selected for evaluation. Non-treated lakes used for comparison with alum-treated lakes are referred to as reference lakes in this report. Benthic invertebrate community structure in reference lakes was compared with benthic communities in the treated lakes. These data were used to address Question 2 in Section 1.4, providing additional information for evaluating the effects of alum treatment on benthic invertebrate communities in Florida lakes.

The sampling effort was designed to supplement existing pre-treatment data by using untreated reference lakes to represent pre-treatment conditions in the selected alum-treated lakes. Prior to treatment, alum-treated lakes were typically eutrophic lakes with urbanized watersheds; therefore the candidate reference lakes presented in the accompanying tables tend to have those characteristics. Post-treatment conditions were assessed simultaneously in the selected alum-treated lakes for comparison with the selected reference lakes. Benthic invertebrate community structure in the selected lakes was evaluated using organism density, number of taxa, Shannon-Weaver species diversity, and feeding guild structure.

4.2 Selection of Alum-Treated and Reference Lakes

4.2.1 Selection of Alum-Treated Lakes

Flocculent sediments that are potentially harmful to benthic organisms are known to accumulate in alum-treated lakes. Based on data from Lake Ella in Tallahassee and Lake Dot in Orlando, the floc layer depth increases 0.5 to 1.0 cm per year (Harper 1990; Harper 1992). The depth of floc is likely to be greatest in lakes that have received treatment for a long time period. To maximize the potential for detecting effects on benthic communities, lakes of longest treatment duration were selected for further study.

Four alum-treated lakes were selected using the following criteria in decreasing order of importance:

- Duration of alum treatment,
- Availability of suitable reference lakes, and
- Availability of historical monitoring data, including pre- and post-treatment data

These criteria were applied in a tiered fashion following the order of importance. To maximize the probability of detecting long-term effects, lakes receiving treatment over a long period of time were given first preference. Lakes meeting this first criterion were eliminated if they did not meet subsequent criteria.

Based on information presented in Table 1, Lake Ella (Tallahassee), Lake Dot (Orlando), Lake Osceola (Winter Park), and Lake Lucerne (Orlando) were selected. Conditions in these lakes prior to treatment startup are presented in the attached tables. Based on site reconnaissance and review of information presented in Tables 1, 2, and 3, suitable reference lakes were identified for each of the four top-ranked treated lakes. Pre- and post-treatment historical information on benthic invertebrate community composition and water chemistry exists for each lake. The search for additional reference lakes was discontinued after a suitable reference lake was identified for each of the four selected treated lakes.

4.2.2 Selection of Reference Lakes

Selection of reference lakes consisted of a two-tiered process. Candidate reference lakes were identified using published and unpublished information obtained from city, county, state, and regional agencies (Tables 2 and 3). Reference lake selection was based on trophic state, surrounding land use, surface area, basin morphometry, and lake management practices (Florida Lakewatch 1997, Schafer et al. 1986, King 1998, Cassidy 1998, Denahan 1998, Florida Department of Environmental Protection (FDEP) 1998, McCann et al. 1998, McCann 1998). Lake management practices considered during the selection process included grass carp stocking, water column aeration, aquatic plant management, and drain systems. Because of the need to mimic pre-treatment water quality as closely as possible, trophic state and management practices associated with the candidate reference lakes were given greater weight than other lake characteristics. Preference also was given to candidate reference lakes with an existing benthic invertebrate database. Some candidate reference lakes were eliminated from consideration because they exhibited fatal flaw differences from the selected alum-treated lakes. Examples of fatal flaws included strong deviance from the pre-treatment water quality conditions in alum-treated lakes, widely differing management practices, and identified contaminants.

Based on information presented in Tables 2 and 3, the following reference lakes were selected for comparison with the corresponding treatment lakes:

Treatment Lake	Reference Lake
Lake Ella	AJ Henry Park
Lake Dot	Lake Lurna

Treatment Lake	**Reference Lake**
Lake Osceola	Lake Ivanhoe
Lake Lucerne	Lake Olive

Selected treated lakes and the candidate reference lake selected for each treated lake appear in bold print in Tables 2 and 3. In some cases the reference lake selection was not an obvious choice (i.e. Lake Angel vs. Lake Olive). Three examples of applying the selection criteria follow:

Selection of Lake Olive - Although water quality conditions in Lake Angel closely resemble pre-treatment conditions in Lake Lucerne, Lake Angel is not aerated and an existing benthic invertebrate database was not identified. For these reasons, Lake Olive was considered to be a more appropriate alternative.

Elimination of Lake Concord - Although conditions in Lake Concord were similar to pre-treatment conditions in Lake Osceola, identified trichloroethylene contamination and the fact that Lake Concord receives some flow from Lake Dot were considered to be fatal flaws.

Selection of Lake AJ Henry – Water quality, size, morphometry, and drainage basin land use of Lake AJ Henry were most similar to conditions in Lake Ella prior to treatment. Grass carp are thought to be present in Lake Ella and absent in AJ Henry (Table 3). Grass carp can have a profound influence on benthic invertebrate habitat because of their strong effect on aquatic plants (macrophytes). The presence of grass carp in Lake Ella (and absence in Lake AJ Henry) was not considered to be of high importance in terms of macroinvertebrate habitat alteration because all benthic samples were collected from the sublittoral zone (2 to 4 meters depth), where macrophytes are absent in all of the selected lakes.

4.3 Benthic Macroinvertebrate Data Collection

4.3.1 Benthic Macroinvertebrate Sampling

Samples were collected in December 1998 and June 1999, coinciding with dry and wet seasons, respectively, to allow evaluation of benthos during both minimum and maximum alum dosing. Benthic invertebrate sampling in all selected alum-treated and reference lakes followed modified methods described in FDEP Standard Operating Procedures for benthic invertebrate sampling in lakes (FLDEPSOP #BA-28). This method specifies that a lake area is to be subdivided into 12 logical units and a grab sample is to be collected from each unit. One advantage of this method is that the entire lake area with water depth ranging from 2 to 4 meters is equally represented. This method effectively eliminates sampling in the vegetated littoral zone where organism distribution can be highly variable and in the deeper profundal zone where dissolved oxygen can be entirely lacking. Confining collection of benthic samples to relatively homogeneous sublittoral habitat serves to reduce variability between lakes caused by factors unrelated to alum treatment.

Sampling methods followed FLDEPSOP #BA-28 with the following modifications. Each lake was subdivided into eight to eighteen sampling units, depending on lake size and extent of alum treatment. A single petite Ponar grab sample was collected at a depth between 2 and 4 meters near the center of each sampling unit. The total number of sampling locations for each lake follows.

Treatment Lake		Reference Lake	
Lake Ella	8	AJ Henry Park	8
Lake Dot	8	Lake Lurna	8
Lake Osceola	18	Lake Ivanhoe	12
Lake Lucerne	8	Lake Olive	8

Sampling locations within each lake are presented in Figures 1 through 8. Rather than compositing the samples at the time of collection as prescribed in FLDEPSOP #BA-28, each grab sample was processed separately to allow an estimate of sample variability within a given lake. All organisms within each sample were enumerated and identified, except for few samples in which extremely high organism abundance of one or two species made it necessary to subsample. Samples were preserved in 95 percent ethanol, as described in Water & Air's state-approved Comprehensive Quality Assurance Plan.

4.3.2 Benthic Invertebrate Laboratory Methods

All samples from the 4 treated lakes and 4 reference lakes were analyzed in the laboratory using methods for processing benthic invertebrate samples described in FLDEPSOP #BA10. Ten-percent of the samples were checked by a coworker for sorting accuracy. All results of accuracy checks were recorded on original bench sheets.

Sample identification procedures followed FLDEPSOP #BA-16. Quality assurance procedures followed Water & Air's approved Comprehensive Quality Assurance Plan.

4.4 Water Quality Sampling

The number of water quality sampling locations required to adequately characterize a lake may depend on lake size, lake bathymetry, maximum water depth, and sediment variability among other factors. Dissolved oxygen, temperature, pH, and conductivity were measured and recorded at the top and bottom of the water column at 3 of the benthic invertebrate sampling stations. Dissolved oxygen and temperature also were measured from top to bottom of the water column at one-foot intervals at the deepest portion of each lake to determine depth of anoxic water. Secchi depth and total water depth measurements also were recorded at the profile (deepwater) station.

5 Results and Discussion

Results are presented in detail in Appendices A, B, and C. Species abundance tables are presented in Appendix A. Abundance (raw counts) data are arranged by macroinvertebrate feeding guilds in Appendix B. Chemical and physical field measurements are provided in Appendix C.

5.1 Evaluation and Use of Historical Data to Address Question 1

Are there statistically significant differences between pre- and post-treatment benthic invertebrate community structure in lakes that have received continuous alum treatment over a long time period?

To address Question 1 (restated above), we compared pre-treatment benthic invertebrate communities with both historical post-treatment data and supplemental data collected during Phase II. Due to inconsistencies in the historical and supplemental data discussed in Section 3, the evaluation presented below is limited to descriptive comparisons within select alum-treated lakes (Table 4). All organism density values discussed in this report are expressed as the number of individuals per square meter. Number of taxa and diversity values are presented as the mean value per sampling location within a given lake to facilitate comparisons between Phase II data and historical data. In evaluating the number of taxa and diversity values, it is important to note that historical mean values (prior to December 1998) are based on mean diversity calculated from 3 discrete grabs collected at each sampling location, whereas Phase II (December 1998 and June 1999) values were derived from a single grab at each sampling location. The total number of grabs collected within each lake varied.

Lake Ella

No macroinvertebrates were observed in benthic samples collected from Lake Ella in November 1985 prior to the first alum treatment (Table 4). Likewise organisms were absent in the first post-treatment samples collected in January 1987. By May 1990 conditions in Lake Ella apparently had improved enough to support two pollution-tolerant species of annelids. The benthic community in 1998 and 1999 was strongly dominated by *Chaoborus punctipennis* and a total of 5 taxa were collected (Tables A-1 and A-9). Data collected during Phase II indicate an increase in *Chaoborus* density since 1990, while number of taxa per sampling location (< 3) and mean Shannon-Weaver diversity (<0.70) remained low (Table 4).

Lake Dot

Lake Dot's alum treatment system became operational in January 1990. Pre- and post-treatment sampling was conducted in January 1989 and January 1991, respectively. In 1989 five taxa were collected consisting of tubificid worms, leeches, *Chaoborus* sp., *Chironomus* sp., and unidentified snails. The same taxa were collected in 1991 with the exception of *Chironomus*. Similarly a total of 5 taxa were collected in June 1999 consisting of *Limnodrilus hoffmeisteri*, nematodes, *Chironomus*, and *Chaoborus* (Table A-11). In contrast, winter collections in December 1998 included a total of 13 taxa (Table A-3), primarily chironomids suggesting considerable seasonal variation, probably driven by the availability of dissolved oxygen. Mean organism density and mean number of taxa per sampling location in winter 1998 were similar to winter 1989 results collected prior to alum treatment, although there was a slight decline in organism density after treatment (Table 4). Mean diversity was higher in winter 1998 (1.48) than in winter 1989 (0.85).

Lake Osceola

Lake Osceola's treatment began in February 1993. Pre-treatment data were collected in October 1992 and post-treatment data were collected in July and December 1995 and January 1997 (Table 4). Mean organism densities in winter 1998 (546) were lower than in pre-treatment collections in October 1992 (approximately 10,000), and winter 1995 (17,953) and winter 1997 (7,021). The mean number of taxa per sampling location in winter 1998 (4.9) was also lower than in winter 1992 (11.2). From 1993 to 1999, mean winter diversity values ranged from 0.81 to 1.85, whereas mean summer values remained low (0.49 to 0.64).

Lake Lucerne

The Lake Lucerne treatment system was fully operational in January 1994. Pre-treatment sampling occurred November 1992 and post-treatment samples were collected in July 1995, December 1995, and January 1997. Mean organism densities declined after treatment from

9,593 in November 1992 to 539 in January 1997 (Table 4). Densities were higher during Phase II winter (1,929) and summer (3,077) sampling events. The mean number of taxa collected per sampling location declined from 11.2 to approximately 4 after treatment. Winter mean diversity declined approximately 60% from 1.87 in November 1992 to 0.70 in December 1995 after two years of treatment. Winter diversity values remained low in 1997 (0.82) and 1998 (0.93).

Lake Cannon
Alum treatment in Lake Cannon began in January 1994. Although Lake Cannon was not included in the current supplemental data collection, the Polk County Natural Resources and Drainage Division provided unpublished historical data for review. Data were collected on a quarterly basis from 1993 to 1995 providing a comparison of pre- and post-treatment benthic communities (Table 4). Organism densities, number of taxa, and Shannon-Weaver diversity tended to be slightly higher after treatment.

5.2 Question 2. Phase II Benthic Data – Comparison of Alum-Treated and Reference Lakes

5.2.1 Statistical Design

For convenience, the second question posed during the design phase of this project is restated below:

Are there statistically significant differences between current benthic communities in treated lakes and benthic communities in untreated lakes with environmental conditions resembling pre-treatment conditions in the treated lakes?

This question is addressed below using a two-pronged statistical analysis by splitting Question 2 into the following two questions:

2.A. Are there differences in the measured response variables between the collective treated and non-treated reference lakes?

2.B. Are there differences in the measured response variables between the treated and non-treated reference lakes within each pair of lakes assigned in the design phase (Section 4.2.2)?

The response variables are:

- Organism density
- Number of taxa
- Shannon-Weaver species diversity index
- Abundance (raw counts) in each feeding guild –
  - Sub-benthic collector-gatherers
  - Epi-benthic collector-gatherers
  - Filterers
  - Plant piercers
  - Shredders
  - Scrapers
  - Predators

Occurrence of individuals in some feeding guilds was very rare and no statistical analyses were conducted for these guilds: filterers, plant piercers, and scrapers.

To address question 2.A. (differences between the collective treated and non-treated lakes), analyses of variance were conducted. The experimental design was a randomized complete block design with four blocks. Each block was a pair of similar lakes, one treated and one non-treated, as follows:

	Treated	**Reference**
Pair 1	Ella	AJ Henry
Pair 2	Dot	Lurna
Pair 3	Osceola	Ivanhoe
Pair 4	Lucerne	Olive

The error term for testing treatment differences was the Pair*Treatment interaction. The residual error term estimates variability between samples within a lake. The factors and degrees of freedom for the model were:

Source	**d.f.**
Pair	3
Treatment	1
Pair*Treatment	3
Residual Error	70

To address question 2.B., (differences between paired lakes) two-sample t-tests were conducted for each pair of lakes. A test for equal variance between the two samples was performed using an α-level of 0.05, and the appropriate t-test (for equal or unequal variances) was conducted. To indicate if the t-test was based on unequal variances, an * will follow the p-value. For a few lakes, no organisms of a particular feeding guild were counted in any of the samples. When this occurred, a one-sided t-test was used to test whether the mean response was greater than zero in the lake where organisms were found. For example, in the summer in the Pair 1 lakes, the treated lake had no sampled epi-benthic collector-gatherers. The test performed here was to determine if the abundance of epi-benthic collector-gatherers in the non-treated lake was significantly greater than zero. These instances are noted in the results below.

Transformations were performed on some of the response variables prior to statistical analysis. Density was transformed using log10(density+1), and all feeding guild abundances were transformed using a square root transformation. These transformations were performed to better meet the assumptions of normality and equal variances.

Separate analyses were performed for each season (summer and winter). The results are organized by response variable, with both summer and winter results presented. An α-level of 0.10 was used for the ANOVAs and t-tests because of small sample sizes and to increase power to detect influences of alum treatment on benthic invertebrate communities.

Inferences made regarding differences between treated and reference lakes are much stronger when based on results from Question 2.A. than when based on results from Question 2.B. Inferences based on Question 2.B. results must be limited to each of the pairs of sampled lakes. Differences between individual lakes within a pair, other than the presence of the alum treatment, may be influencing the composition of the benthic communities. Because the statistical analysis from Question 2.A. used several treated and reference lakes as replicates, the analysis is more robust and inferences based on these results can be applied to a broader population of lakes.

5.2.2 Results of Statistical Analysis

Means and p-values for the collective comparison of alum-treated and reference response variables are presented in Table 5. Similar data comparing response variables within Pairs 1, 2, 3, and 4 are presented in Tables 6, 7, 8, and 9, respectively. Data are provided by sampling location in Tables 10, 11, 12, and B-1 through B-7.

Organism Density - Winter

There was no significant difference in density between the collective alum-treated and reference lakes (p=0.7198).

In Pair 1, there was a significant difference in density between the two lakes (p=0.0102), the reference lake had a higher density. In Pair 2, there was no significant difference in density between the two lakes (p=0.8537). In Pair 3, there was no significant difference in density between the two lakes (p=0.5065*). In Pair 4, there was a significant difference in density between the two lakes (p=0.0132*), the treated lake had a higher density.

Organism Density - Summer

There was no significant difference in density between the collective alum-treated and reference lakes (p=0.8164).

In Pair 1, there was no significant difference in density between the two lakes (p=0.8215). In Pair 2, there was no significant difference in density between the two lakes (p=0.7733). In Pair 3, there was a significant difference in density between the two lakes (p=0.0138), the reference lake had a higher density. In Pair 4, there was no significant difference in density between the two lakes (p=0.1163*).

Number of Taxa - Winter

There was no significant difference in the number of taxa between the collective alum-treated and reference lakes (p=0.2337).

In Pair 1, there was a significant difference in number of taxa between the two lakes (p=0.0045), the reference lake had a higher number of taxa. In Pair 2, there was no significant difference in number of taxa between the two lakes (p=0.1961). In Pair 3, there was a significant difference in number of taxa between the two lakes (p=0.0885), the reference lake had a higher number of taxa. In Pair 4, there was no significant difference in number of taxa between the two lakes (p=0.1824).

Number of Taxa - Summer

There was a significant difference in the number of taxa between the collective alum-treated and reference lakes (p=0.0444); reference lakes had a higher number of taxa.

In Pair 1, there was a significant difference in number of taxa between the two lakes (p=0.0005*), the reference lake had a higher number of taxa. In Pair 2, there was no significant difference in number of taxa between the two lakes (p=0.6378*). In Pair 3, there was a significant difference in number of taxa between the two lakes (p=0.0036*), the reference lake had a higher number of taxa. In Pair 4, there was no significant difference in number of taxa between the two lakes (p=0.2059).

Shannon-Weaver Species Diversity Index - Winter

There was a significant difference in diversity between the collective alum-treated and reference lakes (p=0.0128); reference lakes had a higher diversity.

In Pair 1, there was a significant difference in diversity between the two lakes (p=0.0369), the reference lake had a higher diversity. In Pair 2, there was no significant difference in diversity between the two lakes (p=0.1198). In Pair 3, there was a significant difference in diversity between the two lakes (p=0.0548), the reference lake had a higher diversity. In Pair 4, there was no significant difference in diversity between the two lakes (p=0.4210).

Shannon-Weaver Species Diversity Index - Summer

There was a significant difference in diversity between the collective alum-treated and reference lakes (p=0.0513); reference lakes had a higher diversity.

In Pair 1, there was a significant difference in diversity between the two lakes (p<0.0001), the reference lake had a higher diversity. In Pair 2, there was no significant difference in diversity between the two lakes (p=0.7494). In Pair 3, there was a significant difference in diversity between the two lakes (p=0.0002), the reference lake had a higher diversity. In Pair 4, there was a significant difference in diversity between the two lakes (p=0.0532*), the reference lake had a higher diversity.

Epi-benthic Collector-gatherers – Winter

There was no significant difference in abundance between the collective alum-treated and reference lakes (p=0.6510).

In Pair 1, there was a significant difference in abundance between the two lakes (p=0.0379), the reference lake had a higher abundance. In Pair 2, there was no significant difference in abundance between the two lakes (p=0.3659). In Pair 3, there was no significant difference in abundance between the two lakes (p=0.5065). In Pair 4, there was a significant difference in abundance between the two lakes (p=0.0036*), the treated lake had a higher abundance.

Epi-benthic Collector-gatherers – Summer

There was no significant difference in abundance between the collective alum-treated and reference lakes (p=0.2818).

In Pair 1, all abundances for the treated lake=0; abundance in the reference lake was significantly greater than zero (p=0.0020, one-sided, one-sample t-test). In Pair 2, there was no significant difference in abundance between the two lakes (p=0.3258*). In Pair 3, there was a significant difference in abundance between the two lakes (p=0.0029), the reference lake had a higher abundance. In Pair 4, there was no significant difference in abundance between the two lakes (p=0.4124).

Sub-benthic Collector-gatherers - Winter

There was no significant difference in abundance between the collective alum-treated and reference lakes (p=0.1608).

There were no differences in abundance between alum-treated and reference lakes for all four pairs of lakes (p=0.9909, p=0.8447, p=0.6447, and p=0.9251, respectively).

Sub-benthic Collector-gatherers – Summer

There was no significant difference in abundance between the collective alum-treated and reference lakes (p=0.4101).

In Pair 1, there was no significant difference in abundance between the two lakes (p=0.6029). In Pair 2, there was no significant difference in abundance between the two lakes (p=0.3721). In Pair 3, there was no significant difference in abundance between the two lakes (p=0.7439). In Pair 4, there was a significant difference in abundance between the two lakes (p=0.0165*), the treated lake had a higher abundance.

Shredders – Winter

There was no significant difference in abundance between the collective alum-treated and reference lakes (p=0.4886).

In Pair 1, all abundances for the treated lake=0; abundance in the reference lake was significantly greater than zero (p=0.0298, one-sided, one-sample t-test). In Pair 2, there was no significant difference in abundance between the two lakes (p=0.3805). In Pair 3, there was no significant difference in abundance between the two lakes (p=0.6422).

In Pair 4, there was a significant difference in abundance between the two lakes (p=0.0038*), the treated lake had a higher abundance.

Shredders – Summer

There was no significant difference in abundance between the collective alum-treated and reference lakes (p=0.3568).

In Pair 1, all abundances for the treated lake=0; abundance in the reference lake was significantly greater than zero (p=0.0018, one-sided, one-sample t-test). In Pair 2, there was no significant difference in abundance between the two lakes (p=0.6616). In Pair 3, there was a significant difference in abundance between the two lakes (p=0.0043), the reference lake had a higher abundance. In Pair 4, there was no significant difference in abundance between the two lakes (p=0.3379).

Predators – Winter

There was no significant difference in abundance between the collective alum-treated and reference lakes (p=0.3678).

In Pair 1, there was a significant difference in abundance between the two lakes (p=0.0162), the reference lake had a higher abundance. In Pair 2, there was a significant difference in abundance between the two lakes (p=0.0476), the reference lake had a higher abundance. In Pair 3, there was no significant difference in abundance between the two lakes (p=0.4568). In Pair 4, there was no significant difference in abundance between the two lakes (p=0.2313*).

Predators – Summer

There was no significant difference in abundance between the collective alum-treated and reference lakes (p=0.8289).

There were no differences in abundance between treated and reference lakes for all four pairs of lakes (p=0.7128, p=0.1421, p=0.7198, and p=0.7480, respectively).

5.3 Morphological Deformities

Readily discernible gross morphological deformities were recorded for the following species: *Chironomus* sp. (106 specimens), *Chironomus crassicaudatus* (8 specimens), *Cladopelma* sp. (1 specimen), and *Glyptotendipes paripes* (1 specimen). Percent occurrence of morphological deformities within a given taxon ranged from 0 percent to 44 percent (Table 13).

No deformities were observed in lakes Ella, AJ Henry, and Luma. Number of deformities observed in lakes Osceola, Ivanhoe, Olive, Dot, and Lucerne was 1, 3, 4, 15, and 93, respectively. Deformity frequencies were highest for *Chironomus* sp. in treated lakes (Lucerne and Dot). Winter and summer values in Lake Lucerne were 42 percent and 44 percent, respectively. Percent occurrence of deformities in Lake Dot was 17 percent in December 1998. In comparison the other lakes sampled exhibited values less than 5 percent, with the exception of Lake Olive during the summer (12 percent). A recent benthic survey of four urban central Florida lakes yielded percent occurrences of less than 1 percent (Water & Air Research, unpublished data). Thus in comparison to other urban lakes, frequency of occurrence in Lake Lucerne, Lake Dot, and Lake Olive appear exceptionally high.

Within Lake Dot most deformities occurred at stations 2, 3, and 4 (Table A-3 and Figure 3). Upon entering Lake Dot, alum-treated stormwater flows around the lake in a clockwise direction. Stations 2, 3, and 4 are closest to the discharge point and may receive relatively high rate of floc accumulation.

In Lake Lucerne during winter the highest number of deformities were recorded at stations 6 and 7(Table A-7 and Figure 7). This is not the area of Lake Lucerne receiving most of the treated stormwater. Deformities were most frequent where Shannon-Weaver diversity values were highest (Table A-7). During summer, fewer *Chironomus* larvae were collected and the number of deformities observed was lower and more evenly distributed among the stations. There is not a strong spatial pattern relating frequency of deformities and location of stormwater discharge points as observed in Lake Dot.

Elevated metal concentrations, particularly lead and copper, can cause deformities and perhaps growth inhibition in *Chironomus* larvae (Janssens de Bisthoven, Timmermans, and Ollevier 1992). Deformities can be interpreted as sensitive signals of sublethal contaminant concentrations. It is possible that alum treatment in Lake Lucerne and Lake Dot promotes the accumulation of metals in the sediments and elevated metal concentrations are partially responsible for the higher frequency of deformities. The frequent occurrence of morphological deformities in these lakes suggests that additional effects (i.e. growth, reproduction) and possible causative factors should be explored.

5.4 Within-Lake Distribution of Benthic Invertebrates

Benthic invertebrates are not evenly distributed in Lake Lucerne and Lake Dot. Densities and number of taxa tended to be lower at stations 1 through 5 of Lake Lucerne (Figure 7, Tables A-7 and A-15). In Lake Dot stations 7 and 8 in the northeastern quadrant tended to support lower densities and fewer taxa (Figure 3, Tables A-3 and A-11). These stations are in the portion of Lake Lucerne receiving the largest volume of alum-treated stormwater. These differences were more pronounced in winter than in summer, perhaps due to widespread oxygen deficit in summer. Alum-treated stormwater enters the southern portion of Lake Dot and travels in a clockwise direction around the lake. It is not possible to fully evaluate distribution of benthic organisms because the distribution of floc/metal accumulation within Lake Dot and Lake Lucerne is unknown.

5.5 FDEP Lake Assessment Categories Based on Shannon-Weaver Diversity

Using Shannon-Weaver diversity values based benthic invertebrate data collected from Florida lakes, FDEP has developed the following guidelines for classifying lakes by degree of impairment:

Lake Classification	Diversity Value Range
Unimpaired	> 2.57
Somewhat Impaired	1.83-2.57
Severely Impaired	< 1.83

This classification is routinely used by FDEP for lake assessment (Payne 1996, 1997a, 1997b, 1998; Rutter 1995, 1996, 1997, 1998, and 1999). Based on this classification the selected alum-treated lakes and paired control lakes can be assigned the following categories using Phase II diversity values.

TABLE 5.5.1
Florida Department of Environmental Protection Lake Classification

Lake Name	Somewhat Impaired	Severely Impaired
Lake Ella		
Winter		X
Summer		X
Lake AJ Henry		
Winter		X
Summer		X
Lake Dot		
Winter		X
Summer		X

TABLE 5.5.1
Florida Department of Environmental Protection Lake Classification

Lake Name	Somewhat Impaired	Severely Impaired
Lake Lurna		
Winter	X	
Summer		X
Lake Osceola		
Winter	X	
Summer		X
Lake Ivanhoe		
Winter	X	
Summer		X
Lake Lucerne		
Winter		X
Summer		X
Lake Olive		
Winter		X
Summer	X	

It is not possible to discern with certainty the factors causing several of the lakes to have a more favorable rating in the winter than in the summer. Possible factors include dissolved oxygen depletion during warmer summer months and increased loading of alum, organics, pesticides and other analytes during summer periods of elevated rainfall. The fact that, in contrast to other lakes, Lake Olive, a lake receiving aeration, exhibits a higher rating in summer than in winter lends credence to hypothesis that the seasonal shifting may be at least in part related to dissolved oxygen availability.

5.6 Chemical and Physical Field Data

Chemical and physical field data including dissolved oxygen, temperature, and secchi depth for profile stations are provided in Tables C-1 and C-2 in Appendix C. Other data including dissolved oxygen, temperature, conductivity, and pH are presented in Tables C-3 and C-4 in Appendix C. Dissolved oxygen and pH are likely the most important factors influencing benthic macroinvertebrate distribution. Both factors can undergo wide diurnal fluctuations and the data are considered to be a snapshot, perhaps providing a general indication of the potential range of conditions.

5.6.1 Dissolved Oxygen

In winter, only Lake AJ Henry was stratified (Table C-1). Dissolved oxygen recorded near the bottom at the deepwater profile stations ranged from 0.2 to 7.6 mg/L, with concentrations less than 5.0 mg/L in Lake AJ Henry (0.2 mg/L), Lake Ella (2 mg/L), and Lake Lucerne (4 mg/L). None of the lakes exhibited concentrations less than 5 mg/L at the benthic sampling locations in winter (Tables C-3).

In summer, Lakes Ella, AJ Henry, Dot, Lurna, and Osceola were thermally stratified (Table C-2). Dissolved oxygen concentrations recorded near the bottom at the profile stations was at or near 0 mg/L. Even lakes receiving some form of aeration including Lake Dot (0.4 mg/L), Lake Olive (2.8 mg/L) and Lake Lucerne (1.6 mg/L) exhibited low dissolved oxygen at the profile stations. Dissolved oxygen near the bottom at benthic sampling stations was near zero in Lake Dot; at or below 5 mg/L in Lakes Ella, AJ Henry, Lurna, Osceola, and Olive; and 5.5 to 7.5 mg/L in Lakes Ivanhoe and Lucerne.

5.6.2 Other Chemical-Physical Measurements

Most lakes maintained pH values between 7.5 and 9.0, although Lake Osceola and Lake AJ Henry exceeded 9.0 in summer (Table C-4). Conductivity values ranged from less than 100 μmhos/cm^2 in Lakes Dot and AJ Henry to 320 μmhos/cm^2 in Lake Lucerne. Secchi depths tended to be slightly higher in most lakes during winter ranging from 1.25 feet in Lake AJ Henry to 7.1 feet in Lake Dot. Summer secchi depths ranged from 0.91 feet in Lake AJ Henry to 8.6 feet in Lake Dot.

6 Summary of Findings

6.1 Lake Ella

The trophic state index in Lake Ella has declined from a pre-treatment average of 98 in 1987 to 47 in 1990 (Table 3). During the same period secchi depths have increased from < 0.5 meters to 2.2 meters. Secchi depths recorded during Phase II sampling of the current study were < 1.0 meter. In spite of the general improvement in water quality, all response variables analyzed indicate that the benthic macroinvertebrate community continues to be severely limited. Reasons for this result are not entirely clear. In winter when dissolved oxygen did not appear to be a limiting factor, benthic invertebrate diversity was extremely low. Deformities were not recorded in Lake Ella, but the organisms that typically develop deformities, primarily *Chironomus* spp., were almost entirely lacking. Detrimental effects of accumulated substances in the sediments, as a result of alum treatment, cannot be ruled out in Lake Ella.

6.2 Lake Dot

TSI has declined from a pre-treatment average of 63.22 in 1989 to an average of 57.2 in 1997. During the same period secchi depths increased from 0.85 meters to more than 2 meters (Tables C-3 and C-4). *Vallisneria americana* has become established along shorelines with the increase in light availability. In spite of this improvement the benthic community in Lake Dot is severely impaired, particularly during summer. Hypoxic or anoxic conditions may limit the benthic fauna in summer (Table C-4); however the occurrence of deformities (Table 10) suggests metals or other agents of toxic effects may also lower benthic macroinvertebrate diversity.

6.3 Lake Osceola

During the current investigation, Lake Osceola's benthic community exhibited a dramatic decline in diversity and number of taxa in the summer, perhaps in response to lower dissolved oxygen availability (generally less than 5 mg/L). Deformities were uncommon. Organism densities and number of taxa appear to have declined since alum treatment began. Diversity and number of taxa were significantly lower than in Lake Ivanhoe (reference lake) during both summer and winter.

6.4 Lake Lucerne

The average annual TSI value in Lake Lucerne has declined from a pre-treatment average of 66 in 1993 to 47.3 in 1997. Furthermore Lake Lucerne receives aeration and dissolved oxygen levels remain relatively high (7.5 to 8.5 mg/L) even in summer. Since treatment began in January 1994 the mean number of benthic macroinvertebrate taxa collected per sampling location declined from 11.2 to near 4. In spite of aeration, Lake Lucerne remained severely impaired in both winter and summer based on benthic community diversity. Densities and number of taxa tended to be lower at stations 1 through 5 (Figure 7) where the lake receives the largest volume of alum-treated stormwater. Given the relatively high dissolved oxygen concentrations recorded during this investigation, there is little indication that hypoxia is stressing the benthic community in Lake Lucerne. The relatively high occurrence of morphological deformities suggests that accumulation of metals or other substances capable of producing lethal and sublethal effects may be a more influential factor than dissolved oxygen in Lake Lucerne.

6.5 Other General Findings

1. Organism density decreased following alum treatment in Lakes Dot, Osceola, and Lucerne. Conversely, densities increased in Lake Ella where no organisms were observed prior to treatment.
2. Benthic community diversity or number of taxa decreased following alum treatment in Lakes Osceola and Lucerne. No change in diversity was observed in Lake Dot. Although diversity in Lake Ella increased slightly from zero following treatment, current diversity values (<0.70) remain indicative of a highly impaired lake.
3. There was no significant difference between organism densities observed in the collective alum-treated lakes and reference lakes.
4. Number of taxa collected in alum-treated lakes was significantly lower than in reference lakes in summer. In winter there was no significant difference in number of taxa recorded in treated and reference lakes.
5. During winter and summer collections, diversity of the benthic communities in treated lakes was significantly lower than diversity observed in non-treated reference lakes.
6. There were no significant differences between feeding guilds of the collective alum-treated and reference lakes.
7. Morphological deformities, primarily observed in *Chironomus* spp., were most prevalent in alum-treated lakes (Lake Lucerne and Lake Dot). In Lake Dot highest frequencies of deformities were observed at stations 2, 3, and 4 near the point of release of the alum injection system. Lake Lucerne did not demonstrate a strong spatial pattern relating frequency of deformities and location of stormwater discharge points.

8. Benthic invertebrate densities and number of taxa were relatively low at stations 1 through 5 in Lake Lucerne. These sampling stations were located along the north side of the lake where the greatest volume of alum-treated stormwater enters the lake.

9. In December 1998, benthic sampling stations 7 and 8 within Lake Dot were conspicuously low in organism density, number of taxa, and Shannon-Weaver diversity. These stations are not near the alum system discharge point. Distribution of accumulated floc and/or associated metals is not known.

10. Using FDEP lake classification based on Shannon-Weaver species diversity, three of the four alum-treated lakes (Ella, Dot, and Lucerne) were Severely Impaired during all sampling events. In comparison, three of the four selected reference lakes were classified as Somewhat Impaired during either summer or winter and Severely Impaired during the remaining sampling events.

7 Conclusions

The current investigation has provided a screening to detect potential effects of alum treatment on benthic invertebrates. Potential for detrimental effects of alum treatment on benthic invertebrate communities has been found. Alum injection systems may cause the high rate of morphological deformities and/or the decline in benthic community density and diversity observed in some of the alum-treated lakes. As is typical of screenings, data collected do not consistently allow separation or elimination of confounding factors that may be unrelated to alum treatment (i.e. lake stratification/sediment anoxia, contaminants). Further comment cannot be made without conducting tests that are specifically designed to eliminate these confounding factors.

8 Recommendations for Further Investigation

Further investigation including review of historical data, collection and analysis of water/ sediment chemical and physical data, biological data, and controlled toxicity testing is recommended. Additional testing is needed to address the following questions. Each question below is followed by general recommendations for addressing the question.

1. Where biological effects are evident (i.e. low diversity, morphological deformities, uneven distribution of organisms), what is the horizontal distribution of floc and sediment contaminants?

   Measurement of floc accumulation and sediment metals, polynuclear aromatic hydrocarbons, pesticides, and other contaminants can provide indirect evidence that may be useful in explaining the observed effects. Grain size and chemical analyses of sediments and interstitial waters can be used to determine whether an effect is a result of the physical or chemical nature of the sediments, or perhaps some combination. This information can be used to determine the degree to which alum treatment is responsible for the sediment quality and the observed biological effects.

2. What was the quality of stormwater prior to and during alum treatment? Are there known contamination sources in the alum-treated lakes?

   Deformities and other effects on benthos may be a result of accumulation of contaminants in the sediments where alum treatment has accelerated settling from the water column. Historical stormwater data could be used to assess the quality of water entering the alum-treated lakes. This information could then be used to evaluate relationships between known contaminant sources, sediment contaminants, and the observed effects on benthic invertebrates (deformities, low diversity).

3. What effect does alum treatment have on vegetation (macrophytes) and benthic invertebrate communities in vegetated areas? How does the presence or absence of vegetation effect benthic invertebrate communities?

   The current investigation was limited to evaluation of benthic invertebrate communities in the sublittoral zone where little or no vegetation occurred in the alum-treated and reference lakes. Vegetation communities can be mapped and characterized and the effects of alum treatment on benthic invertebrate communities in the littoral zone can be evaluated.

4. Confounding factors can be eliminated to more directly demonstrate sublethal or lethal effects of alum treatment?

   Once contaminant distribution is known, controlled acute and/or chronic toxicity testing can be performed using a range of contaminant levels to determine toxic effects. Carefully designed initial screening tests can be used to determine whether more costly definitive testing is warranted.

5. Can the compliance monitoring required by construction/operation permits be modified to render more consistent data and strengthen or broaden the inferences that can be drawn from the data?

   Inconsistencies in the existing permit monitoring data limit the inferences that can be made regarding the effects of alum treatment on benthic invertebrate communities. The permitting agencies can develop and implement policies to ensure that sampling design and procedures for biological sample analysis are more consistent. More consistent data might allow broader inferences to be applied to a larger set of lakes.

6. How are fish communities influenced by alum treatment in Florida lakes?

   Published evidence suggests that fish are sensitive to aluminum toxicity, particularly under acid conditions (Gensemer and Playle 1998). Although alum-treated lakes in Florida do not tend to be acidic and permit guidelines allow for treatment only under alkaline conditions, a qualitative or semi-quantitative inventory of fish communities in alum-treated lakes and perhaps the reference lakes is recommended to ensure that alum-related adverse effects are not occurring. Information to be gained from this type of inventory might include fish species composition, relative species abundance, and general condition of fish (length, weight, visual inspection for deformities and lesions). Such information can be used to identify potential effects of alum treatment on fish communities.

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Figures

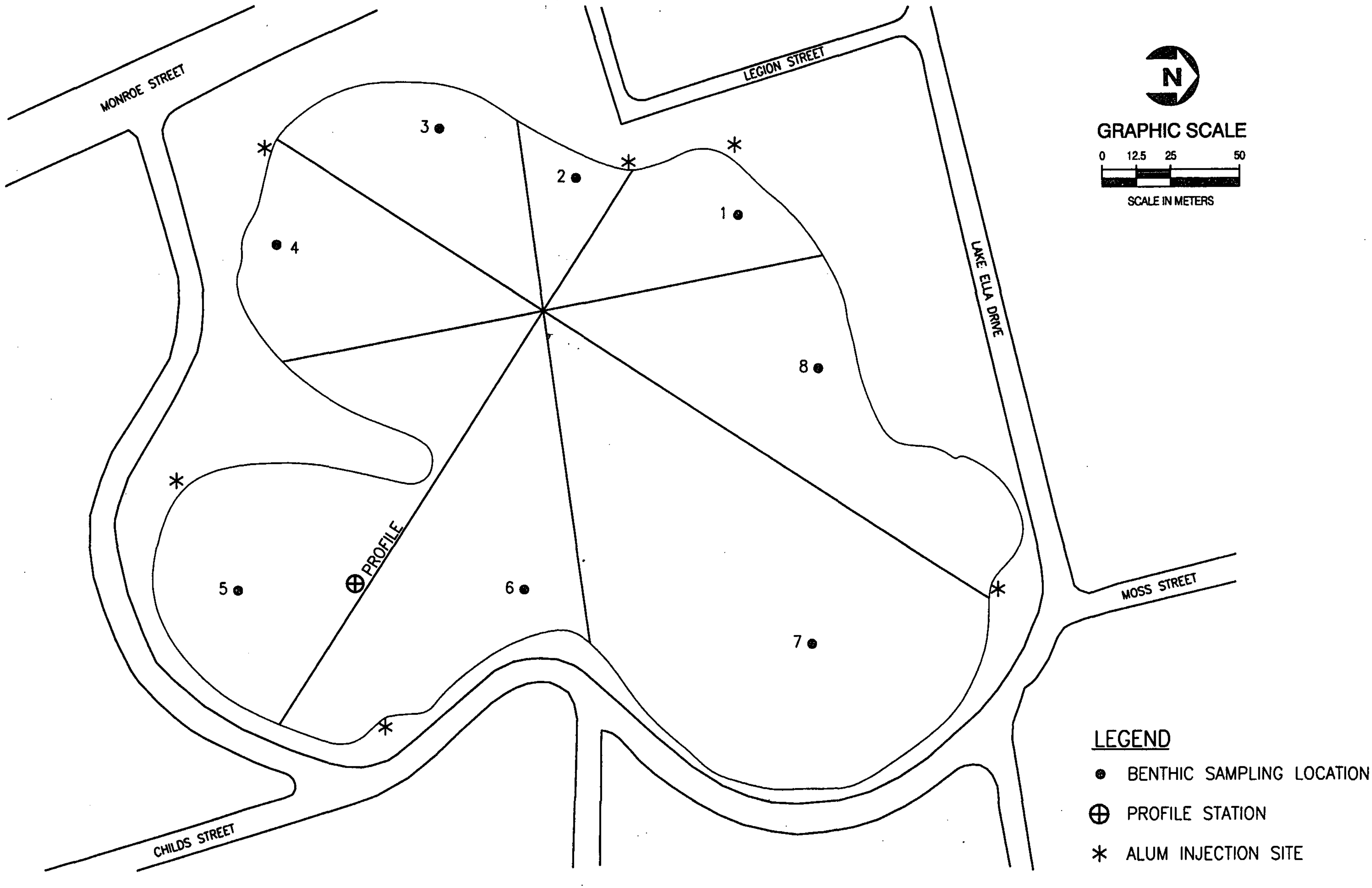

FIGURE 1.
SAMPLING LOCATIONS AT LAKE ELLA,
TALLAHASSEE, FLORIDA

Source: Water and Air Research, Inc., 1999.

water & air RESEARCH, INC.

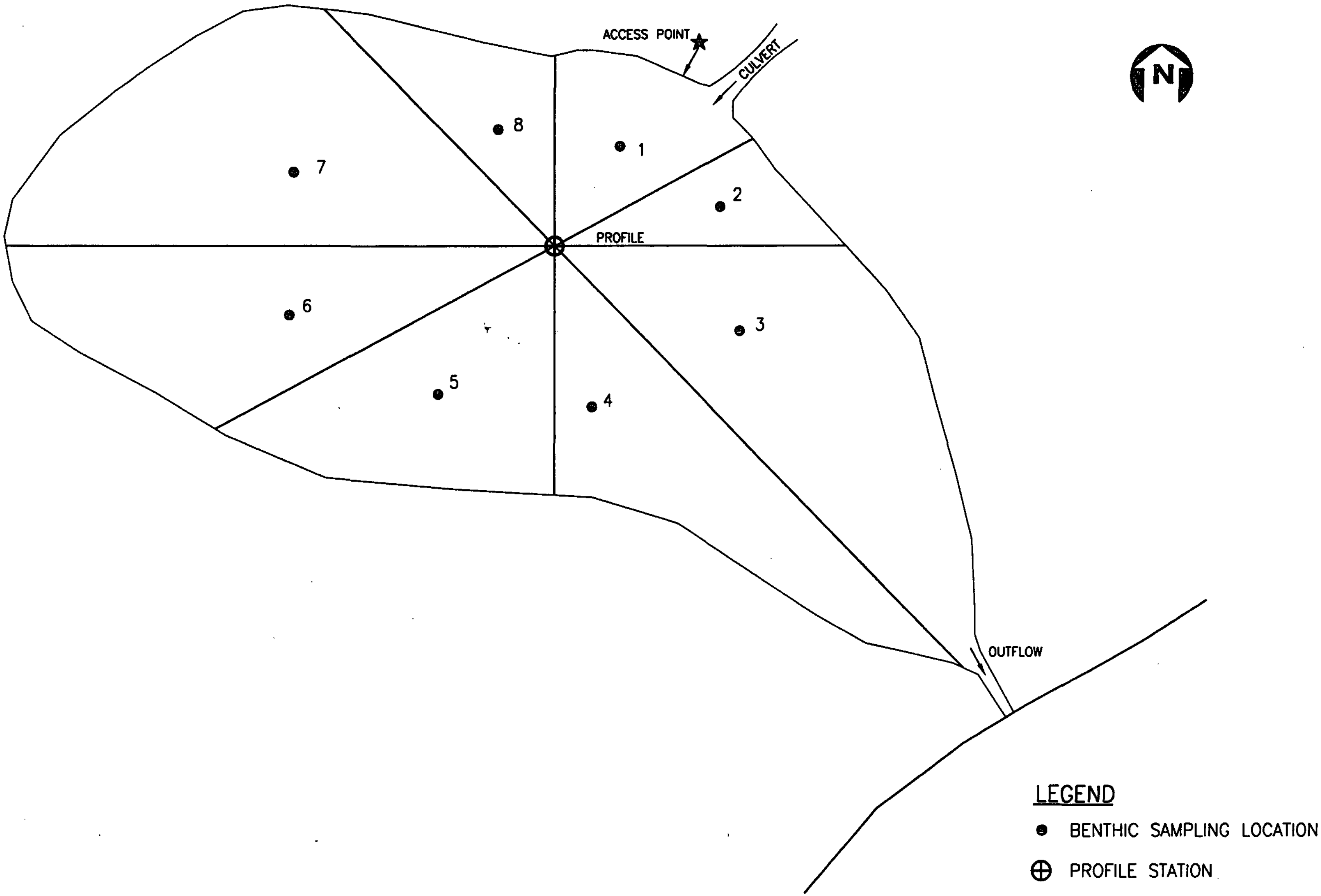

FIGURE 2.
SAMPLING LOCATIONS AT A LAKE IN AJ HENRY PARK, TALLAHASSEE, FLORIDA

Source: Water Air Research, Inc., 1999.

water & air RESEARCH, INC.

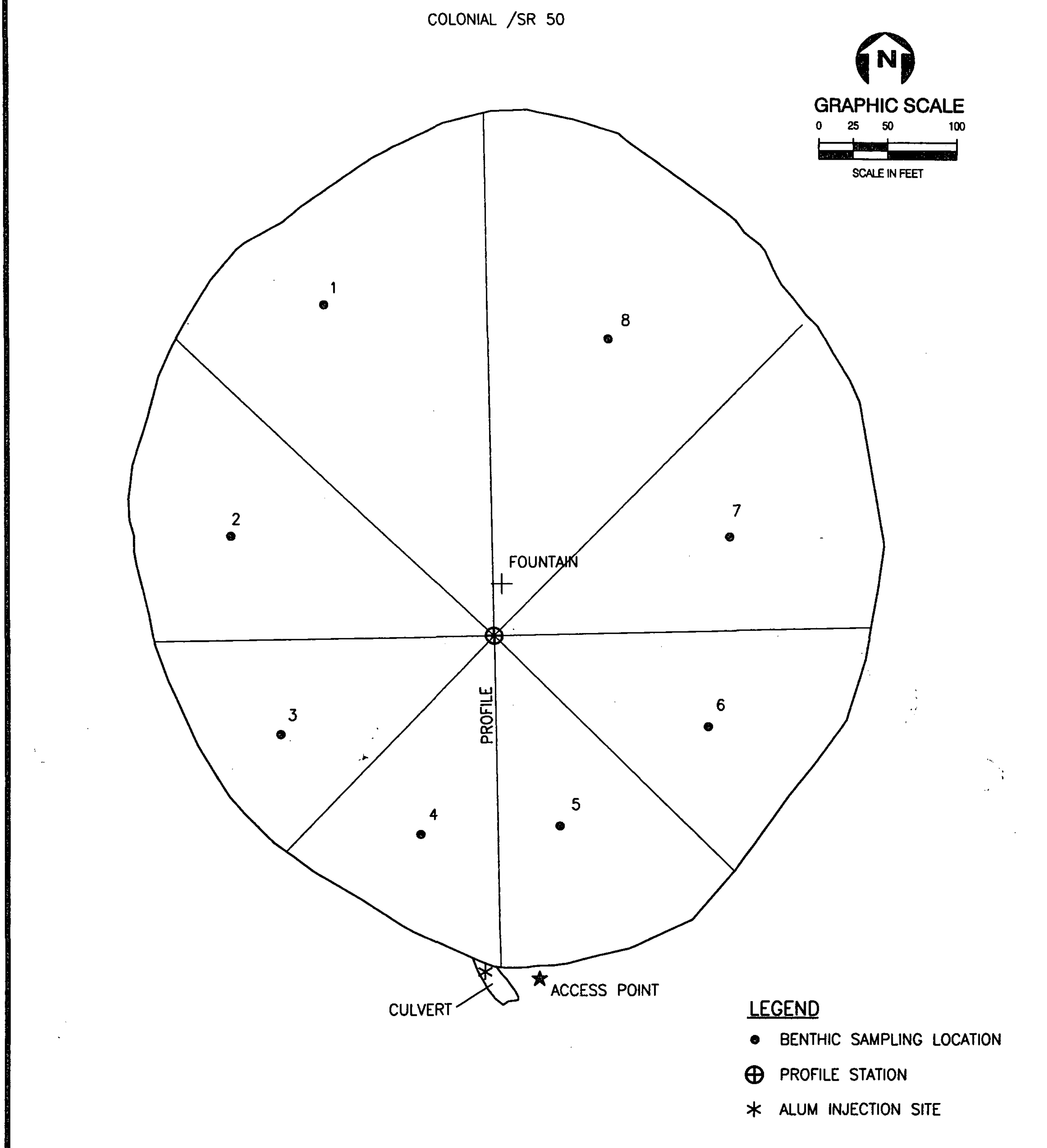

FIGURE 3.
SAMPLING LOCATIONS AT LAKE DOT,
ORLANDO, FLORIDA

Source: Water and Air Research, Inc., 1999.

water & air RESEARCH, INC.

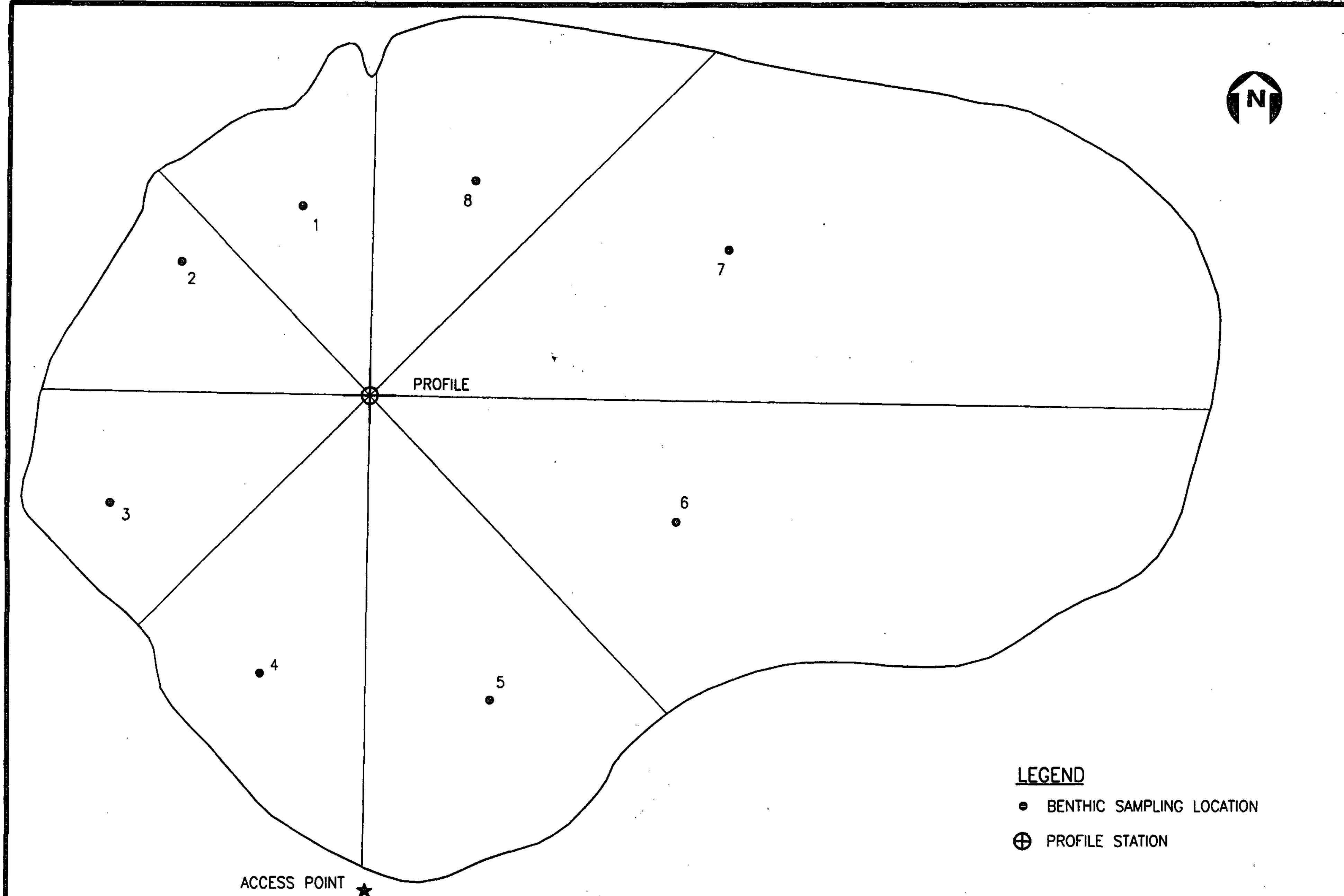

FIGURE 4.
SAMPLING LOCATIONS AT LAKE LURNA,
ORLANDO, FLORIDA

Source: Water and Air Research, Inc., 1999.

water & air RESEARCH, INC.

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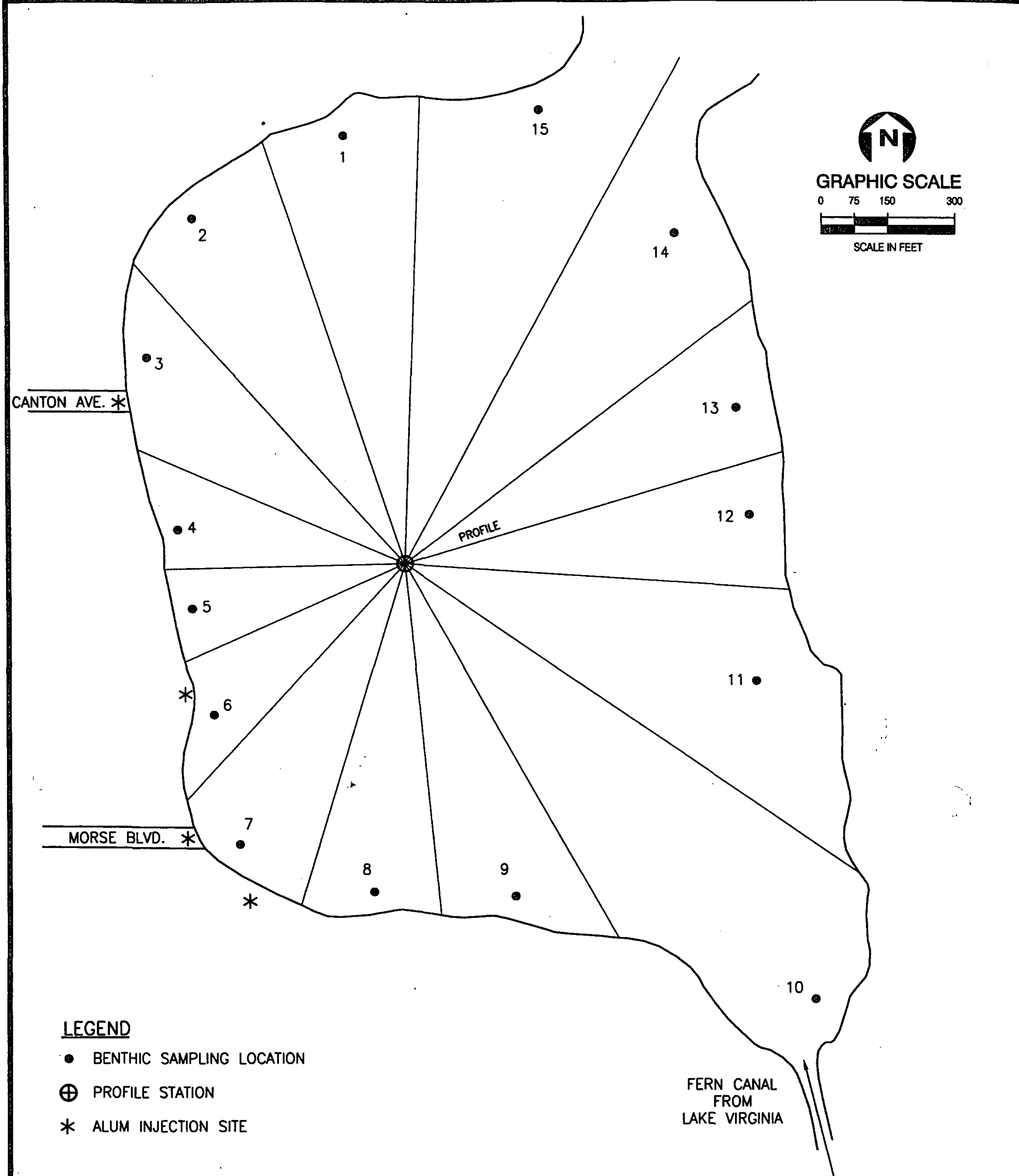

FIGURE 5.1
SAMPLING LOCATIONS WITHIN THE SOUTH LOBE OF LAKE OSCEOLA, WINTER PARK, FLORIDA

Source: Water and Air Research Inc., 1999.

water & air RESEARCH, INC.

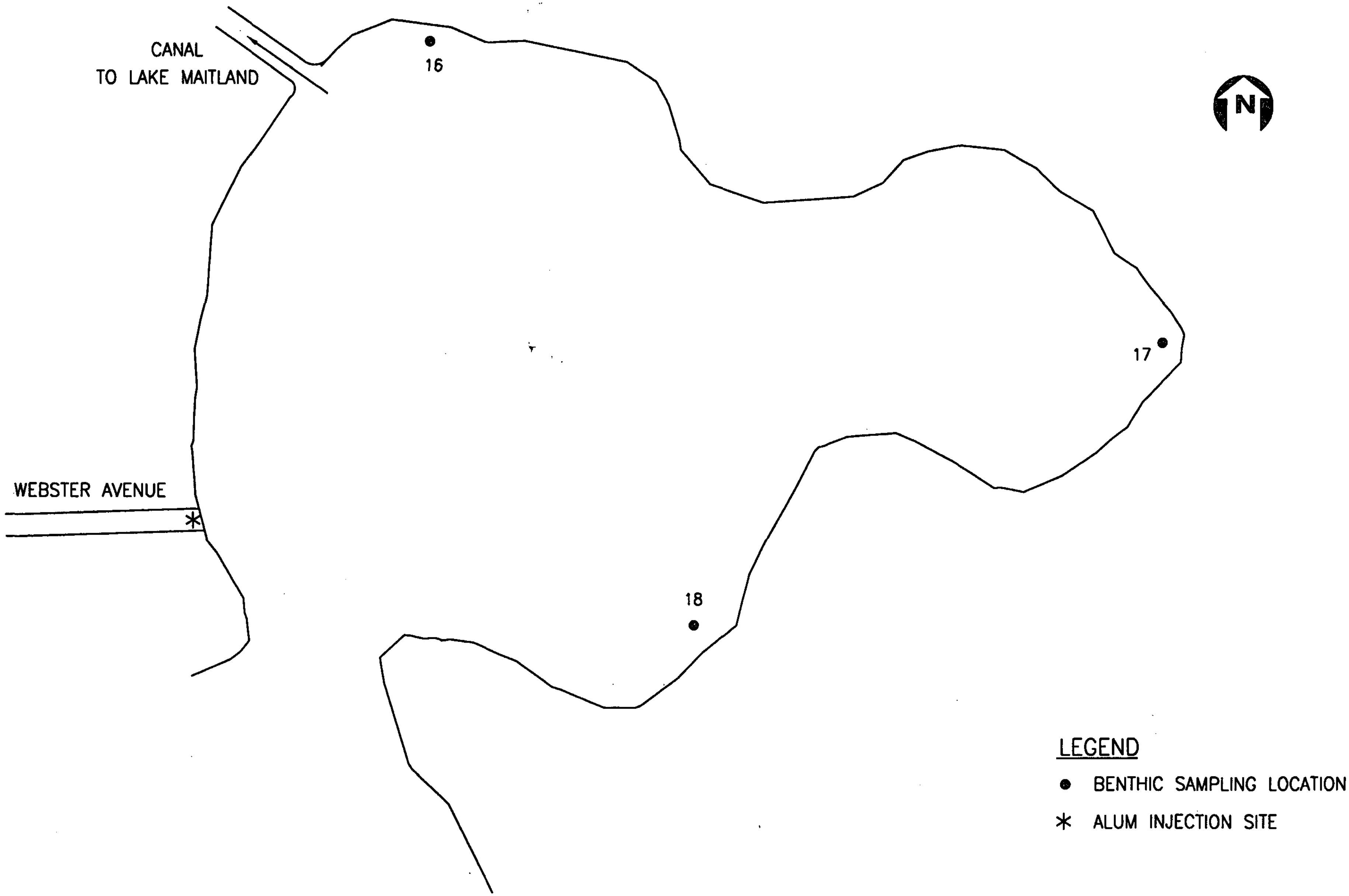

FIGURE 5.2
SAMPLING LOCATIONS WITHIN THE NORTH LOBE OF LAKE OSCEOLA, WINTER PARK, FLORIDA

Source: Water & Air Research, Inc., 1999.

water & air RESEARCH, INC.

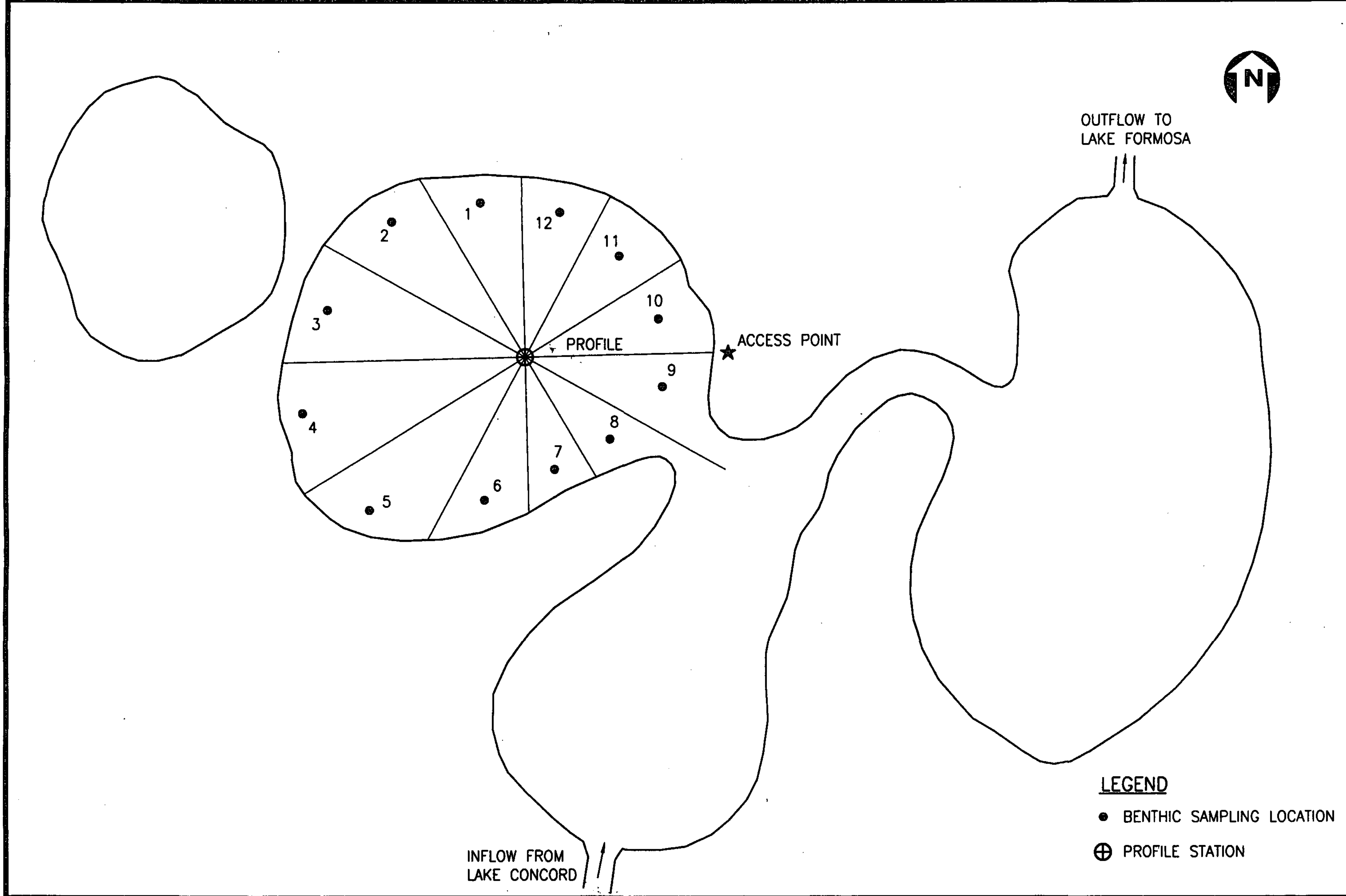

FIGURE 6.
SAMPLING LOCATIONS AT LAKE IVANHOE,
ORLANDO, FLORIDA

Source: Water and Air Research, Inc., 1999.

water & air RESEARCH, INC.

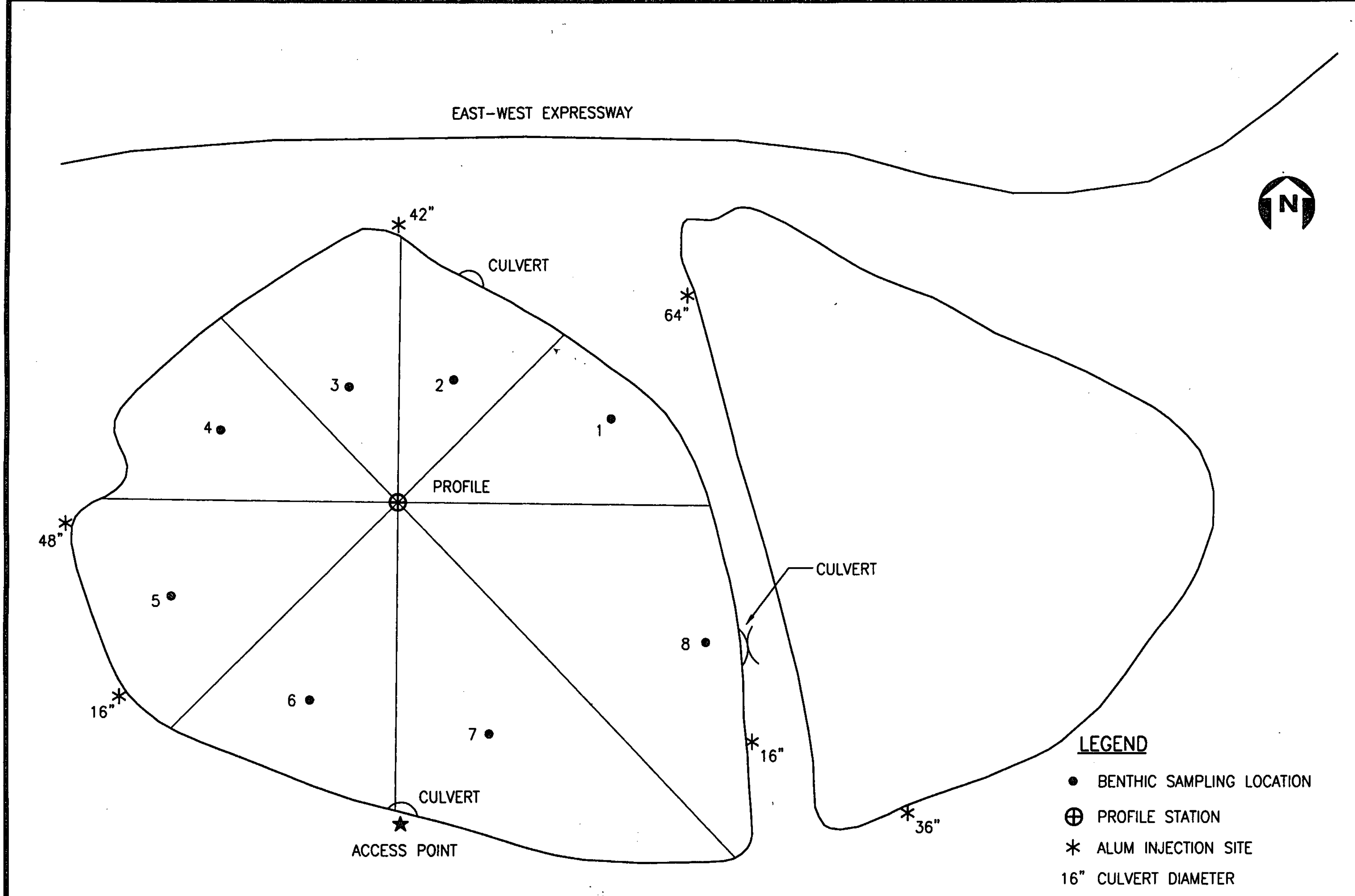

FIGURE 7.
SAMPLING LOCATINOS AT LAKE LUCERNE, ORLANDO, FLORIDA

Source: Water and Air Research, Inc., 1999.

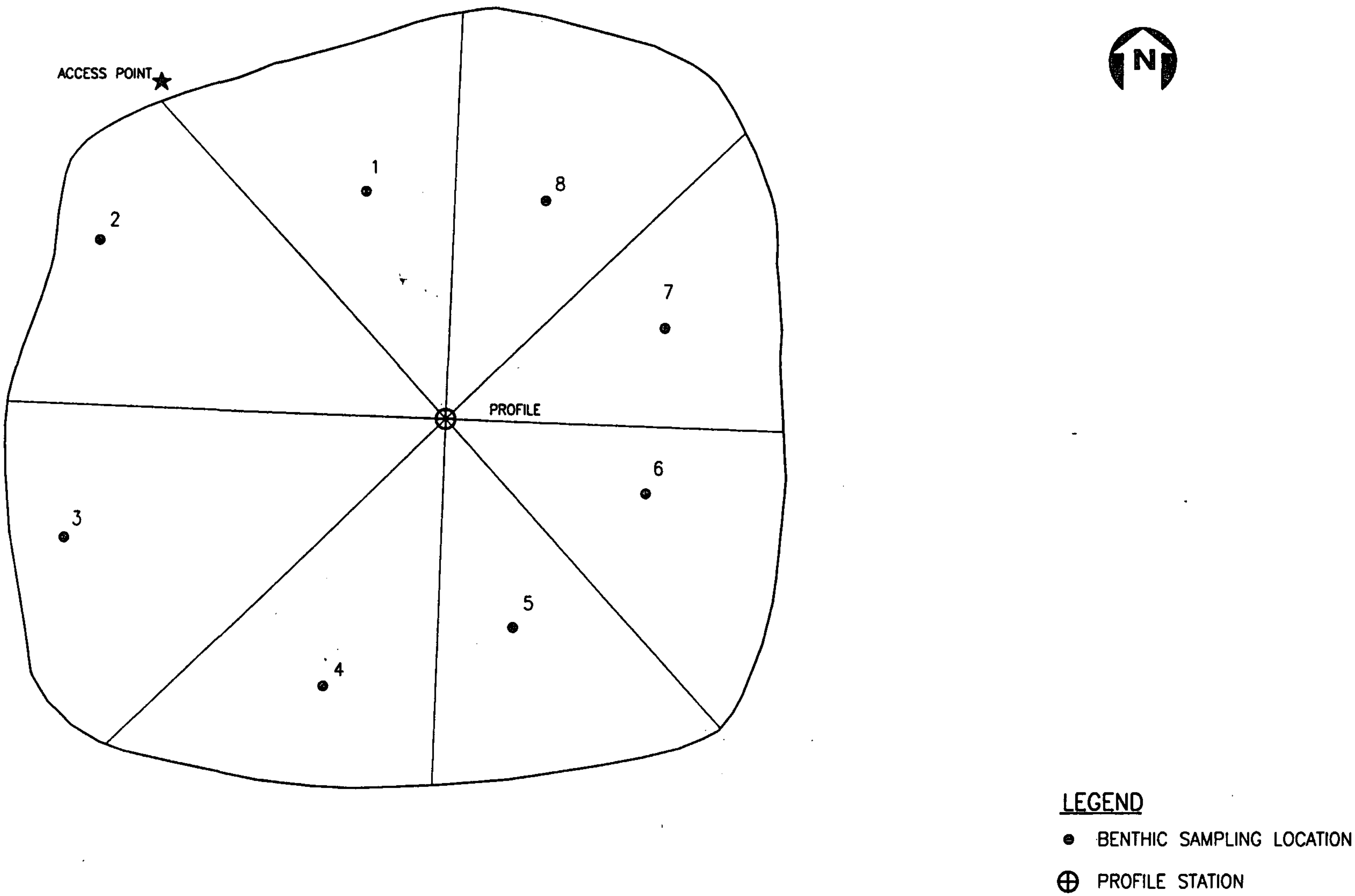

FIGURE 8.
SAMPLING LOCATIONS AT LAKE OLIVE,
ORLANDO, FLORIDA

Source: Water and Air Research, Inc., 1999.

water & air RESEARCH, INC.

Tables

TABLE 1
List of Characteristics Used in Selecting Alum-Treated Lakes

Lake	Startup Date	Treatment Duration (Years)	Pre & Post Data	Sampling Frequency	Post-Treatment Sampling Duration (Years)	Suitable Reference Lake	Comments
Ella	Jul-87	12	Yes	Annually (intermittent)	3	Yes	
Dot	Jan-90	8.7	Yes	Annually	1	Yes	
Osceola	Feb-93	5.6	Yes	Annually	3	Yes	
Lucerne	Jan-94	5.5	Yes	Intermittent	3	Yes	
Cannon	Jan-94	4.6	Yes	Quarterly	2	?	
Apopka	Jul-95	3	Yes	Annually	4	?	
Holden	Aug-96	2	Yes	Annually	2	?	
Tuskawilla	Oct-96	2	Yes	Annually	2	?	
Virginia	Jun-96	2	Yes	Annually	1	?	
Mizell	May-97	1.2	Yes	Semiannually	1	?	
Rowena	Feb-97	1	Yes	Annually	1	?	
Merritt Ridge	Pending?	1	Yes	Semiannually	Unknown	?	Estuarine System

TABLE 2
Data from Selected Alum-Treated Lakes and Candidate Reference Lakes in the Orlando Vicinity

Data Set	Lake Name	TSI	Ave. TP (mg/L)	Chlor. A (mg/m^3)	Secchi Depth (m)	Alkalinity (mg/L)	pH	Surface Area (acres)	Basin Area (acres)	Watershed Ratio	Max. Depth (feet)	Mean Depth (feet)	Drainage Basin Land Use	Lake Type	Grass Carp	Aeration	Drain Wells	Macroinvertebrate Data	Comments/ Fatal Flaws
Prior	Dot	63.22	0.083	36	0.85	68	8.2	6	298	49.67	15	8.3	47%Res,50% Comm	4	No	Fountain	No	Yes	
LT	Lurna	60.8	0.084	41	1.05	No data	No data	9	126	14.00	24.5	10.2	54%Res,46%Comm	4	No	Diffuser	2	No	
1997	Lurna	55.4	0.084	38	1.4														
Prior	Lucerne	66	0.11	50	0.76	102	8.33	7	301	43.00	No data	6.8	Res. 7%, Comm. 93%	?	Yes	Yes	1	Yes	
LT	Olive	61.3	0.127	30	0.97	47	7.12	3.2	86	26.88	25.3	10.5	90% Res,10%Comm	4	Yes	Yes	1	Yes	
1997	Olive	58.3	0.08	21	0.96														
LT	Angel	64.7	0.101	41	0.81	92	7.82	2.4	273	113.75	No Data	7.7	63%Res,37% Comm	?	Yes	No	1	No	
1997	Angel	60.6	0.07	29	0.93														
LT	Walker	70.4	0.124	44	0.58	38	8.16	4	41	10.25	No Data	8.5	Residential	?	Yes	Yes	No	No	
1997	Walker	68.7	0.099	35	0.56	38	8.16	4	41	10.25		8.5							
LT	Wade	64.9	0.117	45	0.93		7.37	4.2	188	44.76	5		77%Res,23%Comm	4	Yes	No	1	No	Periphyton filter operating
1997	Wade	62.9	0.117	30	0.86	55						4							
LT	Kozart	71.5	0.108	43	0.56			7.6	136	17.89	No Data	4.2	Residential		Yes	No	No	No	
1997	Kozart	74.5	0.171	60	0.69	76	7.95												
LT	Emerald	72.5	0.186	52	0.53			2.9	27	9.31		5.6	100% Res	4	Yes	No	No	No	Receives water from Lake Lucerne
1997	Emerald	76	0.296	79	0.53	62	8.04												
LT	Davis	79.2	0.181	95	0.42			17	114	6.71	14.4	6.1	93% Res,4%Comm	4	No	No	1	No	1970's drawdown, 1992 alum treat.
1997	Davis	87.8	0.456	129	0.27														
Prior	Osceola	57	0.037	24.8	1.12	52.25	8.2	157	570	3.63	24	20	20%Res,80%Comm	3	Present	No	No	Yes	Sonar and Aquathol application for plant control
LT	Ivanhoe	57.7	0.032	28	1.01	?	?	125	691	5.53	28	15.8	69% Res., 31% Comm.	2	Yes	Yes	1	?	
1997	East	57.5	0.027	26	0.95														
LT	Lawne	69.6	0.124	39	0.66			125	2840		No Data	7.3	40%Res,38%Comm	1	Yes	No	1	?	Lead in sediments
1997	Lawne	65.6	0.085	40	0.83	63	7.41	125	2840	22.72		7.3							
LT	Orlando	68.2	0.202	43	0.69			170	1800		No Data		31%Res,31%Comm		Yes	No	No	?	
1997	Orlando	64	0.07	29	0.76	54	8.01	170	1800	10.59		5.6							
LT	Concord	56.6	0.044	30.3	1.14	55	8.52	60	361	6.02	35	15	24%Res,76%Comm	2	Yes	Yes	Yes	Yes	Trichloroethylene in groundwater
1997	Concord	56.6	0.041	30	1.14														
LT	Mann	55.9	0.037	20	1.28	No data	8.4	230	1260	5.48	22	11.4	67% Res,23%Comm	1	No	No	1	?	
1997	Mann	64.1	0.031	38	0.73														

Prior = Average prior to alum treatment
LT = Long Term Average
1997 = 1997 Average
Lake Types 1 = Inflowing stream(s); 2 = Outflowing stream(s); 3 = Inflowing and outflowing streams; 4 = Landlocked

TABLE 3
Data from Selected Alum-Treated Lakes and Candidate Reference Lakes in the Tallahassee Vicinity

Data Set	Lake Name	TSI	Ave. TP (mg/L)	Chlor. A (mg/m^3)	Secchi Depth (m)	Alkalinity (mg/L)	pH	Surface Area (acres)	Basin Area (acres)	Watershed Ratio	Max. Depth (feet)	Mean Depth (feet)	Drainage Basin Land Use	Lake Type	Grass Carp	Aeration	Drain Wells	Macroinvertebrate Data	Comments/ Fatal Flaws
Prior	Lake Ella	98	0.232	180	<0.5	25.30	7.41	13.3	157.2	12	9	6.9	52%res.,47%comm	4	Yes	Fountain		Yes	
1990		47	0.026	5	2.2	11.00	6.43	11.9											
Current	Lake AJ Henry Park		0.44	68.49	0.40	25.46	7.57	14.3	497	35	9	5	95% Res., 5% City Park	No data	No	None		Yes	
Current	Lake Hilaman		0.235	35.65	0.43	26.98	7.06	6.5	936	144	No data	No data	100% Golf Course	No data	No	Diffuser		No	
Current	Tom Brown Park		0.08	20.25	0.82	25.15	7.64	4.4	1799	409	11	5.5	100% City Park	No data	No	Fountain		Yes	
Current	Killarney		0.075	15.27	0.92	11.16	7.55	74.7	1568	21	8	3.5	98% Res., 2% Comm.	1	No	None		Yes	
Current	Kanturk		0.06	15.11	0.97	10.56	7.53	68.6	1568	23	7	3.5	98% Res., 2% Comm.	No data	No	None		Yes	

Prior = Average water quality prior to alum treatment
1990 = Average water quality in 1990
Current = Average water quality based on current data; collection period unknown
Lake Types 1 = Inflowing stream(s); 2 = Outflowing stream(s); 3 = Inflowing and outflowing streams; 4 = Landlocked

TABLE 4
Comparisons of Benthic Macroinvertebrate Mean Densities (No./m^2), Number of Taxa, and Shannon-Weaver Diversity Before and After Alum Treatment in Select Alum-Treated Lakes, Orlando and Tallahassee, Florida

Lake Name	Sampling Date	Mean Densities	Mean No. of Taxa	Shannon- Weaver Diversity	No. of Sites	No. of Grabs Per Site
Treated Lakes						
Lake Dot						
Pre-winter 89	1/23/1989	1,742	4.0	0.85	6	3
Post-winter 91	1/31/1991	1,174	3.8	0.81	6	3
Post-winter 98	12/1/1998	824	4.4	1.48	8	1
Post-summer 99	6/1/1999	81	1.3	0.41	8	1
Lake Ella						
Pre-winter 85	11/29/1985	0	0.0	0.00	8	3
Post-winter 87	1/16/1987	0	0.0	0.00	8	3
Post-summer 90	5/25/1990	66	1.4	0.49	8	3
Post-winter 98	12/98	1,525	2.5	0.65	8	1
Post-summer 99	6/99	3,109	1.9	0.49	8	1
Lake Osceola						
Pre- winter 92	10/13/1992	10,820	11.2	1.69	3	3
	10/1/1992	9,112	8.7	1.70	3	3
Post-summer 95	7/1/1995	904	2.0	0.64	3	3
Post-winter 95	12/1/1995	17,953	7.7	0.81	3	3
Post-winter 97	1/1/1997	7,021	6.0	1.17	3	3
Post-winter 98	12/98	546	4.9	1.85	18	1
Post-winter 99	6/99	347	1.9	0.49	18	1
Lake Lucerne						
Pre-winter 92	11/11/1992	9,593	11.2	1.87	6	3
Post-summer 95	7/95	497	3.2	0.47	6	3
Post-winter 95	12/28/1995	555	3.1	0.70	6	3
Post-winter 97	1/21/1997	539	4.0	0.82	6	3
Post-winter 98	12/98	1,929	4.5	0.93	8	1
Post-summer 99	6/99	3,077	3.1	1.56	8	1
Lake Cannon						
Pre-treatment Means		2,489	6.6	0.97		
Pre- winter 93	2/15/1993	3,122	4.0	0.19	4	3
Pre- summer 93	5/18/1993	2,902	7.3	1.12	4	3
Pre-summer 93	8/11/1993	791	3.8	0.99	4	3
Pre- winter 93	11/16/1993	3,141	11.3	1.59	4	3
Post-treatment Means		4,422	9.9	1.87		
Post- winter 94	2/14/1994	5,597	9.0	1.87	4	3
Post- summer 94	5/16/1994	5,943	9.8	1.88	4	3
Post-summer 94	8/8/1994	3,665	7.0	1.42	4	3
Post- winter 94	11/14/1994	3,087	9.5	2.11	4	3
Post- winter 95	2/6/1995	4,812	13.0	2.03	4	3
Post- summer 95	5/22/1995	2,443	7.8	1.55	4	3
Post-summer 95	8/7/1995	4,505	8.3	1.81	4	3
Post-winter 95	11/11/1995	5,465	12.3	1.91	4	3
Post-winter 96	2/12/1996	4,285	12.8	2.28	4	3

TABLE 5
Response Variable Means and p-Values for Comparison of Select Alum-Treated and Reference Lakes, Orlando and Tallahassee, Florida

Response Variable	Season	Mean Values		p-Values
		Treated Lakes	Reference Lakes	
Organism Density	Winter	1,206	1,686	0.7198
	Summer	1,655	1,187	0.8164
Number of Taxa	Winter	4.1	5.6	0.2337
	Summer	2.4	4.6	**0.0444**
SW Diversity Index	Winter	1.23	1.83	**0.0128**
	Summer	0.74	1.47	**0.0513**
Sub-benthic Collectors	Winter	1.1	1.2	0.1608
	Summer	11.4	3.3	0.4101
Epi-benthic Collectors	Winter	9.6	5.0	0.651
	Summer	3.4	4.6	0.2818
Filterers	Winter	N/A	N/A	N/A
	Summer	N/A	N/A	N/A
Plant piercers	Winter	N/A	N/A	N/A
	Summer	N/A	N/A	N/A
Shredders	Winter	5.9	1.8	0.4886
	Summer	3.3	4.1	0.3568
Scrapers	Winter	N/A	N/A	N/A
	Summer	N/A	N/A	N/A
Predators	Winter	10.9	28.5	0.3678
	Summer	20.0	14.9	0.8289

Significant differences $p<0.10$ are in bold
N/A - Excluded from analysis due to insufficient data

TABLE 6
Response Variable Means and p-Values for Comparison of Benthic Macroinvertebrate Communities in Lake Ella and Lake AJ Henry (Pair 1), Tallahassee, Florida

Response Variable	Season	Mean Values Lake Ella	Mean Values Lake AJ Henry	p-Values
Organism Density	Winter	1,525	5,022	**0.0102**
	Summer	3,109	3,001	0.8215
Number of Taxa	Winter	2.5	6.0	**0.0045**
	Summer	1.9	5.1	**0.0005***
SW Diversity Index	Winter	0.65	1.55	**0.0369**
	Summer	0.49	1.56	**<0.0001**
Sub-benthic Collectors	Winter	0.5	0.9	0.9909
	Summer	5.9	11.1	0.6029
Epi-benthic Collectors	Winter	3.9	8.8	**0.0379**
	Summer	0.0	4.9	**0.002**
Filterers	Winter	N/A	N/A	N/A
	Summer	N/A	N/A	N/A
Plant piercers	Winter	N/A	N/A	N/A
	Summer	N/A	N/A	N/A
Shredders	Winter	0.0	1.2	**0.0298**
	Summer	0.0	4.8	**0.0018**
Scrapers	Winter	N/A	N/A	N/A
	Summer	N/A	N/A	N/A
Predators	Winter	31.0	105.4	**0.0162**
	Summer	66.3	48.1	0.7128

Significant differences p<0.10 are in bold
* - T-test based on unequal variances
N/A - Excluded from analysis due to insufficient data

TABLE 7
Response Variable Means and p-Values for Comparison of Benthic Macroinvertebrate Communities in Lake Dot and Lake Lurna (Pair 2), Orlando, Florida

Response Variable	Season	Mean Values		p-Values
		Lake Dot	Lake Lurna	
Organism Density	Winter	824	830	0.8537
	Summer	81	156	0.7733
Number of Taxa	Winter	4.4	6.8	0.1961
	Summer	1.3	1.8	0.6378*
SW Diversity Index	Winter	1.48	2.10	0.1198
	Summer	0.41	0.55	0.7494
Sub-benthic Collectors	Winter	0.4	0.3	0.8447
	Summer	1.0	0.5	0.3721
Epi-benthic Collectors	Winter	10.2	5.4	0.3659
	Summer	0.1	0.8	0.3258
Filterers	Winter	N/A	N/A	N/A
	Summer	N/A	N/A	N/A
Plant piercers	Winter	N/A	N/A	N/A
	Summer	N/A	N/A	N/A
Shredders	Winter	6.4	3.4	0.3805
	Summer	0.1	0.3	0.6616
Scrapers	Winter	N/A	N/A	N/A
	Summer	N/A	N/A	N/A
Predators	Winter	1.9	4.8	**0.0476**
	Summer	0.3	1.4	0.1421

Significant differences p<0.10 are in bold
* - T-test based on unequal variances
N/A - Excluded from analysis due to insufficient data

TABLE 8
Response Variable Means and p-Values for Comparison of Benthic Macroinvertebrate Communities in Lake Osceola and Lake Ivanhoe (Pair 3), Winter Park and Orlando, Florida

Response Variable	Season	Mean Values		p-Values
		Lake Osceola	Lake Ivanhoe	
Organism Density	Winter	546	542	0.5065*
	Summer	338	805	**0.0138**
Number of Taxa	Winter	4.9	6.6	**0.0885**
	Summer	1.8	5.2	**0.0036***
SW Diversity Index	Winter	1.85	2.44	**0.0548**
	Summer	0.49	1.61	**0.0002**
Sub-benthic Collectors	Winter	1.2	1.0	0.6447
	Summer	1.4	1.2	0.7439
Epi-benthic Collectors	Winter	4.8	4.9	0.5065
	Summer	2.1	7.4	0.3258*
Filterers	Winter	N/A	N/A	N/A
	Summer	N/A	N/A	N/A
Plant piercers	Winter	N/A	N/A	N/A
	Summer	N/A	N/A	N/A
Shredders	Winter	2.9	2.5	0.6422
	Summer	2.0	6.9	**0.0043**
Scrapers	Winter	N/A	N/A	N/A
	Summer	N/A	N/A	N/A
Predators	Winter	2.6	2.6	0.4568
	Summer	2.5	2.8	0.7198

Significant differences p<0.10 are in bold
* - T-test based on unequal variances
N/A - Excluded from analysis due to insufficient data

TABLE 9
Response Variable Means and p-Values for Comparison of Benthic Macroinvertebrate Communities in Lake Lucerne and Lake Olive (Pair 4), Orlando, Florida

Response Variable	Season	Mean Values Lake Lucerne	Lake Olive	p-Values
Organism Density	Winter	1,929	350	**0.0132***
	Summer	3,082	787	0.1163*
Number of Taxa	Winter	4.5	3.0	0.1824
	Summer	4.6	6.5	0.2059
SW Diversity Index	Winter	0.93	1.24	0.421
	Summer	1.56	2.16	**0.0532***
Sub-benthic Collectors	Winter	2.5	2.6	0.9251
	Summer	37.4	0.4	**0.0165***
Epi-benthic Collectors	Winter	19.3	0.9	**0.0036***
	Summer	11.4	5.3	0.4124
Filterers	Winter	N/A	N/A	N/A
	Summer	N/A	N/A	N/A
Plant piercers	Winter	N/A	N/A	N/A
	Summer	N/A	N/A	N/A
Shredders	Winter	14.4	0.3	**0.0038***
	Summer	11.3	4.7	0.3379
Scrapers	Winter	N/A	N/A	N/A
	Summer	N/A	N/A	N/A
Predators	Winter	8.3	1.4	0.2313*
	Summer	11.2	7.4	0.748

Significant differences p<0.10 are in bold
* - T-test based on unequal variances
N/A - Excluded from analysis due to insufficient data

TABLE 10

Benthic Macroinvertebrate Densities (No./m^2) in Select Alum-Treated and Non-Treated Reference Lakes, Orlando and Tallahassee, Florida

Number of Organisms Per Square Meter

	Winter Ella	Summer Ella	Winter AJ Henry	Summer AJ Henry	Winter Dot	Summer Dot	Winter Lurna	Summer Lurna	Winter Osceola	Summer Osceola	Winter Ivanhoe	Summer Ivanhoe	Winter Lucerne	Summer Lucerne	Winter Olive	Summer Olive
Mean	1,525	3,109	5,022	3,001	824	81	830	34,139	546	338	542	805	1,929	3,082	350	787
Site																
1	647	2,845	14,353	5,862	1,293	43	172	13,005	302	129	733	86	647	259	603	2,328
2	690	3,879	4,397	1,466	2,241	259	302	9,290	216	43	474	819	388	302	302	991
3	0	302	2,414	2,931	1,509	43	1,034	27,869	647	302	216	1,422	905	603	776	733
4	948	216	2,457	1,422	690	43	86	143,059	3,319	129	948	302	1,164	819	345	302
5	86	2,716	6,638	1,983	216	172	560	7,432	172	172	560	388	733	1,250	86	1,121
6	1,810	2,888	3,276	2,888	474	0	819	18,579	431	0	388	172	2,845	6,853	216	216
7	517	4,052	3,362	5,086	172	0	2,414	37,158	862	431	216	172	5,517	8,922	259	302
8	7,500	7,974	3,276	2,371	0	86	1,250	16,721	388	86	517	1,466	3,233	5,647	216	302
9									517	86	302	1,853				
10									733	0	474	1,034				
11									474	862	776	819				
12									345	86	905	1,121				
13									172	1,034						
14									388	1,207						
15									0	690						
16									302	259						
17									431	560						
18									129	0						

TABLE 11

Number of Benthic Macroinvertebrate Taxa in Select Alum-Treated and Non-Treated Reference Lakes, Orlando and Tallahassee, Florida

Number of Taxa

	Winter Ella	Summer Ella	Winter AJ Henry	Summer AJ Henry	Winter Dot	Summer Dot	Winter Lurna	Summer Lurna	Winter Osceola	Summer Osceola	Winter Ivanhoe	Summer Ivanhoe	Winter Lucerne	Summer Lucerne	Winter Olive	Summer Olive
Total Taxa	5	2	15	9	13	4	26	10	33	13	32	24	18	16	14	20
Mean No. Taxa	2.5	1.9	6	5.1	4.4	1.3	6.8	1.8	4.9	1.8	6.6	5.2	4.5	4.6	3	6.5
Site																
1	2	2	3	6	9	1	3	3	4	1	6	1	5	3	2	10
2	1	2	10	3	6	3	4	0	4	1	6	11	1	4	5	10
3	0	2	6	8	5	1	10	1	6	2	3	10	3	4	5	6
4	5	2	8	5	4	1	2	0	10	2	6	4	3	4	2	3
5	1	2	4	4	5	2	5	1	3	2	10	4	2	3	2	12
6	5	2	5	4	4	0	6	1	7	0	8	3	7	5	3	4
7	3	2	5	5	2	0	14	8	3	1	4	3	10	8	4	3
8	3	1	7	6	0	2	10	0	6	1	8	6	5	6	1	4
9									7	1	6	6				
10									4	0	7	2				
11									9	6	4	7				
12									6	2	11	5				
13									4	5						
14									1	3						
15									0	3						
16									6	2						
17									6	1						
18									3	0						

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TABLE 12
Benthic Macroinvertebrate Diversity in Select Alum-Treated and Non-Treated Reference Lakes, Orlando and Tallahassee, Florida
Shannon-Weaver Diversity

	Winter Ella	Summer Ella	Winter AJ Henry	Summer AJ Henry	Winter Dot	Summer Dot	Winter Lurna	Summer Lurna	Winter Osceola	Summer Osceola	Winter Ivanhoe	Summer Ivanhoe	Winter Lucerne	Summer Lucerne	Winter Olive	Summer Olive
Mean Diversity	0.65	0.49	1.55	1.56	1.48	0.41	2.10	0.55	1.85	0.49	2.44	1.61	0.93	1.56	1.24	2.16
Pooled Diversity	1.00	0.41	1.66	1.92	2.27	1.86	3.68	3.22	4.02	2.18	4.17	3.00	2.19	2.19	2.77	3.47
Site																
1	0.35	0.65	0.22	1.21	2.30	0.00	1.50	1.50	1.84	0.00	2.13	0.00	2.04	1.25	0.59	2.49
2	0.00	0.35	2.60	1.49	2.04	1.25	1.66	0.00	1.92	0.00	2.41	3.08	0.00	1.84	2.24	3.00
3	0.00	0.59	1.95	2.12	1.21	0.00	2.51	0.00	2.15	0.59	1.52	2.45	0.96	1.79	1.93	2.18
4	1.21	0.97	2.22	1.57	1.65	0.00	1.00	0.00	2.59	0.92	2.41	1.95	0.46	1.58	0.81	1.15
5	0.00	0.63	0.30	1.04	2.32	1.00	1.99	0.00	1.50	0.81	3.09	1.75	0.32	1.52	1.00	3.24
6	1.60	0.43	1.57	1.57	1.49	0.00	2.18	0.00	2.65	0.00	2.95	1.50	1.38	1.55	1.52	1.92
7	1.28	0.30	1.37	1.50	0.81	0.00	2.97	2.87	0.57	0.00	1.92	1.50	1.71	1.55	1.79	1.45
8	0.78	0.00	2.14	1.97	0.00	1.00	3.01	0.00	2.50	0.00	2.75	1.07	0.55	1.39	0.00	1.84
9									2.45	0.00	2.52	1.62				
10									1.14	0.00	2.73	0.74				
11									3.10	2.10	1.50	2.42				
12									2.41	1.00	3.33	1.22				
13									2.00	1.66						
14									0.00	0.44						
15									0.00	0.67						
16									2.52	0.65						
17									2.32	0.00						
18									1.58	0.00						

TABLE 13
Percent Occurrence of Morphological Deformities in Larval Chironomid Mental Plates from Select Alum-Treated and Reference Lakes, Orlando and Tallahassee, Florida

Species		Parameter	Ella	AJ Henry	Dot	Lurna	Osceola	Ivanhoe	Lucerne	Olive
Chironomus sp.										
	Winter	Total No. Individuals	nc	17	**83**	24	2	8	**192**	2
		No. Deformed Larvae	nc	0	**14**	0	0	0	**80**	0
		Percent Occurrence	nc	0%	**17%**	0%	0%	0%	**42%**	0%
	Summer	Total No. Individuals	nc	76	1	2	4	21	**27**	24
		No. Deformed Larvae	nc	0	0	0	0	0	**12**	0
		Percent Occurrence	nc	0%	0%	0%	0%	0%	**44%**	0%
Chironomus crassicaudatus										
	Winter	Total No. Individuals	nc	nc	nc	nc	nc	1	nc	nc
		No. Deformed Larvae	nc	nc	nc	nc	nc	0	nc	nc
		Percent Occurrence	nc	nc	nc	nc	nc	0%	nc	nc
	Summer	Total No. Individuals	nc	nc	nc	nc	64	101	nc	**33**
		No. Deformed Larvae	nc	nc	nc	nc	1	3	nc	**4**
		Percent Occurrence	nc	nc	nc	nc	2%	3%	nc	**12%**
Cladopelma sp.										
	Winter	Total No. Individuals	2	nc	27	2	2	1	2	4
		No. Deformed Larvae	0	nc	1	0	0	0	0	0
		Percent Occurrence	0%	nc	4%	0%	0%	0%	0%	0%
	Summer	Total No. Individuals	nc	nc	nc	4	1	nc	nc	3
		No. Deformed Larvae	nc	nc	nc	0	0	nc	nc	0
		Percent Occurrence	nc	nc	nc	0%	0%	nc	nc	0%
Glyptotendipes paripes										
	Winter	Total No. Individuals	nc	nc	nc	nc	40	17	35	3
		No. Deformed Larvae	nc	nc	nc	nc	0	0	0	0
		Percent Occurrence	nc	nc	nc	nc	0%	0%	0%	0%
	Summer	Total No. Individuals	nc	nc	nc	nc	1	11	78	9
		No. Deformed Larvae	nc	nc	nc	nc	0	0	1	0
		Percent Occurrence	nc	nc	nc	nc	0%	0%	1%	0%

nc = taxon was not collected.

Appendix A

TABLE A-1
Benthic Macroinvertebrate Species Abundance, Lake Ella, Tallahassee, Florida
December 21, 1998

Taxa	ELLW1	ELLW2	ELLW3	ELLW4	ELLW5	ELLW6	ELLW7	ELLW8	Totals / Means
Limnodrilus hoffmeisteri				1		2	1		4
Cladopelma sp.				1		1			2
Einfeldia natchitocheae				2		7		20	29
Procladius bellus var. 2	1			1		6	4	8	20
Chaoborus punctipennis	14	16		17	2	26	7	146	228
No. of Organisms / m^2	647	690	0	948	86	1,810	517	7,500	1,525
Total Raw Count	15	16	0	22	2	42	12	174	283
Total No. of Taxa	2	1	0	5	1	5	3	3	5
Shannon-Weaver Species Diversity	0.35	0	0	1.21	0	1.6	1.28	0.78	1.00

TABLE A-2
Benthic Macroinvertebrate Species Abundance, Lake AJ Henry, Tallahassee, Florida
December 21, 1998

Taxa	HENW1	HENW2	HENW3	HENW4	HENW5	HENW6	HENW7	HENW8	Totals / Means
Aulodrilus pigueti		6							6
Limnodrilus hoffmeisteri				1					1
Helobdella sp. im.								1	1
Hyalella azteca		2							2
Enallagma sp. dam.								1	1
Chironomini (immature)								2	2
Chironomus sp. im.	4	4		2	2		5		17
Clinotanypus sp.		2							2
Coelotanypus concinnus				2		5	10	7	24
Coelotanypus sp. im.		8	1	4					13
Einfeldia natchitocheae		4	16	12		3	2	17	54
Procladius bellus var. 2	6	36	23	26	2	10	5	20	128
Procladius sp. im.		10	3						13
Ceratopogonidae		2	1	1	2	8			14
Chaoborus punctipennis	323	28	12	9	148	50	56	28	654
No. of Organisms / m^2	14,353	4,397	2,414	2,457	6,638	3,276	3,362	3,276	5,022
Total Raw Count	333	102	56	57	154	76	78	76	932
Total No. of Taxa	3	10	6	8	4	5	5	7	15
Shannon-Weaver Species Diversity	0.22	2.60	1.95	2.22	0.30	1.57	1.37	2.14	1.66

TABLE A-3
Benthic Macroinvertebrate Species Abundance, Lake Dot, Orlando, Florida
December 15, 1998

Taxa	DOTW1	DOTW2	DOTW3	DOTW4	DOTW5	DOTW6	DOTW7	DOTW8	Totals / Means
Limnodrilus hoffmeisteri	1		2						3
Chironomini (damaged)					1				1
Chironominae (pupae)	1								1
Chironomus sp. im.	1								1
Chironomus stigmaterus	15	22	27	8		7	3		82
Cladopelma sp.	4	12	3	5	1	2			27
Coelotanypus sp. im.	1					1			2
Cryptochironomus fulvus gr.		2			1				3
Glyptotendipes sp. im.		2							2
Polypedilum halterale gr.		12	2	2	1				17
Procladius bellus var. 2	5				1	1	1		8
Tanypus neopunctipennis		2							2
Tanytarsus sp. G	1		1	1					3
Chaoborus punctipennis	1								1
No. of Organisms / m^2	1,293	2,241	1,509	690	216	474	172	0	824
Total Raw Count	30	52	35	16	5	11	4	0	153
Total No. of Taxa	9	6	5	4	5	4	2	0	13
Shannon-Weaver Species Diversity	2.30	2.04	1.21	1.65	2.32	1.49	0.81	0.00	2.27
Deformed Chironomus	1	4	7	2	NC	0	0	NC	14
Deformed Cladopelma	0	0	1	0	0	0	NC	NC	1
% Chironomus	6%	18%	26%	25%	NC	0%	0%	NC	17%
% Cladopelma	0%	0%	33%	0%	0%	0%	NC	NC	4%

NC-None Collected

TABLE A-4
Benthic Macroinvertebrate Species Abundance, Lake Lurna, Orlando, Florida
December 16, 1998

Taxa	LURW1	LURW2	LURW3	LURW4	LURW5	LURW6	LURW7	LURW8	Totals / Means
Limnodrilus hoffmeisteri			1	1					2
Hyalella azteca							3	3	6
Caenis diminuta							2	1	3
Perithemis tenera seminole	1								1
Ablabesmyia rhamphe gr.		1					1		2
Chironomus sp. im.			3						3
Chironomus stigmaterus			12				4	5	21
Cladopelma sp.			1	1					2
Cladotanytarsus sp.								1	1
Coelotanypus sp. im.		1				1			2
Cryptochironomus fulvus gr.	2	4	1			4	3	3	17
Dicrotendipes simpsoni							1		1
Dicrotendipes sp. im.			1					1	2
Labrundinia sp. A	1				2				3
Parachironomus carinatus							1		1
Polypedilum halterale gr.		1			6	7	5	4	23
Procladius bellus var. 2			2		1	1	4	3	11
Procladius sp. im.					1				1
Tanypus carinatus			1						1
Tanytarsus sp. K							6	7	13
Tanytarsus sp. G			1		3				4
Ceratopogonidae			1						1
Oecetis osteni							1	1	2
Elimia sp.							1		1
Viviparus georgianus						1	1		2
Corbicula fluminea						5	23		28
No. of Organisms / m^2	172	302	1,034	86	560	819	2,414	1,250	830
Total Raw Count	4	7	24	2	13	19	56	29	154
Total No. of Taxa	3	4	10	2	5	6	14	10	26
Shannon-Weaver Species Diversity	1.50	1.66	2.51	1.00	1.99	2.18	2.97	3.01	3.68

TABLE A-5
Benthic Macroinvertebrate Species Abundance, Lake Osceola, Winter Park, Florida
December 17, 1998

Taxa	OSCW1	OSCW2	OSCW3	OSCW4	OSCW5	OSCW6	OSCW7	OSCW8	OSCW9	OSCW10	OSCW11	OSCW12	OSCW13	OSCW14	OSCW15	OSCW16	OSCW17	OSCW18	Totals / Means
Aulodrilus pigueti												1							1
Dero pectinata												1							1
Haber speciosus			1																1
Limnodrilus hoffmeisteri	1		3			2		2	1	1	1	1	1			1	4		18
Hyalella azteca					2	3	1			13		3	1	9					32
Caenis diminuta			1	2	1	1		2	2		1						1		11
Aphylla williamsoni											1								1
Erythrodiplax miniscula										1									1
Chironomini (immature)				4															4
Chironomus sp. im.				1															1
Chironomus stigmaterus																1			1
Cladopelma sp.		1				1													2
Cladotanytarsus sp.		1						2	5		1					2	1	1	13
Coelotanypus sp. im.												1							1
Cryptochironomus blarina				1				1	1		2								5
Cryptochironomus fulvus gr.		1	2	7													1		11
Einfeldia natchitocheae																1			1
Endochironomus nigricans				1															1
Glyptotendipes paripes	3		7	30															40
Glyptotendipes sp. im.				15		1													16
Goeldichironomus amazonicus			1	8															9
Nilothauma sp.	2								1									1	4
Polypedilum halterale gr.				8		1					1	1	1				2		14
Procladius bellus var. 2						1	1												2
Procladius sp. im.		2							1										3
Tanypus carinatus																1			1
Tanytarsus sp. dam.	1																		1
Tanytarsus sp. G											1					1			2
Ceratopogonidae																	1		1
Chaoborus puntipennis							18	1		2									21
Viviparus georgiana					1			1	1		2		1					1	7
Corbicula fluminea											1								1
No. of Organisms / m^2	302	216	647	3,319	172	431	862	388	517	733	474	345	172	388	0	302	431	129	546
Total Raw Count	7	5	15	77	4	10	20	9	12	17	11	8	4	9	0	7	10	3	228
Total No. of Taxa	4	4	6	10	3	7	3	6	7	4	9	6	4	1	0	6	6	3	33
Shannon-Weaver Species Diversity	1.84	1.92	2.15	2.59	1.50	2.65	0.57	2.50	2.45	1.14	3.10	2.41	2.00	0.00	0.00	2.52	2.32	1.58	4.02

TABLE A-6
Benthic Macroinvertebrate Species Abundance, Lake Ivanhoe, Orlando, Florida
December 18, 1998

Taxa	IVANW1	IVANW2	IVANW3	IVANW4	IVANW5	IVANW6	IVANW7	IVANW8	IVANW9	VANW10	VANW11	IVAN12	Totals / Means
Dugesia sp.					1								1
Haber speciosus		1				1		4	1	2		3	12
Limnodrilus hoffmeisteri	1	3			1	1	1	1	2	1		3	14
Helobdella sp. im.				1	1	1							3
Helobdella stagnalis			2										2
Hyalella azteca				3	4		1	1	1		11		21
Caenis diminuta				3									3
Asheum beckae					1								1
Chironomus crassicaudatus							1						1
Chironomus sp. im.	1												1
Chironomus stigmaterus	2									1	4		7
Cladopelma sp.												1	1
Cladotanytarsus sp.						1		1			1		3
Clinotanypus sp.		1	1										2
Coelotanypus concinnus										2			2
Coelotanypus scapularis						2							2
Coelotanypus sp. im.							2	2					4
Cryptochironomus blarina	5							1		1		3	10
Cryptochironomus fulvus gr.						1							1
Dicrotendipes simpsoni					1								1
Dicrotendipes sp. im.					1								1
Glyptotendipes paripes	7	1	2	4	1							2	17
Glyptotendipes sp. im.				4									4
Goeldichironomus carus				7									7
Parachironomus carinatus					1								1
Polypedilum halterale gr.								1	1	2	2	2	8
Procladius bellus var. 2					1							2	3
Procladius sp. im.	1												1
Tanytarsus sp. G									1	2		1	4
Viviparus georgianus		2				1		1				1	5
Corbicula fluminea									1			1	2
Elliptio buckleyi		3				1						2	6
No. of Organisms / m^2	733	474	216	948	560	388	216	517	302	474	776	905	542
Total Raw Count	17	11	5	22	13	9	5	12	7	11	18	21	151
Total No. of Taxa	6	6	3	6	10	8	4	8	6	7	4	11	32
Shannon-Weaver Species Diversity	2.13	2.41	1.52	2.41	3.09	2.95	1.92	2.75	2.52	2.73	1.50	3.33	4.17

TABLE A-7
Benthic Macroinvertebrate Species Abundance, Lake Lucerne, Orlando, Florida
December 15, 1998

Taxa	LUCW1	LUCW2	LUCW3	LUCW4	LUCW5	LUCW6	LUCW7	LUCW8	Totals / Means
Dero digitata							1		1
Dero nivea						1			1
Limnodrilus hoffmeisteri	5		4	1	1	6	1		18
Caenis diminuta								69	69
Ablabesmyia peleensis							1		1
Chironomini (immature)							1	1	2
Chironomus stigmaterus	3	9	16	25	16	48	75		192
Cladopelma sp.			1			1			2
Cryptochironomus blarina	5								5
Cryptochironomus fulvus gr.				1		8	13		22
Cryptochironomus sp. im.	1								1
Glyptotendipes paripes							32	3	35
Glyptotendipes sp. im.							1		1
Procladius bellus var. 2						1			1
Procladius sp. im.	1								1
Tanytarsus sp. G						1	2		3
Oecetis nocturna							1	1	2
Orthotrichia sp.								1	1
No. of Organisms / m^2	647	388	905	1,164	733	2,845	5,517	3,233	1,929
Total Raw Count	15	9	21	27	17	66	128	75	358
Total No. of Taxa	5	1	3	3	2	7	10	5	18
Shannon-Weaver Species Diversity	2.04	0.00	0.96	0.46	0.32	1.38	1.71	0.55	2.19
Deformed Chironomus	1	3	7	7	7	36	19	NC	80
Percent Occurrence	100%	33%	44%	28%	44%	75%	25%	NC	42%

NC - *None collected*

TABLE A-8
Benthic Macroinvertebrate Species Abundance, Lake Olive, Orlando, Florida
December 16, 1998

Taxa	OLIW1	OLIW2	OLIW3	OLIW4	OLIW5	OLIW6	OLIW7	OLIW8	Totals / Means
Aulodrilus pigueti							1		1
Limnodrilus hoffmeisteri		2	8			2	3	5	20
Brachymesia gravida				2					2
Libellulidae imm.			1						1
Chironomus sp. im.		2							2
Cladopelma sp.	2					1	1		4
Clinotanypus sp.		1							1
Cryptochironomus fulvus gr.					1	2			3
Djalmabatista pulchra							1		1
Glyptotendipes paripes			3						3
Procladius sp. im.		1							1
Ceratopogonidae		1	1						2
Hydrachna sp.					1				1
Corbicula fluminea	12		5	6					23
No. of Organisms / m^2	603	302	776	345	86	216	259	216	350
Total Raw Count	14	7	18	8	2	5	6	5	65
Total No. of Taxa	2	5	5	2	2	3	4	1	14
Shannon-Weaver Species Diversity	0.59	2.24	1.93	0.81	1.00	1.52	1.79	0.00	2.77

TABLE A-9
Benthic Macroinvertebrate Species Abundance, Lake Ella, Tallahassee, Florida
June 7, 1999

Taxa	ELLW1	ELLW2	ELLW3	ELLW4	ELLW5	ELLW6	ELLW7	ELLW8	Totals / Means
Limnodrilus hoffmeisteri	11	6	6	3	10	6	5		47
Cladopelma sp.									0
Einfeldia natchitocheae									0
Procladius bellus var. 2									0
Chaoborus punctipennis	55	84	1	2	53	61	89	185	530
No. of Organisms / m^2	2,845	3,879	302	216	2,716	2,888	4,052	7,974	3,109
Total Raw Count	66	90	7	5	63	67	94	185	577
Total No. of Taxa	2	2	2	2	2	2	2	1	2
Shannon-Weaver Species Diversity	0.65	0.35	0.59	0.97	0.63	0.43	0.30	0.00	0.41

TABLE A-10
Benthic Macroinvertebrate Species Abundance, Lake AJ Henry, Tallahassee, Florida
June 7, 1999

Taxa	HENW1	HENW2	HENW3	HENW4	HENW5	HENW6	HENW7	HENW8	Totals / Means
Aulodrilus pigueti									0
Limnodrilus hoffmeisteri	13		14	2	1	39	1	19	89
Helobdella sp. im.									0
Hyalella azteca									0
Enallagma sp. dam.									0
Einfeldia natchitocheae			1						1
Chironomini (immature)									0
Chironomus sp. im.	4	6	26	3	1	5	10	21	76
Clinotanypus sp.									0
Coelotanypus concinnus	1		1				3		5
Coelotanypus sp. im.									0
Einfeldia natchitocheae									0
Procladius bellus var. 2								1	1
Procladius sp. im.									0
Procladius (Holotanypus) sp.			1						1
Ceratopogonidae									0
Chaoborus punctipennis	105	15	20	21	34	16	65	9	285
Chaoborus albatus	10	13	4	6	10	7	39	4	93
Chaoborus (pupae)	3		1	1				1	6
No. of Organisms / m^2	5,862	1,466	2,931	1,422	1,983	2,888	5,086	2,371	3,001
Total Raw Count	136	34	68	33	46	67	118	55	557
Total No. of Taxa	6	3	8	5	4	4	5	6	9
Shannon-Weaver Species Diversity	1.21	1.49	2.12	1.57	1.04	1.57	1.50	1.97	1.92

TABLE A-11
Benthic Macroinvertebrate Species Abundance, Lake Dot, Orlando, Florida
June 2, 1999

Taxa	DOTW1	DOTW2	DOTW3	DOTW4	DOTW5	DOTW6	DOTW7	DOTW8	Totals / Means
Limnodrilus hoffmeisteri		4	1		2			1	8
Nematoda sp. A		1			2			1	4
Chironomini (damaged)									0
Chironomin (pupae)									0
Chironomus sp. im.	1								1
Chironomus stigmaterus									0
Cladopelma sp.									0
Coelotanypus sp. im.									0
Cryptochironomus fulvus gr.									0
Glyptotendipes sp. im.									0
Polypedilum halterale gr.									0
Procladius bellus var. 2									0
Tanypus neopunctipennis									0
Tanytarsus sp. G									0
Chaoborus punctipennis		1		1					2
No. of Organisms / m^2	43	259	43	43	172	0	0	86	81
Total Raw Count	1	6	1	1	4	0	0	2	15
Total No. of Taxa	1	3	1	1	2	0	0	2	4
Shannon-Weaver Species Diversity	0.00	1.25	0.00	0.00	1.00	0.00	0.00	1.00	1.86

TABLE A-12
Benthic Macroinvertebrate Species Abundance, Lake Lurna, Orlando, Florida
June 3, 1999

Taxa	LURW1	LURW2	LURW3	LURW4	LURW5	LURW6	LURW7	LURW8	Totals / Means
Aulodrilus pigueti							2		2
Limnodrilus hoffmeisteri	1						1		2
Hyalella azteca									0
Caenis diminuta									0
Perithemis tenera seminole									0
Ablabesmyia rhamphe gr.									0
Chironomus sp. im.							2		2
Chironomus stigmaterus									0
Cladopelma sp.	1						3		4
Cladotanytarsus sp.									0
Coelotanypus sp. im.									0
Cryptochironomus fulvus gr.									0
Dicrotendipes simpsoni									0
Dicrotendipes sp. im.									0
Labrundinia sp. A									0
Parachironomus carinatus									0
Polypedilum halterale gr.							2		2
Procladius bellus var. 2							5		5
Procladius sp. im.	2								2
Tanypus carinatus									0
Tanytarsus sp. G									0
Tanytarsus sp. K									0
Ceratopogonidae									0
Chaoborus punctipennis			2		2				4
Oecetis osteni									0
Elimia sp.									0
Viviparus georgianus							2		2
Corbicula fluminea						1	3		4
No. of Organisms / m^2	172	0	86	0	86	43	862	0	156
Total Raw Count	4	0	2	0	2	1	20	0	29
Total No. of Taxa	3	0	1	0	1	1	8	0	10
Shannon-Weaver Species Diversity	1.50	0.00	0.00	0.00	0.00	0.00	2.87	0.00	3.22

TABLE A-13
Benthic Macroinvertebrate Species Abundance, Lake Osceola, Winter Park, Florida
June 2, 1999

Taxa	OSCW1	OSCW2	OSCW3	OSCW4	OSCW5	OSCW6	OSCW7	OSCW8	OSCW9	OSCW10	OSCW11	OSCW12	OSCW13	OSCW14	OSCW15	OSCW16	OSCW17	OSCW18	Totals / Means
Aulodrilus pigueti																			0
Dero nivea													1						1
Dero pectinata																			0
Haber speciosus																			0
Limnodrilus hoffmeisteri			1		1						1	1	2		1		13		20
Hyalella azteca																			0
Caenis diminuta																			0
Aphylla williamsoni																			0
Erythrodiplax miniscula																			0
Chironomus crassicaudatus											9		15	26	14				64
Chironomini (immature)																			0
Chironomus sp. im.											4								4
Chironomus stigmaterus																			0
Cladopelma sp.														1					1
Cladotanytarsus sp.																			0
Coelotanypus sp. im.																			0
Cryptochironomus blarina													3						3
Cryptochironomus fulvus gr.																			0
Einfeldia natchitocheae																			0
Endochironomus nigricans																			0
Glyptotendipes paripes																1			1
Glyptotendipes sp. im.																			0
Goeldichironomus amazonicus																			0
Nilothauma sp.																			0
Polypedilum halterale gr.													3						3
Procladius bellus var. 2											1								1
Procladius sp. im.											1								1
Tanypus carinatus																			0
Tanytarsus sp. dam.																			0
Tanytarsus sp. G																			0
Ceratopogonidae																			0
Chaoborus punctipennis	3	1	6	2	3		10	2	2		4	1		1		5			40
Chaoborus (pupae)				1															1
Gastropoda (damaged)															1				1
Viviparus georgiana																			0
Corbicula fluminea																			0
No. of Organisms / m^2	129	43	302	129	172	0	431	86	86	0	862	86	1,034	1,207	690	259	560	0	338
Total Raw Count	3	1	7	3	4	0	10	2	2	0	20	2	24	28	16	6	13	0	141
Total No. of Taxa	1	1	2	2	2	0	1	1	1	0	6	2	5	3	3	2	1	0	13
Shannon-Weaver Species Diversity	0.00	0.00	0.59	0.92	0.81	0.00	0.00	0.00	0.00	0.00	2.10	1.00	1.66	0.44	0.67	0.65	0.00	0.00	2.18
Deformed Chironomus crassicaudatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Percent Occurrence	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	7%	0%	0%	0%	2%

TABLE A-14
Benthic Macroinvertebrate Species Abundance, Lake Ivanhoe, Orlando, Florida
June 3, 1999

Taxa	IVANW1	IVANW2	IVANW3	IVANW4	IVANW5	IVANW6	IVANW7	IVANW8	IVANW9	IVANW10	IVANW11	IVAN12	Totals / Means
Dugesia sp.													0
Haber speciosus								1				2	3
Limnodrilus hoffmeisteri		1		2	4	1		2	1				11
Helobdella elongata		1											1
Helobdella sp. im.													0
Helobdella stagnalis			1										1
Hyalella azteca					3								3
Caenis diminuta													0
Asheum beckae													0
Chironomus crassicaudatus			1					28	25	19	8	20	101
Chironomus sp. im.		1						1	12	5	2		21
Chironomus stigmaterus													0
Cladopelma sp.													0
Cladotanytarsus sp.		1											1
Clinotanypus sp.													0
Coelotanypus concinnus		1	2										3
Coelotanypus scapularis													0
Coelotanypus sp. im.													0
Cryptochironomus blarina							1				1	2	4
Cryptochironomus fulvus gr.			2										2
Dicrotendipes simpsoni													0
Dicrotendipes modestus					1								1
Dicrotendipes sp. im.		1											1
Glyptotendipes paripes		1	6			2		1			1		11
Glyptotendipes sp. im.													0
Goeldichironomus carus													0
Parachironomus carinatus													0
Polypedilum halterale gr.		6	16	2			1				3	1	29
Procladius bellus var. 2			2						1				3
Procladius (Holotanypus) sp.			1								2		3
Procladius sp. im.		3		1	1		2						7
Tanytarsus sp. G						1		1					2
Pseudochironomus sp.			1										1
Ceratopogonidae			1						1		2	1	5
Chaoborus punctipennis	2			2					3				7
Viviparus georgianus		1											1
Corbicula fluminea		2											2
Elliptio buckleyi													0
No. of Organisms / m^2	86	819	1,422	302	388	172	172	1,466	1,853	1,034	819	1,121	805
Total Raw Count	2	19	33	7	9	4	4	34	43	24	19	26	224
Total No. of Taxa	1	11	10	4	4	3	3	6	6	2	7	5	24
Shannon-Weaver Species Diversity	0.00	3.08	2.45	1.95	1.75	1.50	1.50	1.07	1.62	0.74	2.42	1.22	3.00
Deformed Chironomus crassicaudatus	0	0	1	0	0	0	0	1	1	0	0	0	3
Percent Occurrence	0%	0%	100%	0%	0%	0%	0%	4%	4%	0%	0%	0%	3%

TABLE A-15
Benthic Macroinvertebrate Species Abundance, Lake Lucerne, Orlando, Florida
June 4, 1999

Taxa	LUCW1	LUCW2	LUCW3	LUCW4	LUCW5	LUCW6	LUCW7	LUCW8	Totals / Means
Dero digitata									0
Dero nivea	1								1
Limnodrilus hoffmeisteri	4	3	3	2	6	96	130	51	295
Pristina synclites								2	2
Nematoda sp. C				1					1
Hyalella azteca								71	71
Caenis diminuta								1	1
Ablabesmyia peleensis									0
Ablabesmyia rhamphe gr.							1		1
Chironomini (immature)									0
Chironomus sp. im.		1	4	10	10		2		27
Chironomus stigmaterus									0
Cladopelma sp.									0
Cryptochironomus blarina									0
Cryptochironomus fulvus gr.							1		1
Cryptochironomus sp. im.									0
Glyptotendipes paripes		1				34	42	1	78
Glyptotendipes sp. F								5	5
Glyptotendipes sp. im.									0
Procladius (Holotanypus) sp.							4		4
Procladius bellus var. 2							1		1
Procladius sp. im.			1			7			8
Tanytarsus sp. G									0
Chaobrus punctipennis	1	2	6	6	13	21	26		75
Oecetis nocturna									0
Orthotrichia sp.									0
Elliptio buckleyi						1			1
No. of Organisms / m^2	259	302	603	819	1,250	6,853	8,922	5,647	3,082
Total Raw Count	6	7	14	19	29	159	207	131	572
Total No. of Taxa	3	4	4	4	3	5	8	6	16
Shannon-Weaver Species Diversity	1.25	1.84	1.79	1.58	1.52	1.55	1.55	1.39	2.19
Deformed Chironomus	0	1	2	3	4	NC	2	NC	12
Percent Occurrence	0%	100%	50%	30%	40%	NC	100%	NC	44%
Glyptotendipes paripes	NC	0	NC	NC	NC	0	1	0	1
Percent Occurrence	NC	0%	NC	NC	NC	0%	2%	0%	1%

NC - None collected

TABLE A-16
Benthic Macroinvertebrate Species Abundance, Lake Olive, Orlando, Florida
June 3, 1999

Taxa	OLIW1	OLIW2	OLIW3	OLIW4	OLIW5	OLIW6	OLIW7	OLIW8	Totals / Means
Aulodrilus pigueti		1							1
Dero botrytis					1				1
Limnodrilus hoffmeisteri					1				1
Helobdella stagnalis		6	1	5	1	1			14
Hyalella azteca				1					1
Brachymesia gravida									0
Libellulidae imm.									0
Chironomin (pupae)					2	1			3
Chironomus crassicaudatus	23				3	2	3	2	33
Chironomus sp. im.	2	2	7		7		3	3	24
Cladopelma sp.	2				1				3
Clinotanypus sp.							1		1
Cryptochironomus fulvus gr.	2	1	1		1			1	6
Djalmabatista pulchra									0
Glyptotendipes paripes	6	2			1				9
Goeldichironomus carus	1								1
Parachironomus carinatus				1					1
Polypedilum halterale gr.	4	1			3				8
Procladius (Holotanypus) sp.	1	2			3			1	7
Procladius bellus var. 2	1	1			2	1			5
Procladius sp. im.		2	3						5
Tanytarsus sp. G			1						1
Ceratopogonidae									0
Chaoborus punctipennis	12	5	4						21
Hydrachna sp.									0
Corbicula fluminea									0
No. of Organisms / m^2	2,328	991	733	302	1,121	216	302	302	787
Total Raw Count	54	23	17	7	26	5	7	7	146
Total No. of Taxa	10	10	6	3	12	4	3	4	20
Shannon-Weaver Species Diversity	2.49	3.00	2.18	1.15	3.24	1.92	1.45	1.84	3.47
Deformed Chironomus crassicaudatus	3	0	0	0	0	0	0	1	4
Percent Occurrence	13%	0%	0%	0%	0%	0%	0%	50%	12%

Appendix B

TABLE B-1
Abundance of the Sub-Benthic Collector-Gatherer Feeding Guild in Select Alum-Treated and Non-Treated Reference Lakes, Orlando and Tallahassee, Florida

	Winter Ella	Summer Ella	Winter AJ Henry	Summer AJ Henry	Winter Dot	Summer Dot	Winter Lurna	Summer Lurna	Winter Osceola	Summer Osceola	Winter Ivanhoe	Summer Ivanhoe	Winter Lucerne	Summer Lucerne	Winter Olive	Summer Olive
Mean	0.50	5.88	0.88	11.13	0.38	1.00	0.25	0.50	1.17	1.39	1.00	1.17	2.50	37.38	2.63	0.38
Site																
1	0.00	11.00	0.00	13.00	1.00	0.00	0.00	1.00	1.00	0.00	0.00	0.00	5.00	5.00	0.00	0.00
2	0.00	6.00	6.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	3.00	2.00	1.00
3	0.00	6.00	0.00	14.00	2.00	1.00	1.00	0.00	4.00	1.00	0.00	0.00	4.00	3.00	8.00	0.00
4	1.00	3.00	1.00	2.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	2.00	1.00	3.00	0.00	0.00
5	0.00	10.00	0.00	1.00	0.00	2.00	0.00	0.00	0.00	1.00	0.00	4.00	1.00	6.00	0.00	2.00
6	2.00	6.00	0.00	39.00	0.00	0.00	0.00	0.00	2.00	0.00	1.00	1.00	7.00	96.00	2.00	0.00
7	1.00	5.00	0.00	1.00	0.00	0.00	0.00	3.00	0.00	0.00	0.00	0.00	2.00	130.00	4.00	0.00
8	0.00	0.00	0.00	19.00	0.00	1.00	0.00	0.00	2.00	0.00	4.00	3.00	0.00	53.00	5.00	0.00
9									1.00	0.00	1.00	1.00				
10									1.00	0.00	2.00	0.00				
11									1.00	1.00	0.00	0.00				
12									3.00	1.00	3.00	2.00				
13									1.00	3.00						
14									0.00	0.00						
15									0.00	1.00						
16									1.00	0.00						
17									4.00	13.00						
18									0.00	4.00						

TABLE B-2

Abundance of the Epi-Benthic Collector-Gatherer Feeding Guild in Select Alum-Treated and Non-Treated Reference Lakes, Orlando and Tallahassee, Florida

	Winter Ella	Summer Ella	Winter AJ Henry	Summer AJ Henry	Winter Dot	Summer Dot	Winter Lurna	Summer Lurna	Winter Osceola	Summer Osceola	Winter Ivanhoe	Summer Ivanhoe	Winter Lucerne	Summer Lucerne	Winter Olive	Summer Olive
Mean	3.88	0.00	8.81	4.88	10.19	0.06	5.38	0.75	4.83	2.06	4.92	7.38	19.31	11.44	0.94	5.31
Site																
1	0.00	0.00	2.00	2.00	12.50	0.50	0.00	1.00	4.00	0.00	6.00	0.00	1.50	0.00	2.00	20.50
2	0.00	0.00	8.00	3.00	31.00	0.00	1.00	0.00	1.50	0.00	3.50	5.00	4.50	1.00	1.50	2.50
3	0.00	0.00	16.50	14.00	18.00	0.00	10.50	0.00	5.00	0.00	1.00	13.00	9.00	2.00	2.00	4.00
4	3.00	0.00	13.50	1.50	10.50	0.00	1.00	0.00	40.50	0.00	14.00	1.00	12.50	5.00	0.00	1.00
5	0.00	0.00	2.00	0.50	2.50	0.00	4.50	0.00	1.50	0.00	6.00	2.00	8.00	5.00	0.00	8.00
6	8.00	0.00	7.00	2.50	5.50	0.00	3.50	0.00	4.00	0.00	1.50	1.50	25.50	17.00	1.00	1.00
7	0.00	0.00	4.50	5.00	1.50	0.00	11.50	5.00	0.50	0.00	2.00	0.50	56.50	22.50	1.00	3.00
8	20.00	0.00	17.00	10.50	0.00	0.00	11.00	0.00	2.00	0.00	2.50	15.50	37.00	39.00	0.00	2.50
9									4.50	0.00	3.50	19.00				
10									6.50	0.00	3.50	12.00				
11									2.00	6.50	9.00	8.00				
12									2.00	0.00	6.50	11.00				
13									1.00	9.00						
14									4.50	14.00						
15									0.00	7.00						
16									3.50	0.50						
17									2.50	0.00						
18									1.50	0.00						

TABLE B-3

Abundance of the Filterer Feeding Guild in Select Alum-Treated and Non-Treated Reference Lakes, Orlando and Tallahassee, Florida

	Winter Ella	Summer Ella	Winter AJ Henry	Summer AJ Henry	Winter Dot	Summer Dot	Winter Luma	Summer Luma	Winter Osceola	Summer Osceola	Winter Ivanhoe	Summer Ivanhoe	Winter Lucerne	Summer Lucerne	Winter Olive	Summer Olive
Mean	0.00	0.00	0.00	0.00	0.19	0.00	4.81	0.50	0.50	0.00	1.04	0.38	0.19	0.13	2.88	0.06
Site																
1	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	12.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	3.00	3.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.50	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.50
4	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	1.50	0.00	0.00	0.00	1.00	0.50	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	5.00	1.00	0.00	0.00	1.50	0.50	0.50	1.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	26.50	3.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	4.50	0.00	1.00	0.00	0.50	0.50	0.00	0.00	0.00	0.00
9									2.50	0.00	1.50	0.00				
10									0.00	0.00	1.00	0.00				
11									2.00	0.00	0.50	0.00				
12									0.00	0.00	3.50	0.00				
13									0.00	0.00						
14									0.00	0.00						
15									0.00	0.00						
16									1.50	0.00						
17									0.50	0.00						
18									0.50	0.00						

TABLE B-4

Abundance of the Plant-Piercer Feeding Guild in Select Alum-Treated and Non-Treated Reference Lakes, Orlando and Tallahassee, Florida

	Winter Ella	Summer Ella	Winter AJ Henry	Summer AJ Henry	Winter Dot	Summer Dot	Winter Lurna	Summer Lurna	Winter Osceola	Summer Osceola	Winter Ivanhoe	Summer Ivanhoe	Winter Lucerne	Summer Lucerne	Winter Olive	Summer Olive
Mean	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00
Site																
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
9									0.00	0.00	0.00	0.00				
10									0.00	0.00	0.00	0.00				
11									0.00	0.00	0.00	0.00				
12									0.00	0.00	0.00	0.00				
13									0.00	0.00						
14									0.00	0.00						
15									0.00	0.00						
16									0.00	0.00						
17									0.00	0.00						
18									0.00	0.00						

TABLE B-5

Abundance of the Shredder Feeding Guild in Select Alum-Treated and Non-Treated Reference Lakes, Orlando and Tallahassee, Florida

	Winter Ella	Summer Ella	Winter AJ Henry	Summer AJ Henry	Winter Dot	Summer Dot	Winter Lurna	Summer Lurna	Winter Osceola	Summer Osceola	Winter Ivanhoe	Summer Ivanhoe	Winter Lucerne	Summer Lucerne	Winter Olive	Summer Olive
Mean	0.00	0.00	1.19	4.75	6.38	0.06	3.44	0.25	2.92	2.00	2.46	6.88	14.38	11.31	0.31	4.69
Site																
1	0.00	0.00	2.00	2.00	8.00	0.50	0.00	0.00	1.50	0.00	5.00	0.00	1.50	0.00	0.00	17.50
2	0.00	0.00	3.00	3.00	18.00	0.00	0.50	0.00	0.00	0.00	0.50	4.00	4.50	1.00	1.00	2.50
3	0.00	0.00	0.00	13.00	14.50	0.00	7.50	0.00	3.50	0.00	1.00	11.50	8.00	2.00	1.50	3.50
4	0.00	0.00	1.00	1.50	5.00	0.00	0.00	0.00	27.50	0.00	5.50	1.00	12.50	5.00	0.00	0.50
5	0.00	0.00	1.00	0.50	0.50	0.00	3.00	0.00	1.00	0.00	2.50	1.50	8.00	5.00	0.00	7.00
6	0.00	0.00	0.00	2.50	3.50	0.00	3.50	0.00	2.50	0.00	0.00	1.00	24.00	17.00	0.00	1.00
7	0.00	0.00	2.50	5.00	1.50	0.00	6.50	2.00	0.50	0.00	1.00	0.50	54.50	22.00	0.00	3.00
8	0.00	0.00	0.00	10.50	0.00	0.00	6.50	0.00	0.00	0.00	1.00	15.00	2.00	38.50	0.00	2.50
9									0.00	0.00	1.00	18.50				
10									6.50	0.00	1.50	12.00				
11									0.50	6.50	8.50	7.00				
12									2.00	0.00	2.00	10.50				
13									1.00	9.00						
14									4.50	13.00						
15									0.00	7.00						
16									0.50	0.50						
17									1.00	0.00						
18									0.00	0.00						

TABLE B-6
Abundance of the Scraper Feeding Guild in Select Alum-Treated and Non-Treated Reference Lakes, Orlando and Tallahassee, Florida

	Winter Ella	Summer Ella	Winter AJ Henry	Summer AJ Henry	Winter Dot	Summer Dot	Winter Lurna	Summer Lurna	Winter Osceola	Summer Osceola	Winter Ivanhoe	Summer Ivanhoe	Winter Lucerne	Summer Lucerne	Winter Olive	Summer Olive
Mean	0.00	0.00	0.00	0.00	0.00	0.00	0.56	0.25	0.69	0.06	0.42	0.08	0.00	0.06	0.00	0.00
Site																
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	1.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.50	0.00	1.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	3.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	2.00	0.00	1.00	0.00	0.00	0.50	0.00	0.00
9									2.00	0.00	0.00	0.00				
10									0.00	0.00	0.00	0.00				
11									2.50	0.00	0.00	0.00				
12									0.00	0.00	1.00	0.00				
13									1.00	0.00						
14									0.00	0.00						
15									0.00	1.00						
16									0.00	0.00						
17									0.50	0.00						
18									1.00	0.00						

TABLE B-7

Abundance of the Predator Feeding Guild in Select Alum-Treated and Non-Treated Reference Lakes, Orlando and Tallahassee, Florida

	Winter Ella	Summer Ella	Winter AJ Henry	Summer AJ Henry	Winter Dot	Summer Dot	Winter Lurna	Summer Lurna	Winter Osceola	Summer Osceola	Winter Ivanhoe	Summer Ivanhoe	Winter Lucerne	Summer Lucerne	Winter Olive	Summer Olive
Mean	31.00	66.25	105.38	48.13	1.88	0.25	4.81	1.38	2.56	2.50	2.63	2.79	8.25	11.19	1.38	7.44
Site																
1	15.00	55.00	329.00	116.00	7.00	0.00	4.00	2.00	0.00	3.00	6.00	2.00	7.00	1.00	0.00	16.00
2	16.00	84.00	85.00	28.00	3.00	1.00	5.50	0.00	3.00	1.00	1.00	5.00	0.00	2.00	2.50	17.00
3	0.00	1.00	39.50	26.00	0.00	0.00	4.00	2.00	2.00	6.00	3.00	8.50	0.00	7.00	1.50	9.00
4	18.00	2.00	41.50	27.00	0.00	1.00	0.00	0.00	8.00	2.00	1.00	3.00	1.00	6.00	2.00	5.50
5	2.00	53.00	151.00	44.00	2.00	0.00	4.00	2.00	0.00	3.00	3.50	1.00	0.00	13.00	2.00	7.00
6	32.00	61.00	69.00	23.00	2.00	0.00	6.00	0.00	1.00	0.00	4.00	0.00	9.00	28.00	2.00	2.00
7	11.00	89.00	71.00	107.00	1.00	0.00	8.50	5.00	19.00	10.00	2.00	3.00	14.00	32.50	1.00	1.00
8	154.00	185.00	57.00	14.00	0.00	0.00	6.50	0.00	2.00	2.00	3.00	0.00	35.00	0.00	0.00	2.00
9									2.00	2.00	0.00	4.50				
10									3.00	0.00	3.00	0.00				
11									3.00	6.00	0.00	4.00				
12									1.00	1.00	5.00	2.50				
13									0.00	3.00						
14									0.00	1.00						
15									0.00	0.00						
16									0.50	5.00						
17									1.50	0.00						
18									0.00	0.00						

Appendix C

TABLE C-1
Physical-Chemical Profiles (1-Foot Interval) at Deepest Locations in Select Alum-Treated and Non-Treated Reference Lakes, Orlando and Tallahassee, Florida
December 1998

	Orlando Treatment Lake LAKE DOT 12/15/1998 15:30 Secchi Depth = 7.1' Total Depth = 15.5'		Orlando Reference Lake LAKE LURNA 12/16/1998 10:41 Secchi Depth = 5.6' Total Depth =23.5'		Orlando Treatment Lake LAKE OSCEOLA 12/17/1998 9:44 Secchi Depth = 3.6' Total Depth = 22.5'		Orlando Reference Lake LAKE IVANHOE 12/18/1998 8:35 Secchi Depth = 4.0' Total Depth = 22.5'	
Profile Depth	**D.O.**	**Temperature***	**D.O.**	**Temperature**	**D.O.**	**Temperature**	**D.O.**	**Temperature**
Surface	8.8	21.5	7.8	20.5	7.7	20.5	7.7	19.5
2ft.	8.9	21.5	7.1	20.5	7.6	20.5	7.8	19.5
3ft.	8.8	21.5	6.7	20.5	7.6	20.5	7.7	19.5
4ft.	8.7	21.5	6.8	20.5	7.6	20.5	7.7	19.5
5ft.	8.6	21.5	6.7	20.5	7.6	20.5	7.7	19.5
6ft.	8.5	21.5	6.7	20.5	7.4	20.5	7.8	19.5
7ft.	8.6	21.5	6.7	20.5	7.4	20.5	7.8	19.5
8ft.	8.7	21.5	6.6	20.5	7.3	20.5	7.8	19.5
9ft.	8.8	21.5	6.0	20.5	7.3	20.5	7.8	19.5
10ft.	8.8	21.5	6.1	20.5	7.2	20.5	7.7	19.5
11ft.	8.2	21.5	5.7	20.5	7.4	20.5	7.7	19.5
12ft.	8.0	21.5	5.9	20.5	7.4	20.5	7.4	19.5
13ft.	7.6	21.5	5.9	20.5	7.3	20.5	7.7	19.5
14ft.	7.3	21.5	5.7	20.0	7.4	20.5	7.8	19.5
15ft.	7.2	21.5	5.6	20.0	7.3	20.5	7.8	19.5
16ft.			5.6	20.0	7.4	20.5	7.7	19.5
17ft.			5.5	20.0	7.4	20.5	7.6	19.5
18ft.			5.5	20.0	7.4	20.5	7.6	19.5
19ft.			5.4	20.0	7.4	20.5	7.6	19.5
20ft.			5.4	20.0	7.3	20.5	7.6	19.5
21ft.			5.6	20.0	7.3	20.5	7.6	19.5
22ft.			5.6	20.0	7.3	20.5	7.6	19.5
23ft.			5.5	20.0				

	Orlando Treatment Lake LAKE LUCERNE 12/15/1998 10:35 Secchi Depth = 2.4' Total Depth = 17.0'		Orlando Reference Lake LAKE OLIVE 12/16/1998 15:00 Secchi Depth = 2.6' Total Depth =23.5'		Tallahassee Treatment Lake LAKE ELLA 12/21/1998 9:36 Secchi Depth = 2.55' Total Depth = 12.5'		Tallahassee Reference Lake LAKE AJ HENRY 12/21/1998 15:27 Secchi Depth = 1.25' Total Depth = 6.5'	
Profile Depth	**D.O.**	**Temperature**	**D.O.**	**Temperature**	**D.O.**	**Temperature**	**D.O.**	**Temperature**
Surface	9	22.0	8.8	20.5	6.6	16.0	9.2	18.0
2ft.	9	22.0	9.1	21.0	6.6	16.0	8.8	17.0
3ft.	8.9	22.0	9.1	21.0	6.8	16.0	7.2	16.0
4ft.	8.8	22.0	8.6	21.0	6.6	16.0	3.8	15.0
5ft.	8.8	22.0	7.5	20.5	6.6	16.0	3.0	15.0
6ft.	8.8	22.0	6.8	20.5	6.2	15.5	0.2	15.0
7ft.	8.9	22.0	6.5	20.5	5.6	15.0		
8ft.	9	22.0	6.4	20.4	5.2	15.0		
9ft.	9	22.0	6.3	20.5	5.0	15.0		
10ft.	9.1	22.0	6.2	20.0	4.8	15.0		
11ft.	9.2	22.0	6.1	20.0	4.8	15.0		
12ft.	9.0	22.0	6.2	20.0	2.0	15.0		
13ft.	9.1	22.0	6.1	20.0				
14ft.	8.8	22.0	6.1	20.0				
15ft.	8.8	22.0	6.2	20.0				
16ft.	8.9	22.0	6.1	20.0				
17ft.	4.0	22.5	6.0	20.0				
18ft.			6.0	20.0				
19ft.			6.0	20.0				
20ft.			6.0	20.0				
21ft.			6.0	20.0				
22ft.			5.9	20.0				
23ft.			5.9	20.0				

D.O. = Dissolved Oxygen concentration in mg/L
* All temperatures are in degrees Celsius

TABLE C-2

Physical-Chemical Profiles (1-Foot Interval) at Deepest Locations in Select Alum-Treated and Non-Treated Reference Lakes, Orlando and Tallahassee, Florida

June 1999

	Orlando Treatment Lake		Orlando Reference Lake		Orlando Treatment Lake		Orlando Reference Lake		Orlando Treatment Lake		Orlando Reference Lake		Tallahassee Treatment Lake		Tallahassee Reference Lake	
	LAKE DOT 6/2/1999 11:46 Secchi Depth = 7.1' Total Depth = 15.5'		LAKE LURNA 6/3/1999 10:45 Secchi Depth = 8.83' Total Depth = 23.5'		LAKE OSCEOLA 6/2/1999 16:15 Secchi Depth = 3.05' Total Depth = 2 21'		LAKE IVANHOE 6/3/1999 14:17 Secchi Depth = 3.21' Total Depth = 2 21'		LAKE LUCERNE 6/4/1999 14:05 Secchi Depth= 1.98' Total Depth = 17.0'		LAKE OLIVE 6/3/1999 10:05 Secchi Depth = 22.31' Total Depth =23.5'		LAKE ELLA 6/7/1999 9:10 Secchi Depth =2.63' Total Depth = 12.5'		LAKE AJ HENRY 6/7/1999 14:00 Secchi Depth= 0.91' Total Depth=6.0'	
Profile Depth	**D.O.**	**Temperature***	**D.O.**	**Temperature**	**D.O.**	**Temperature**	**D.O.**	**Temperature**	**D.O.**	**Temperature**	**D.O.**	**Temperature**	**D.O.**	**Temperature**	**D.O.**	**Temperature**
Surface	16	25	6.25	28.5	9.2	29.5	8.8	29.0	8.0	29.0	6.8	29	6.8	29.0	5.8	30.0
2ft.	16.5	25	8.2	28.0	9.0	29.5	8.6	29.0	8.2	28.5	6.4	29.0	6.0	29.0	4.0	29.0
3ft.	16.5	25	8	29.0	8.8	29.5	8.6	28.0	8.4	28.5	6.0	29.0	5.8	29.0	2.0	28.0
4ft.	16	24.5	7.2	28.5	8.8	29.5	8.8	28.0	8.0	28.5	5.8	29.0	5.2	29.0	0.4	27.0
5ft.	16	24.5	7.0	28.0	9.0	29.0	8.4	28.0	8.0	28.5	5.8	28.5	5.0	29.0	0.2	26.5
6ft.	16	24.5	7.4	28.5	8.6	29.0	8.6	28.0	8.0	27.5	5.6	28.5	2.0	28.5	0.2	26.5
7ft.	15	24.5	7.2	28.5	8.4	28.0	8.6	28.0	7.4	27.5	5.4	28.5	0.6	26.0		
8ft.	13	24.5	7.4	28.5	8.2	28.0	8.0	28.0	7.2	27.5	5.0	28.5	0.8	25.0		
9ft.	10.5	24	7.2	28.0	6.8	27.5	7.8	28.0	7.2	27.5	5.0	28.5	0.4	24.5		
10ft.	1	23	7.4	28.0	5.2	27.0	7.2	28.0	7.2	28.0	5.0	28.5	0.2	24.5		
11ft.	0.3	23	1.8	27.5	3.8	26.0	7.0	27.5	7.0	27.5	5.0	28.5	0.2	24.5		
12ft.	0.4	21	1.0	27.0	1.8	25.0	7.8	27.5	7.0	27.5	5.0	28.5	0.2	24.5		
13ft.	0.4	20.5	0.4	26.0	0.6	24.0	6.2	27.0	6.8	27.5	5.0	28.5				
14ft.	0.4	20.5	0.2	26.0	0.4	24.0	5.4	27.0	6.6	27.5	5.0	28.5				
15ft.	0.4	20.5	0.2	26.0	0.2	23.0	4.0	27.0	4.4	27.0	5.0	28.0				
16ft.			0.2	26.0	0.2	22.5	2.8	27.0	3.0	27.0	5.0	28.5				
17ft.			0.2	25.5	0.2	22.5	2.0	27.0	1.6	27	5.0	28.5				
18ft.			0.2	25.5	0.2	22.0	0.8	26.5			5.0	28.5				
19ft.			0.2	25.5	0.2	22.0	0.4	26.0			5.0	28.0				
20ft.			0.2	25.0	0.2	21.5	0.2	26.0			5.2	28.5				
21ft.			0.2	25.0	0.0	21.5	0.0	26.0			5.0	28.5				
22ft.			0.2	25.0							5.0	28.5				
23ft.			0.0	25.0							2.8	28.0				

D.O. = Dissolved Oxygen concentration in mg/L

* All temperatures are in degrees Celsius

TABLE C-3
Physical and Chemical Field Measurements in Select Alum-Treated and Non-Treated Lakes, Orlando and Tallahassee, Florida
December 1998

Orlando Treatment Lake	Date	Time	O/S	Water Depth (feet)	Surface D.O. (mg/L)	Bottom D.O. (mg/L)	Surface Temp. (°C)	Bottom Temp (°C)	Surface Cond. (μmhos/cm²)	Bottom Cond. (μmhos/cm²)	Surface pH	Bottom pH	Secchi Depth (feet)
LAKE DOT station #'s													
Dotwp-1	12/15/1998	15:30	4	15.5	8.8	7.2	21.5	21.5	260	270	7.6	7.62	7.1
Dotw-1	12/15/1998	16:10	3	9.0	9.2	7.4	21.5	21.5					
Dotw-2	12/15/1998	16:28	3	10.25	8.8	7.7	21.5	21.5	260	260	7.37	7.57	
Dotw-3	12/15/1998	16:48	1,4	10.0	8.9	7.4	21.5	21.5					
Dotw-4	12/15/1998	16:58	1,4	12.5	9.3	8.3	21.5	21.5					
Dotw-5	12/15/1998	17:15	4,3	10.3	9.6	8.6	21.5	21.5					
Dotw-6	12/15/1998	17:30	4	11.5	9.8	8.1	21.5	21.5					
Dotw-7	12/16/1998	8:22	4	8.5	7.4	7.2	20.5	20.5	290	290	7.67	6.97	
Dotw-8	12/16/1998	8:43	4	9.5	7.3	6.9	20.0	20.0					

Orlando Treatment Lake	Date	Time	O/S	Water Depth (feet)	Surface D.O. (mg/L)	Bottom D.O. (mg/L)	Surface Temp. (°C)	Bottom Temp (°C)	Surface Cond. (μmhos/cm²)	Bottom Cond. (μmhos/cm²)	Surface pH	Bottom pH	Secchi Depth (feet)
LAKE LURNA station #'s													
Lurwp-1	12/16/1998	10:41	4	23.5	7.8	5.5	20.5	20.0	160	160	7.73	7.63	5.6
Lurw-1	12/16/1998	11:21	4,3	8.0	6.1	5.5	21.0	21.0	160	160	7.65	7.57	
Lurw-2	12/16/1998	11:40	1,3	10.3	6.2	5.6	21.0	21.0					
Lurw-3	12/16/1998	11:56	3	12.0	6.0	5.4	21.0	20.5					
Lurw-4	12/16/1998	12:10	4	10.5	6.5	5.7	21.0	21.0	150	160	7.73	7.58	
Lurw-5	12/16/1998	12:28	4	8.0	6.6	5.4	21.0	21.0					
Lurw-6	12/16/1998	12:43	1,2	10.5	6.6	5.6	21.0	21.0					
Lurw-7	12/16/1998	12:57	1,4	8.0	6.8	6.3	21.5	21.5	160	160	7.3	7.59	
Lurw-8	12/16/1998	13:14	1	9.0	6.4	6.0	21.5	21.0					

TABLE C-3
Physical and Chemical Field Measurements in Select Alum-Treated and Non-Treated Lakes, Orlando and Tallahassee, Florida
December 1998

Orlando Treatment Lake	Date	Time	O/S	Water Depth (feet)	Surface D.O. (mg/L)	Bottom D.O. (mg/L)	Surface Temp. (°C)	Bottom Temp (°C)	Surface Cond. (µmhos/cm²)	Bottom Cond. (µmhos/cm²)	Surface pH	Bottom pH	Secchi Depth (feet)
LAKE OSCEOLA station #'s													
Oscwp-1	12/17/1998	9:30	1	22.5	7.7	7.3	20.5	20.5	230	230	7.89	7.8	3.6
Oscw-1	12/17/1998	9:57	1,4	12.5	7.5	7.5	20.5	20.5	220	220	7.87	7.75	
Oscw-2	12/17/1998	10:19	1,3	12.0	7.7	7.6	20.5	20.5					
Oscw-3	12/17/1998	10:38	1,3	11.5	7.7	7.2	20.5	20.5					
Oscw-4	12/17/1998	10:52	1	11.0	7.6	7.3	20.5	20.5	200	210	7.87	7.82	
Oscw-5	12/17/1998	11:05	3	11.5	7.9	7.2	21.0	20.5					
Oscw-6	12/17/1998	11:17	3,1	10.5	7.9	7.3	20.5	20.5					
Oscw-7	12/17/1998	11:29	1	12.5	7.8	7.3	21.0	20.5					
Oscw-8	12/17/1998	11:39	1	10.5	7.8	7.5	21.0	20.5					
Oscw-9	12/17/1998	11:58	4	10.5	7.8	8.0	21.0	20.0					
Oscw-10	12/17/1998	12:11	1	10.0	8.3	8.1	20.5	21.0	200	220	7.97	7.93	
Oscw-11	12/17/1998	13:56	1	10.5	8.4	8.4	21.0	21.0					
Oscw-12	12/17/1998	14:15	1	10.0	8.2	8.6	20.5	20.0					
Oscw-13	12/17/1998	14:31	1	9.0	8.3	8.2	21.0	20.5					
Oscw-14	12/17/1998	14:50	1	10.5	8.2	7.6	21.0	20.5					
Oscw-15	12/17/1998	15:06	1	8.0	8.8	8.7	20.5	20.0					
Oscw-16	12/17/1998	15:30	1	8.0	8.8	7.9	20.5	20.0					
Oscw-17	12/17/1998	15:46	1,5	10.0	8.8	8.6	20.0	20.0					
Oscw-18	12/17/1998	16:00	1	10.5	8.9	8.7	21.0	21.0					

Orlando Treatment Lake	Date	Time	O/S	Water Depth (feet)	Surface D.O. (mg/L)	Bottom D.O. (mg/L)	Surface Temp. (°C)	Bottom Temp (°C)	Surface Cond. (µmhos/cm²)	Bottom Cond. (µmhos/cm²)	Surface pH	Bottom pH	Secchi Depth (feet)
LAKE IVANHOE station #'s													
Ivawp-1	12/18/1998	8:35	1	22.5	7.7	7.6	19.5	19.5	220	220	7.97	7.81	4.0
Ivaw-1	12/18/1998	9:52	1	11.5	7.9	7.7	20.0	20.0					
Ivaw-2	12/18/1998	10:06	1	10.0	7.8	7.8	20.0	20.0					
Ivaw-3	12/18/1998	10:20	1	12.0	7.9	7.6	20.0	20.0	200	200	8.03	7.95	
Ivaw-4	12/18/1998	10:33	4,3	10.0	7.7	7.4	20.0	20.0					
Ivaw-5	12/18/1998	10:45	3	11.5	7.5	7.6	20.0	20.0					

TABLE C-3

Physical and Chemical Field Measurements in Select Alum-Treated and Non-Treated Lakes, Orlando and Tallahassee, Florida

December 1998

Ivaw-6	12/18/1998	10:49	3	11.0	7.6	7.6	20.0	20.0	190	200	7.9	7.93	
Ivaw-7	12/18/1998	11:10	1,3	10.5	7.7	7.7	20.0	20.0					
Ivaw-8	12/18/1998	11:19	1	10.5	8.4	8.12	20.0	20.0					
Ivaw-9	12/18/1998	11:31	1	11.0	7.8	7.6	20.0	20.0					
Ivaw-10	12/18/1998	9:10	1	12.0	7.8	7.2	19.5	19.5	220	210	7.89	7.89	
Ivaw-11	12/18/1998	9:28	1	11.0	7.7	7.7	19.5	19.5					
Ivaw-12	12/18/1998	9:40	1	11.5	7.8	7.8	19.5	19.5					

Orlando Treatment Lake	Date	Time	O/S	Water Depth (feet)	Surface D.O. (mg/L)	Bottom D.O. (mg/L)	Surface Temp. (°C)	Bottom Temp (°C)	Surface Cond. (µmhos/cm²)	Bottom Cond. (µmhos/cm²)	Surface pH	Bottom pH	Secchi Depth (feet)
LAKE LUCERNE station #'s													
Lucwp-1	12/15/1998	10:35	1	17.5	9.0	4.0	22.0	22.5	320	300	8.16	8.02	2.4
Lucw-1	12/15/1998	11:30	1,4	9.5	9.8	8.6	22.0	22.0					
Lucw-2	12/15/1998	12:00	2,4	9.0	9.7	9.0	22.0	22.0	290	290	8.12	8.1	
Lucw-3	12/15/1998	12:25	2,4	8.5	10.2	9.0	22.0	22.0					
Lucw-4	12/15/1998	13:10	4	10.5	10.4	9.1	22.5	22.0					
Lucw-5	12/15/1998	13:31	3,4	9.0	10.4	8.7	22.0	22.0					
Lucw-6	12/15/1998	13:45	4,1	9.0	10.9	9.7	22.5	22.0					
Lucw-7	12/15/1998	14:00	4,1	10.5	10.6	9.2	22.0	22.0	290	280	8.13	8.08	
Lucw-8	12/15/1998	14:12	1,4	9.3	11.2	10.8	22.0	22.0					

Orlando Treatment Lake	Date	Time	O/S	Water Depth (feet)	Surface D.O. (mg/L)	Bottom D.O. (mg/L)	Surface Temp. (°C)	Bottom Temp (°C)	Surface Cond. (µmhos/cm²)	Bottom Cond. (µmhos/cm²)	Surface pH	Bottom pH	Secchi Depth (feet)
LAKE OLIVE station #'s													
Oliwp-1	12/16/1998	15:00	4	23.5	8.8	5.9	20.5	20	190	220	7.77	7.55	2.6
Oliw-1	12/16/1998	15:35	4,3	9	9.3	6.1	21.0	20.5	200	230	7.75	7.6	
Oliw-2	12/16/1998	17:31	4	10.25	8.4	6.1	20.0	20.0					
Oliw-3	12/16/1998	17:20	2,3	8.5	8.9	8.3	20.5	20.5					
Oliw-4	12/16/1998	17:09	4,3	9.25	9.9	7.3	20.5	20.0	240	240	7.77	7.69	
Oliw-5	12/16/1998	16:56	3,4	9.5	10.1	6.9	20.5	20.0					
Oliw-6	12/16/1998	16:39	4	9	10.2	6	20.5	20.5	220	230	7.84	7.66	
Oliw-7	12/16/1998	16:20	4,3	10.3	9.4	6	20.5	20.0					
Oliw-8	12/16/1998	16:03	4,3	10.5	9.4	6.1	20.5	20.0					

TABLE C-3
Physical and Chemical Field Measurements in Select Alum-Treated and Non-Treated Lakes, Orlando and Tallahassee, Florida
December 1998

Orlando Treatment Lake	Date	Time	O/S	Water Depth (feet)	Surface D.O. (mg/L)	Bottom D.O. (mg/L)	Surface Temp. (°C)	Bottom Temp (°C)	Surface Cond. (μmhos/cm²)	Bottom Cond. (μmhos/cm²)	Surface pH	Bottom pH	Secchi Depth (feet)
LAKE ELLA station #'s													
Ellwp-1	12/21/1998	9:36	4	12.5	6.6	2.0	16.0	15.0	140	140	7.86	7.81	2.55
Ellw-1	12/21/1998	10:02	4,5	7.5	6.8	6.6	16.0	15.0	140	140	7.76	7.63	
Ellw-2	12/21/1998	10:31	3,4	9.0	7.2	5.4	16.0	15.0					
Ellw-3	12/21/1998	10:52	4	7.5	7.4	6.8	16.0	15.5					
Ellw-4	12/21/1998	11:17	3,4	7.5	7.4	7.0	17.0	16.0	140	130	7.91	7.83	
Ellw-5	12/21/1998	11:48	4	7.5	6.8	6.2	17.0	15.5					
Ellw-6	12/21/1998	12:10	4,5	8.5	6.8	6.0	17.0	15.0					
Ellw-7	12/21/1998	12:28	4	10	7.2	6.4	17.0	16.0	130	130	8.3	8.17	
Ellw-8	12/21/1998	12:50	4,5	9	7.0	6.2	17.0	16.0					

Orlando Treatment Lake	Date	Time	O/S	Water Depth (feet)	Surface D.O. (mg/L)	Bottom D.O. (mg/L)	Surface Temp. (°C)	Bottom Temp (°C)	Surface Cond. (μmhos/cm²)	Bottom Cond. (μmhos/cm²)	Surface pH	Bottom pH	Secchi Depth (feet)
LAKE AJ HENRY station #'s													
Henwp-1	12/21/1998	15:27	2	6.5	9.2	0.2	18	15	60	60	8.85	7.99	1.25
Henw-1	12/21/1998	16:25	2,3	5	9.2	5.2	18	15					
Henw-2	12/21/1998	16:40	1	4	9	5.8	18	16	60	60	8.8	7.7	
Henw-3	12/21/1998	16:56	2,3	3.5	9.2	5.8	17	15					
Henw-4	12/21/1998	17:08	3,4	3.5	9.4	8.2	18	16					
Henw-5	12/21/1998	17:19	3,4	4.5	9.2	7	18	16	60	50	8.7	8.2	
Henw-6	12/21/1998	17:33	3	3.5	9.6	5.2	18	16					
Henw-7	12/21/1998	17:47	3,4	3	9.2	6.2	18	17					
Henw-8	12/21/1998	18:05	3	3.5	9.2	8.5	18	18	60	60	10.12	10.27	

O/S - Observations per sediment key: 1=sand; 2=silt/clay; 3=coarse particulate organic matter; 4=muck; 5=Submerged Aquatic Vegetation

TABLE C-4
Physical and Chemical Field Measurements in Select Alum-Treated and Non-Treated Lakes, Orlando and Tallahassee, Florida
June 1999

Orlando Treatment Lake	Date	Time	O/S	Water Depth (feet)	Surface D.O. (mg/L)	Bottom D.O. (mg/L)	Surface Temp. (°C)	Bottom Temp. (°C)	Surface Cond. (µmhos/cm²)	Bottom Cond. (µmhos/cm²)	Surface pH	Bottom pH	Secchi Depth (feet)
LAKE DOT station #'s													
Dotsp-1	6/2/1999	12:08	4	15'	16	4	25	20.5	90	260	8.33	6.88	8.6
Dots-1	6/2/1999	12:19	2,1	9.1'	6	1.2	29	27					
Dots-2	6/2/1999	12:35	4,3	10.1'	6	1.2	29	27					
Dots-3	6/2/1999	12:47	3	10.0'	6.2	1.4	29	27					
Dots-4	6/2/1999	12:57	4	12.4'	6	0.08	28.5	25.5	190	200	7.93	7.42	
Dots-5	6/2/1999	13:24	3	10.2'	6.02	0.04	29	26					
Dots-6	6/2/1999	13:34	4	11.3	5.8	0.06	29	25					
Dots-7	6/2/1999	13:44	3,4	8.9'	5.6	0.4	28.5	26	190	120	7.88	7.38	
Dots-8	6/2/1999	14:56	4	9.6'	5.8	0.8	29.0	26.5					

Orlando Treatment Lake	Date	Time	O/S	Water Depth (feet)	Surface D.O. (mg/L)	Bottom D.O. (mg/L)	Surface Temp. (°C)	Bottom Temp. (°C)	Surface Cond. (µmhos/cm²)	Bottom Cond. (µmhos/cm²)	Surface pH	Bottom pH	Secchi Depth (feet)
LAKE LURNA station #'s													
Lursp-1	6/3/1999	10:40	4	23.0	6.25	0.0	28.5	25.0	190	210	8.69	7.1	3.83
Lurs-1	6/3/1999	11:00	1	8.0	8	5.8	29.0	28.5	190	190	8.61	8.03	
Lurs-2	6/3/1999	11:22	3,4	10.6	8	1.8	29.5	28.0					
Lurs-3	6/3/1999	11:27	3,4	12.0	7.6	2.4	29.0	27.5					
Lurs-4	6/3/1999	11:31	4,1	10.5	7.4	4.2	30.0	28.0	190	190	8.31	8.09	
Lurs-5	6/3/1999	11:40	4,3	8.0	7.6	5	30.0	28.0					
Lurs-6	6/3/1999	12:03	4,1	10.5	8.2	4.6	29.0	28.0					
Lurs-7	6/3/1999	12:15	1	8.0	7.2	4.8	29.5	28.0	190	180	8.61	7.87	
Lurs-8	6/3/1999	12:30	4	9.0	7.2	4.8	29.0	28.0					

TABLE C-4

Physical and Chemical Field Measurements in Select Alum-Treated and Non-Treated Lakes, Orlando and Tallahassee, Florida

June 1999

Orlando Treatment Lake	Date	Time	O/S	Water Depth (feet)	Surface D.O. (mg/L)	Bottom D.O. (mg/L)	Surface Temp. (°C)	Bottom Temp. (°C)	Surface Cond. (µmhos/cm^2)	Bottom Cond. (µmhos/cm^2)	Surface pH	Bottom pH	Secchi Depth (feet)
LAKE OSCEOLA station #'s													
Oscsp-1	6/2/1999	16:15	1	21.0	9.2	0.0	29.5	21.5	1.5	1.5	9.04	7.32	3.05
Oscs-1	6/2/1999	16:35	2	13.0	10.2	6.6	29	27	200	180	9.1	7.93	
Oscs-2	6/2/1999	17:08	2	12.0	9	4	29	25					
Oscs-3	6/2/1999	17:22	4,3	11.0	8.04	4.2	29	26					
Oscs-4	6/2/1999	17:34	1,4	11.0	8	4.2	29	26.5	190	170	9.05	7.96	
Oscs-5	6/2/1999	17:46	4,1	11.0	8	4.2	29.0	27.0					
Oscs-6	6/2/1999	17:55	4	11.0	8.2	4	29.0	27.0					
Oscs-7	6/2/1999	18:13	4	12.0	8	4.4	29.0	26.5					
Oscs-8	6/2/1999	18:22	4	11.0	8	4.2	29.0	26.5					
Oscs-9	6/2/1999	18:40	4,2	11.0	8.2	3.4	29.0	26.0					
Oscs-10	6/2/1999	18:54	4,3	10.0	8.4	4.8	29.0	27.0					
Oscs-11	6/2/1999	19:06	1	10.0	8.2	4.2	29.0	26.0	160	150	9.21	7.98	
Oscs-12	6/2/1999	19:24	1	10.0	8.2	3.8	29.0	26.0					
Oscs-13	6/2/1999	19:35	1	9.0	8	6	29.0	27.0					
Oscs-14	6/2/1999	19:45	1	10.0	8.4	4	29.0	26.0					
Oscs-15	6/2/1999	19:55	1	8.0	8.2	5	29.0	27.0					
Oscs-16	6/2/1999	20:02	1	8.0	8.2	6	29.0	27.0					
Oscs-17	6/2/1999	20:13	1	10.0	8.4	4	29.0	26.0					
Oscs-18	6/2/1999	20:25	1	11.0	8.4	6	28.0	27.0					

Orlando Treatment Lake	Date	Time	O/S	Water Depth (feet)	Surface D.O. (mg/L)	Bottom D.O. (mg/L)	Surface Temp. (°C)	Bottom Temp. (°C)	Surface Cond. (µmhos/cm^2)	Bottom Cond. (µmhos/cm^2)	Surface pH	Bottom pH	Secchi Depth (feet)
LAKE IVANHOE station #'s													
Ivasp-1	6/3/1999	14:17	1	21.0	8.8	0.0	29.0	26.0	200	200	8.54	7.54	3.21
Ivas-1	6/3/1999	15:22	1	12.0	8	5.6	30.0	28.0					
Ivas-2	6/3/1999	15:40	1	10.0	8.2	7.2	30.0	28.0					
Ivas-3	6/3/1999	16:00	1	12.0	7.8	6	30.0	26.5	200	190	**??**	8.23	
Ivas-4	6/3/1999	16:17	4	12.0	8	6.2	30.0	27.5					
Ivas-5	6/3/1999	16:30	3	12.0	8	5	30.5	27.0					
Ivas-6	6/3/1999	16:45	3	11.0	8.6	6.8	29.0	27.5	190	180	8.74	7.93	
Ivas-7	6/3/1999	17:07	4,1	11.0	8.2	7.2	30.0	28.0					
Ivas-8	6/3/1999	17:19	1	11.0	8	8	29.5	28.0					

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June 1999

Ivas-9	6/3/1999	17:30	1	11.0	8.2	7.4	29.0	27.5					
Ivas-10	6/3/1999	17:40	1	11.0	8.2	6.2	29	27.5	190	230	8.69	8.27	
Ivas-11	6/3/1999	17:50	1	11.0	8.4	5.6	29	27.5					
Ivas-12	6/3/1999	18:02	1	12.0	8.2	7.2	29	27.5					

Orlando Treatment Lake	Date	Time	O/S	Water Depth (feet)	Surface D.O. (mg/L)	Bottom D.O. (mg/L)	Surface Temp. (°C)	Bottom Temp. (°C)	Surface Cond. (µmhos/cm²)	Bottom Cond. (µmhos/cm²)	Surface pH	Bottom pH	Secchi Depth (feet)
LAKE LUCERNE station #'s													
Lucsp-1	6/4/1999	14:05	1	17.0	8.0	1.6	29.0	27.0	210	210	8.67	7.65	1.98
Lucs-1	6/4/1999	14:15	1,4	9.5	7.6	7.2	29.5	27.5					
Lucs-2	6/4/1999	14:47	1,4	9.0	8	6.8	29.0	27.5	210	210	8.62	8.27	
Lucs-3	6/4/1999	14:59	1,4	8.5	8	7.0	29.0	28.0					
Lucs-4	6/4/1999	15:23	4	10.5	8.4	7.2	28.0	27.0					
Lucs-5	6/4/1999	15:45	4	9.0	8.4	7	28.0	27.5					
Lucs-6	6/4/1999	16:54	3,4	9.0	7.8	7.4	27.5	27.5					
Lucs-7	6/4/1999	17:10	1	10.5	7.8	6.6	28.0	27.0	230	230	8.51	8.04	
Lucs-8	6/4/1999	17:24	4,3	10	8.2	6.8	28.0	27.0					

Orlando Treatment Lake	Date	Time	O/S	Water Depth (feet)	Surface D.O. (mg/L)	Bottom D.O. (mg/L)	Surface Temp. (°C)	Bottom Temp. (°C)	Surface Cond. (µmhos/cm²)	Bottom Cond. (µmhos/cm²)	Surface pH	Bottom pH	Secchi Depth (feet)
LAKE OLIVE station #'s													
Olisp-1	6/3/1999	10:05	4	23.0	6.8	2.8	29	28	200	210	8.06	7.84	2.31
Olis-1	6/3/1999	10:32	4	9.0	6	5	29.0	28.0	190	190	7.86	7.65	
Olis-2	6/3/1999	10:45	4,3	10.0	6.2	5.2	29.0	28.5					
Olis-3	6/3/1999	11:00	3,4	9.0	6	5.2	29.0	28.0					
Olis-4	6/3/1999	11:10	3,4	10.0	5.8	5	29.0	28.0	170	180	7.73	7.69	
Olis-5	6/3/1999	11:22	4	10.0	5.8	5	29.0	28.0					
Olis-6	6/3/1999	11:40	4	9.0	6.8	5.4	29.0	28.0	230	230	7.92	7.74	
Olis-7	6/3/1999	12:00	4	10.0	6.8	5.2	30.0	28.5					
Olis-8	6/3/1999	12:17	4	11.0	6.8	4.4	29.0	28.0					

TABLE C-4
Physical and Chemical Field Measurements in Select Alum-Treated and Non-Treated Lakes, Orlando and Tallahassee, Florida
June 1999

Orlando Treatment Lake	Date	Time	O/S	Water Depth (feet)	Surface D.O. (mg/L)	Bottom D.O. (mg/L)	Surface Temp. (°C)	Bottom Temp. (°C)	Surface Cond. (µmhos/cm²)	Bottom Cond. (µmhos/cm²)	Surface pH	Bottom pH	Secchi Depth (feet)
LAKE ELLA station #'s													
Ellsp-1	6/7/1999	9:10	4	12	6.8	0.2	29.0	29.0	130	160	7.92	6.97	2.63
Ells-1	6/7/1999	10:05	4	7.5	7	4.0	29.0	27.0	130	130	7.88	7.73	
Ells-2	6/7/1999	10:20	4,2	9.0	7	1.0	29.0	27.0					
Ells-3	6/7/1999	10:40	3,1	7.5	7.2	5.2	29.0	27.5					
Ells-4	6/7/1999	10:53	4,3	7.5	6.8	6.2	29.0	27.5	140	140	7.9	7.84	
Ells-5	6/7/1999	11:06	4	7.5	7.2	3.0	29.0	27.0					
Ells-6	6/7/1999	11:15	4	8.5	7	5.6	29.0	27.0					
Ells-7	6/7/1999	11:30	3	10	7.4	2.2	29.0	27.5	160	150	7.81	7.3	
Ells-8	6/7/1999	11:42	4	9	7.0	2.4	29.0	27.0					

Orlando Treatment Lake	Date	Time	O/S	Water Depth (feet)	Surface D.O. (mg/L)	Bottom D.O. (mg/L)	Surface Temp. (°C)	Bottom Temp. (°C)	Surface Cond. (µmhos/cm²)	Bottom Cond. (µmhos/cm²)	Surface pH	Bottom pH	Secchi Depth (feet)
LAKE AJ HENRY station #'s													
Hensp-1	6/7/1999	14:00	4	6.0	5.8	0.2	30.0	26.5	90.0	140.0	8.7	7.1	0,91
Hens-1	6/7/1999	14:30	4	5.0	8.0	2.0	29.0	28.0					
Hens-2	6/7/1999	14:40	4	4.0	5.8	3.8	29.0	28.0	90.0	90.0	8.9	7.5	
Hens-3	6/7/1999	14:50	4	3.5	7.2	2.0	30.0	28.0					
Hens-4	6/7/1999	15:15	4,3	3.5	5.8	2.0	29.0	27.5					
Hens-5	6/7/1999	15:25	4	4.2	6.8	1.6	29.0	28.0	80.0	90.0	7.8	7.2	
Hens-6	6/7/1999	15:35	3	3.5	7.2	2.2	30.0	28.0					
Hens-7	6/7/1999	15:43	3	3.0	8.0	2.0	30.0	28.0					
Hens-8	6/7/1999	15:55		3.5	7.0	2.0	30.0	27.5	80.0	90.0	9.3	8.0	

O/S - Observations per sediment key: 1=sand; 2=silt/clay; 3=coarse particulate organic matter; 4=muck; 5=Submerged Aquatic Vegetation