WATER QUALITY SURVEY OF TWENTY-FOUR STORMWATER WET-DETENTION PONDS (FINAL REPORT)

Environmental Section
Southwest Florida Water Management District
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BY

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EXECUTIVE SUMMARY

As part of stormwater management responsibility, the Southwest Florida Water Management District (AKA, the District) conducts research to implement better stormwater regulations. During the latter months of 1988 and continuing through December 1989, the District conducted a water-quality survey of twenty-four, stormwater wet-detention ponds in the Tampa Bay Region, which had been permitted by the District. The objectives of the survey were threefold; (1) to provide regional, base-line water-quality data in urban, stormwater wet-detention ponds, (2) to document whether the water quality of potential effluents from wet-detention ponds met state water-quality standards, providing insight concerning the effectiveness of stormwater management rules used by the District, and (3) to explore relationships among physical/chemical (water-quality) variables, water-level variables, and pond-dimension variables. This report describes the design, implementation, and results of the survey; discusses the problems encountered; and makes recommendations for future stormwater surveys and projects.

Summary and Conclusions

1. Exceedence of water-quality standards at the outfall station (located at the point of discharge from wet-detention ponds) occurred in 10 percent or more of samples for five variables (dissolved oxygen, zinc, cadmium, copper and total suspended solids). The lead standard was exceeded in 7 percent of samples.

2. Although inputs and outputs were not measured, exceedence of the total suspended solids standard (20 mg/L -- for an efficient secondary sewage treatment) in just 10 percent of samples, and exceedence of the turbidity standard (29 NTU) in just 4 percent of samples indicates the survey wet-detention ponds were generally effective as sedimentation basins. The conclusion is supported by treatment efficiency data in the literature, and by data from an intensive study carried out in one of the 24 ponds (Pond S), where reduction of total suspended solids between infall and outfall averaged 57% for the storms that were studied.

3. Although water quality "within" wet-detention ponds contributes to the quality of water discharging through the control structure, exceedence of standards within ponds may not constitute an exceedence of State water-quality standards by water being discharged. The process of water discharging through a control structure (e.g., weir) might alter several variables (e.g., dissolved oxygen, total suspended solids, and turbidity), and associated constituents (e.g., heavy metals).

4. Evaluation of seasonal patterns in the data indicates that hydrologic conditions (i.e., water levels) were rainfall related, as expected. More importantly, several variables (conductivity, turbidity, cadmium, and possibly zinc and iron) are inversely correlated with rainfall-related water-level indicators (i.e., the number or percent of ponds discharging, and the bottom depth at the sample location). Also, as would be expected seasonal temperature patterns were important with regards to dissolved oxygen levels. No other seasonal patterns related to hydrologic conditions or temperature were obvious.

5. The inverse relationship between the number of ponds discharging and mean outfall-station concentrations for certain water-quality variables also suggests that higher means and perhaps more exceedences of standards corresponded with periods of lower rainfall when fewer ponds were discharging. Thus, an exceedence during dry periods might not actually constitute a violation of water-quality standards.

6. For some variables the number of exceedences may have fluctuated with the seasonal patterns in their mean values; however, the data was inconclusive. Changes in the number of exceedences for specific variables may have corresponded with fluctuating water levels, with first flush effects after dry periods, with variable watershed and atmospheric sources, or even with internal cycles (for heavy metals).

7. Results of multivariate statistical analyses (cluster techniques, multiple regressions, etc.) provided evidence that hydrologic conditions and pond dimensions were important for certain water-quality variables, especially suspended particles and iron. The results also suggested a relationship between water quality and primary production in wet-detention ponds since temperature, dissolved oxygen and Ph were closely related.

8. Data from the land-use evaluations and cluster analyses of ponds suggested that multi-family residential ponds are among those with poorest water-quality.

9. More than 80 percent of the data for several heavy metals (cadmium, lead, chromium and nickel) had values that were below laboratory limits of quantitation. Therefore the analyses that were performed using one half the detection limit for these data (i.e., censored data) should be viewed with caution.

Recommendations for Future Surveys

Although this survey has provided some valuable insights, a more thorough analysis of water-quality data within stormwater ponds, within discharge effluent, and within receiving waters would provide a clearer picture of the potential for degradation or improvement of receiving water quality. Future surveys of stormwater ponds should also incorporate some additional parameters for more complete evaluation of water-quality data (e.g., total hardness, alkalinity, redox potential, nutrients and/or chlorophyll, and color). These variables are important because of their influence on metal concentrations and metal toxicity, as well as, on other water-quality characteristics. Furthermore, the sampling regime of future surveys might also include input water samples, output water samples, open-water samples (i.e., near the middle of ponds), depth profiles, sediment samples, groundwater samples, if more complete assessment the water-quality treatment effectiveness of wet-detention stormwater ponds is desired. The investigation of stormwater systems continues to grow, emphasizing control and abatement of flooding, erosion, sedimentation, and pollutant discharge. Research concerning the ecological value of stormwater ponds has been mostly overlooked. Biological sampling (e.g., plants, algae, and benthos) would help determined the strengths and weaknesses of stormwater ponds as fish and wildlife habitat. With ever increasing development pressures reducing wetland and surface-water resources, the habitat value of stormwater systems needs to be studied. Future surveys would also benefit from a more complete analysis of the land uses, the watershed characteristics, and the temporal and spatial characteristics of rainfall, if accurate and timely information are available.

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INTRODUCTION

Over the last twenty-five years, a significant reduction in "point-source" discharges to the nation's surface waters has occurred. As a result stormwater runoff is now recognized as the major "nonpoint source" of pollution to surface water bodies (USEPA, 1983; Livingston, 1986). Stormwater runoff is blamed in part for many negative ecological changes (e.g., accumulation of nutrients, metals, pesticides and other pollutants leading to algae blooms; fish kills and species composition changes) noted throughout the Great Lakes region and elsewhere. Major changes were noted in the decline of fisheries in Lake Erie, that appeared to improve with the reduction of point source and nonpoint source pollution (e.g., stormwater runoff) (Bastian, 1986; and Marsalek, 1986).

Stormwater may vary in water quality depending on such factors as rainfall amounts, land uses, or the specific treatment "best management practice" (BMP) being employed (Wanielista, 1978; Terstriep et al., 1986; and Whalen and Cullum, 1988). For instance, the number of days since the last rain event defines the antecedent periods during which pollutants accumulate. Also, residential, commercial and industrial land uses may affect constituent concentrations in stormwater ponds differently. Whalen and Cullum (1988) found that heavy metals contamination was more common from commercial and roadway projects than from residential, light industrial, or mixed urban land uses. The same study reported no trend in total suspended solids (TSS) as a function of land use, but higher nutrient loads were reported in residential areas than in commercial, mixed urban, light industrial or roadway areas. The researchers concluded that highly variable runoff quality from different land uses makes prescribing stormwater treatment difficult (Whalen and Cullum, 1988). Thus, agreement between similar studies regarding the substances that reach levels considered to be pollution can not always be found.

Livingston (1986) states that in recent times urbanization has continued to encroach into areas of open and agricultural lands throughout Florida, reducing the amount of pervious surfaces and a dramatically increasing stormwater runoff to surface waters beyond what would be considered natural. The result of urbanization and increased urban stormwater runoff from impervious surfaces laden with pollutants has been to increase loads of sediments and pollutants that enter surface waters (lakes, streams, rivers, and estuaries) of the state. As the overseeing agency for water quality regulation in the state, Florida's Department of Environmental Regulation (FDER) reviewed research that was conducted in Florida under administration of Section 208 of the federal Clean Water Act (CWA). FDER's findings determined that stormwater was responsible for over half the pollution loads entering Florida waters; in many watersheds stormwater accounts for all of the pollution.

Livingston (1986) further states that stormwater pollution is responsible for the following impacts on state surface waters:

(1) 80 to 95 percent of heavy metals loading into state waters.
(2) Virtually all of the sediments deposited into state waters.
(3) 450 times the suspended solids and 9 times the BOD_5 substances entering state waters.
(4) Nutrient loads to state waters comparable to secondarily treated sewage treatment plant effluent.

Livingston (1986) also provides a discussion of the technical basis for current stormwater rules in Florida. In summary, treatment of stormwater runoff is required by law for new development in Florida, and currently compliance with minimum stormwater load reduction standards is suggested and set forth under the revisions to the State Water Policy, Chapter 17-40 of the Florida Administrative Code (FAC). Regulations now propose an 80 percent reduction in annual pollutant loads from new systems (permitted after February 1, 1982) to surface waters of the state, and a 95 percent reduction if the discharge enters an Outstanding Florida Water (OFW) (FAC, 1990 through 1992) . The technical basis for the stormwater treatment performance standard is found in two properties of stormwater: annual "storm frequency" and the "first flush" (highest concentrations) of pollutants. On average 90 percent of storms in Florida produce one inch (2.54 cm) or less of rainfall on a regional basis; 75 percent of total annual rainfall volume will fall in storms of one inch or less. In Florida studies for a variety of land uses, the first half inch of runoff (projected to annual loads) contained 80 to 95 percent of total annual loads of most pollutants. Various BMP's or combinations of BMP's can meet the load reduction standard and be permitted on a case by case basis, by treating the first one-half inch of runoff or the first inch of rainfall (Livingston, 1986).

Several types of stormwater treatment systems are routinely permitted by regulatory agencies. Generally, stormwater treatment in Florida is accomplished through "retention" or "detention" (Livingston, 1986). By definition retention is diversion of a prescribed amount of stormwater runoff to a treatment area with no subsequent discharge to waters of the state. Thus, retention results in near total treatment of the diverted water. Detention is diversion of a prescribed amount of stormwater runoff to a treatment area for prescribed residence times that allow for the settling of pollutants. By backing up and holding a specific volume of runoff, detention ponds cause the sedimentation of suspend solids and any pollutants attached to them (Stahre and Urbonas, 1990). Detention includes controlled discharge of the treated volume of stormwater to receiving waters (Livingston, 1986). Wet-detention basins can provide good to excellent removal efficiencies for suspended solids, metals and nutrients, because the water column of wet-detention basins removes pollutants through sedimentation, degradation, vegetative uptake and other physical and biological processes (Whalen and Cullum, 1988). Recent trends indicate an increase in the use of wet-detention (designed to maintain a permanent pool) for the treatment of stormwater; approximately 21 percent of permits issued by the Southwest Florida Water Management District since January 1990 have been for wet-detention systems.

Based on requirements established by the U.S Environmental Protection Agency (USEPA) in Section 208 of the Federal Clean Water Act, the Florida Department of Environmental Regulation (FDER) developed rules for the management of point-source and nonpoint source, surface-water pollution (Livingston, 1986). FDER's efforts to specifically regulate urban, stormwater runoff eventually led to the adoption of a stormwater rule; Chapter 17-25, Florida Administrative Code (FAC). The five Florida Water Management Districts' stormwater regulatory authority is based on Florida Statutes (FS) Chapter 373, Part IV and Chapter 403. The Districts' stormwater regulations are based on guidelines in several state laws (Florida Administrative Code [FAC] Chapters 17-3, 17-4, 17-25, 17-302 [1]). The Southwest Florida Water Management District rules (Chapter 40D-4 -- Management and Storage of Surface Waters; and Chapter 40D-40 -- General Permits) also apply within its jurisdiction (SWFWMD, 1988). The Southwest Florida Water Management District (the District) carries out its' stormwater management responsibilities through regulation and research. In keeping with the objectives of stormwater management, water quality surveys are part of the District's approach to stormwater research.

During the latter months of 1988 and continuing through December 1989, the District conducted a water-quality survey of twenty-four stormwater, wet-detention ponds in the Tampa Bay Region. The objectives of the survey were threefold. First the survey provided regional, base-line water-quality data in urban, stormwater wet-detention ponds. Second, the survey documented whether the water quality of potential effluents from wet-detention ponds met state water-quality standards, thereby providing data concerning the effectiveness of stormwater management rules used by the District. Finally, the analyses of the data explored the relationships among physical/chemical (water-quality) variables, water-level variables, and pond-dimension variables.

Rushton et al. (1989) provided an initial summary of the data from the first four sample events of this survey. Later, Kehoe et al. (1990) reported a preliminary analysis of the data from the completed sampling schedule. Both papers provide discussions of water-quality criteria and standards, and they review pertinent stormwater literature. The report that follows summarizes the complete data set and presents results and discussion of additional analyses performed on the observational data collected during the pond survey.

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[1] Chapter 17-3 (1989) surface, water-quality standards were transferred to Chapter 17-302 in 1990.

STUDY METHODOLOGY

SITE SELECTION

The criteria used to select ponds as study sites included;

(1) Ponds that discharge (directly or indirectly) to surface waters of the State (i.e., wet-detention ponds).

(2) Ponds built prior to 1988.

(3) Ponds built during 1988 and before October 1988 with "As-Built" certifications (i.e., documentation of completion and/or changes to original design).

(4) Ponds located within 75 miles of District Headquarters in Brooksville, Florida (a limited travel distance was necessary).

(5) Ponds that were accessible by foot from public roads.

The search for study sites resulted in selection of twenty-four permitted wet-detention ponds (under Chapters 40D-4 and 40D-40, FAC) located in the Tampa Bay region (Figure 1 and Table 1). Although all of the 24 ponds discharged, some discharged into storm drains; therefore not all receiving waters could be sampled. Data for six ponds (25%) were dropped from analyses (except for percent exceedence -- %E), because they did not function as wet-detention systems during the entire study period (see Operational and Structural Problems at Six Wet-Detention Ponds). Also, one pond included in this survey (Pond S) was the subject of an intensive study of stormwater treatment efficiency and pollutant removal during 22 rain events (Rushton, 1992 - in review). Data from that study were useful for discussion in this report.

SAMPLING PROCEDURES

Water-quality analysis consisted of two components, field measurements and laboratory tests. During the summer rainy season, water samples and field measurements were taken during the two or three day period immediately following storm events; however, not all storms could be sampled because of limited personnel and equipment. During dry periods and sometimes between rain events, sampling was carried out to attain ambient water-quality data. The result of this survey design was approximately monthly samples collected during a 2-3 day period allowing seasonal analysis of the data. Only the date of the last day during a 2-3 day sample run was reported. A single crew of two workers conducted all of the sampling, travelling in excess of 300 miles each time. Only daytime samples were collected (between 8:00 AM and 5:30 PM; Table Q -- Appendix). When water was present, field measurements and grab samples were collected at two or three stations (near the shoreline) associated with each wet-detention pond:

(1) Within the pond, directly in front of the control structure or point of departure from the pond (i.e., the outfall station).
(2) Within the pond, located away from the point of departure from the pond (i.e., the pond station).
(3) Within the receiving water (if available), upstream of the discharge point (i.e., the receiving-water station).

Shoreline field measurements and grab samples were collected over a period of 15 months. Most of the data analysis includes only data from the outfall station samples, because only outfall station water samples had metal analyses performed. When possible, pond station data are included for graphical comparison with the outfall station data (e.g., comparing field measurements and land-use relationships). The data from receiving water stations were available for only a limited number of ponds (fifteen of twenty-four). Receiving water summary tables are included in the Appendix of this report.

Field measurements, using either a Hydrolab 4041 or a Hydrolab Surveyor II, multiple-sensor water-quality unit included measurements of temperature (°C), dissolved oxygen (mg/L), pH (standard units), and specific conductance (umhos/cm or mmhos/cm) taken on the bottom at the time that surface grab samples were collected for laboratory analysis. On one occasion Yellow Springs Instruments (YSI) dissolved oxygen and conductivity meters, and an Orion Research Model 201 digital pH meter were substituted. Additionally, the time of day, whether or not the control structure was discharging water (either over the weir or through the bleeddown orifice), and whether a fountain was "on" or "off" (if present) were recorded. Finally, depth to the bottom was measured (in inches) at the location of the multiple-sensor unit (converted to feet or meters for analyses).

The depth measurement did not coincide with the depth of the grab sample unless the water was very shallow (less than about 1.5 feet). In most cases samples were collected at shoreline locations that were shallow with depths of 2.5 feet or less at the outfall and pond stations. Most outfall mean bottom depths were less than 2 feet. Also, grab samples and field measurements were not necessarily taken at a fixed location each time samples were collected, especially at the pond and receiving water station. During dry periods outfall station samples may have been collected some distance in front of the weir, in some ponds.

Coinciding with the field measurements, surface water grab samples were collected at each station in opaque, plastic (polypropylene) bottles -- 250 milliliter (mL) and 1.0 liter (L). Depths of grab samples ranged from as little as 0.10 meter (4 to 5 inches) to a maximum of about 0.50 meter (1.5 feet) when possible, and were not consistent because of fluctuating water levels in ponds. At outfall stations 1.0-L grab samples were collected for laboratory tests of total suspended solids (TSS) (mg/L), and turbidity (NTU), and 250-mL samples were collected and preserved (fixed) with nitric acid (HNO_3) for heavy metals analysis (ug/L or mg/L). At the pond and receiving water stations, only 1.0-L samples for turbidity and TSS were collected. All water samples were placed on ice and transported to the District laboratory in Brooksville for the appropriate analyses.

At the end of the data collection phase, water samples and field measurements had been collected on 14 separate occasions. Because of some doubt about sample techniques (i.e., depth of grab samples, and whether or not to avoid bottom sediments and debris), the sample procedures were revised after the first three sample runs (10-18-88 to 11-23-88) to exclude sediments and debris (e.g., avoid stepping in the area where samples are collected). After considering the effects of resuspended sediments and the probability that suspended solids were higher in surface grab samples on the first three dates due to several possible sources of sampling error, only water-quality data from the 11 more recent sample dates (11-28-88 to 12-19-89) have been included in the analysis.

Although there was no single publication addressing matters of water-sample quality assurance and quality control during the survey period, the Quality Assurance/Quality Control (QA/QC) procedures that were followed are now published in the Comprehensive Quality Assurance Plan (CQAP) of the Southwest Florida Water Management District. The CQAP specifies all aspects of water-quality sampling procedures, preservation, protocols, documentation, custody (SWFWMD 1992).

Laboratory analyses were performed according to either Standard Methods (A.P.H.A., 1989) or EPA 600/4-79-020, Methods for Chemical Analysis of Water and Wastes (E.P.A., 1979). TSS were calculated using Standard Methods (A.P.H.A., 1980) for total filterable residue at 103 to 105 degrees Centigrade, within six days of collecting samples. Turbidity was measured with a Hach 18900 Turbidity Meter, within 48 hours of collecting samples. In addition to turbidity and TSS, routine heavy metals analysis of outfall station samples usually included the following tests for total metals: zinc (Zn), copper (Cu), lead (Pb), cadmium (Cd), iron (Fe), nickel (Ni), chromium (Cr) and manganese (Mn). The EPA digestion and atomic absorption procedure was used with the furnace technique (method in parenthesis) for copper (220.2), chromium (218.2), lead (239.2) and nickel (249.2); and with a flame spectrophotometer for cadmium (213.1), iron (236.1), zinc (289.1), and manganese (243.1) (USEPA, 1979). Table 2 presents three categories of survey variables that were used in the final report. Also, shown in Table 2 are the pseudonyms representing variables and their transformations in the statistical analyses of this report, as well as, the units used for each variable and transformation.

DATA ANALYSIS AND STATISTICS

Variable Selection

Characteristics of each pond and contributing basin were obtained from information in permit files of the District (Table 1). Initially, numerous pond and watershed characteristics were examined to determine which were an accurate description of conditions in the field; in many cases information was not accurate (e.g., impervious area), or developments and their stormwater projects had been partially developed or had been modified. To determine if water-quality could be related to project design characteristics, project area, drainage area, basin area, pond area, impervious area (or percent), littoral zone characteristics (slope, depth, vegetated area), maximum depth, and treatment volume were examined. Three characteristics (pond area, maximum depth, and treatment volume) were determined to have relationships with certain water-quality variables. Others like mean depth and total volume could not always be determined from available permit information, but are considered to be important in the literature (Wetzel, 1975 and Boyd, 1979). Calculation of several ratios to aid in the interpretation of data did not prove to be important for the data of this study. Examples include the ratio of pond area to impervious area (pond area/impervious area) and the ratio of pond area to drainage area (pond area/drainage area).

Initial calculations and analyses (e.g., percent exceedence, medians and means) were performed on the data from all 24 wet-detention ponds. The statistical analysis of seasonal effects on water-quality variables and the analysis of relationships among annual means and among date means were performed on two data sets, one with all twenty-four ponds and one with the final eighteen ponds (six ponds excluded). Pond deletion resulted in the comparison of eighteen rather than twenty-four annual means for the variables. Pond deletion had little effect on the graphical analysis of seasonal effects on date means (i.e., the graphs did not change noticeably), and the six ponds were deleted from further statistical analyses due to improper operation or structural problems (Pond G, Pond I, Pond L, Pond N, Pond O and Pond W) (See Operational and Structural Problems at Six Wet-Detention Ponds).

The seasonal effects on date means for all eight metals are graphically depicted and discussed in this report. Means and other statistics were calculated for all eight metals by substitution of one-half the detection limit (DL) for left-censored values as suggested by Gilliom and Helsel (1986).

However, only four metals were included in certain statistical analyses (Factor, Cluster and Regression analyses), because their data was less than 50 percent left-censored (except Cu, 58 percent left-censored). Left-censoring occurs when data values fall below a laboratory-specific detection limit for a variable. The metals included in the additional, multivariate analyses and their percent left censoring are Zn (22%), Fe (<1%), Mn (50%), and Cu (58%) (Appendix tables). All four are essential metallic micronutrients (Wetzel, 1975). The metals deleted from further analyses and the percent of left-censoring were Cd (82%), Cr (82%), Pb (83%) and Ni (88%) (Appendix tables). A total of ten physical/chemical water-quality variables were retained in statistical analyses -- four metals, TSS, turbidity, DO, pH, specific conductance, and temperature. Additionally, three pond-dimension variables -- pond area, maximum depth, treatment volume (not total pond volume) -- plus discharge frequency (status) -- equal to the number of ponds that were observed discharging on sampling dates or the number of times a pond was observed discharging during the study -- and bottom depth (at the sample location) proved to be useful in statistical analyses (Table 2).

<u>Operational and Structural Problems at Six Wet-Detention Ponds</u>

Unexplained drops in water level at Pond G occurred between 3-3-89 and 4-19-89, resulting in water-levels 5 to 10 feet below the designed normal (pool), water levels. Consequently, Pond G did not discharge after the water level fell. Because of the water level problem, samples were collected at the outfall on just four of the sample runs that were included in the initial analyses, none after 3-2-89. Consequently, Pond G was dropped from statistical analyses, after analysis for percent exceedence and discharge frequency.

At Pond I, the control device was located at too low an elevation allowing backflow and equilibrium with receiving waters during high flows. The same problem occurred during high tides in receiving water at Pond N. While Pond N was observed to discharge on several occasions, conductivity readings were two orders of magnitude above most other ponds, and tidal backflow was finally observed on 8-29-89. The discharge status was never determined at Pond I, and a post-survey inspection of the control structure revealed that the control device (not seen on previous inspections) was 2-3 feet under water, and that Pond I water levels had been at equilibrium with the receiving stream during the entire survey. Because the situations at Ponds I and N were not fully understood until late in the survey, samples were collected throughout the survey at both ponds. Never-the-less, both Pond I and Pond N were dropped from later analyses when the problems were confirmed.

At Pond L, the redesign and relocation of the outfall structure was started sometime between the 4-18-89 and 6-7-89 sample runs. From 4-18-89 through 11-1-89, the original outfall structure was blocked with a pile of sand. After 4-18-89, discharge from the original control structure was never again verified. Discharge from the control device of the new structure was observed on the last sample run (12-19-89). Samples were collected on just five sample runs early in the survey; and, because of the operational problems at Pond L, the data were dropped from later statistical analyses.

Pond O was a constructed, wetlands-treatment system that was essentially dry on most sample dates. The reasons were two-fold. First, the pond was not designed deep enough or the control device elevation was too high. Second, development of the project site had not been completed when the survey was conducted; therefore, stormwater treatment-volume was less than designed amounts. Because samples were collected on just five sample runs, and because efforts to exclude sediments from samples in shallow water at Pond O were not always successful, the data were dropped from later statistical analyses.

Finally, the earthen berm supporting the control structure at Pond W washed out due to heavy rainfall and flows on three occasions during the survey. The result was that water was observed flowing around the structure several times, and the berm went unrepaired in one instance. Samples were collected on all but on three dates; however, because the stormwater system was essentially nonfunctional on some dates, the Pond W data were dropped from later statistical analyses.

Statistical Methods

SAS ™ Release 6.03 (1988) procedures and Lotus 1-2-3 ™ Release 2.01 (1986) were used to conduct statistical and graphical analyses of data. Lotus 1-2-3 and SAS Proc Means were used to calculate means and other simple statistics (with equivalent results) for different applications in the data analysis. The initial tabular, graphical and statistical data summaries conducted on all twenty-four ponds were limited to Lotus 1-2-3 and focused on evaluating compliance of outfall station water quality with State of Florida Administrative Code (FAC), Chapter 17-302 water-quality standards (especially Class III standards) (Table 3), as well as, seasonal patterns in water quality. Because analyses of all heavy metals resulted in left-censoring of metals data at the laboratory detection limit (DL) (Table 4), one-half the detection limit (DL/2) was substituted for concentration values that were below detection limits (BDL) to estimate means, standard deviations and medians for each heavy metal parameter. This substitution method performs very well as a "first-look" at the estimation of means and standard deviations of censored data, but performs only roughly (up to 275% RMSE [2]) for estimation of medians (Gilliom and Helsel, 1986). The summary tables that were produced in Kehoe et al. (1990) are included again (Figures 2 through 13, and Appendix -- Tables A through Q) with minor changes, and the data were used to evaluate seasonal effects in this report. Statistical

[2] RMSE (ratio mean square error) or error rate is the ratio of the MSE of censored data with estimates for values BDL to the MSE of data had it not been censored in Gilliom and Helsel's, 1986 model calibration.

information in the Appendix tables include the mean, median, minimum, maximum, standard deviation, and variance calculated for each pond (rows) and for each sample date (columns) for each variable. After six ponds were dropped from the analyses, the evaluation of seasonal effects used data in the Appendix tables to produce line graphs (Figures 15 to 32) of untransformed means versus sample date (calculated using eighteen ponds with Lotus 1-2-3).

The application of SAS statistical software provided additional insights about existing trends in data. SAS Proc Means was also used to calculate annual means and date means (using 18 ponds). SAS Proc Univariate (W:Normal)[3] determined the normality of the distribution of date means and pond (annual) means (Tables 5 and 6, respectively). Means were then transformed, as necessary, to improve the normality of distributions of means, and to improve the validity of using parametric (normal distribution) statistics. The log 10 transformation was most often used to normalize data; however, identical results were achieved with the log e transformation. Other variable transformations that were tested included several positive and negative exponential functions (e.g., x^n and x^{-n}) (Ott, 1984). Because there were no zero values (due to censoring at values greater than zero) using log 10 (variable + 1) was not required, and the log 10 transformation provided the most uniform approximation to a normal distribution of the annual means and of the date means, except for date discharge frequency (DCHARGE1) (Table 5). A suitable transformation could not be found for DCHARGE1. Untransformed Fe, Mn, DO, pH, temperature and depth for the 11 date means were considered normally distributed (Table 5); Fe, Zn, DO, pH, temperature, and discharge frequency for the eighteen pond means were also normally distributed as untransformed variables (Table 6). Note that the square root of maximum depth (SQZMAXCM) provided the best transformation of the eighteen pond maximum depths (Table 6). While normally distributed variables were not transformed, they were standardized (mean = 0 and standard deviation = 1) in cluster analysis, to remove the effects of unit scale differences. Subsequently, SAS procedures employed transformed means when normality was improved.

SAS Proc Corr was used to produce the best Pearson Correlations for each variable using applicable untransformed and transformed variable means for dates (Table 7) and for ponds (Table 8). Statistically significant correlations ($p <= 0.10$) existed for most variables included in this report. A relatively high cut-off point ($p=0.10$) was frequently used to search for potentially important correlations. Although transformations for non-normally distributed data were used, most of the strong Pearson correlations existed for either transformed and untransformed data. Finally, SAS Proc Reg was used to conduct stepwise, multiple regression and examine inferences about linear relationships among variable means for dates and ponds (Tables 9 and 10, respectively). Other

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[3] (W:Normal approaching 1 with Prob<W = 0.10 (cutoff point) or greater and approaching 1.0, means do not reject Ho: a normal distribution)

multivariate statistical analyses of means using SAS included analyses of variable relationships with Proc Factor (Table 11) and Proc Varclus (Table 12), and analyses of pond relationships with Proc Cluster (Tables 13 and 14; Figures 43 and 44) to explore underlying relationships between variables and between ponds. These SAS procedures reduce the number of variables or ponds to a smaller number of clusters or common factors with similar or related members. Finally, SAS Proc Plot was used to graphically depict selected correlations (see **ADDENDUM**) between variable means. Graphs between variable date means are indicated by an asterisk (*); these plots are followed by graphs between pond annual means that are indicated by the letter associated with each pond. Also included in these plots are the Pearson correlation coefficient (r) and level of significance (p) of the correlation.

RESULTS AND DISCUSSION

PRELIMINARY RESULTS [4]

In early analyses of the data, exceedence of Florida Administrative Code (FAC), Chapter 17-302, Class III water-quality standards at the outfall[5] station of each pond was evaluated for each of the 24 ponds, for each of the 11 sample dates, and for all samples over the whole study. The results for all three stations (metals sampled at the outfall station only) are shown in the Appendix tables for each variable as a number (n) or percent (%n) less than (<) or greater than (>) the standard for a variable, as applicable. Rows correspond to ponds, columns correspond to sample dates (the first three dates are excluded from calculations), and totals for the entire study are summarized at the end of appropriate rows or columns in each table. Also, the number and percent of left-censoring (data below detection limit--BDL or <DL) is shown in the Appendix tables, when applicable.

The data were compared to state water-quality standards (Chapter 17-302, FAC) to identify exceedence of and compliance with standards, and to identify areas of further analysis and research. Table 3 provides a summary of 1989 water-quality standards for criteria that apply to state surface-waters, to drinking water supplies, and to sewage treatment plant (STP) discharge. Of particular interest are the Chapter 17-302, Class III standards (fishable/swimmable), because the stormwater management systems that were studied discharged to Chapter 17-302, Class III waters. In the absence of Chapter 17-302 Class III standards for manganese (Mn) and for total suspended solids (TSS), the Class II (shellfish) standard (for Mn) or an efficient sewage treatment plant's (STP) discharge concentration (for TSS) are compared. Also, Chapter 17-550 primary and secondary drinking water standards are included in Table 3 as a reference, for some parameters.

Table 4 is extracted from the Appendix, Tables A through Q. Table 4 provides a summary of the "median" annual <u>outfall</u> station concentrations and the percent exceedence (%E) of the applicable water quality standards for each parameter at each outfall station. Figure 2 summarizes Total %E by parameter and is based on values in Table 4. The median value was initially utilized as the better measure of central tendency for censored and possibly non-normally distributed data. Subsequent data substitutions (DL/2) and transformations (Log 10) to achieve normality allowed equally reasonable use of the "mean" (annual and date means) for variables. Never-the-less, the median provides a valuable measure of central tendency, and comparing the mean and median of

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[4] Preliminary results for the completed sampling schedule were published in the District's 1989-1990 Annual Report for the Stormwater Research Program (Kehoe <u>et</u> <u>al</u>., 1990)

[5] (Although some variables had data available from a second station within the pond, and from a limited number of receiving waters, only the outfall stations had metals data.)

variables (Appendix tables) gives an indication of whether the distribution of data is normal or skewed (McClave and Dietriech, 1982). In Table 4 outfall stations are arranged by decreasing pond size and also alphabetically by pond letter (Ltr), while columns are arbitrarily arranged by decreasing total percent exceedence (Total %E) of all water-quality standards. Total %E represents the percentage of times, for all sampling dates and for all twenty-four ponds, that a standard was exceeded for a specific variable. Note that the number of outfall stations that exceeded a standard one or more times (# Ponds) is also listed in Table 4.

The higher the Total %E (i.e., those standards more frequently exceeded) the greater the number of outfall stations (# Ponds) that exceeded standards for a variable (Table 4). For example, Zn had a Total %E of 30 percent and 21 outfall stations (87%) exceeded the Zn standard at least once, while Ni and Mn had only one pond that exceeded applicable Class III or II standards (Total %E < 1.0), respectively. However, when Total %E is less than about 10 percent, the relationship is less strict. Also, the relationship is strongest if only metals are considered. If only Chapter 17-302, Class III criteria are considered (Figure 2), total zinc was the most frequently exceeded standard (30%) and was followed closely by cadmium (18%) and copper (14%). All three are variables with greater than 10 percent exceedence of applicable standards. Except for lead (7%) all others had 5% or less Total %E. Although not strictly applicable, the dissolved oxygen (DO) standard was apparently one of the most frequently exceeded. Thirty-nine percent (Total %E = 39%) of the DO data was below the 24-hour mean standard (5.0 mg/L); 30 percent was below the 24-hour lowest allowable DO standard (4.0 mg/L).

DISCHARGE FREQUENCY

Table 4 summarizes the annual discharge frequency (DF) for each outfall station, but discharge frequency for each sample date is not shown. Discharge frequency was calculated in two ways (1) annually -- equal to the number of times a pond was discharging during the study period, and (2) seasonally by dates -- equal to the number of ponds discharging on a sample date (see Appendix, Table B). In Table B for discharge frequency, values under date columns are based on all twenty-four ponds, and may vary from values that are based on eighteen ponds. In either case (dates or ponds) discharge frequency is based on the percent (or number) of times that water was observed discharging through a control structure (i.e., either water flowing freely over the weir, or through a bleeddown pipe). The two discharge frequencies were compared to either date and annual means of other variables in graphical and statistical analysis with some interesting results.

Date discharge frequency demonstrates a distinct seasonal pattern that can be related to rainfall and bottom depth data, as well as, the data for several other variables. Annual, pond discharge frequencies were calculated for specific outfalls and ranged from zero (Pond R) to 100 percent (Pond U - with a known intermittent bleeddown due to a level-activated pump). Note that most outfalls (17) were discharging on at least 50 percent of sampling dates, that one control structure was never observed to discharge (Pond R), and that discharge data is missing for one outfall station (Pond I) (Table 4). Pond I was dropped from multivariate statistical analyses (see Operational and Structural Problems at Six Wet-Detention Ponds).

Discharge frequency is not a quantitative measurement. In using date discharge frequency as an indicator of water level and hydrologic conditions in ponds, the assumption is made that wet-season conditions (i.e., rainfall amounts and groundwater levels) affect the number or percent of ponds discharging on a given date. Also, because not all storm events could be sampled, annual pond discharge frequency is only a rough estimate of the number of times specific control structures discharged during the study. Nevertheless, the total discharge frequency (59% for all ponds on all dates) may be a good estimate for wet-detention ponds in the region, because the storm events and dry periods we sampled were typical of the study period and included a tropical storm and samples during more than 100 days of drought.

EXCEEDENCE OF STANDARDS WITHIN PONDS (%E)

Evaluation of exceedence of State water-quality standards in this report is fairly straight forward, and is based on whether samples exceeded specific standards. Although a valid distinction can be made in the data, samples collected when ponds were not discharging (about 41% of samples) were not deleted from this analysis of percent exceedence. This approach correctly presents the characteristic exceedences within ponds and for specific dates; however, specific State water-quality standards do not apply directly to stormwater ponds, even though the standards apply to discharge from stormwater ponds. Thus, the interpretation in this report should not be used to imply that exceedence of standards at one or two stations within the pond is equivalent to "discharging" water that exceeds standards, even though a relationship may exist. If a detention pond receives stormwater runoff but does not discharge, then it acts as retention pond and standards do not apply. While the evaluation in this report provides a useful comparison of water quality in stormwater ponds, future surveys should characterize the water-quality of discharge water and compare it with the water within stormwater ponds, providing a clear distinction between the two. The process of water flowing through a control structure could affect some parameters that may be influenced by water movement (dissolved oxygen and pH), that may be physically removed by skimmers (oils, greases and trash), that may settle (suspended solids and turbidity), and that are adsorbed or bonded to particles that settle such as nutrients, heavy metals, and pesticides (Stahre and Urbonas, 1990).

Dissolved Oxygen (DO)

The State water-quality standard for DO requires diurnal sampling to be strictly applicable; never-the-less, the data were compared to the standards for DO (Table 3). Eighteen outfall stations (Figure 3 and Table 4) and roughly 39 percent of all field measurements (Figure 2) (88 of 226 samples - Appendix, Table D) fell below the 24-hour-mean, DO standard (5.0 mg/L). A total of nine outfall stations had greater than 50 %E of the DO standard (Figure 3), all with annual medians below the DO standard (Table 4).

Although the 24-hour DO standards require diurnal (24-hour) sampling, valuable information was obtained by comparing single field measurements to the 24-hour-mean (5.0 mg/L) and the 24-hour-lowest allowable (4.0 mg/L) DO standards. Thirty-nine percent (88 of 226 = 39%) of outfall stations DO measurements were below 5.0 mg/L, and 30 percent (67 of 226) were below 4.0 mg/L (Appendix, Table D). Most exceedences of the 24-hour DO standard occurred in nine ponds (60% or more, below 5.0 mg/L) with heavily vegetated outfalls that probably reduced circulation near the outfall and enhanced build-up of organic material. One possible reason for low DO at some outfalls may be that measurements were generally recorded near the bottom, and probably near or below light extinction depth or beneath thick vegetative cover, in some ponds. Bottom DO is often lower due to the higher oxygen demand of organic sediments that leads to anaerobic conditions. Low DO at the bottom is often related to reduced light penetration and greater microbial respiratory activity than photosynthetic activity. Factors that may have caused DO to be lowered at these outfall stations include shallow depths, with channelization or constriction at the outfall that promotes vegetation, sedimentation, and stagnant water (i.e., a dead zone at the control structure). Also, surface-water and ground-water inputs of highly colored water may result in a lower DO concentration caused by demands for DO that are higher than DO supplies in colored stormwater ponds (i.e., possibly lower photosynthetic supply and higher respiratory demand in colored versus uncolored water). If ponds are designed with vegetation zones located so that a deeper, wider open-water zone is maintained immediately in front of the control structure, circulation and water movements that promote higher DO concentrations near the control structure, and reduction of the effect of sedimentation on DO concentrations would be more likely. Pond maintenance to exclude undesirable plant abundance and species, to remove built-up organic matter and sediments, and to maintain the open-water zone directly in front of the control structure is desirable (SWFWMD, 1988 and Stahre and Urbonas, 1990).

Six outfall stations never fell below 5.0 mg/L, and eight outfall stations never fell below 4.0 mg/L (five more fell below 4.0 mg/L only once). Possible common outfall station characteristics in the thirteen ponds with the least %E for DO included both less aquatic macrophytes and less organic matter accumulation in zones near control structures, water that was not highly colored, and mixing in the water column enhanced by fountains and open-water areas with less stagnant water due constriction or channelization near the outfall. Three ponds (Pond Q, Pond T and Pond R) had fountains that were frequently operating, and three (Pond F, Pond G and Pond M) had large, open-water areas. Fountains and open-water areas are factors that contribute to mixing and aeration of the water column, and that under the right conditions improve DO saturation. Studies have suggested the positive effects of shallow mixing (e.g., between the metalimnion and epiliminion -- photic zone), so that DO supply can meet DO demands above anoxic bottom layers in the water column (hypolimnion) and sediments (Boyd, 1979). Limnology texts suggest that the wind forces mixing and turnover in the water column, and may promote aeration and physical saturation of DO in the water column under the right conditions (Wetzel, 1975) (e.g., when at least some DO is available in bottom waters and the DO demand is equal or slightly less than the supply). In some cases rapid water-column mixing (e.g., mixing due to runoff events) when anoxic conditions exist below the epilimnion (especially in ponds that stratify and are characterized as eutrophic) could result in DO depletion throughout the water column, exceedence of standards in discharge water, and fish kills if fish are present. While a lack of vegetational canopy in large, open surface waters may promote algae growth and photosynthetic activity, increasing midday DO concentrations in the epilimnion, higher rates of photosynthesis may also increase DO demand during the night, and anoxic water layers below the photic zone. Also, diurnal DO fluctuations, as well as, depression of DO due to overcast weather are also well documented (Wetzel, 1975; and Boyd, 1979). Diurnal fluctuations probably had an effect on DO data for single grab samples collected at different times of day --between early morning (8:00 AM) and late afternoon (5:30 PM). Finally, a seasonal pattern in mean dissolved oxygen may be indicated for our data and is probably temperature related. Because of the interaction of many physical/chemical, biological, temporal/spatial and seasonal factors affecting DO in surface waters, the specific pond size, shape, depth and vegetation zones (i.e., stormwater system design) that will provide optimal DO concentrations can be determined on site by site basis.

Because the State DO standards are not strictly applicable to the data, caution should be used in the interpretation of Total %E for DO. Single samples prevented the calculation of the 24-Hour mean concentration, as well as, the determination of exact, lowest concentrations over a 24-hour period. However, single samples may give a good representation of particular outfalls when they are the only samples that are logistically possible. Because we sampled mainly during daylight hours and DO concentrations usually reach a low in the pre-dawn hours, using the 24-hour-mean DO standard would be more accurate for single, day-time samples. However, on some occasions samples were collected within a few hours of sunrise (Appendix - Table Q). The 24-hour-lowest allowable DO standard may be more appropriate for single early morning samples. Never-the-less, even with minimal data (one sample per day), 30% fall below the 24-hour lowest allowable concentration (4.0 mg/L).

During the 24-pond study, fish -- including mosquitofish (*Gambusia* sp.) and other livebearers (Family Poeciliidae), killifish (Family Cyprinodontidae), sunfish (*Lepomis* sp.), largemouth bass (*Micropterus salmoides*), suckers (Family Catostomidae), and at least two exotic species (Family Cichlidae) -- were observed in ponds that had suitable hydroperiods and other desirable habitat factors, indicating adequate DO in the water column. While numerous fish and invertebrate species can tolerate the DO levels encountered during the survey in the detention ponds, the extent and duration of anoxic conditions in the study ponds were not measured. The synergistic effects of anoxia on the toxicity of heavy metals and other pollutants (to fish) have been reported (Irwin, 1988). A detailed evaluation of the habitat value (e.g., water quality and habitat availability) for fish and invertebrates would be useful information, especially for urban, water-resource managers and agencies, that are interested in biological control of insects (mosquitos) and plants, or that promote wildlife utilization of stormwater ponds.

Zinc (Zn)

An essential micronutrient for freshwater flora (Wetzel, 1975), zinc is a common constituent of urban runoff (up to 50% coming from highway runoff in some areas), and one of the Environmental Protection Agency's (E.P.A.) 65 priority pollutants. Zinc was detected in 94 percent of the samples (88 of 94 samples) in EPA's National Urban Runoff Program (NURP) (E.P.A., 1983). A micronutrient for humans and animals, in mammals excess zinc levels may cause copper deficiencies, may interfere with iron metabolism, and may interact with lead and drugs (Irwin, 1988). Sources of zinc in stormwater runoff included petroleum products, antifreeze, undercoating and galvanizing, brake linings, rubber, asphalt and concrete (Whalen and Cullum, 1988). Atmospheric sources of zinc and other metals are indicated by recent rainfall data in the Tampa Bay Region (Rushton 1992 -- in review) and are suggested for most heavy metals and trace elements (wetfall and dryfall) (Arimoto and Duce, 1987).

None of the annual medians for zinc were below the detection limit (BDL), and only 22 percent of the samples (55 of 248 samples) were less than the zinc detection limit (0.005 mg/L). A large number of outfall stations (21) (Figure 4 and Table 4) and 30 percent of the grab samples (Figure 2) (74 of 248 samples - Appendix, Table I) exceeded the zinc standard (0.03 mg/L). Three outfall stations that had greater than 50 %E also had annual medians greater than the zinc standard (Pond N, Pond O and Pond T); 21 outfall stations had less than 50 %E, and 14 outfall stations had less than 30 %E. Most of the outfall stations that exceeded the zinc standard did so more than once, except Pond D, Pond G and Pond V (Appendix, Table I). Only three outfall stations complied with the zinc standard on all sampling dates (Pond F, Pond J and Pond P).

Zinc was probably the most problematic heavy metal measured during the study, with 30% of all samples exceeding the Chapter 17-302, Class III zinc standard and originating from 21 of 24 outfall stations. Ten outfalls exceeded the zinc standard in 36% or more of samples; fifteen outfalls exceeded the zinc standard in 27% or more of samples. The three outfalls that never exceeded the zinc standard were heavily vegetated, yet six other heavily vegetated outfalls exceeded the zinc standard 3 or more times. Of the outfall stations that exceeded the zinc standard only once, one pond was highly vegetated (Pond V), one was a cypress dome (Pond D), and one was without any vegetated zones (Pond G). The relationship, if any, between zinc levels (as well as other heavy metals) and vegetation in this survey is thus unclear at this time.

On five of eleven sample dates, 40% or more samples exceeded the zinc standard; on one date 75% of samples (18 of 24) exceeded the zinc standard. In contrast, on five sample dates less than 15% of samples exceeded the zinc standard. Higher means and more exceedences of the zinc standard on specific dates, suggests the possibility for an atmospheric source of zinc or a seasonal effect that may be related to changes in water levels, rainfall amounts and antecedent periods, wind-induced mixing, or internal cycling. In the summer of 1990, zinc was detected in 20 of 22 (91%) of rainfall samples during an intensive study of wet-detention treatment in Pond S, during which mass balances of substances were determined. The mean instantaneous rainfall zinc concentration was 0.045 mg/L with rainfall zinc concentrations ranging from 0.016 to 0.201 mg/L (Rushton 1992 -- in review). Also, 12 of the 22 storms (55%) and the annual mean exceeded the State standard (0.03 mg/L) (Chapter 17-302, FAC). The mean removal efficiency for zinc was 42%, calculated as an average reduction of the event mean concentration (EMC) (a mass balance measurement) of zinc from 0.051 mg/L at the infall to 0.03 mg/L at the outfall. The infall EMC exceeded the outfall EMC for only 2 of the 22 storms (9%) (Rushton 1992 -- in review). The effect of dry fall on the concentration of zinc and other metals in stormwater ponds was not determined, however. More recently, zinc was detected in 16 of 32 rain events (50%) from May 20, 1991 to October 9, 1990 during an intensive study of a wetlands-treatment system north of Tampa, Florida. Only 2 of 32 instantaneous rainfall samples (6%) exceeded 0.03 mg/L, however (Betty Rushton[6], unpublished). Besides rainfall, numerous other sources are known (Whalen and Cullum, 1988). Because the majority of the 24 ponds and 30 percent of outfall station samples in this report exceeded the zinc standard (Total %E = 30), zinc should remain a source of concern in stormwater projects at the District.

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Cadmium (Cd)

Based on evidence in literature, Irwin (1988) stated that cadmium can be toxic to fish and wildlife species, causing behavioral, growth, and other physiologic problems even at sublethal levels. Furthermore, Irwin (1988) reported that cadmium bioaccumulates, especially in benthic species when the sediments have been contaminated, and that cadmium acts as a cumulative poison. Cadmium is one of E.P.A.'s 65 priority pollutants and one of the 25 hazardous substances posing a threat to human health at priority Superfund sites, and the list of toxic effects of cadmium on mammals is fairly long (Irwin, 1988). Air pollution sources are numerous, as are nonpoint sources (Irwin, 1988). Some major sources of cadmium found in stormwater runoff include petroleum products and rubber (Whalen and Cullum, 1988).

The bioavailability and toxicity of metals (in fish) are affected by temperature, pH, organic and inorganic ligands, and hardness. Hardness, alkalinity and pH are related through the carbonate-bicarbonate buffer system; hardness and alkalinity are reported in milligrams per liter as $CaCO_3$. While temperature and pH directly affect the rate at which metal ions are complexed by various ligands and by carbonate ions, hardness indirectly affects metals toxicity. Through antagonistic mechanisms, calcium and magnesium ions associated with hardness interfere with metals uptake by competing for uptake sites on cells of the gill membrane in fish (Davies, 1986). Generally, higher total hardness levels result in higher pH and alkalinity levels. As hardness increases, metals toxicity decreases and higher concentrations or longer exposures to specific concentrations of metal ions may be required to yield a given acute or chronic toxic response in fish. For the Chapter 17-302, Class III cadmium standard, the hardness cutoff point is 150 mg/L (as $CaCO_3$). Above 150 mg/L, the cadmium standard is 0.0012 mg/L; however, below 150 mg/L, the cadmium standard is 0.0008 mg/L (Table 3).

Calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions -- the main constituents of hardness in most waters -- are usually derived from carbonate minerals, which are also the major sources of alkalinity (e.g., HCO_3^-) (Boyd,1979) and very abundant throughout Florida (Canfield and Hoyer 1988). Combined concentrations of Ca^{2+} and Mg^{2+} are often similar to the combined concentrations of HCO_3^- and CO_3^{2-}, and total hardness will be nearly equal to carbonate hardness. In such conditions hardness and alkalinity may vary together within an individual water body and between surface waters. If CO_2 is present, CO_2 reacts with Ca and Mg carbonates in water yielding Ca^{2+} and Mg^{2+} and HCO_3^- (Boyd, 1979). HCO_3^- has the property of either an acid or a base, but most often reacts like a base to yield water and CO_2 when H^+ is added. Similarly, CO_3^{2-} is a stronger base than CO_2 is an acid; CO_3^{2-} hydrolyses to give OH^- (Boyd, 1979). In many waters, an increase in HCO_3^- and CO_3^{2-} elevates equilibrium pH levels as total hardness increases. Thus, higher pH values might occur in waters with geological characteristics that contribute Ca and Mg carbonates. Canfield and Hoyer (1988) described the statewide areal variation of chemical constituents in surface waters, and noted that pH and most other constituents (including alkalinity and hardness) generally increase from northwest to southeast across Florida, and from upland to more lowland physiographic regions. The main source of the variation was attributed to regional surface geology and physiography, agreeing with studies from other regions in this regard (Canfield and Hoyer 1988). In contrast, pH values may fluctuate diurnally with photosynthesis; and, in soft waters (low in Ca and Mg carbonates) or in hardwaters (dominated by cation others than Ca and Mg) with high nutrient inputs, widely fluctuating CO_2, pH, and alkalinity levels could occur.

Hardness and alkalinity were not measured during this survey, so whether the ponds were hardwater (>150 mg/L as $CaCO_3$) or softwater (<150 mg/L as $CaCO_3$) in character was uncertain. For discussion in this paper, the higher, hardwater standard for cadmium (Chapter 17-302, Class III = 0.0012 mg/L) was used. However, recent data from an ongoing stormwater survey indicates that hardness may be quite variable within and between stormwater ponds in the Tampa Bay region. Total hardness values ranging from 0.0 to over 200 mg/L as $CaCO_3$ have been recorded (M. Kehoe unpublished[7]). As in many Florida lakes, hardness in wet-detention ponds probably varies depending on the regional surface geology and physiography (Canfield and Hoyer 1988). However, the effects of water-level fluctuation, the influx of ground-water, and to some extent the effects of internal cycling and primary production are several factors that may affect the concentrations of calcium and magnesium carbonates (Wetzel, 1975). Recently revised State of Florida water-quality standards, base heavy metals standards on a calculation using the natural log of total hardness in a surface waters (Florida Administrative Code, Chapter 17-302, 1992).

Note that median cadmium values were below the method detection limit (BDL or <) of the laboratory (0.002 mg/L) for every outfall except Pond I (Table 4), and that 82 percent of grab samples (186 of 226 samples) were BDL for cadmium (Table N). Even though 23 of 24 annual medians were BDL, whether or not the cadmium standard was exceeded in samples when cadmium levels were BDL is unknown, because the standards (0.0008 and 0.0012 mg/L) are also less than 0.002 mg/L. In fact, cadmium may be present at levels between 0.0012 mg/L and 0.002 mg/L (i.e., less than the detection limit and exceeding the standard). Because the cadmium Chapter 17-302, Class III standard is less than the DL, cadmium was in exceedence of its standard whenever values occurred above its DL. Consequently, cadmium may have been in exceedence even when concentrations were less than the DL and probably more often than reported here. Most of the outfall stations (20 of 24) (Figure 5 and

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Table 4) and 18 percent of the grab samples originating from 20 of 24 outfall stations (Figure 2) (40 of 226 samples - Appendix, Table N) clearly exceeded the cadmium standard for fresh, hardwater (0.0012 mg/L). Twelve outfalls stations clearly exceeded the cadmium standard two or more times. Thus, only four outfalls never exceeded the cadmium standard, but data below the cadmium detection limits adds uncertainty to this assessment. Most cadmium exceedences occurred on two sampling dates, one during a dry period (6-7-89) and one during a more rainy period (12-19-89), each with 13 of 24 outfalls exceeding the cadmium standard.

Like zinc, an atmospheric source of cadmium or a seasonal effect that may be related to changes in water levels, rainfall amounts, wind-induced mixing, or internal cycling may be involved. During the summer of 1990 intensive study at Pond S, cadmium was detected in 7 of the 22 rain events (32%) (Rushton 1992 - in review). Because standards are below the detection limit, all detectable concentrations exceeded the cadmium standard (0.0012 mg/L). The cadmium removal efficiency of Pond S was not determined, because of the high percent of samples below detection limits for cadmium; however, the outfall event mean concentration (EMC) exceeded the infall EMC for 5 of 8 storms (63%) indicating that the removal efficiency was probably negative and that more cadmium exited than entered Pond S for the 5 storms (Rushton 1992 - in review). In the 1991, intensive study of a wetlands treatment system (near Tampa, Florida), cadmium was detected in 13 of 32 rain events (41%) between May 20 and October 9, 1991. All exceeded the cadmium standards (0.0008 mg/L and 0.0012 mg/L), which were below detection limit (0.002 mg/L). Removal efficiencies for the wetlands treatment system have not been calculated, however (Rushton unpublished). Other anthropogenic sources of cadmium are common and most are related to automobiles, fossil fuels, and combustion of fossil fuels (Whalen and Cullum, 1988).

The cadmium data from the 24-pond survey were difficult to assess, because most of the data (82%), as well as, the Chapter 17-302, Class III freshwater cadmium standard (0.0012 mg/L) were below the detection limit (0.002 mg/L). A total 18% of samples clearly exceeded 0.002 mg/L. The analysis would be equally vague (most data below DL) even if wet-detention ponds were assumed to be softwater in character or of mixed hardness. The 1989, Class III standard for cadmium was lower in softwater (0.0008 mg/L in hardness < 150 mg/L as $CaCO_3$) than in hardwater (0.0012 mg/L in hardness > 150 mg/L as $CaCO_3$); however, the need exists for more sensitive analytical methods for cadmium. Also, including the analysis of total hardness would have allowed the application of specific soft-water and hard-water cadmium standard (Chapter 17-302, Class III), and provide additional information for understanding the analysis of heavy metals in stormwater runoff. The remaining Chapter 17-302 exceedences were less difficult to interpret than cadmium, because the standards are above the DL. Because exceedence of the cadmium standard occurs for the majority of ponds, and

Total %E approaches 20 percent (and is probably higher), cadmium should remain a source of concern and investigation in District stormwater projects.

Copper (Cu)

A commonly used metal and one of E.P.A.'s 65 priority pollutants, copper is also an essential dietary element (Irwin, 1988) and an essential micronutrient for freshwater flora and fauna (Wetzel, 1975). The toxic properties of copper by itself are usually the result of high concentrations; however, copper bioaccumulates, and increased toxicity will also occur synergistically in the presence of ammonia, cadmium and zinc (Irwin, 1988). Sources of copper in stormwater runoff include petroleum products, antifreeze, brake linings, asphalt, concrete and engine wear (Whalen and Cullum, 1988). Also, copper compounds are commonly used in herbicides and algicides, which may be a source of copper in urban stormwater ponds where a balance of aquatic plants is desirable and the aesthetic appeal of ponds is important. The exact number of ponds that received herbicides or algicides and the frequency of application during the survey was unknown. If a permit requires creation of a littoral zone (i.e.; for biological treatment or as mitigation for wetland loss), the creation of a balanced plant community may also require removal of exotic and undesirable species for the first three years (SWFWMD, 1990); however, the method of maintenance (e.g., herbicides, algicides or physical removal) is not usually specified and is assumed to be carried out by the pond owner having necessary permits.

Only seven outfall stations had annual medians above the DL for copper, and 58 percent (142 of 246 samples - Table K) of grab samples were less than the copper detection limit (0.01 mg/L). All of the outfall stations had less than 50 %E of the copper standard (two had 45 %E); therefore, none of the outfall stations had annual medians above the copper standard. Eighteen outfall stations (Figure 6 and Table 4) and 14 percent of grab samples originating from 18 of 24 outfall stations (Figure 2) (34 of 246 samples - Appendix, Table K) exceeded the copper standard (0.03 mg/L). Thus, samples from six outfalls never exceeded the copper standard; three of these outfalls were heavily vegetated (Ponds C, J and V) . Nine outfalls exceeded the copper standard two or more times; two outfalls exceeded the copper standard 5 times each (Ponds F and T). A third outfall had three exceedences of the copper standard (Pond V). While vegetation appeared to be impacted occasionally at Ponds F, T, and others, whether or not herbicides containing copper were used was unknown. Exceedences of the copper standard occurred mostly on three dates, one in a dry month and two during rainy months. The mean copper from the one dry period sample date was about 33% and 47% higher than the means from two wet-period dates. The general seasonal pattern in mean copper and number of exceedences of the copper standard may indicate an inverse water-level (seasonal) effect or increased herbicide treatments -- especially on one dry period date. Recent rainfall data from other stormwater studies conducted by the District suggest the latter two factors are more likely to be sources of copper than rainfall. 1990 rainfall data for Pond S (Rushton, 1992 -- in review) and 1991 data for a wetlands treatment system (B. Rushton, unpublished) indicate that rainfall is not a major source of copper. Copper was detected in only 3 of 21 storms (14%) in 1990, and only 1 of 21 storms (4.8%) in 1991. None of the samples exceeded the Class III copper standard (0.03 mg/L). Although rainfall appeared to be insignificant as a copper source, other copper sources are numerous (Whalen and Cullum, 1988). Because most of the ponds and about 14 percent of samples exceeded the Chapter 17-302, Class III copper standard, copper should also remain a source of concern and investigation in District stormwater projects.

Total Suspended Solids (TSS)

There is no established Chapter 17-302 standard for TSS; therefore, TSS concentrations reported for efficient secondary sewage treatment plants (2' STP) (Randall et al., 1982) were used for comparison (20 mg/L - Table 3). Only one outfall station had a %E of the 2' STP standard greater than 50 percent (73 percent - Pond R), thus Pond R was the only outfall station with an annual median greater than 20.0 mg/L (Figure 7). Nine outfall stations (Table 4 and Figure 7) and roughly 10 percent of grab samples originating from 9 of 24 outfall stations (Figure 2) (22 of 225 samples - Appendix, Table G) exceeded the 2' STP effluent standard. Thus, samples from 15 outfalls never exceeded the 2' STP standard for TSS. Pond R with 8 of 11 samples (73%) greater than 20.0 mg/L TSS standard, accounted for 36% (8 of 22) of all TSS exceedences. One other outfall (Pond H) exceeded 20.0 mg/l on 4 of 11 dates, three outfalls (Ponds N, O and T) had 2 exceedences, and four outfalls (Ponds B, E, F and G) exceeded the TSS standard once.

The water level in Pond G dropped steadily after March 2, 1989. Acting as a "retention" pond for the remainder of the study, Pond G was dropped from analyses that followed analysis of percent exceedence (see Operational and Structural Problems at Six Wet-Detention Ponds). Pond G (TSS %E = 25) and two others, Pond R (TSS %E = 73) and Pond T (TSS %E = 22) had limited or no aquatic macrophytes. The outfall stations of two more were either dry and not sampled (Pond O, TSS %E = 40), or were so shallow that when samples were collected they contained organic material (Pond E, TSS %E = 11). One pond (Pond N, TSS %E = 18) was influenced by tidal backflow from the receiving water high in "dissolved" solids that appeared to directly influence (elevate) the measurement of "suspended" solids (note TSS and Specific Conductance for Pond N, Appendix Tables G and F, respectively); the pond was subsequently dropped from further analyses because of the backflow problem. Finally, one pond (Pond F, TSS %E = 9) was large and well-vegetated. TSS values were generally low in this pond, and exceeding the 2' STP value one time (11-01-89) may have been due to excessive organic material in the sample (Appendix, Table G). Another pond (Pond B, TSS %E = 9) was also large and vegetated, but several of the Pond B samples were high in TSS besides the one sample when the 2' STP concentration was exceeded. This may have been due to construction activities which were occurring adjacent to the pond during the study period. The source of TSS in samples was probably both inorganic and organic in nature (i.e., soil particles and algae, respectively). The extent of organic solids depends upon the trophic state characteristics of ponds and their drainage areas. Also, the seasonality of mean TSS during the 24-pond survey was not distinct; although, the onslaught of summer rains may have had a dilution effect on ambient suspended solids concentrations in the survey ponds.

Studies and reports suggest that the reduction of suspended solids improves with increasing detention times (Whipple, 1979; Whipple and Hunter, 1981). Pretreatment basins or deeper sedimentation zones are also recommended (SWFWMD 1990). Also, the potential benefit of properly maintained vegetational zones (e.g., located away from the outfall) for the reduction of suspended solids, nutrients, and other constituents (bound to solids) has been suggested from studies that evaluated wetlands for additional treatment of treated sewage effluent (Shih, 1981) and for treatment of industrial wastewater (Fetter et al., 1978). Although not strictly comparable, the "event mean concentrations" (EMC) of TSS reported by Whalen and Cullum (1988) for different land uses are generally much higher than the "annual means and medians" at the outfall stations during the 24-pond survey. Also, EMC's are based on flow-related pollutant loadings over the runoff hydrograph for a given rain event, and not on intermittent single samples over the duration of a study. Fifteen of the wet-detention ponds we surveyed did not exceed the 2' STP standard. About 10 percent of samples exceeded the STP standard, but exceedences occurred at less than half (9) of the ponds.

Although there was no current Chapter 17-302 standard to exceed during the survey, and we did not measure inputs and outputs, the 1990 intensive study of Pond S (Rushton 1992 -- in review) reports mean TSS removal efficiencies of 57%, with the mean infall TSS (EMC = 27.35 mg/L) much higher than the mean outfall TSS (EMC = 11.81 mg/L). Similar removal efficiencies are being observed in another intensive study being carried out by the District, in a wetlands treatment system north of Tampa. Infall TSS concentrations ranging from 8.03 to 40.29 mg/L (EMC) and outfall concentrations ranging from 0.58 to 6.21 mg/L (EMC) have been recorded (Rushton unpublished). Data from the District's 24-pond survey, from the District's intensive studies, and from studies elsewhere indicate the general effectiveness of wet-detention systems as sedimentation basins. Finally, while TSS generally did not appear to be a problem in the twenty-four ponds during the survey, the relationships between TSS and other variables (e.g., heavy metals and nutrients) reported in the literature warrants continued measurement of TSS in District stormwater projects.

Lead (Pb)

The toxic effects of lead to animal and human life has been a well documented and important concern for many years. Lead toxicity includes acute, chronic, bioaccumulative and synergistic effects on survival, growth, learning, reproduction, development, behavior and metabolism (especially concerning children). Like cadmium, lead is both, one of E.P.A.'s 65 priority pollutants and among the 25 most hazardous substances at Superfund sites (Irwin, 1988). Sources of lead in stormwater runoff include petroleum products, auto emissions, undercoatings, brake linings, rubber and concrete (Whalen and Cullum, 1988).

Sediment core studies in the Great Lakes region report that lead levels above background concentrations probably occurred in the mid-1800's, corresponding to rapid industrial growth in North America. Dramatic increases in lead deposition also corresponded with the 1920's, and resulted from rapidly increasing use of the automobile and leaded gasoline. With the introduction of unleaded gasoline in the 1970's, decreasing lead in sediment cores is expected; however, sediment analysis resolution is not sufficient to reveal a decrease in lead from recent cores (Charles and Hites 1987).

None of the annual median concentrations exceeded the lead standard, and all annual medians for ponds were less than the detection limit for lead (0.01 mg/L - Table 4). Fifteen outfall stations (Table 4 and Figure 8) and roughly 7 percent of the grab samples originating from 15 of 24 outfall stations (Figure 2) (17 of 246 samples -- Appendix, Table M) exceeded the lead standard (0.03 mg/L). Thirteen outfalls exceeded the lead standard only once, and two outfalls had two exceedences (Pond E and Pond Q -- Appendix, Table M). Thus, samples from nine outfalls never exceeded the lead standard. The highest outfall station annual "mean" was 0.034 mg/L at Pond S, at least 10 times less than EMC values reported for lead in the NURP report (Whalen and Cullum, 1988). Rainfall lead data were not available for the 1990 intensive study of Pond S (Rushton 1992 -- in review); however, rainfall analysis for lead in the 1991 wetlands intensive study showed lead in only 1 of 32 storms (B. Rushton unpublished). The concentration (0.06 mg/L) exceeded Chapter 17-302 (FAC) standard for lead (0.03 mg/L).

Most lead exceedences occurred on three dates, two during wet periods and one during a dry period (Table M -- Appendix). The remaining eight dates had one (three dates) or zero (five dates) exceedences of the lead standard. Nearly half of all lead exceedences (7 of 17) occurred on one sample date when 29% of samples exceeded the lead standard (12-19-89). The general seasonal pattern for lead might show an inverse water-level effect. While rainfall did not appear to be a significant source of lead during the District's intensive study of a wetlands treatment system, an atmospheric source of lead in dryfall was not evaluated and may occur. Note the winter peaks that are nearly an order of magnitude higher than other sample dates (Figure 29). Greater automotive activity and subsequent dry fallout containing lead during the winter tourism period is a possibility that may increase lead levels in surface waters, including stormwater ponds. Another possible cause of higher mean lead concentration for the two winter dates (in December 1988 and 1989) is winter turnover and mixing of anoxic bottom waters with surface water resulting in resuspension of sediment bound lead. Also, the death of aquatic macrophytes could be a source of metals, depending on the degree that macrophytes uptake metals and release metals after dying. Although most of the data (83% -- 204 of 246 samples, Appendix, Table M) are below the lead detection limit (0.01 mg/L) and only a few samples exceed the Chapter 17-302, Class III standard for lead, over half the ponds (15) exceeded the standard at least once. Because of its bioaccumulative and extreme toxicity, lead should continue to be a subject of investigation in District stormwater projects.

Specific Conductance

Specific conductance is the reciprocal of specific resistance; a measure of electrical flow resistance for a solution (Wetzel, 1975). Resistance decreases and the conductance of a solution increases as the concentration of dissolved solutes capable of carrying electrical flow increases. Thus, specific conductance reflects the concentration of dissolved solutes and electrical flow capacity of water. Specific conductance levels (Appendix, Table F) in this survey were well below the Chapter 17-302 standard for freshwater (1.275 mmhos/cm -- Table 3). All outfall stations were in compliance with the standard except one (Pond N --Table 4) which received tidal influx on a regular basis and can not be considered freshwater; therefore, Pond N was dropped from subsequent statistical analyses (see Operational and Structural Problems at Six Wet-Detention Ponds. Pond N's annual median specific conductance value exceeded the twenty-three other outfall stations by two orders of magnitude. The twenty-three freshwater outfall stations were one order of magnitude below the Chapter 17-302 standard (Table 4). The Total %E of 4.9% (11 of 226 samples) (Figure 2 and Table 4) was due entirely to Pond N. Except for Pond N, specific conductance did not appear to be a problem in the stormwater ponds included in the survey. However, mean specific conductance appears to demonstrate a seasonal pattern, and may be higher for coastal areas (Pond A, Pond F and Pond R), for sites built on fill material of marine origin (Pond S), and for sites with ongoing construction (Pond B).

Iron (Fe)

The primary sources of iron in surface waters include soil erosion, urban runoff (e.g., engine wear), and industrial discharges; iron also leaches from municipal landfills. Little is known about the toxic effects of iron on fish and their predators (Irwin, 1988). Iron is a major nutrient for mammals, and essential to the oxygen carrying hemoglobin molecule. Iron is also an essential micronutrient for freshwater flora and fauna (Wetzel, 1975); however, potable water supplies that are heavily laden with iron can be annoying to consumers (Irwin, 1988).

Eight outfall stations (Table 4 and Figure 9) and only 4.5 percent of the grab samples originating from 8 of 24 outfall stations (Figure 2) (11 of 247 samples - Appendix, Table J) exceeded the Chapter 17-302 iron standard (1.0 mg/L - Table 3). Thus, samples from 16 outfalls never exceeded the iron standard, only one outfall station exceeded the iron standard more than once (4 times at Pond G). All the outfall stations had less than 50 %E; the largest %E was 44 percent at Pond G. Only two of the grab samples (2 of 247 = 0.81%) and none of the outfall station annual median iron concentrations (Table 4 and Appendix--Table J) were less than the DL for iron (0.02 mg/L). Because less than half the ponds and only eleven samples exceeded the Chapter 17-302, Class III iron standard, iron does not appear to be a problem in the wet-detention ponds included in the survey. Never-the-less Fe-nutrient internal cycling (Armstrong et al., 1987) and Fe-Mn distributions in relation to other trace metals (Murray, 1987) remain important areas of limnological investigation, and potentially important mechanisms in stormwater ponds.

After an initial decrease on December 13, 1988, mean iron concentration increased steadily through the dry season (until June 7, 1989) probably due to solute concentration or increased groundwater influence as water levels dropped. After June 7, 1989 the general downward trend for mean iron is probably due to dilution from increased rainfall, but mean iron alternates up and down. The fluctuation observed for mean iron during this period may be due to internal cycling of iron in ponds, variable groundwater inputs, or perhaps varying amounts of iron in rainfall. Iron was detected in rainfall at concentrations ranging from 0.10 to 0.11 mg/L (Rushton 1992 -- in review), and ranging from 0.02 to 0.21 mg/L (B. Rushton unpublished) during the District's 1990 and 1991 intensive studies.

Turbidity

Five outfall stations (Table 4 and Figure 10) and only 4.4 percent of grab samples originating from 5 of 24 outfall stations (Figure 2) (10 of 228 samples - Appendix, Table H) exceeded the Chapter 17-302 turbidity standard (29 NTU - Table 3). Thus, nineteen outfalls never exceeded the turbidity standard. Three outfalls exceeded the turbidity standard just one time (Ponds H, O and S); however, one outfall exceeded the standard three times (Pond R), and one outfall exceeded the standard four times (Pond G). Overall, turbidity measurements did not appear to be excessively high, except perhaps for Pond G and Pond R. Of the five outfalls that exceeded the turbidity standard shallow depth (Ponds O and S), lack of vegetation (Ponds G and R), clay soils (Ponds G and H), construction activity (Pond H), wind-blown particles from a fill dirt operation (Pond H), and high levels of algal productivity (Ponds G, H, R and S) were all probable factors that may have increased the turbidity of samples. One outfall station (Pond G) exceeded the standard on all four occasions that it was sampled; the annual median for Pond G was almost twice the standard. However, Pond G ceased to operate as a wet-detention system early in the survey (March 1989), after cumulative water-level drops of about five to seven feet (below the control structure). Thereafter, Pond G functioned as a large, retention pond; it received stormwater, but did not discharge to the adjacent cypress dome as designed. The water in Pond G and nearby Pond H always appeared cloudy (probably due to clay soils) and green in color (probably due to algal production). The cause of Pond G's extreme water-level decreas remains in question, and it was dropped from further statistical analyses.

Except for Pond G and possibly Pond R (neither was observed to discharge during the period of analysis), turbidity levels did not appear to be a major concern for the ponds in the survey. However, inverse relationships between log mean turbidity (LOGTURB) and water-level (DCHARGE1) (Tables 7 and 8), between (LOGTURB) and maximum depth (SQZMAXCM) (TABLE 8), as well as, other correlations with turbidity (LOGTURB) in Table 7 (LOGNIU, LOGCOND_K) and in Table 8 (LOGTSSU, IRON1 and PH) appear to be significant. As a measure of fine suspended matter, turbidity measurements should continue to be analyzed during stormwater projects in order to explore relationships with metals, nutrients and other variables.

pH

pH is important in trace metals speciation and mobility (Murray, 1987). As pH values are lowered, the more acidic environment makes some metals more mobile and more toxic. Low pH has been correlated with elevated mercury accumulation in fish (Irwin, 1988). The effects of elevated pH should logically have the reverse effect. Like hardness, alkalinity, redox potential and several other variables, pH can provide valuable information during studies concerning heavy metals (e.g., copper in this report).

The evaluation of whether or not pH values in a surface water of the state violates Chapter 17-302 standards, requires knowledge of "natural background" pH in receiving waters. The discharge of stormwater should not cause a change in the pH of receiving waters; however, rainfall alone can induce, short-term changes in the pH of surface waters (including stormwater ponds, Rushton unpublished). The analysis in this report interprets pH changes within the ponds in order to approximate the potential for discharges to cause pH changes in receiving waters. Median outfall pH ranged from 6.52 to 8.10 (Ponds J and P, respectively); the lowest outfall pH recorded during the survey was 5.75 (Pond J) and the highest was 9.25 (Pond M). Receiving water median pH ranged from 5.07 to 7.55 (Ponds G and L, respectively); the lowest receiving water pH was 4.70 (Pond G) and the highest was 8.70 (Pond A). The natural variability of pH is evident from the data (Table E - - Appendix). Differences of 1 or 2 pH units were observed at 18 outfalls and 13 receiving waters; however, the data provide no evidence that changes in receiving water pH resulted from discharges of stormwater from the survey ponds.

Exceedences of the Chapter 17-302 standard for pH "within ponds" have been reported here based on fluctuations from the natural background level as equated to the annual median pH value for each outfall station. If employing the "median" pH as natural background for a specific outfalls is plausible, then about 3.1% (7 of 227 samples - Appendix, Table E) of pH measurements were exceedences of the Chapter 17-302, Class III pH standard. The exceedences of the pH standard occurred at 7 of 24 outfalls (Table 4 and Figure 11) each with only one exceedence, and were based on the median outfall pH +/- 1.0 pH units, if the median pH was between 6.0 and 8.5. However, if median outfall pH for a specific pond was less than 6.0, then the pH standard was exceeded if the pH on a given sample date fell below the median or exceeded the median by more than 1.0 pH units. If median pH was greater than 8.5, then the pH standard was exceeded if the pH on a given sample date was greater than the median or fell below the median by more than 1.0 pH units. Seventeen outfall stations never exceeded the pH standard; therefore, due to the infrequency of pH exceedences, pH does not appear to have been a problem in the survey ponds. Although they did not constitute actual exceedences in receiving waters induced by discharge of stormwater, the data help to establish an understanding of natural background pH in stormwater ponds. The information about pH in stormwater ponds will be useful in future assessments of water quality. Because of the importance of pH in metals speciation and solubility, and because pH fluctuates diurnally and seasonally, pH measurement during stormwater projects is essential to describing wet-detention pond water-quality.

Chromium (Cr)

Chromium is another metal on E.P.A.'s list of 65 priority pollutants, and is on the list of 25 most hazardous pollutants at Superfund sites. Chromium is also considered one of the 14 most toxic heavy metals. Valence state has control over the extent of chromium toxicity; trivalent and hexavalent species are most toxic. Known chromium sources include several metal plating industries and a variety of chemical, photography, scrap metal, machine shop, power plant, and industrial facilities (Irwin, 1988). Elevated chromium levels have been found in sewage sludge and in municipal landfill leachate (Irwin, 1988). Major sources of chromium in stormwater runoff are brake linings and engine wear (Whalen and Cullum, 1988). Chromium was not detected in rainfall during 1991 storms during the intensive study of a wetland-treatment system (B. Rushton unpublished); therefore, rainfall may not be a significant source of chromium.

Six outfall stations (Table 4 and Figure 12) and only 3.3 percent of grab samples (Figure 2) (8 of 246 samples - Appendix, Table O) exceeded the Chapter 17-302 chromium standard (0.05 mg/L). Two outfall stations exceeded the chromium standard two times (Pond N and Pond T) and four others one time each (total of eight exceedences), so the highest %E was for Pond N and Pond T (18 percent). None of the annual chromium medians exceeded the standard and nineteen annual medians were less than the DL; 82 percent of grab samples (201 of 246 samples--Appendix, Table O) were less than the DL. Although chromium levels do not appear to have posed a problem in the wet-detention ponds that were surveyed, due to its extreme toxicity, periodic measurement of chromium in District stormwater projects is still warranted in order to monitor chromium levels along with other heavy metals. Periodic tests (e.g., quarterly) for metals, pesticides and other substances would help establish a data base to document changes in levels of specific substances in stormwater ponds over time. Also, despite the data being greater than 80 percent BDL, mean chromium may demonstrate a seasonal pattern.

Nickel (Ni)

Nickel is an abundant metal in the crust of the earth, and is another metal on E.P.A.'s list of 65 priority pollutants, and on the list of 25 most hazardous pollutants at Superfund sites. Nickel (considered one of the 14 most toxic heavy metals) was reported to be carcinogenic to several mammals in experimental doses, and it is found in asbestos (Irwin, 1988), perhaps contributing to that material's carcinogenic properties. While nickel occurs in surface water due to soil erosion, it is often found at four times background levels in urban settings (Irwin, 1988). Sources of nickel in stormwater runoff include air pollution fallout due to combustion of fossil fuels, auto emissions, and the atmospheric depositions arising from smelters, scrap yards, and other industrial sources; also uncombusted petroleum products, brake linings and asphalt (Irwin, 1988; and Whalen and Cullum, 1988). Nickel is also present in sewage sludge and landfill leachate (Irwin, 1988). Nickel was detected in rainfall during 1 of 32, 1991 storms during the intensive study of a wetland-treatment system (B. Rushton unpublished); therefore, rainfall may not be a significant source of nickel.

Nickel was detected at eighteen of the twenty-four survey outfall stations (Appendix, Table P); it was detected at a concentration exceeding the Chapter 17-302 standard (0.1 mg/L) only once (Table 4, Figure 2 and Figure 13); the nickel concentration was four times the standard at the Pond T outfall station (Appendix, Table P -- 1 of 180 grab samples = 0.6 Total %E). Nickel levels were less than the detection limit (0.01 mg/L) in 88 percent of the grab samples (158 of 180 samples -- Appendix, Table P), and data were missing for three sample dates, because of analysis errors. Except for one exceedence of nickel's Chapter 17-302, Class III standard (which may be in error) nickel levels did not appear to be problematic for the wet-detention ponds in this survey. Because nickel data were missing for three sample dates, the occurrence of a seasonal pattern in mean nickel was difficult to assess. Because of the common occurrence of nickel in stormwater ponds, nickel levels should continue to be measured periodically in order to maintain current information regarding patterns or any changes in nickel levels in regional stormwater ponds.

Manganese (Mn)

Manganese is an essential micronutrient that poses less toxicity problems in natural waters than most other contaminants. Although not found alone as a natural metal, manganese is frequently found in association with iron, in salts and minerals (USEPA, 1976). Soil erosion accounts for naturally occurring levels of iron-manganese salts in surface waters. Other sources are atmospheric deposition from power plants, sewage treatment plant effluent, and municipal landfill leachate. Because of its occurrence in soils, humans ingest some in many foods. Poisonings from excess levels have occurred in humans (Irwin, 1988), that may have been due to inhalation or ingestion (USEPA, 1976). Fish have some ability to excrete excess manganese. Association of Mn with Fe in redox cycles at aerobic/anaerobic interfaces may be important for the internal cycling of nutrients and trace metals (Murray, 1987). Manganese was detected in rainfall during 6 of 32, 1991 storms during the intensive study of a wetland-treatment system (B. Rushton unpublished); therefore, rainfall may be a occasional source of manganese.

Manganese was repeatedly detected at every outfall station except Pond H (only once); it was detected only twice at Pond G, Pond J and Pond P (twice each) (Appendix, Table L). Manganese concentrations exceeded the Chapter 17-302 Class II standard (0.1 mg/L) (no Chapter 17-302, Class III standard) only once (Table 4, Figure 2 and Figure 14), at the Pond C outfall station (Appendix, Table L -- 1 of 225 samples = 0.44 Total %E). Manganese was less than the detection limit (0.01 mg/L) in only 50 percent of the grab samples (112 of 225 samples - Appendix, Table L), and does not appear to be problematic in the wet-detention ponds in this survey. Association of the Mn and Fe internal cycles and possible relationships with other trace metals in the literature, as well as, a seasonal pattern in mean manganese (possibly opposite to several other metals) warrants the continued investigation of Mn in stormwater projects at the District.

Summary of Exceedence of Standards (E%)

The data from water-quality field measurements and grab samples collected during a thirteen month period from November 1988 to December 1989 were compared to water-quality standards (Chapter 17-302 -- Class III or II, and Secondary STP effluent concentrations). Table 4 is extracted from the Appendix (Tables A through Q) and shows the %E for each variable at each pond, and the

Total %E (over all ponds) for each variable. Figure 2 (extracted from Table 4) also shows the Total %E for each variable. Chapter 17-302 standards were exceeded in 10 percent or more of samples for three heavy metals (zinc - 30%, cadmium - 18%, and copper - 14%). Exceedences of the 24-hour DO standards (39% and 30% of samples, for the 24-hour "mean" and "lowest allowable", respectively) were noted from a comparison with the DO standards. Diurnal sampling would be necessary for strict application of the 24-hour mean DO standard. If diurnal sampling had been conducted, the 24-hour, lowest allowable standard would likely be exceeded more frequently. Never-the-less, percent exceedences for DO and zinc of 30 percent or more warrant continued investigation of how often "violations" of these standards occur. Sampling that would assess the role of pond design, outfall configuration and macrophyte distribution are needed. After dissolved oxygen, the zinc standard was most frequently exceeded (30%). The cadmium standard was probably exceeded more often than the data indicate (18%), because the cadmium standard was less than the laboratory detection limit during the survey. Exceedence of the cadmium standard certainly could reach a much higher percent of samples if a method that allows detection and quantitation of lower concentrations becomes available. Also, percent exceedence of the copper standard (14%) and possibly the lead standard (7%) warrant concern, because most ponds exceeded these standards at least once during the survey (Table 4).

Percent exceedence of standards under 5 percent are of less concern. Thus for iron (4.5%), turbidity (4.4%), pH (3.1%), chromium (3.2%), nickel (0.6%) and manganese (0.4%); the rare exceedence of state water-quality standards indicates these variables infrequently reach dangerous levels, except perhaps in isolated cases (e.g., chromium and nickel at Pond U, or iron and pH at Pond G). Never-the-less continued measurement of these variables is advised in order to maintain current information regarding levels of all substances that can reach dangerous levels in stormwater ponds. Exceedence of the specific conductance standard in about 5 percent of samples was due entirely to Pond N, where the freshwater standard does not apply because of regular backflow from the receiving water, a tidal creek. Also, no Chapter 17-302 standard exists for TSS; exceedence was based on an efficient secondary STP effluent concentration; 10 percent of samples and nine (9) ponds exceeded this TSS standard.

Finally, exceeding a water-quality standard "within" stormwater wet-detention ponds may not indicate that a violation of Chapter 17-302 (FAC) water-quality standards in discharging waters has occurred. Because the State water-quality standards apply to the effluent but not the ponds, no violation of standards occurs unless a discharge existed when samples exceeding standards were collected and water-quality was not changed by the process of being discharged. Conservative estimates of total "violations" of water-quality standards might incorporate the total "discharge frequency" of 59 percent and the Total %E for water-quality variables, or the discharge frequency and

%E of individual ponds. However, such applications of discharge frequency would over estimate violations for ponds that never exceeded standards, or that exceeded standards but did not discharge.

SEASONAL RELATIONSHIPS FOR VARIABLES OTHER THAN HEAVY METALS

An evaluation of seasonal effects on water-quality variables proceeded by constructing line graphs of variable date means (for eighteen ponds) versus date; the one exception is that "median" rather than "mean" pH was used in the line graphs. Overall, deleting six ponds from the data set had little effect on the patterns of the line graphs (Figures 15 to 32). Except for Figures 15 and 16, the x-axis was labeled (11-28, 12-13, 1-23, 3-2, 4-18, 6-7, 6-26, 7-24, 8-28, 11-1 and 12-19), corresponding to sample dates from November 28, 1988 to December 19, 1989. Figure 15 is a line graph of the average of historical mean-monthly rainfall calculated from five District basins for a three year period (January 1988 to December 1990). The historical mean calculated for 1990 was used to estimate the historical mean for 1989 and 1991, the year before and after the study. The graph is overlaid with the line graph of the average of mean-monthly rainfall for eighteen rainfall stations (18 rain gauges) in and around the region in which the twenty-four wet-detention ponds were located (Figure 1). The assumption is that historical means do not change dramatically from year to year, and that the historical mean for the 18 rain gauges should resemble the historical mean of the 5 basins, if the period of record is long enough. The five District basins in the Tampa Bay region include Southern Coastal, Pinellas-Anclote, NW Hillsborough, Hillsborough, and Alafia Basins. Figure 16, which is extracted from Figure 15, shows only the 18-gauge average of mean-monthly rainfall during the study period (November 1988 to December 1989) and is used in the discussion of seasonal effects.

Mean Monthly Rainfall

The five-basin average of historical mean-monthly rainfall depicts a relatively smooth annual pattern over a three-year period, January 1988 through December 1990 (Figure 15). In contrast, the 18-station mean-monthly rainfall during the study period was a mixture of rainfall amounts that are above and below historical mean-monthly rainfall amounts. Historically, the greatest rainfall in the study region occurs in during four-month period from June to September; mean-monthly rainfall over the rest of the year was at least 4 to 5 inches less (Figure 15). July and August are the peak rainfall months, averaging over 8 inches. November was the driest month averaging only about 2 inches of rainfall. Usually, slightly cooler and drier weather occurs during the late-summer or early-fall period. Dry weather usually dominates throughout the winter unless some tropical moisture persists or late-fall to winter frontal storms reach central Florida from more northern latitudes. Historical mean-monthly rainfall increased slowly from November to March, and April was drier than March for the data.

Figure 15 also indicates that deviations from historical rainfall amounts are expected in any year. August, September and November 1988 were well above average leading into the study; October was below average. The effect of Tropical Storm Keith and other storms, in mid-November 1988, resulted in a mean rainfall six inches above normal for that month over the Tampa Bay region. The normal increase (Figure 15) from November through March did not occur during the survey in 1989. Instead, a downward trend and mostly below-normal mean-monthly rainfall followed Keith, until June 1989. The summer during the survey (1989) more closely resembled the historical mean than the summer before (1988) or after (1990) the study, and was more typical than either the spring or fall of 1989. The survey ended during December 1989, which had above normal rainfall.

Figure 16 is extracted from Figure 15 and gives an estimate of the mean monthly rainfall that occurred during the study period. Mean monthly rainfall for the eighteen rainfall stations ranged from less than one inch (February 1989) to more than eight inches (June 1989) during the study. In Figure 16 the seasonal rainfall pattern is depicted, closely resembling the historical pattern. The seasonal rainfall pattern that was observed for 1989 helps to explain the patterns observed in two variables that are indicators of water level in ponds; discharge frequency (the number of ponds discharging on a sample date) and bottom depth (at the sample location). Except that discharge frequency is not a monthly mean, and that samples were not taken in some months, both discharge frequency (Figure 17) and bottom depth (Figure 18) showed fluctuations that can be attributed to fluctuations in mean monthly rainfall (Figure 16).

Discharge Frequency for the Eleven Sample Dates

Discharge frequency was calculated for each date as either the percent or the number of ponds (18 total) that were discharging on a sample date; it is a hydrologic or water-level characteristic rather than a water-quality characteristic. Monthly discharge frequency (# ponds discharging) ranged from a low of one pond (June 7, 1989) to a high of fifteen ponds (January 23, 1989) during the study period. Seasonal patterns in the discharge frequency for 11 sample dates (Figure 17) can be related to the seasonal pattern of mean monthly rainfall (Figure 16). In Figure 17, discharge frequency (# ponds discharging), which is high in November 1988 due to Tropical Storm Keith (on or about November 22 and 23, 1988) and possibly other heavy rain events in the preceding summer months, increases slightly to a high in mid-January 1989 due to above normal January rainfall. Discharge frequency then falls reaching a low on June 7, 1989 corresponding to lower rainfall during spring months. After the low on June 7, discharge frequency then rises sharply through June 1989 (probably lagging slightly behind mean monthly rain), reaching a peak in July 1989 and remaining high through August 1989, corresponding to the rainy season in Figure 16. The spring and autumn decreases in discharge frequency, as well as, the slight winter increases (January and December 1989) are indicative of rainfall patterns that occurred in the region.

Three significant correlations ($p <= 0.10$) between water-quality variables and discharge frequency (DCHARGE1) for 11 sample dates are noted in Table 7 (Pearson correlation). Log mean specific conductance (LGCOND_K), log mean turbidity (LOGTURB) and log mean cadmium (LOGCDU) had strong, negative correlations with DCHARGE1 ($p < 0.05$). These inverse correlations may result from either or both increasing concentrations in runoff, and increasing concentrations from longer residence times for stormwater runoff volumes as water levels decreased (reflected in fewer outfalls discharging). Also, mean bottom depth at sample location (DPTHCM) shows a strong positive correlation with DCHARGE1 ($p < 0.05$), thus supporting the association of discharge frequency and bottom depth with water levels in the wet-detention ponds. Only the relationships between discharge frequency and specific conductance, and between discharge frequency and turbidity are supported by stepwise regression (Table 9); DCHARGE1 is a significant, negative regressor for both log mean specific conductance and log mean turbidity.

Bottom Depth for the Eleven Sample Dates

Seasonal patterns for mean bottom depth at the two stations within ponds (outfall and pond stations) are depicted in Figure 18. Generally, mean bottom depth is a useful indicator of water levels in ponds; the seasonal patterns for the outfall station and the pond station graphs support each other. The pond station mean bottom depth is somewhat deeper than the outfall station, probably due to more flexibility in the pond station location. Outfall station mean bottom depth ranged from about 1.1 feet to about 1.7 feet, while the pond station ranged from about 1.3 feet to about 2.0 feet (converted to metric for SAS statistical analyses). Only the outfall station data are used in statistical analyses.

The seasonal pattern in outfall station mean bottom depth for 11 sample dates (Figure 18) resembles the pattern observed in Figure 17 for discharge frequency and is similarly related to mean monthly rainfall. However, the inverse relationship between outfall station mean bottom depth and discharge frequency from November 28 to December 13, 1988 probably resulted from higher than expected water levels and a larger percentage of ponds discharging during the fall and winter 1989-1990 period. The higher than normal rainfall that occurred during the late summer and fall of 1988 (including Tropical Storm Keith) had elevated surface waters levels. The argument that mean bottom depth more closely reflects below normal rainfall in December 1988, and above normal rainfall in January 1989 may be valid. Also, increasing discharge frequency lags slightly behind increasing outfall mean bottom depth from April to late June 1989, indicating the transition from dry to wet weather (Figure 16) with water-levels increasing. While they measure two rough indications of water level in the survey wet-detention ponds, an important difference between discharge frequency and mean bottom depth as indicators of water levels and wet-dry transitions is that only discharge frequency is recorded for a permanent location. Even though bottom depth was recorded in the same general locations at outfall stations (directly in front of the weir) and pond stations, the specific locations where samples were collected and bottom depths were recorded changed for some ponds as water levels changed.

Three variables (DCHARGE1, LGCOND_K and LOGCDU) were strongly correlated with mean bottom depth (DPTHCM) for the 11 sample dates. The strong, positive correlation with DCHARGE1 ($p<0.05$) has been discussed, and like DCHARGE1, DPTHCM was inversely correlated with LGCOND_K ($p<0.05$) and log mean cadmium (LOGCDU) ($p<0.10$) in Table 7. Additionally, dissolved oxygen is often inversely related to depth (i.e., when ponds stratify). Log mean dissolved oxygen (LOGDO) is negatively correlated with DPTHCM, however not significantly ($p=0.14$). It is not clear whether shallower bottom depths, colder temperatures or both were involved. No effects were noted for DPTHCM in stepwise regression (Table 9).

Water Temperature for the Eleven Sample Dates

Identical seasonal patterns of mean water temperature exist at the outfall and pond stations (Figure 19). Seasonal mean water temperature at both stations ranged from about 15 °C on December 13, 1988 to about 32 °C on August 28, 1989. Again, only outfall station data are used in statistical analyses. Mean water temperature shows an expected seasonal pattern that has characteristic winter lows and summer highs (Figure 19). Note that mean temperature was relatively stable from April 18 to August 28, 1989. During that four month period, mean temperature climbed above 26 °C and remained fairly stable, increasing only 4 to 5 °C by August 28 (Appendix, Table C). During the remainder of the study, transitional periods were indicated by more dramatic falling and rising water temperatures of 10 °C or more over roughly three-month periods (January 23 to April 4, 1989 and August 28 to December 19, 1989).

By comparing the line graphs of other variables with the mean temperature line graph, correlations might be expected between mean TEMP1 and specific conductance (LGCOND_K). However, the only significant correlation with TEMP1 was a strong, negative correlation with log mean dissolved oxygen (LOGDO) ($p<0.10$) (Table 7). The relationship between temperature and dissolved oxygen is repeated in the results of stepwise multiple regression (Table 9); temperature was the only significant regressor for LOGDO. The inverse effect of temperature on physical saturation of dissolved oxygen is well documented in water chemistry and limnology literature (Wetzel, 1975; and Boyd, 1979).

Dissolved Oxygen for the Eleven Sample Dates

Generally, similar seasonal patterns in mean dissolved oxygen exist for the outfall and pond stations, with outfall station mean DO slightly below pond station mean DO on most dates (nine) (Figure 20). The difference between outfall station and pond station mean DO is slight, however. Generally higher DO at pond stations may also be due to higher primary productivity or lower oxygen demand at pond stations; or greater mixing of the water column at the more open-water, pond stations. Only the outfall station means are used in statistical analyses.

Outfall station mean dissolved oxygen was about 5.0 mg/L immediately after Tropical Storm Keith, but increased sharply afterwards with higher values on December 13, 1988, probably due to falling water temperature (Figure 19). Outfall station mean dissolved oxygen remained above about 5.0 mg/L until June 7, 1989, when mean water temperature went above 28 °C. Over the summer rainy season, outfall station mean DO fluctuated between about 5.0 and 5.5 mg/L. Not until mean water temperature fell to 24 °C on November 1, 1989, did outfall station mean dissolved oxygen go above 5.5 mg/L, declining again in December 1989. Thus, a seasonal, temperature-related pattern for mean dissolved oxygen is plausible, and is supported by the results of correlation analysis for LOGDO and TEMP1 (Table 7) and the results of stepwise regression (Table 9). While a 4 °C drop in temperature (from 28 °C to 24 °C) will cause only a 0.75 mg/L increase in the physical saturation of DO in pure water (Boyd 1979), a much wider range of temperatures was observed on any sample date. The lowest outfall temperature recorded on November 28, 1988 was 14.9 °C and dropped to 12.3 °C on December 13, 1988. The highest temperature recorded was 22.6 °C on November 28, 1988 and 18.0 °C on December 13, 1988. Corresponding minimum DO readings were 0.5 mg/L on November 28, 1988 and 1.8 mg/L on December 13, 1988, while maximum DO readings were 8.2 mg/L on November 28, 1988 and 12.10 mg/L on December 13, 1988.

The data suggest an inverse correlation between temperature and DO, but other factors (e.g., photosynthesis and respiration) affect equilibrium DO concentrations, even in colder weather (Wetzel 1975). The combined effects of temperature, depth, stratification, physical saturation, photosynthesis, and respiration establish dissolved oxygen levels in ponds. Because field measurements (including DO, temperature, conductivity, and pH) were taken only on the bottom and in most cases in less than 2 feet of water, stratification was unlikely. However, 17 ponds had minimum DO values below 4.00 mg/L (13 below 3.0 mg/L), and 7 ponds had annual means below 4.00 mg/L (2 pond annual means below 3.00 mg/L). The data suggests that the variability of mean DO may have been caused by many factors.

Another significant seasonal relationship with dissolved oxygen was found in the positive correlation with log mean zinc (LOGZNU) ($p<0.05$) (Table 7) and the significant regression effect of log mean DO on log mean zinc (Table 9). An explanation for the relationship was not obvious, however. Finally, negative correlations between monthly mean dissolved oxygen (LOGDO) and DPTHCM were fairly strong, but not significant ($p=0.14$). This negative correlation may have been an indication of a possible inverse rainfall related effects on dissolved oxygen. Dissolved oxygen may be depressed by 1.0 to 1.5 mg/L one to five days following rain events (Heany and Huber, 1984). Also, decreased DO concentrations following storms may result from increased demand for DO due to BOD loads in runoff, combined with reduced DO supply from decreased photosynthesis associated rainfall and overcast weather (Boyd 1979). The inverse, rainfall effect on DO may have acted along with increasing mean temperature and higher demand to depress mean dissolved oxygen during the summer rainy season of this survey (Rushton et al., 1989).

pH for Eleven Sample Dates

Similar seasonal patterns in "median" pH existed at the outfall and pond stations, with median pH ranging from about 6.9 to 7.6 at the outfall station, and from about 6.9 to 7.8 at the pond station. Median outfall station pH was consistently lower than the corresponding median pond-station pH, except for two sample dates; however, the statistical significance was not determined. Only outfall station pH was used in statistical analyses.

The seasonal pattern in Figure 21 is not well-defined, and is perhaps more distinct for the outfall stations. The highest median pH values (outfall and pond stations) corresponded with the lowest, outfall station discharge frequency on June 7, 1989 (Figure 17) and relatively low mean bottom depth on June 7, 1989 (Figure 18). Correlations between "mean" pH and means of water-level variables (DPTHCM and DCHARGE1) or mean water temperature (TEMP1) were not significant, and did not appear in Table 7, when SAS selected the 5 to 10 best correlations. The only significant relationship with "mean" pH was the inverse correlation with log mean copper (LOGCUU) ($p=0.06$). In stepwise regression, "mean" pH accounted for 33 percent of the variation in log mean copper (LOGCUU) (Table 9). Two other metals, log mean chromium (LOGCRU) ($p=0.15$) and log mean lead (LOGPBU) ($p=0.19$), had an inverse relationship with pH that was not significant. Generally, as pH decreases metals become more soluble, and as pH increases formation of metal complexes and sedimentation of metals are promoted (Campbell and Teisser 1987). Note, that outfall station median pH reached a low (falls below 7.0) on April 18, 1989, when most mean metals were increasing or reach a peak (Figures 25, 27, 28, 29, 30 and 31). The relationship between pH and heavy metals in stormwater ponds requires more detailed assessment, and should include other variables (e.g., hardness, nutrients, and oxidation-reduction potential).

Specific Conductance for Eleven Sample Dates

A strong, inverse water-level related pattern occurred for monthly mean specific conductance, that was nearly identical for the outfall station and pond station (Figure 22). Over the study period, mean specific conductance ranged from about 0.225 to 0.400 millimhos per cm for sample dates. Both stations demonstrated a seasonal fluctuation that can be attributed to seasonal rainfall and water-level patterns (Figures 16, 17, and 18). Only outfall station data for specific conductance were used in statistical analyses.

The steady increase in mean specific conductance from November 1988 to June 1989 followed by the summer 1989 decline and the fall 1989 increase, probably occurred because of concentration and dilution of ions caused by fluctuation in rainfall and water levels, and perhaps because of fluctuation of ground water inputs due to changes in water levels. The changes in mean specific conductance appeared to be generally the reverse of patterns in mean monthly rainfall (Figure 16) and water levels -- discharge frequency and mean bottom depth (Figures 17 and 18).

The peak mean specific conductance occurred on June 7, and corresponded to the low in discharge frequency during the spring of 1989. Although, mean bottom depth was increasing from a low on April 18, the first week of June was probably lacking in rainfall keeping mean specific conductance on the increase until June 7, 1989. The sharp drop in mean specific conductance (Figure 22) from early June 7 to late July 24, 1989 probably resulted from the dilution caused by elevated water-levels in ponds (Figure 17 and 18) due to increased summer rainfall (Figure 16). Mean specific conductance is increasing from July 24 to November 1, 1989, probably due to continually decreasing mean monthly rainfall, and declining water levels. The decrease in mean specific conductance from November 1 to December, 19 1989 corresponds to increasing rainfall and water levels. Although conductivity is expected to increase with increasing temperature (APHA 1986), significant correlations between LGCOND_K and mean water temperature (TEMP1) were not seen during the 24-pond survey

When considering the statistical results, seasonal water level changes had a the greatest impact on mean specific conductance. Strong (inverse) correlations ($p < 0.05$) occurred for LGCOND_K with both DCHARGE1 and DPTHCM (Table 7). A similar inverse relationship between water levels and specific conductance might be indicated by data in other studies (Wanielista, 1978; and Goldstein, 1986). Significant correlations were also noted between LGCOND_K and log mean total suspended solids (LOGTSSU), log mean turbidity (LOGTURB), and log mean cadmium (LOGCDU) (Table 7). Also, significant effects on LGCOND_K were noted in stepwise regression for DCHARGE1 and LOGTSSU. Besides considering the possible dilution/concentration effects of rainfall/evaporation, the direct effect of groundwater inputs on specific conductance during dry periods were probably important.

Total Suspended Solids for Eleven Sample Dates

The seasonal patterns in mean total suspended solids (TSS) were similar for the outfall and pond stations; however, the outfall station mean were slightly higher on most dates. Outfall station mean TSS ranged from 4.5 to 13.5 mg/L; pond-station mean TSS ranged from 3.5 to 10 mg/L. Only outfall station TSS data were used in statistical analyses.

Examination of the line graph of outfall station mean total suspended solids versus date indicates a weak seasonal pattern and a relatively constant level (Figure 23). However, seasonal mean TSS was one variable the may have been significantly affected by deleting six ponds from the analysis, because a seasonal pattern was more evident when all twenty-four ponds were used in the line graph. Outfall station mean TSS decreased on June 26, 1989 and December 13, 1989 and increased on November 1, 1989, corresponding to changes in rainfall and water level that may have resulted from dilution by rainfall. An increase in TSS due to increased algal production might be expected during the summer and warmer water temperatures. Ambient TSS might be higher in the summer between storms due to increased algal production, and lowered due to the dilution caused by stormwater after the first flush of solids is settled. Correlations and regression effects between log mean outfall total suspended solids (LOGTSSU) and seasonal water-level variables (DCHARGE1 and DPTHCM) or seasonal mean temperature (TEMP1) were not significant, however (Tables 7 and 11). The strongest correlation and regression effect with LOGTSSU was for LGCOND_K, discussed previously. Although "suspended solids" were measured in this survey, "dissolved" solids which are generally expected to be directly related to specific conductance were not measured.

Sampling methods may have contributed to the lack of seasonal, water-level related patterns in mean total suspended solids. In many instances especially during drier periods, excluding filamentous algae, periphyton, organic debris, and flocculent sediments from outfall station samples was desirable but not possible, and prefiltration techniques were not applied. However, samples were usually collected one to three days after storm events (during wet periods), thus the bulk of the first-flush of suspended solids loads usually had time to settle before samples were collected. A more appropriate sample for TSS might be collected from deeper, open-water areas of stormwater ponds where the settling of suspended solids is probably the greatest and resuspension is probably the least.

If TSS measurement was compromised by including too much resuspended organic material from sediments or heavily vegetated water columns, then turbidity may have provided a better indication of "suspended" particles of the size and type that can be attributed to stormwater inputs and that remain suspended for longer periods. Mean turbidity demonstrated a more distinct seasonal pattern than mean TSS. While LOGTSSU and log mean turbidity (LOGTURB) were correlated for pond (annual) means in Table 8, LOGTSS and LOGTURB for date means were not correlated (Table 7).

Turbidity for the Eleven Sample Dates

The seasonal pattern in mean turbidity at the outfall and pond stations were similar, with the pond-station mean being higher than the outfall station mean in most cases (six of eleven dates -- Figure 24). Seasonal patterns in mean turbidity were more distinct than seasonal patterns of mean total suspended solids, and the depression due to the onslaught of the summer rains is seemingly more apparent for mean turbidity. In Figure 24, outfall station mean turbidity generally appeared to fluctuate inversely with mean monthly rainfall (Figure 16) and water-level indicators (Figures 17 and 18). In fact, outfall station log mean turbidity (LOGTURB) was negatively correlated with DCHARGE1 ($p<0.05$) (Table 7) indicating the influence of water-level changes was important. Also, LOGTURB was positively correlated with LGCOND_K ($p<0.10$), a relationship probably based on the inverse effect of water-level on both variables, indicating a possible connection between conductivity and "suspended" particles. The relationship between conductivity and "dissolved" constituents is well known (Wetzel, 1975). Log mean nickel (LOGNIU) (and log mean cadmium (LOGCDU)) were positively correlated with LOGTURB (Table 7), but all correlations with LOGNIU were suspect due to missing nickel data on three dates.

SEASONAL PATTERNS OF HEAVY METALS

General mechanisms affecting heavy metals concentrations in natural waters include biological recycling, sediment fluxes, oxidation-reduction cycling, and "scavenging" by sinking particles (adsorption and removal of dissolved elements from the water column) (Murray, 1987). More specifically several factors that influence metal complexation and species in natural waters are described by Campbell and Tessier (1987). The factors include organic ligands, stability of metal-ligand complexes, competing cations (e.g., Ca^{2+} and Mg^{2+}), redox potential, temperature, pH, and equilibrium state of predominant metal forms. Only two of these factors (pH and temperature) were directly measured during the twenty-four pond survey; pH having the best association (generally inverse) with metals when comparing seasonal date means (see Correlation analysis, Table 7).

Dissolved metals speciation in "natural" waters is sensitive to pH changes. Ranked from most to least sensitive are the following metals (Pb > Cu > > Cd = Ni > Mn > Zn); with Pb and Cu being much more sensitive than the others (Campbell and Tessier, 1987). Also, differences in pH sensitivity are much greater between Cu and Cd, than between Cd and Zn, despite the ranking. Most of the speciation changes for Pb, Cu, Ni, and Cd are reported to occur between pH 7.0 and pH 6.0; Pb and Cu undergoing much greater percent changes becoming much more soluble at lower pH than the other metals discussed. The pH range 7.0 to 6.0 is within the range of the twenty-four pond survey (Appendix, Table E). Within that range, a pH decrease from 7.0 to 6.0 brings about a change from 79 percent to 98 percent dissolved species for Pb, and a change from about 40 percent to about 91 percent dissolved species for Cu. In fact, pH greater than 7.0 commonly occurred during the study, perhaps causing higher percentage of metals complexes, and less solubility for some of the more soluble metals (e.g., Zn and Mn). Cd, Mn, Ni and Zn are all at least 79% in dissolved form at pH less than or equal to 7.00. Changes and solubility increases of about 1 percent (from 99 to 100% soluble) occur for Zn species with changes from pH 6.0 to pH 5.0. A change of pH from 7.00 to 6.00 increases Cd solubility from 98 to 99%. Similarly, Mn species changes and solubility increases of about 1 percent (from 99 to 100% soluble) occur with changes from pH 5.0 to pH 4.0 (Campbell and Tessier, 1987). The pH change from 6.0 to 4.0, generally, was not within the twenty-four pond study pH range for outfall stations (Appendix, Table E). Compared to Cu and Pb solubility changes with decreasing pH, the other metals analyzed were much more soluble, and Cu and Pb solubilities were more affected by decreasing pH.

Least Censored Metals (Zinc, Iron, Copper and Manganese)

The first group of metals considered are the metals that were the least left-censored (less than 50 percent BDL, except Copper -- 58%). Censored data were replaced by one-half the detection limit (DL/2), and the means were calculated for use in line graphs. Because 50 percent or more of the data are above detection limits, the median value is known and more confidence can be given to the statistics calculated for these variables after substituting DL/2 (Gilliom and Helsel, 1986).

Zinc and Copper for the Eleven Sample Dates

Patterns in the line graphs of mean zinc and mean copper are similar, with both reaching a peak in the spring of 1989 (as does mean cadmium and perhaps mean lead). Mean zinc (Figure 25) and mean copper (Figure 27) had possible inverse water-level related patterns, as well as, possible inverse relationships with pH. LOGZNU and LOGCUU were not significantly correlated with each other, and the only significant correlation with LOGZNU was with LOGDO ($p<0.05$), as previously discussed (Table 7). LOGDO was a significant regressor on LOGZNU accounting for 46% of the variability of log mean zinc (Table 9). LOGZNU was better correlated with LOGCRU than any other metal (Table 7), but not significantly ($p=0.17$). LOGCUU, however, was positively correlated

($p < 0.05$) with two heavily left-censored metals -- log mean cadmium (LOGCDU) and log mean lead (LOGPBU). Cu, Pb and to a lesser degree Cd are sensitive to pH changes from 7 to 6. Copper speciation is very sensitive to pH changes (Murray 1987); copper solubility increased dramatically with decreasing pH in the pH 7 to pH 6 range. Zinc on the other hand is 99% soluble at pH 7 (Murray 1987). LOGCUU was negatively correlated with pH ($p < 0.05$) (Table 7). pH was a significant regressor on LOGCUU in stepwise regression (Table 9). Thus, zinc and copper were more closely related to more heavily left-censored metals than to each other, perhaps because of differing pH sensitivity (Campbell and Tessier, 1987).

Mean zinc and mean copper were at relatively low levels in November 1988, following Tropical Storm Keith. Mean zinc increased sharply in March 1989 and mean copper increased sharply in April 1989. Although their negative correlations with DPTHCM were not significant (Table 7), increases may have been related to decreasing water-level (decreasing mean bottom depth - Figure 18) and generally decreasing rainfall (Figure 16). Mean zinc and mean copper sharply returned to lower levels when summer water levels increased (June 7 to July 24, 1989) (i.e., rainfall increased dramatically in June 1989). Mean zinc and mean copper then fluctuated over the summer-fall months, with copper generally increasing (zinc less so) through December 1989. Lower and fluctuating mean zinc and mean copper likely occurred in the summer, because of dilution by stabilized, elevated rainfall in July, August and September 1989 following a first flush in June. Higher levels of metals might be expected in the first flush of rainfall following a period of little rainfall (February to May 1989). Higher levels during dry periods could also be attributable to infrequent, low-volume rain events after long periods of metals accumulation on impervious surfaces. The occurrence of zinc in rainfall was much more frequent than the occurrence of copper during the intensive studies at Pond S and a wetlands-treatment site (Rushton 1992 -- in review).

Murray (1987) reported the greatest flux of dissolved copper from a lake's sediment occurred in the spring; mean copper in our study reached a peak in April. The release may be similar to the maximum dissolved manganese flux from sediments in the summer. Removal of most of the dissolved copper is reported to occur by mid-summer, and may involve Fe and Mn internal cycles. Note that mean iron and mean manganese appeared to be highest during the summer rainy season when most other metals were lower.

The data from the twenty-four pond survey suggests that mean concentrations of zinc and copper, as well as other heavy metals, are likely to be influenced by several factors. Rainfall and water level changes; dissolved oxygen, as related to zinc (perhaps associated with redox potential or pH); pH changes; and perhaps the levels of Fe and Mn may be important factors in determining concentrations of heavy metals during the study.

Iron and Manganese for the Eleven Sample Dates

The line graphs for mean iron (Figure 26) and mean manganese (Figure 28) do not depict a clear seasonal pattern. Although mean iron (IRON1) may have been negatively correlated with DCHARGE1 ($r = -0.49$, $p = 0.13$) (Table 7), the summer peak in mean manganese did not result in a significant, positive correlations between water-level indicators and MN1. While the line graph for mean manganese (Figure 28) indicates a peak June 26, 1989, that corresponds to the peak for water temperature (Figure 19), correlations for mean manganese (MN1) with water temperature (TEMP1) were positive, but not significant (Table 7). Although, mean iron may have also been negatively correlated with log mean nickel (LOGNIU), the nickel data included just eight of eleven sample dates. Thus, the correlations with LOGNIU are suspect. No other significant correlations occurred for mean iron and mean manganese in Table 7. Neither mean iron or mean manganese were given significant regressors in stepwise multiple regression (Table 9). Thus, seasonal patterns in mean iron and mean manganese can not be directly explained by statistical relationships in the data.

Murray (1987) reported on studies that found oxides of iron and manganese may be transporters of other trace elements to sediments (i.e., across the anoxic interface) through oxidation-reduction recycling (Fe > > Mn), but the evidence was not always strong. Studying the relationships between Fe and Mn levels and levels of other heavy metals in stormwater ponds may be important.

Heavily Censored Metals (Lead, Cadmium, Chromium and Nickel)

The data for the second group of heavy metals were heavily left-censored (data for each metal were more than 80% BDL). Never-the-less the censored data were replaced by DL/2 and means were calculated for graphical analyses of seasonal patterns. Also, the four heavily censored metals were included in correlation analyses, but not in factor, cluster, or regression analyses. However, caution should be used in the interpretation of correlations between the mean values of these metals and other variables. The characteristics of data that are BDL are actually unknown, and an estimate of the distribution of censored data is not presented in this report. Data for heavily left-censored metals may also be right-skewed (non-normal) with values above the DL representing outliers, and normal distribution statistical methods may not be applicable. Statistical assessment of these heavily censored variables assumes random fluctuation below the detection limits. Also, nickel data was only available for eight of eleven sample dates; cadmium data was available for ten of eleven dates.

Lead for the Eleven Sample Dates

At first the seasonal pattern in mean lead (Figure 29) resembles that of mean zinc or mean copper. In fact log mean lead (LOGPBU) is positively correlated with log mean copper (LOGCUU) (Table 7), but not log mean zinc (LOGZNU). Campbell and Tessier (1987) reported that Cu and Pb form strong carbonates, and that large percentage changes in lead and copper solubility occur in the pH range of 7 to 4. Mean copper and mean lead seem to fluctuate quite closely with each other. Although they reach peaks in different months, median pH is low for both peaks. Thus, lead and copper concentrations are highest when pH is relatively low perhaps enhancing sediment flux of metals into the water column due to higher solubility. The inverse correlation of LOGPBU with pH (Table 7) is not significant; however, note that the fluctuation of mean lead (Figure 29) is the inverse of median pH (Figure 21), until June 7, 1989. LOGPBU was not correlated with either DPTHCM or DCHARGE1. Peaks in mean lead also corresponded to sample dates in winter months with above normal mean rainfall (i.e., January and December 1989), and may reflect increased automobile traffic due to winter tourism.

Cadmium for the Eleven Sample Dates

The seasonal pattern in the line graph of mean cadmium was defined by higher values during drier sample periods (April 18 and June 7, 1989) (Figure 30). In fact log mean cadmium (LOGCDU) was inversely correlated with both DCHARGE1 ($p<0.05$) and DPTHCM ($p<0.10$) (Table 7). Additionally, LOGCDU is positively correlated with LOGCUU ($p<0.05$), LGCOND_K ($p<0.05$), LOGTURB ($p=0.10$), and possibly LOGTSSU ($p=0.12$) (Table 7); all except LOGTSSU were negatively correlated with DCHARGE1 or DPTHCM (Table 7). Most of the data for cadmium were BDL, so that cadmium data may be right skewed (non-normal); therefore, the significance of correlations with LOGCDU may be suspect.

Although both cadmium and zinc are relatively insensitive to pH changes, Campbell and Tessier (1987) reported that cadmium's solubility was slightly less than that of zinc, and that cadmium was 98 to 99 percent soluble in the pH range of 7.0 to 4.0. Unlike the 100 percent solubility of zinc at pH 4, cadmium remains about 1 percent complexed as pH 4 is approached. The 1 percent increase in cadmium solubility that occurs between pH 7 and pH 6, occurs for zinc between pH 6 and pH 5. However, no correlation exists between pH and either cadmium or zinc (Table 7).

Chromium for the Eleven Sample Dates

The seasonal pattern in the line graph of mean chromium for the 11 dates does not appear to be related to water levels, but may be inversely related to pH (Figure 31). Peaks (above the DL) occur during both dry (April 1989) and wet (July 1989) months. Neither of the water-level variables, DCHARGE1 or DPTHCM, nor TEMP1 are correlated with LOGCRU (Table 7). The only possible seasonal correlations with LOGCRU are a nonsignificant inverse correlation with pH ($p=0.15$), and a nonsignificant positive correlation with LOGZNU ($p=0.17$) (Table 7). In contrast, significant correlations between LOGCRU exist for LOGMNU, DO1, TEMP1 and PH within ponds (Table 8).

Nickel for the Eleven Sample Dates

Mean nickel could only be calculated for eight of the eleven samples, because nickel analyses were omitted for samples taken on three dates, by mistake. The lack of data occurred for April 18, June 7 and July 24, 1989. The line graph was included for comparison, but comparison with other plots is difficult (Figure 32). The highest mean nickel occurred on the last sample date, and is three to four times higher than the other seven available means, all of which are BDL due to left-censoring. Correlations with LOGNIU are questionable, because of censored data, and because the missing data reduces the amount of available information from which to make inferences.

SUMMARY OF SEASONAL RELATIONSHIPS

An empirical evaluation of the seasonality of survey variables employed comparison of patterns in the line-graphs of variable means that were calculated by sample date. Also, correlation analysis (Table 7) and regression analysis (Table 9) helped to confirm graphical relationships. Ponds were treated as replicates of samples collected for each sample date to evaluate seasonality. Seasonality in the data appeared to be dominated by hydrologic conditions in the wet-detention ponds; however, a significant, inverse relationship ($r=-0.53$, $p=0.09$) between log mean DO (LOGDO) and mean temperature (TEMP1) indicates the expected seasonality between these two variables.

Graphical seasonal patterns were noted for two water-level indicators, mean discharge frequency (DCHARGE1) and mean bottom depth (DPTHCM). Although not statistically validated, both mean discharge frequency and mean bottom depth appeared graphically related to mean monthly rainfall over the study region. The significant direct correlation ($r=0.73$, $p=0.001$) between DCHARGE1 and DPTHCM (Table 7) helps to confirm their relationship with each other, and supports the association of discharge frequency and bottom depth with rainfall-related hydrologic conditions during the survey. Several negative correlations between water-quality variables and DCHARGE1 and/or DPTHCM (Table 7) indicate possible relationships that are dependent on the seasonal hydrology. Log mean conductivity (LGCOND_K), log mean cadmium (LOGCDU) and log mean turbidity (LOGTURB) have significant, negative correlations with DCHARGE1 and/or DPTHCM, while log mean DO (LOGDO) and mean iron (IRON1) have nearly significant, negative correlations.

Other correlations between date means indicate possible relationships that may have seasonal patterns, but not an obvious association with either seasonal hydrology or temperature. Significant positive correlations with LGCOND_K and both LOGTSSU and LOGTURB, probably have hydrological associations, however. The negative correlation between "mean" pH (PH1) and log mean copper (LOGCUU) (Table 7) is the only significant pH-metal correlation; however, log mean chromium (LOGCRU) and log mean lead (LOGPBU) are nearly, inversely correlated with mean pH. The similar, seasonal graphical patterns for several metals (Cu, Zn, Pb, Cd and Cr) point to possible inverse water-level and/or inverse pH-related patterns.

Finally, correlations with the heavily-censored metals (80% or more BDL for Pb, Cd, Cr, and Ni) should be regarded with caution, because censored data were replaced with one half the detection limit and are only an approximation. Similar seasonal patterns for Pb, Cd, and Cr are indicated in line-graphs, but correlations (Table 7) are tentative since the distribution of data that is BDL is unknown. Correlations with Ni are even more suspect, because Ni data are only available for eight of eleven sample dates.

RELATIONSHIPS AMONG VARIABLES

Annual variable means were calculated for ponds using SAS Proc Means and were then used in other statistical procedures to examine empirical relationships among variables. Examination of relationships among the annual means from the eighteen ponds was carried out using multivariate factor and cluster analyses (Proc Factor and Proc Varclus), as well as, correlation analysis (Proc Corr) and stepwise multiple regression (Proc Reg). Sample dates were treated as sample replicates collected for each pond over the study period. Because the data are observational rather than the result of controlled, designed experiments, explanation of the results required both rationalization and statistical inference for a plausible interpretation and discussion. As in the seasonal evaluation, statistical procedures were utilized more to explore the data than to make concrete inferences.

Variable Factor Analysis and Variable Clusters

Exploring variable relationships by factor analysis and cluster analysis using SAS procedures was performed with the annual variable means for ponds and sought to group related variables. This approach differs from the graphical evaluation, correlation analysis and multiple regression of seasonal (date) means that was carried out for the analysis of seasonal effects; however, correlation analysis (Table 8) and multiple regression analysis (Table 10) were also performed on the annual means. Analysis of seasonal effects relied on comparison and contrast of graphical patterns, and on statistical interpretations, while analysis of relationships among variables relied on statistical interpretations only.

SAS Proc Factor uses factor analysis, a form of principle component analysis, to reduce a large number of variables to a smaller number of "common factors", that account for a large proportion of the variation in the original variables. Once formed, the original common factors are rotated (transformed) in several ways to optimize the interpretation of the common factors (SAS, 1988). Proc Varclus is also a variable reduction method, that is more easily interpreted than principle component analysis. A large set of variables is replaced by a set of variable clusters with little informational loss. The results of Proc Factor and Proc Varclus are comparable (Tables 11 and 12, respectively).

The results of factor analysis (Proc Factor) and cluster analysis (Proc Varclus) for the annual means of fifteen variables (nine physical/chemical and six dimensional variables) are quite similar. Because the results of Proc Factor and Proc Varclus are so similar, presentation of results and discussion are combined for these procedures. Interpretation of factors and clusters is carried out by comparison and contrast. Interrelationships between trace metals are discussed in two papers cited in this report (Campbell and Tessier, 1987; and Murray, 1987), but only subjective comparisons with findings from the cited studies can be offered in our discussion.

Six common factors were formed by Proc Factor with eigenvalues greater the 1.0, accounting for a cumulative proportion of 86 percent of the data variation (Table 11). Similarly, Proc Varclus resulted in the formation of six clusters (Table 12) (two 4-variable cluster; one 3-variable cluster; one 2-variable cluster; and two 1-variable clusters). The proportion of data variance explained by formation of four multivariable clusters, and two single variable clusters is roughly 74 percent, and while somewhat less than the factor analysis results, the lower variance explained is probably caused by fewer variables in clusters than in common factors.

Factor 1 and Cluster 1 (Suspended Particles)

Factor 1 (Table 11) accounts for about 23 percent of data variability and corresponds exactly with Cluster 1 (Table 12), which explains about 24 percent of data variability. After rotation/transformation by SAS (top of Page B-14) The four main variables with large loadings in Factor 1 are the four variables in Cluster 1 (bottom of Page B-15) (LOGTSSU, LOGTURB, IRONU and DCHARGE1), with the exception of pH, which loads more strongly in Factor and Cluster 2. Large positive factor loadings for LOGTSSU (93), LOGTURB (87), and IRONU (67) are contrasted by the large negative loading for DCHARGE1 (-75). The annual means for TSS (LOGTSSU) and turbidity (LOGTURB) have inverse correlations with annual discharge frequency (DCHARGE1) ($p<0.05$ and $p<0.10$, respectively); and have positive correlations with mean annual iron (IRON1) ($p<0.05$) for ponds (Table 8). The largest positive loadings in Factor 1 (LOGTSSU and LOGTURB) are measurements of suspended particles; however, turbidity can be affected by dissolved material (e.g., suspended colloids) (Wetzel 1975, and Boyd 1979). The significant, positive correlation between IRON1 and LOGTSSU and LOGTURB (Table 8) indicates a direct relationship between mean iron concentrations and suspended particles, and corroborates the association in Factor 1 and Cluster 1. LOGTSSU is also a significant regressor for IRON1 (Table 10). The large negative loading of DCHARGE1 for Factor 1, is supported by significant, negative correlations (Table 8) and significant regressor effects (Table 10), between DCHARGE1 and both LOGTSSU and LOGTURB. The statistical evidence provides an indication that, on an annual basis, ponds that discharged less frequently tended to be higher in suspended particles. Because of the emphasis on suspended particles and closely associated variables, Factor 1 and Cluster 1 are tentatively labelled the "Suspended Particles" factor and cluster.

The positive loading for pH in Factor 1 is not the highest for pH, but agrees with the positive correlations between pH and LOGTSSU and LOGTURB in Table 8. Higher pH in ponds with higher TSS and turbidity could mean a stronger buffering capacity associated with suspended particles, or higher productivity as indicated by the strong correlation between pH and DO (Table 8). Also, note the negative loadings on all three pond-dimension variables -- pond size (LGPS_M2), treatment volume (LGVOL_M3) and maximum depth (SQZMAXCM) -- in Factor 1, especially for SQZMAXCM and LGVOL_M3. Inverse correlations between IRON1 and LGPS_M2 ($p=0.17$); between IRON1 ($p=0.19$), LOGTSSU ($p=0.16$) and LGVOL_M3; and between LOGTURB ($p<0.10$), LOGTSSU ($p=0.12$) and SQZMAXCM are indicated in Table 8; however, most are not significant. Thus, to some extent pond-dimensions may have an effect on suspended particles (and related variables), perhaps by affecting sedimentation or resuspension processes. Maximum depth may have had the greatest effect for our data, as seen in the inverse correlations between SQZMAXCM and LOGTSSU ($p=0.12$) and LOGTURB ($p<0.10$) (Table 8). Finally, the nearly significant, positive correlation between LOGTSSU and ZINC1 ($p=0.11$) indicates that mean zinc levels may be higher in ponds with higher mean TSS (Table 8).

Factor 2 and Cluster 2 (Productivity)

Factor 2 (Table 11) accounts for roughly 21 percent of the data variability and corresponds exactly with Cluster 2 (Table 12), which explains 25 percent of the data variability. The four main variables in Factor 2 correspond to the four variables in Cluster 2 (DO, pH, TEMP1 and LOGCUU). Note that annual means for dissolved oxygen (DO1), pH (PH1) and water temperature (TEMP1), and log-mean annual copper (LOGCUU) all have significant, positive correlations ($p<0.05$ or $p<0.10$) with each other (Table 8). Also, pH is a significant regressor for both DO and LOGCUU, while TEMP1 is a significant regressor on DO in Table 10. The next highest loadings into Factor 2 are mean annual zinc (ZINCU), then LOGTSSU and LOGTURB, and log-mean annual specific conductance (LGCOND_K).

Contrary to evaluation of seasonal effects, mean DO and temperature are positively correlated ($p<0.05$) for annual means in Table 8, rather than negatively correlated ($p<0.10$) as in Table 7. Because DO and pH are may be related through changes linked to aquatic primary production (photosynthesis and the bicarbonate buffer system), and because primary production often increases directly with increasing day length and water temperature (i.e., during the summer months) (Wetzel 1975); Factor 2 and Cluster 2 are tentatively labelled the "Productivity" factor and cluster.

The association of higher mean annual copper (LOGCUU) with higher mean annual DO (DO1), mean annual pH (PH1), and mean annual water temperature (TEMP1) in Factor 2 and Cluster 2, are supported by the positive correlations ($p<=0.10$) between LOGCUU and DO1, PH1 and TEMP1 in Table 8, as well as the regression effects in Table 10. As with DO and temperature, LOGCUU was inversely correlated ($p<0.10$) to PH1 for seasonal, date means (Table 7) and the inverse relationship between metals solubility and pH was discussed. The apparent positive relationship between mean "annual" pH and mean "annual" copper (LOGCUU) in ponds may also be related to the sensitivity of copper to pH changes. Increase formation of copper complexes and particulates as pH increases (i.e., decreased copper solubility) might occur in ponds with higher algal productivity indicated by higher DO and pH, and perhaps higher TSS and turbidity. Higher copper concentrations in surface-water metals samples could occur as copper becomes less soluble (forming particulates and complexes) in the more productive surface layers, depending on the temporal and spatial distributions of copper, and the internal cycling of copper species. The involvement of copper based algicides or herbicides is unclear, but might have been greater in the more productive ponds during the survey.

In lake studies, oxidation and complexing of copper (and lead) into particulates and carbonates increases with pH (Campbell and Tessier, 1987). Particulates and carbonates may increase as primary production does, and diurnal patterns in pH often result from diurnal photosynthesis patterns (Wetzel, 1975). Note the positive loadings of LOGTSSU and LOGTURB in Factor 2. Both are positively correlated with mean annual pH (Table 8) and perhaps influenced by higher primary production and algal biomass in larger more steady state ponds. LOGCUU and pH had a significant, inverse correlation for date means (Table 7). Sediment trap studies in lakes show the anoxic flux of copper from sediments into the water column is highest in March and April (Murray, 1987), which corresponds with our peak mean copper concentrations and relatively low mean pH (slightly below neutral). Thus, positive loadings for PH1 and LOGCUU in Factor 2, and their positive correlation in Table 8, may seem contrary to the inverse seasonal correlation between PH1 and LOGCUU (Table 7). However, based on the empirical evaluation of data from this study, a two-fold physical/chemical and biological control of copper and other metals (e.g., chromium) may exist in the survey ponds; a control that is probably related to pH (or oxidation-reduction potential).

Factor 3 and Cluster 3 (Pond-Dimensions)

Factor 3 (Table 11) accounts for roughly 21 percent of data variability and corresponds exactly with Cluster 3, which also explains about 21 percent of data variability. The three main variables in Factor 3 are the variables that make-up Cluster 3 (LGPS_M2, LGVOL_M3, and SQZMAXCM), the three transformed pond-dimension variables taken from permit information files. Thus, Factor 3 and Cluster 3 are tentatively labelled the "Pond-Dimensions" factor and cluster.

The significant, positive correlations (Table 8) between the pond-dimension variables is expected, because permits require certain dimensions so that each pond treats a designed volume of stormwater runoff. Significant correlations (Table 8) between the three pond-dimension variables and water-quality variables include significant, positive correlations between LOGVOL_M3 and LGCOND_K, and LOGVOL_M3 and LOGCDU; also negative correlations between SQZMAXCM and LOGTURB, and possibly SQZMAXCM and LOGTSSU ($p=0.12$). In Factor 3, the negative loadings for LOGTSSU, LOGTURB, IRONU, LOGCUU and ZINCU, as well as, positive loading for DO1 and LGCOND_K indicate possible water-quality improvement. Thus, correlations (Table 8) and factor loadings (Table 11) indicate possible improvements in water quality (especially suspended particles) as some pond-dimensions increase (i.e., treatment volume and maximum depth). However, questions concerning optimal pond-dimensions, especially with regards to watershed factors, have not been addressed with the data.

Factors and Clusters 4, 5, and 6

Factors 4, 5, and 6 account for roughly 12, 12, and 11 percent (respectively) of the data variability. The variables with the highest loadings in each of these factors correspond exactly to the variables in Clusters 4, 5, and 6; which explain roughly 12, 9, and 9 percent (respectively) of the data variability. Note the variability explained by each of these three factors and clusters is about half that explained by each of the previous three factors and clusters.

The main variables in Factor 4 (ZINCU and LOGMNU), are the two variables in Cluster 4. Although they are related through factor analysis (both positive loadings) and cluster analysis, the positive correlation between mean annual zinc (ZINC1) and log mean annual manganese (LOGMNU) (Table 8) is not significant ($r=0.33$ $p=0.18$). A partial correlation exists between zinc and manganese, however (Table 10). Several relatively equal positive loadings in Factor 4 include IRONU, DCHARGE1, TEMP1 and SQZMAXCM, while LGPS_M2 loads negatively into Factor 4; however, the loadings that represent significant relationships is less clear in Factor 4, and the importance of Factor 4 (and Cluster 4) is uncertain. Note that Factor 4 is the only factor having positive loadings for all four metals included in the analysis. Manganese may somehow be involved with internal cycling of zinc (both are 99 to 100 percent soluble between pH 7 and pH 4), or perhaps higher mean annual zinc and log-mean annual manganese (and other metals), can be expected in smaller, deeper, more frequently discharging ponds. But, these interpretations can not be implied from correlation analysis alone, especially when cut-off significance levels are approached.

The next highest loading for ZINC1 is in Factor 2, implying that productivity variables and zinc may be related. Although seasonal LOGDO and LOGZNU are positively correlated ($p<0.05$) in Table 7, annual DO1 and ZINC1 are not correlated in Table 8. The next highest loading for LOGMNU is positive in Factor 5, perhaps implying a bottom depth relationship. Although not significant, LOGMNU was positively correlated with SQZMAXCM ($p=0.20$) in Table 8. The strongest correlations for mean annual zinc and mean annual manganese in Table 8 are a positive correlation between ZINC1 and LOGTSSU ($p=0.11$) and a negative correlation between LOGMNU and LOGCRU ($p<0.05$) (Cr was not included in factor or cluster analyses).

The main variable in Factor 5 (LGDPTHCM) is the single variable in Cluster 5, and the main variable in Factor 6 (LGCOND_K) is the single variable in Cluster 6. Several other variables load into Factors 5 and 6. The next highest in Factor 5 is a positive loading by IRONU. LGDPTHCM and IRONU are not directly correlated (Table 8); however, LGDPTHCM and IRONU are partially correlated through multiple regression analysis (Table 10). The next highest in Factor 6 is a positive loading by LGVOL_M3. The single high loadings for LGDPTHCM and LGCOND_K in Factors 5 and 6, respectively, imply that mean annual depth and mean annual specific conductance have fewer relationships with variables used in this analysis. Neither LGDPTHCM or LGCOND_K are correlated with many other variables included in factor and cluster analyses; except LGCOND_K is positively correlated with LGVOL_M3 ($p<0.05$) (Table 8), probably due to the outlier effect of Pond A, a coastal pond and the study's largest wet-detention system.

Difficulties surrounding the interpretation of Factors 5 and 6, and Clusters 5 and 6 are the same as those encountered in the interpretation of Factor and Cluster 4. The significance of Factors 5 and 6, and Clusters 5 and 6 are unclear; several other variables load with levels well below the high loading of single variables in Factors 5 and 6. At this point the subjectivity in establishing levels of significance and cutoff points in statistical tests conducted by SAS becomes important. By changing the minimum eigenvalue criteria (MINEIGEN) of Proc Factor, and the PROPORTION (proportion of variation explained) or MAXEIGEN (maximum value of the second eigenvalue) of Proc Varclus, it would be possible to eliminate Factors and Clusters 4, 5, and 6. However, the levels for the criteria in the SAS procedures we used are normally adequate to omit nonsignificant relationships.

Summary of Variable Relationships

Factor, cluster, correlation, and regression analyses were used to explore empirical relationships among annual means of study variables. Results from each analysis provided supportive evidence for some significant relationships among variables for the survey ponds. Factor analysis and cluster analysis provided an interpretation of how certain variables can be related through hydrologic conditions (suspended particles), through productivity, and through pond dimensions. Many of the relationships among variables within clusters and factors were explored and supported by correlation and regression analyses.

Within the "Suspended Particles" factor and cluster (Factor 1 and Cluster 1), significant direct relationships among TSS, turbidity, and iron are highlighted, as are the significant, inverse relationships with discharge frequency and both TSS and turbidity. Statistical evidence for these significant relationships are also provided by Pearson correlations (Table 8) and by stepwise multiple regression (Table 10). Other less important relationships are the inverse relationships between suspended particles and pond-dimensions (especially maximum depth), and the direct relationship between suspended particles and pH.

Within the "Productivity" factor and cluster, significant (Factor 2 and Cluster 2), direct relationships among the main variables (DO, pH, temperature, and copper) are highlighted; all significant, positive relationships among these four variables are supported by correlations (Table 8), and most are also found in the regression analyses (Table 10). Other less significant, direct relationships noted in Factor 2 include zinc, suspended particles, and conductivity. Few inverse relationships are indicated.

Within the "Pond-Dimension" factor and cluster (Factor 3 and Cluster 3), direct relationships among the pond dimensions are expected for designed stormwater ponds. The direct relationship with specific conductance may be due to higher groundwater inputs in larger, deeper ponds, but are more likely the result of highest mean conductivity in the largest pond which discharged to tidal ditches. However, inverse relationships with pond dimensions are indicated for suspended particles and for iron. Certain correlations (Table 8) and regressions (Table 10) among suspended particles, specific conductance, and pond-dimensions are indicated for the data.

Within Factors and Clusters 4, 5, and 6 relationships are not strong. Zinc and manganese are related through factor analysis, cluster analysis (in Factor 4 and Cluster 4), and possibly regression analysis, but not in correlation analysis. Only in Factor 4 do all four metals included in multivariate analyses have positive loading values. Still the importance of Factor 4 and Cluster 4 is unclear. The relationships with bottom depth in Factor 5 and Cluster 5 do not result in significant correlations (Table 8); however, bottom depth is a significant regressor for iron (Table 10). The relationships with specific conductance in Factor 6 and Cluster 6 have been explained for (treatment) volume (and other pond dimensions) and is probably due to high conductivity in the largest pond. Specific conductance and turbidity are related in Factor 6 and regression analysis (Table 10), but not in correlation analysis.

RELATIONSHIPS AMONG PONDS

Pond relationships were explored using two methods. First, ponds were grouped by land use, then land-use water-quality means were calculated and compared. Second, multivariate cluster analysis (SAS Proc Cluster) was used to cluster ponds; however, not all of the same variables were used in the land-use evaluation and the cluster analysis. Duncan multiple range tests were then conducted to test the equality of means for land-uses and pond clusters (Addendum -- Tables I, II, and III). The results of the two methods agreed to some extent about where the highest mean concentrations for certain water-quality variables were found.

Land-Use Relationships

Studies have often evaluated the effects of different land uses on water-quality in stormwater ponds (Wanielista, 1978; and Whalen and Cullum, 1988). In this report, evaluation of the effects of different land uses on water quality was carried out graphically, and with Duncan multiple range tests for equality of means (see Addendum tables). Bar graphs constructed to compare water-quality means from four land-use types -- heavy commercial (HC), light commercial (LC), single-family residential (SR), and multi-family residential (MR) -- provided a first look to compare the wet-detention ponds in this study. Duncan multiple range tests helped discern statistically significant differences between variable means by land-use. The criteria for each land use were fairly subjective, as was the assignment of specific ponds to the four land-use types. Quantitative assessment of the various activities in the four land uses was not possible, and common activities among the land uses include roadways and parking lots with varying degrees of utilization and traffic flow. The following summary briefly describes the four land uses applied to the original twenty-four ponds.

Heavy commercial (HC) sites (7 of the 24) consisted of light industrial developments, a car dealership, and a large shopping center. Four of the final eighteen sites were classified as heavy commercial and included two light-industrial sites, the car dealership, and the shopping center. Light commercial (LC) sites (6 of the 24) were in urban business parks or isolated office complexes. Five of the final eighteen sites were classified light commercial. Multi-family residential (MR) sites (6 of the 24) involved high-density apartments, townhouses, or mobile home parks. Four of the final eighteen sites were classified multi-family including one of the mobile home sites. Finally, all of the original single-family residential (SR) sites (5 of the 24) of varying densities were included in the evaluation of land-uses on water quality. The single-family sites were generally of lower density than multi-family sites; however, the multi-family mobile home sites might be intermediate in family density.

The variables used in the graphical land-use evaluation included mean TSS, mean turbidity, and the means for the eight heavy metals (Zn, Fe, Cu, Mn, Pb, Cd, Cr, and Ni) for each land use (Figures 33 to 42). Dissolved oxygen, pH, specific conductance and temperature were compared by land-use only with multiple range tests (see Addendum Tables I to III). A single mean was calculated for each land use from all of the ponds and all water samples taken in each land use. The results were comparable to the mean of annual means when ponds are grouped by land use. Lotus 1-2-3 bar graphs were created by sorting land-use outfall station means in ascending order. Figures 33 to 42 present the results of the land-use evaluation.

For TSS and turbidity (Figures 33 and 34, respectively) the outfall station and pond station means were graphed and compared once they were sorted by ascending outfall station means; no pond station metals data were available. Generally, the ascending arrangement of mean TSS and mean turbidity by land-use are similar, probably due to the highly significant positive correlation ($r=0.82$, $p=0.0001$) between mean annual TSS and mean annual turbidity (transformed LOGTSSU and LOGTURB, respectively) (Table 8). In the Duncan multiple range tests (Addendum Table I), the means for multi-family (MR) TSS and turbidity were higher than means of other land uses ($p<0.05$). The three other TSS and turbidity means (LC, HC and SF) were not statistically different from each other, but were statistically less than MR mean. Multi-family mean outfall TSS (highest, about 13.5 mg/L) was more than twice that of the light-commercial mean outfall TSS (lowest, about 5.5 mg/L).

Multi-family outfall mean turbidity (highest, about 10 NTU) was more than twice that of the single-family outfall mean turbidity (lowest, about 4.5 NTU).

Outfall station mean TSS was generally higher than the pond station except for the light commercial sites (Figure 33) (no statistical test). The inverse correlation between mean bottom depth (LOGDPTHCM) and mean TSS (LOGTSSU) is not significant (Table 8); however, the inverse relationship between discharge frequency (DCHARGE1) and LOGTSSU is significant. Thus, the argument can be made that shallower outfall stations have higher TSS more frequently; however, samples form shallower pond locations have a greater chance of being contaminated with bottom sediments. Conversely, pond station mean turbidity was generally higher than the outfall station except for the light commercial sites (Figure 34) (no statistical test); again DCHARGE1 was inversely correlated with mean turbidity (LOGTURB) in Table 8, but LOGDPTHCM was not. The difference between outfall and pond stations mean TSS and turbidity was greatest for the multi-family sites.

Field variables were also compared by land-use with Duncan multiple range tests (Addendum -- Table I), but not graphically. The MR mean for dissolved oxygen and pH were numerically greatest, but the MR means were second highest numerically for specific conductance and temperature. Statistically, the MR mean for dissolved oxygen was higher than the LC mean, which was statistically higher than both the SR and HC means. The MR mean for pH was statistically equal to the LC and HC means, and the SR pH mean was statistically lower than the other three means. The LC mean for specific conductance was numerically and statistically higher than other three means (which were statistically equal), because Pond A was a LC pond and had high specific conductance values throughout the survey due to the tidal influence in receiving waters and probably due to brackish ground water inputs.

The multi-family mean for zinc (highest, about 0.045 mg/L) was more than twice the single-family mean for zinc (lowest, about 0.02 mg/L) (Figure 35). The multi-family mean for iron (highest, about 0.35 mg/L) was only about 50 percent (0.1 mg/L) higher than the light-commercial mean for iron (lowest, about 0.22 mg/L) (Figure 36). The multi-family mean for copper (highest, about 0.03 mg/L) was nearly three times the heavy-commercial mean for copper (lowest, about 0.011 mg/L) (Figure 37). Finally, the single-family mean for manganese (highest, about 0.016 mg/L) was only slightly above the multi-family mean. The light-commercial and heavy commercial means for manganese, were only slightly less than the two residential land uses (Figure 38). If the heavily-censored metals are considered (Pb, Cd, Cr, and Ni are greater than 80% BDL) (Figures 39 to 42), the multi-family mean was highest for cadmium (Figure 40) and nickel (Figure 42), but lowest lead (Figure 39). Light-commercial, single-family and heavy-commercial means were about equal for lead, and only the multi-family mean was below lead's DL (0.01, Figure 39). The multi-family mean for nickel was the only land-use mean above the DL (0.01) for nickel (Figure 42). The heavy-commercial mean for cadmium was below the DL (0.002) for cadmium (Figure 40), and only the heavy-commercial mean was clearly above the DL (0.01) for chromium (Figure 41).

In Figures 35 to 42, mean heavy metals for the four land uses are ranked in ascending order, and only outfall station data are available. For three of the four least left-censored metals (Zn, Fe, and Cu) (Figures 35 to 37), the multi-family sites have the highest mean. To some extent, the Duncan multiple range tests (Addendum Table I) agree with the graphical/numerical differences for zinc, iron, and copper. The MR mean was statistically greater than the HC and SR means for total zinc; was statistically greater than the LC, SR, and HC means for total copper; and was statistically greater than the LC mean for total iron. For manganese, cadmium, lead, chromium and nickel there may be slight numerical differences (Figures 38 to 42), but the means were statistically equal (Addendum Table I). Also, none of the four land-use annual means for Zn, Fe, Cu, or Mn were below detection limits (BDL) (see DL in Table 4).

Significant trends are difficult to derive from this evaluation of land-use on water quality in wet-detention ponds; however, the multi-family site annual means were numerically highest for nine of the ten variables included in this evaluation (DO, pH, TSS, turbidity, Zn, Fe, Cu, Cd and Ni). None of the multi-family annual means for the seven variables were below detection limits. Statistically, MR annual means were greatest for DO, TSS, turbidity and copper, and were among the highest for zinc and iron (Addendum -- Table I).

Pond Clusters

Cluster analysis using SAS Proc Cluster was performed on annual means from ponds for two groups of variables. Cluster analysis was performed first on ten variables, then on seven variables that were previously used in factor and cluster analyses. Ponds were then identified in the resulting clusters. Ten variables (TSS, turbidity, specific conductance, temperature, pH, Zn, Fe, Cu, and Mn) were included in the first group. In both cluster structures, pond-dimensional variables plus LGDPTHCM and DCHARGE1 were eliminated so that their effects would not obscure the effects of water-quality variables in cluster formation. DO, pH, and TEMP1, which vary diurnally, were then omitted from the second set of (seven) variables, in order to eliminate diurnal effects on cluster formation and then compare results with the ten-variable structure. By taking annual means, seasonal effects on each variable have been included unless data are missing. Again, heavily censored trace metals (Pb, Cd, Cr, and Ni) were not included in cluster analyses of this report.

Proc Cluster used the "average-linkage method" (SAS, 1988) to form hierarchical clusters of ponds based on variable means from the eighteen ponds (i.e., ponds were identified in clusters formed by average {distance} linkage clustering of variable means). If a variable was not transformed, then it was normally distributed (Table 6), and it was standardized (mean=0, standard deviation=1) to remove the effects of different scales or units prior to cluster analysis.

The hierarchical cluster structures of the ten-variable and seven-variable groups are shown in Figures 43 and 44, respectively. The ten-variable group includes the following variables: LOGTSSU, LOGTURB, IRONU, ZINCU, LOGMNU, LOGCUU, LOGCOND_K, DO1, pH and TEMP1. The seven-variable group does not include DO1, pH and TEMP1. Annual means, as well as, the "cluster mean" of annual means for the ten-variable and seven-variable cluster structures are listed in Tables 13 and 14, respectively. Tables 13 and 14 help to interpret the cluster formations in Figures 43 and 44, respectively. In addition to summarizing the annual means for the eighteen ponds and for each cluster, Tables 13 and 14 also show the ranking of cluster means in ascending order for each variable, as well as, the results of Duncan multiple range tests that compare the equality of cluster means. Results of the Duncan multiple range tests for the 3-cluster and 2-cluster structures are also shown in Addendum Tables II and III, respectively.

Ten-Variable Cluster Structure

An "average distance between clusters" of about 1.0 results in the grouping of the eighteen ponds in three clusters (Clusters I, II, and III) (Figure 43). In part the result of the (ten) variables selected, the three clusters consist of a two-pond cluster (Cluster I), a seven-pond cluster (Cluster III), and a nine-pond cluster (Cluster II). Cluster I splits from Clusters II and III at and average distance of about 1.2, and consists of two light-commercial (LC) ponds within the same business park that is located within a mile of tidal creeks. In fact drainage ditches surrounding the development are tidal. Besides the tidal influence on receiving waters, the two ponds (Pond A and Pond F) are large and well-vegetated. Clusters II and III split at an average distance of about 1.1. The nine ponds in Cluster II consist of all four multi-family (MR) ponds, two of five single-family (SR) ponds, one of four heavy-commercial (HC) ponds, and two of five light-commercial (LC) ponds. Note that all four of the multi-family ponds are together in Cluster II. The seven ponds in Cluster III consisted of three of four heavy-commercial ponds, three of six single-family ponds, and one of five light-commercial ponds.

When the cluster means (means of pond annual means) are ranked in ascending order in Table 13, highest cluster means for DO, pH, specific conductance; and lowest cluster means for TSS, turbidity, zinc and iron are found in Cluster I. Lowest cluster means for DO, pH, and copper; and the highest cluster mean for manganese are found in Cluster III. The lowest cluster means for specific conductance and manganese; and the highest cluster means for TSS, turbidity, zinc, copper, and iron are found in Cluster II. Mean temperature follows DO and pH in cluster ranking. From the ranking of water quality variables in ascending order, Cluster I appears to be the lowest and Cluster II the highest in terms of TSS, turbidity and two of the four heavy metals (Zn and Fe). Cluster II is also numerically highest for copper. Cluster I appears to be highest and Cluster III lowest with regards to dissolved oxygen and pH. The grouping of the four multi-family residential ponds in Cluster II, appears to have affected Cluster II's "highest" rank for five of the ten variables (TSS, turbidity, zinc, copper and iron).

Results of the Duncan multiple range tests (Duncan alpha=0.05) are indicated in Table 13 (and Addendum Table II) for the ten-varibable, three-cluster structure. For temperature, zinc, and manganese, the cluster means are statistically equal. Cluster I is statistically highest for mean DO and mean conductivity, as well as, being statistically equal to Cluster II and statistically higher than Cluster III for "mean" pH and mean copper. Cluster I is also statistically lowest for mean iron, as well as, being statistically equal to Cluster III for mean TSS and mean turbidity. Cluster II is statistically highest for mean TSS and mean turbidity, as well as, being statistically equal to Cluster I by being statistically higher than Cluster III for mean copper. Finally, Cluster II is statistically equal to Cluster III, by being statistically higher than Cluster I for mean iron.

Seven-Variable Cluster Structure

Deleting three of the "Productivity" variables (pH, DO, and TEMP1) with diurnal or seasonal patterns, and selecting an average distance between clusters of about 1.2, results in just two clusters; an eleven-pond cluster (Cluster I) and a seven-pond cluster (Cluster II) (Table 14 and Figure 44). In Table 14, Clusters I and II are clearly divided into numerically highest (Cluster II) and lowest (Cluster I) cluster means for the seven variables. Cluster I is a mixture of light-commercial, heavy-commercial, and single-family residential ponds, while Cluster II contains all four multi-family residential ponds plus three light-commercial ponds. The higher means for multi-family residential ponds that were observed during the evaluation of different land-uses were apparently influential in the formation of clusters in both the ten-variable and seven-variable groupings. Results of Duncan multiple range tests for the equality of cluster means indicate that the two cluster means were statistically equal for conductivity and manganese, but that Cluster II means were statistically higher than Cluster I means for TSS, turbidity, zinc, copper, and iron (Table 14 and Addendum Table III).

Again, the subjectivity of cluster procedures should be emphasized; removing three variables has changed the cluster structure rather dramatically. Basically, Clusters I and III of the ten-variable cluster structure were combined, and certain pond associations were changed. Lowering the "average distance between clusters" cutoff (i.e., considering smaller clusters of ponds) complicates the interpretation and results in more cluster with fewer ponds in each cluster.

Summary of Relationships Among Ponds

Two methods were employed to compare water-quality variables among ponds, (1) grouping ponds by land uses and comparing water-quality means, and (2) multivariate cluster analysis using water-quality variable means, and identifying ponds in clusters. Grouping ponds by land-uses required a subjective assessment of similar land-use activities in the watersheds utilizing ponds for capturing stormwater runoff. Cluster analysis utilized "average linkage" cluster to group ponds, first based on ten variables, then based on seven variables.

The land-use evaluation provided evidence that of the four land uses, the multi-family residential ponds were statistically among the ponds with highest mean concentrations for TSS, turbidity, and three heavy metals (Zn, Fe and Cu) (Duncan multiple range test, alpha=0.05). The cluster analysis procedure was first used on ten variables, but the four heavily-censored metals (Pb, Cd, Cr and Ni) were dropped, and pH, DO, temperature, and specific conductance were included. Three multivariable clusters -- Cluster I (two ponds), Cluster II (nine ponds) and Cluster III (seven ponds) -- were produced using the ten variables (Table 13 and Figure 43). Cluster I, consisting of two large, well-vegetated, light-commercial ponds had statistically higher means for three variables (DO, pH and conductivity) and statistically lower means for three variables (TSS, turbidity and iron). Cluster II which contained all four of the multi-family residential ponds had statistically higher means for four variables (TSS, turbidity, copper, and iron) (Table 13 and Addendum Table II). Cluster II was statistically intermediate for mean DO, and statistically one of the two clusters that were lowest for mean conductivity. Cluster analysis using just seven variables divided the ponds into two clusters, Cluster I (eleven ponds) and Cluster II (seven ponds). Cluster I means were statistically lower than the Cluster II means for five variables (TSS, turbidity, Zn, Fe and Cu), but statistically equal to Cluster II for mean conductivity and mean manganese (Table 14 and Addendum Table III). Again, all four multi-family residential ponds were clustered together, in Cluster II (Table 14 and Figure 44).

SUMMARY

WATER QUALITY STANDARDS

1. Total percent exceedence of Florida, Class III, water-quality standards for the 24 wet-detention outfalls ranged from less than 1% to 30%.

Dissolved Oxygen (30 to 39%)	Total Zinc (30%)
Total Cadmium (at least 18%)	Total Copper (14%)
Total Lead (7%)	Specific Conductance (5%)
Total Iron (4.5%)	Turbidity (4.4%)
Total Chromium (3.3%)	pH (3.1%)
Total Nickel (0.6%)	Total Manganese(0.4%) (Class II)

2. Percent exceedence of the secondary STP standard (20 mg/L) for total suspended solids occurred in 10% of outfall samples. Based on treatment efficiencies at Pond "S", TSS loading values in the literature, and the ambient TSS values during the survey, the 24 ponds were probably effective as sedimentation basins.

3. Water quality of wet-detention ponds probably determines discharge water quality, but exceedence of particular standards "within" a pond, may not constitute a violation of state water-quality standards. Some variables may be altered as discharge flows through a control structure (e.g., dissolved oxygen and total suspended solids).

SEASONAL EFFECTS

4. Seasonal rainfall amounts determined the water levels and hydrologic conditions in ponds. Average outfall conductivity, turbidity, and cadmium were inversely correlated with seasonal water-level indicators (discharge frequency and bottom depth).

5. Additional inverse relationships with seasonal water levels suggested that exceedences during dry periods were less likely to constitute a violation of standards; however, the data were not conclusive for DO, zinc, copper, iron and TSS.

Summary (continued)

6. Other significant seasonal correlations for outfall data included:

   Positive correlations occurred between: Discharge frequency and bottom depth, TSS and specific conductance, turbidity and specific conductance, cadmium and specific conductance, copper and cadmium, DO and zinc, and copper and lead.

   Negative correlations occurred between: pH and copper; and temperature and dissolved oxygen.

7. Sources of seasonal variability in stormwater constituents probably included antecedent conditions and first-flush effects; rainfall and water level changes; variable watershed and atmospheric sources; and in-pond processes.

HYDROLOGY, POND DIMENSIONS, AND PRIMARY PRODUCTION

8. Correlation analysis and multivariate statistics provided evidence that hydrologic conditions, pond dimensions and primary production had impacts on the water quality of the wet-detention ponds in this study. Both positive and negative relationships existed.

   Positive correlations occurred between:

   Three Pond Dimensions
   Specific Conductance and Treatment Volume
   pH and DO
   Temperature and Copper with both DO and pH
   TSS and Turbidity
   pH and Iron with both TSS and Turbidity

   Negative correlations occurred between:

   Discharge Frequency with both TSS and Turbidity
   Bottom Depth with both Cadmium and Lead
   Cadmium and Iron
   Chromium and Manganese

Summary (continued)

10. Variable factors explained 86% and variable clusters explained 74% of the total data variability. Together, the suspended particles, productivity, and pond-dimension factors and clusters explained 65% to 75%, respectively, of the data variability.

11. The land-use evaluation and cluster analysis of ponds suggested that multi-family residential ponds are among the ponds with the poorest water quality. This is probably due to a higher population density and more impervious surfaces.

RECOMMENDATIONS

When wet-detention is the type of stormwater management system to be built, design recommendations that optimize treatment efficiency are well-documented, and have been used by agencies such as the Southwest Florida Water Management District as guidelines for wet-detention system regulations. The recommendations assume that the best available information has been considered. Furthermore, it is assumed that site specific characteristics are to be considered when designing wet-detention basins. Pond design characteristics and stormwater management practices that are being utilized in the state of Florida are often based on the following broad recommendations found in the literature (SWFWMD 1988, Stahre and Urbanos 1990, Livingston and McCarron 1992) and elsewhere.

1. Optimize pond-design and dimensional characteristics for sedimentation, and for chemical and biological treatment of pollutants.

    -- Maximize sedimentation with pretreatment basins.
    -- Lesson the effects of sediment accumulation at the outfall by making the outfall area deeper and free of aquatic macrophytes.
    -- Maximize treatment time with the greatest possible separation between the inflow and the outfall.
    -- Design ponds for longer detention times.
    -- Prevent short-circuiting of flow with a length to width ratio of 2 to 1; and by spreading inflows with a baffle structure.
    -- Prevent dead zones and stagnant water with a gradual widening of the pond from the inflow to the outfall.
    -- Maximize sedimentation and biological treatment with littoral zones and shallower, open-water areas between deeper zones at the inflow and outfall.
    -- Littoral zones should occupy roughly 30% of the pond, with no steeper than 4:1 slopes and preferably with 10:1.

3. Whenever possible utilize management practices to pretreat stormwater, such as the following:

Sedimentation basins	Grass swales	Porous pavement
Off-line retention	Street cleaning	

Recommendations (continued)

4. Utilize non-structural management practices (Good Housekeeping) to improve stormwater quality.

   Land-use planning and management
   Wetlands and floodplain protection
   Fertilizer and pesticide control
   Public education
   Solid wastes management
   Non-leaded gasoline and ethanol-gasoline mixtures
   Erosion control

5. Utilize the watershed management approach to stormwater treatment.

   Stormwater utilities
   Regional facilities
   Retrofit existing structures

MANAGEMENT IMPLICATIONS

The Southwest Florida Water Management District Stormwater Research Program was started soon after the District was delegated stormwater permitting responsibility from the Florida Department of Environmental Regulation to the District. The goal of the program has been to assess the effectiveness of stormwater systems for reducing pollutant loads in state waters, and to eventually provide feedback on how well regulations were working. Regulations could then be modified to achieve more effective management of stormwater runoff and pollutant loads.

The 24-pond survey provided badly needed data from the Tampa Bay region, that has been useful in recognizing the need for additional research and monitoring studies within the Southwest Florida Water Management District. Soon after the 24-pond survey began, an intensive study of Pond S was started. Along with an intensive study of a wetlands-treatment system a better understanding of wet-detention treatment effectiveness is being achieved. Also, data concerning temporal and spatial patterns in substances that may reach pollutant levels is being collected. The District is also conducting an experimental pond study, that will add to the knowledge of how water quality varies in wet-detention ponds with different dimensions and varying aquatic macrophyte communities.

Incorporating natural wetlands into stormwater treatment systems is a controversial practice receiving attention in many states (USEPA 1992). Soon after some preliminary analysis of the data from the 24-pond survey, a survey of wetlands-treatment, stormwater systems was started. The data analysis from the wetlands survey is ongoing, and may provide data for a better insight on the effects of stormwater on water quality of natural wetlands.

One shortfall of the 24-pond survey was that "exceedences" were identified within ponds, where State water quality standards do not apply (Chapter 17-302, FAC). Since completion of the 24-Pond survey and completion of data collection for the wetlands treatment survey, the need to have a better understanding of discharge water quality has been recognized. Beginning in May 1992, data collection for a survey of wet-detention outfalls was started. The outfalls of properly-functioning, permitted wet-detention systems from both the 24-pond survey and the wetlands-treatment survey are being sampled. The objective is to describe the water quality as it is being discharged from the control structure, and to compare discharge water quality with the water quality within the pond just prior to discharge (i.e., within the pond, at the outfall structure). One goal of this outfall survey is to determine the variables that are changed during the process of water flowing through the control structure. If water quality is unchanged by discharge of water through a control structure, then water quality "within" wet-detention ponds might justifiably be used as criteria for water-quality regulations applied to wet-detention ponds. Some variable will probably remain unchanged by water flowing

Management Implications (continued)

through a control structure (dissolved metals, nutrients, and pesticides). Preliminary findings of the outfall survey have shown that dissolved oxygen may be increased as water is discharged and flows through the control structure in many of the wet-detention systems being surveyed.

Another shortfall of the surveys is that natural background water quality in receiving waters has not been adequately described, sampled or compared to the potential discharge waters in stormwater ponds. Also, receiving waters are not always available for sampling, and discharge to ditches, storm drains, and other stormwater systems preclude comparison of specific discharges with receiving water samples. The omission of studies on receiving water impacts is the result of the large scope of the stormwater problem, the shortages in funding of stormwater programs, and the need to utilize performance based water-quality and water-quantity treatment standards to achieve adequate treatment of stormwater, until better management practices can be found.

Since the reduction of point-sources of pollution to surface waters at the national level and the identification of stormwater runoff (point and nonpoint sources) as a major source of pollutants, water-resource managers and government agencies have focused on ways to further reduce pollutant loads (including point-source reductions, atmospheric pollutant reduction, and nonpoint source reduction). Many controversial, ecological and economic issues surround the regulation and management of stormwater treatment systems. Experience in the past with point-source pollution reduction, indicates that there are many cost/benefit considerations working to determine the rate and extent of pollution control and abatement. Cost burdens for constructing and maintaining stormwater systems are usually carried by developers, but they may be passed on to consumers and the general public in the form of higher prices, fees and rents. New national and state regulations for the reduction of stormwater pollutant loads (NPDES) require reductions of from 80% to 95%. As the costs and the number of systems increase there will be even greater needs for accurate information concerning stormwater treatment. The watershed approach to stormwater management in high population density areas is gaining popularity; for example, stormwater utilities as a way of creating cost effective stormwater treatment systems is becoming a popular idea for cities, counties and municipalities. States, like Florida, with abundant water resources are taking the lead in stormwater research, and providing valuable insights into the multi-faceted management concerns surrounding stormwater issues.

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GLOSSARY

24-Hour lowest allowable - refers to the Chapter 17-302 (FAC) Class III dissolved oxygen standard (4.0 mg/L, prior to 2-13-92).

24-Hour mean - refers to the Chapter 17-302 (FAC) Class III dissolved oxygen standard (5.0 mg/L, prior to 2-13-92).

Acute - having a sudden onset, sharp rise, and short course.

Acute toxic response or Acute toxicity - under Chapter 17-302, where determined for a significant species to the indigenous aquatic community, is said to occur or may be expected when one-third the concentration that is lethal to 50 percent of test organisms in 96 hours (i.e., 1/3 the 96-hour LC_{50}) is present.

Aerobic (conditions) - refers to situations where oxygen is relatively abundant and organisms dependent on its availability can survive.

Algicide - any agent used to kill or inhibit the growth of algae.

Alkalinity - the acid-neutralizing capacity of water, measured as the sum of all titratable bases and expressed as equivalent calcium carbonate ($CaCO_3$) in mg/L. Total alkalinity is the sum of carbonate (CO_3^{2-}), bicarbonate (HCO_3^-), and hydroxide (OH^-) alkalinity (as $CaCO_3$). Alkalinity may increase as productivity increases, and there often is a simultaneous increase in nutrients (nitrogen and phosphorus).

Anaerobic (conditions) - Anoxic and reducing (conditions) may be used as equivalent terms. Refers to conditions where oxygen is absent (anoxia) or nearly so, and where organisms and their life cycles are not based on the presence of oxygen. In anoxic layers (e.g., the hypolimnion) a preponderance of reduced substances occurs, hence the term reducing conditions.

Annual mean - the mean numerical value of a given variable calculated from samples collected over the period of one year.

Antecedent period - the dry period of time (usually hours or days) immediately prior to a rainfall event.

As-built certification - after the initial approval of stormwater system designs, any further documents and drawings are certified "As-built". They are submitted to the permitting agency with or without changes to approved designs, essentially certifying completion of a stormwater system. Changes are then approved (when the final result compliments the approved designs), or rejected.

Backflow - backwards flow.

GLOSSARY (continued)

Background (conditions) - under Chapter 17-302 (FAC), refers to the condition of waters in the absence of the activity or discharge under consideration based on the best scientific information available.

Basin area - the surface area of the stormwater pond and its immediate watershed as defined by predevelopment conditions. Prior to development basin area is equal to the drainage area, but after development occurs the drainage area may be larger, if there are other contributions to drainage from outside the basin area.

BDL - Below Detection Limits.

Below detection limits (BDL) - concentrations that are not detected falling below the limit of detection for a given variable.

Benthic species or benthic fauna - aquatic invertebrates living on or within, or associated with the bottom of ponds, rivers, lakes or the oceans.

Best Management Practice(s) - refers to the practice(s) used for a given set of conditions (e.g., soil type, water shed area, and land-use) that will achieve a satisfactory water quality and water quantity at a minimum cost.

Bicarbonate buffer system - Carbonate (CO_3^{2+}) and bicarbonate (HCO_3^+) are naturally occurring bases in most waters. Bicarbonate buffers water against sudden pH changes. In equation (1), if the concentration hydrogen ions ($[H^+]$) increase, H^+ reacts with HCO_3^+ to form carbon dioxide (CO_2) and water H_2O. If the concentration of hydroxide ions ($[OH^-]$) increases, a momentary drop in $[H^+]$ occurs, but CO_2 and H_2O react to form more H^+. In either case the equilibrium constant (K_1) is maintained and pH changes little in equation 2.

(1) $C0_2 + H_2O <--> H_2CO_3 <--> H^+ + HCO_3^+$

(2) $pH = pK_1 + (\log [HCO_3^-]) / (\log [\text{Total } CO_2])$

Bioaccumulative - able to accumulate or increase in concentration through repeated exposure, or through passage to successive levels in the food chain.

Biological recycling - refers to recycling of essential nutrients and minerals facilitated by organisms in the food web (e.g. bacteria, benthic invertebrates, plankton and fish).

Bleed down - the gradual, controlled release of water from a stormwater, detention pond into a receiving water body.

Bleed-down orifice - a type of control device in control structures that allows gradual, controlled discharge of the treated volume of stormwater.

BMP - Best Management Practice(s).

GLOSSARY (continued)

BOD - (biological oxygen demand), one of several measurements of relative oxygen requirements of water and effluents. BOD measures the oxygen required for the biochemical degradation of organic and inorganic materials.

Buffer capacity - the ability (of a substance in solution) to neutralize both acids and bases, thereby maintaining the original acidity and basicity of a solution.

Carcinogenic - capable of producing or causing cancer.

Chapter 40D-4 (SWFWMD) - Management and Storage of Surface Waters.

Chapter 17-40 (FAC) - State Water Policy.

Chapter 17-302 (FAC) - Surface Water Quality Standards.

Chapter 17-550 (FAC) - Drinking Water Standards, Monitoring and Reporting.

Chapter 40D-40 (SWFWMD) - General Surface Water Management Permits.

Chapter 373 (FS) - Florida Water Resources Act, 1972.

Chapter 17-4 (FAC) - Permits of the FDER.

Chapter 17-25 (FAC) - Regulation of Stormwater Discharge.

Chapter 17-3 (FAC) - Water Quality Standards.

Chapter 403 (FS) - Florida Air and Water Pollution Control Act.

Chronic - marked be long duration or frequent recurrence.

Chronic toxic response or Chronic toxicity - under Chapter 17-302, where determined for a significant species to the indigenous aquatic community, is said to occur or may be expect when on-twentieth the concentration that is lethal to 50 percent of test organisms in 96 hours (i.e., 1/20 the 96-hour LC_{50}) is present.

Class II - Under Chapter 17-302 (FAC), Class II waters are designated as waters for the support of shell fish propagation and harvesting.

Class III - Class III waters under Chapter 17-302(FAC) are designated as waters for recreation and propagation and maintenance of healthy and well-balanced populations of fish and wildlife.

Class I - Under Chapter 17-302 (FAC), Class I waters are potable (drinkable) waters and are designated as supplies supporting public consumption.

GLOSSARY (continued)

Class III - Under Chapter 17-302 (FAC), Class III waters are designated as waters for recreation, and for propagation and maintenance of a healthy, well-balanced population of fish and wildlife.

Competing cations - refers to all cations in solution that (including metals), based on their binding affinities, compete for binding sites in sediments, within ligands, or at other sites.

Control structure - (discharge structure) refers to a structural device, usually of concrete, metal or other durable material, through which water is discharged from a project to a receiving water.

Control device - the element of a control structure that allows gradual controlled (or bleed-down) release of water from a stormwater detention pond. The control device may be a bleed-down mechanism (e.g. orifice, notch, weir or filtration system).

Correlation - an interdependence (especially statistical) between variables.

CWA - Clean Water Act.

Date mean - the numerical mean value of a variable calculated from samples collected on a specific date.

Detection limit (DL) - a characteristic minimum value for a particular water quality variable and a particular analytic method.

Detention - refers to the collection and temporary storage of stormwater in order to provide treatment through physical, chemical, or biological processes with subsequent gradual release.

Discharge (water) - refers to the water that after treatment (e.g., detention) is gradually released from the stormwater system (e.g., wet detention), or the water that over flows (crests) the control structure (exceeds the seasonal high water level).

Discharge frequency - the number or percent of times that outfalls were observed to discharge on a particular sample date, or for a particular pond.

Diurnal (sampling) - diurnal refers to a daily cycle occurring on a 24 hour cycle. Thus diurnal sampling would be time based occurring over a distinct 24 hour period.

DL - Detection Limit.

Drainage area - the entire surface area that drains into and contributes stormwater runoff to a stormwater pond either by natural surface runoff or via a surface drainage system. It may be equivalent to the basin area or include more than the area of the immediate watershed.

Dry period - (or dry season) refers to periods of little or no rainfall during which water levels drop and stormwater ponds may go dry (often the winter and spring in Florida).

GLOSSARY (continued)

Eigenvalue - the characteristic root associated with a factor in multivariate factor analysis.

EMC - Event mean concentration.

EPA - Environmental Protection Agency.

Epilimnion - the warmer more oxygen-rich layer of water that overlays the vertically stratified region of greatest temperature decline (thermocline) in a lake. The epilimnion overlays the metalimnion, and the hypolimnion in a vertically stratified lake during the summer.

Event mean concentration - a value equal to the total mass of a pollutant divided by the total volume of runoff from the discharge an individual storm event. The EMC allows comparison of different runoff events and different sites.

FAC - Florida Administrative Code.

Fallout - substances that descend (fall out) through the atmosphere, as in deposition of air borne pollutants.

Fauna - all animal life (including microscopic) associated with a region, period, or specific environment,distinguished from plant life.

FDER - Florida department of Environmental Regulation.

Filamentous algae - a general term for algae produced in long thin filaments that often developed attached to a substrate,(and may be included in the periphyton).

First-flush - the initial shock load of pollutants due to the washing action of stormwater on accumulated pollutants in a watershed. The first-flush effect usually occurs during the first inch of rainfall or first half inch of runoff (in Florida).

Flocculent sediments - loosely aggregated, fine, suspended organic sediments.

Flocculent - material composed of flocs or floccules, which are loose aggregates of fine suspended particles.

Flora - all plant life (distinguished from animal life) associated with a region, period, or specific environment.

Freshwater flora - all plant life (distinct from animal life) associated with a freshwater environment (e.g.algae and plants).

Frontal storms - storms and rainfall resulting from and occurring in association with the boundary region between dissimilar air masses.

GLOSSARY (continued)

FS - Florida Statutes.

Hardness - in aquatic chemistry total hardness is defined as the sum of the calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions, expressed as calcium carbonate ($CaCO_3$) in mg/L.

Heavy metals - also trace metals or metals are equivalent terms. Zinc, cadmium, iron, lead, manganese, nickel, and chromium, can be found in the " heavy metals " section of the periodic table.

Herbicide - any agent used to kill or inhibit the growth of plants.

Hexavalent - refers to valence states where six outer shell electrons are shared in a bond or bonds between atoms, ions, molecules or radicals.

Hierarchical clusters - are organized so that one cluster may be contained entirely within another cluster, with no other kind of overlap between cluster.

Hydrograph - (1) a plot of stormwater discharge or run off time for a unit area. (2) a graphical representation of discharge versus time for a particular point in a stream or channel. (3) a hydrograph represents the "portion of rainfall" that runs off of the land into a receiving channel or stream referred to as rainfall excess or direct run off. (4) a hydrograph will not include rainfall accounted for by infiltration, evaporation, and storage, but includes delayed base flow to the stream later in the storm.

Hydrologic (conditions) - refers to patterns in the temporal spatial distribution of water in stormwater, ponds due to changes in groundwater, and rainfall in and associated with the stormwater ponds.

Hydroperiod - the range of water fluctuation and duration of inundation in a wetland.

Ill-conditioned - a descriptive term referring to a data set with many censored values, frequency distributions, or other underlying characteristic (e.g. non-randomness) that make statistical methods difficult to apply.

Impervious - Land surfaces which do not allow, or minimally allow, the penetration infiltration of water. (e.g. buildings, roads, parking lots, clay soils, etc..).

Internal cycle - within an aquatic ecosystem internal cycles refer to the movement of nutrients, minerals or chemical substances between sediments and overlaying water layers, or between different layers in the water column. Internal cycles may occur through physical, chemical, and biological pathways.

Land-use - refers to the type of dominant activity prevailing on a given area of land, or Light Commercial, Heavy Commercial, Single-family and Multi-family residential are the 4 land-uses encountered during the survey.

Leachate - a solution or product obtained by leaching of soluble components.

GLOSSARY (continued)

Left-censored data - data that are not known below a minimum cut off value, established by a specific detection limit.

Ligands - a group, ion or molecule coordinated (bonded) to a central atom in a chemical complex.

Loading - assigning a relative numerical value (based on positive and negative correlations) that describes the relationship of a variable to other variables within a multivariate space (variable) (i.e., a multivariate factor or cluster).

Macronutrients - elements required by organisms in large amounts (e.g., carbon, hydrogen, and nitrogen).

Metal complexes - a complex molecule formed by joining metal ions with organic or inorganic ligands.

mg/L - milligrams per liter.

Micronutrients - elements required by organisms in small amounts (e.g., copper, iron, zinc, and manganese).

National Urban Runoff Program - NURP was the EPA's study of nonpoint source pollution (i.e., urban runoff) at 39 sites in 28 U.S. cities . NURP's goal was to "develop information for rational, cost-effective decision making in stormwater management".

Natural background - the conditions of waters in the absence of man-induced alterations based on the best available information. Altered water bodies can be compared to similar unaltered (reference) water-bodies.

Nonnormal - refers to any frequency distribution of data that is not characterized by a symmetrical bell-shaped distribution that has 68% of data within one standard deviation of the mean, 95% of data within two standard deviations, and essentially all data within three standard deviations.

Nonpoint-source - refers to pollution that results from many unspecified sources of emission or discharge to the atmosphere or waterways (e.g., auto emissions).

Nonstructural BMP's - BMP's that improve water quality by reduction of pollution at or near their source (e.g., land-use planning, fertilizer and pesticide controls, and street cleaning).

Normal Pool - water level elevation in a pond defined by the bleeddown or control device. Normal pool is usually set at the seasonal high water table (SHWT) for wet-detention systems in Florida.

NURP - National Urban Runoff Program.

OFW - Outstanding Florida Waters.

GLOSSARY (continued)

Order of magnitude - a range of magnitude extending from some value to ten times that value.

Organic debris - generally refers to all plant and animal material that has died and settled to the bottom of a water body.

Organic ligands - arise from coordinate covalent bonds between a central ion and organic molecules.

ORP - Oxidation-reduction potential.

Outstanding Florida Waters - under Chapter 17-302 (FAC) (surface water-quality standards) Section 17-302.200 are waters that are designated by the Florida Environmental Regulation Commission as being worthy of special protection because of their natural attributes.

Oxidation-reduction - refers to the transfer of electrons from one atom (oxidized) to another atom (reduced) in certain chemical reactions.

Oxidation-reduction potential - (or Redox potential expressed as E_h or E_7), refers to the standardized measurement of the potential for electron loss (oxidation) or for electron gain (reduction) under present conditions of a solution. There is tendency for the oxidized phase to dominate inorganic chemical systems (Fe^{2+} to Fe^{3+}), although the oxidized and reduced states exist together in equilibrium. Removing free electrons causes further oxidation, while adding electrons inhibits oxidation and promotes reduction (Fe^{3+} to Fe^{2+}). ORP is proportional to the equivalent free energy change per mole of electrons associated with a given reduction. Changes in DO have very little effect on E_h (a 99% change in DO would change E_h by only about 30 mV). While changes in pH (H^+ activity) have a stronger effect (+ or - 58 mv per pH unit under standardized conditions), temperature may also affect E_h (about 2 mv per degree change between 0 and 30 degrees Celsius at pH 7).

Oxidation-reduction cycling - (or Redox recycling), refers to chemical cycling brought about by redox reactions. Substances may move between different sediment layers, between sediments and overlying water layers, and between layers in the water column.

Percent imperviousness - the area of impervious surfaces within a project, contributing run off to the stormwater system, divided by the total area drained, multiplied by 100.

Periphyton - algae that live attached to underwater surfaces.

Point-source - refers to specific sources of emission or discharge of pollution to waterways or the atmosphere (e.g, sewage treatment discharge).

Pond area - the surface area of the stormwater pond at a specific elevation on its banks (e.g., at normal pool).

GLOSSARY (continued)

Potable - suitable for human consumption.

Primary production - the quantity of new organic matter created by photosynthesis or the stored energy the organic matter represents.

Project area - the entire area under development within which the stormwater system operates.

Pollutant - anything that causes pollution (see Pollution).

Pollution - "the presence in the outdoor atmosphere or waters of the state of any substances, contaminants, noise, or man-made or man-induced alteration of the chemical, physical, biological or radiological integrity of air or water in quantities or levels which are or may be potentially harmful or injurious to human health or welfare, animal or plant life, or property, including outdoor recreation." (Chapter 17-302.200{18}, Florida Administrative Code).

Regressor - an independent variable that is comparable to a dependent variable to determine their relationship in a regression model.

Removal efficiency (or efficiency) - is the difference between the mass/volume input and mass/volume discharge for a pollutant; or simply the change in concentration from the input to the output, usually on a flow weighted (total mass/total volume) basis over the duration of a storm event.

Resuspension - physical movement of substances from the sediments to the water column by the action of currents, upwellings, or other water movements.

Retention - refers to the prevention of stormwater discharge into surfaces waters through complete on-site storage.

Right-skewed - refers to the asymmetrical distribution of data characterized by more values below the mean than above the mean. Thus, the mean is greater than the median (middle) value.

Runoff - (or stormwater runoff) refers to the proportion of precipitation falling on land that ultimately reaches a surface water. The term rainfall excess is often used by scientists and engineers focusing on the proportion of rainfall that does not infiltrate the soil or other pervious surfaces.

Scavenging - refers to the bonding of one atom, ion, radical, or molecule to another (scavenger) and both being cycled to another zone or layer of the environment. The substance being scavenged might not otherwise be transported.

Seasonal effects - the variability in water quality attributable to seasonal changes in climate factors such as day length, temperature, and precipitation.

GLOSSARY (continued)

Seasonal High Water Table (SHWT) - The highest water elevation expected during the rainy season, based on physical, biological and ecological evidence, and/or historical water level date for a particular site.

Secondary treatment - (secondary sewage treatment = 2' STP) after removal of solids in primary treatment, secondary treatment attempts to reduce nutrients (N and P) and organic material using bacteria and other microbes in activated sludge or trickle filter systems.

Sediment fluxes - generally refers to all chemical cycles transporting nutrients and minerals between the sediments and overlaying water layers.

Sedimentation (basins) - or settling basins, are usually incorporated as pre-treatment basins in stormwater systems to help reduce sediment deposits in receiving waters or in natural wetlands using in stormwater treatment.

Sedimentation - The process of forming or depositing sediment. The accumulation of all matter that settles to the bottom of a lake, pond, river or stream.

SHWT - elevation of the Seasonal-High Water Table usually specified as the Normal Pool elevation.

Significant (regressor) - statistical significance based of the probability that the null hypothesis is false inferring that a relationship exists.

Speciation - formation of a particular kind of molecule or ion.

Specific conductance - the reciprocal of specific resistance, a measure of a solution's ability to conduct the flow of electricity. A measure of the concentration of solutes capable of conducting electrical flow.

State Water Policy - Chapter 17-40, FAC. Recognizes the waters of the state as a basic resource to be managed to conserve, to protect and to realize their full beneficial use. Chapter 17-40 is intended to clarify water policy expressed in Chapters 187, 373, 403.

State Water Policy - Chapter 17.40 FAC.

Stepwise regression - either stepwise forward or stepwise backward multiple regression where variables are either added to or subtracted from (respectively) a model equation in a stepwise manner. The analysis ends when stopping criteria are met.

Storm event - Rain event and storm are equivalent terms. Storm events are described as having a duration (a beginning and perhaps an end); although storm events may overlap. Other quantitative characteristics of storms are the intensity, the time of concentration, and the peak flow rate. Duration and intensity may be used to place limits on storms included in analyses.

GLOSSARY (continued)

Stormwater - the flow of water that results from, and that occurs immediately following rainfall event.

Stormwater Treatment - any practice which addresses controlling quality and/or quantity of stormwater run off.

Stormwater Management - refers to any decision or action that seeks to (1) reduce pollutants in stormwater, (2) to provide surface drainage and flood protection, (3) to control erosion and sedimentation, (4) to enhance aesthetics and recreation opportunities, and (5) to find ways to reuse stormwater.

STP - Sewage Treatment Plant.

Structural BMP's - BMP's that control stormwater volume and peak discharge rate, as well as, controlling sedimentation, filtration, and evapotranspiration. The best structural BMP is off-line retention with a "smart weir". The first flush is diverted off-line via a weir box that diverts water until a certain level is reached.

Superfund sites - sites selected by the US Environmental Protection Agency, and given priority for clean up of toxic wastes. The superfund is made up of federal dollars to support cleanup of toxic waste sites.

Surface waters - All water bodies contained by basins of depressions in the earth's surface. They are often continuous with ground water.

SWFWMD - Southwest Florida Water Management District, one of 5 Florida Water Management districts.

Synergistic effects - combined effects of two or more substances that are greater than the sum of the individual effects.

The District - Southwest Florida Water Management District (SWFWMD).

Total Dissolved Solids - solids that pass through the filter. Highly mineralized waters (highly dissolved solids) may be unsuitable for many purposes.

Total Suspended Solids - the portion of total solids (total solids is determined by evaporation only). Waters high in suspended solids may be aesthetically or hygienically unappealing.

Transformation - a mathematical operation that changes the values of a particular variable to achieve a particular frequency distribution for the data (e.g., a normal distribution). The result of transformation is a new variable related to the original variable by the transformation.

GLOSSARY (continued)

Treatment volume - the design volume of runoff to by treated by a stormwater system. It may be calculated in several ways, for example: For projects less than or equal to 40 acres, treat the first 0.5 inches of runoff; drainage area (acres) x 0.5 inches (runoff) divided by 12 inches per foot = acre-feet. For ponds with a permanent pool (i.e., wet-detention ponds) treatment volume is added to the total volume or storage volume at the normal pool elevation.

Trivalent - refers to valence states where three outer shell electrons are shared in a bond or bonds between atoms, ions, molecules or radicals.

TSS - Total Suspended Solids.

Turbidity - a measurement of water clarity or lack of water clarity. Turbidity is measured in Nephelometric Turbidity Units (NTU) and increases as suspended matter increases in water.

Turnover - in the study of surface waters, turnover occurs when layers, profiles or other vertical distributions within the water column are broken down by circulation and mixing due to temperature changes, flow changes, solute concentration changes, or some other means.

ug/L - micrograms per liter.

Valence (state) - the degree of combining power of and element, ion, or radical. Valence state is expressed as the valance number (positive or negative) that is equal to the number of outer-shell electrons available for bonding. Excess outer-shell electrons result in a negative valence state, while a shortage of outer-shell electrons (excess protons) results in a positive valance state.

Weir - a type of control device in discharge structures that allows controlled release of stormwater.

Wet detention - a stormwater treatment system (pond) that utilizes a design water pool (permanent) in association with aquatic vegetation for the treatment of pollutants in stormwater runoff. Treatment occurs through sedimentation, absorption by soils and sediments, and nutrient uptake by vegetation. Dry detention or retention differs by the absence of a permanent pool and usually by a lack of aquatic macrophytes.

Wet-season or wet-period (conditions) - refers to the hydrologic conditions during the rainiest period of the year (e.g. June, July, August and September).

FIGURES

Stormwater Wet Detention Ponds Location Map

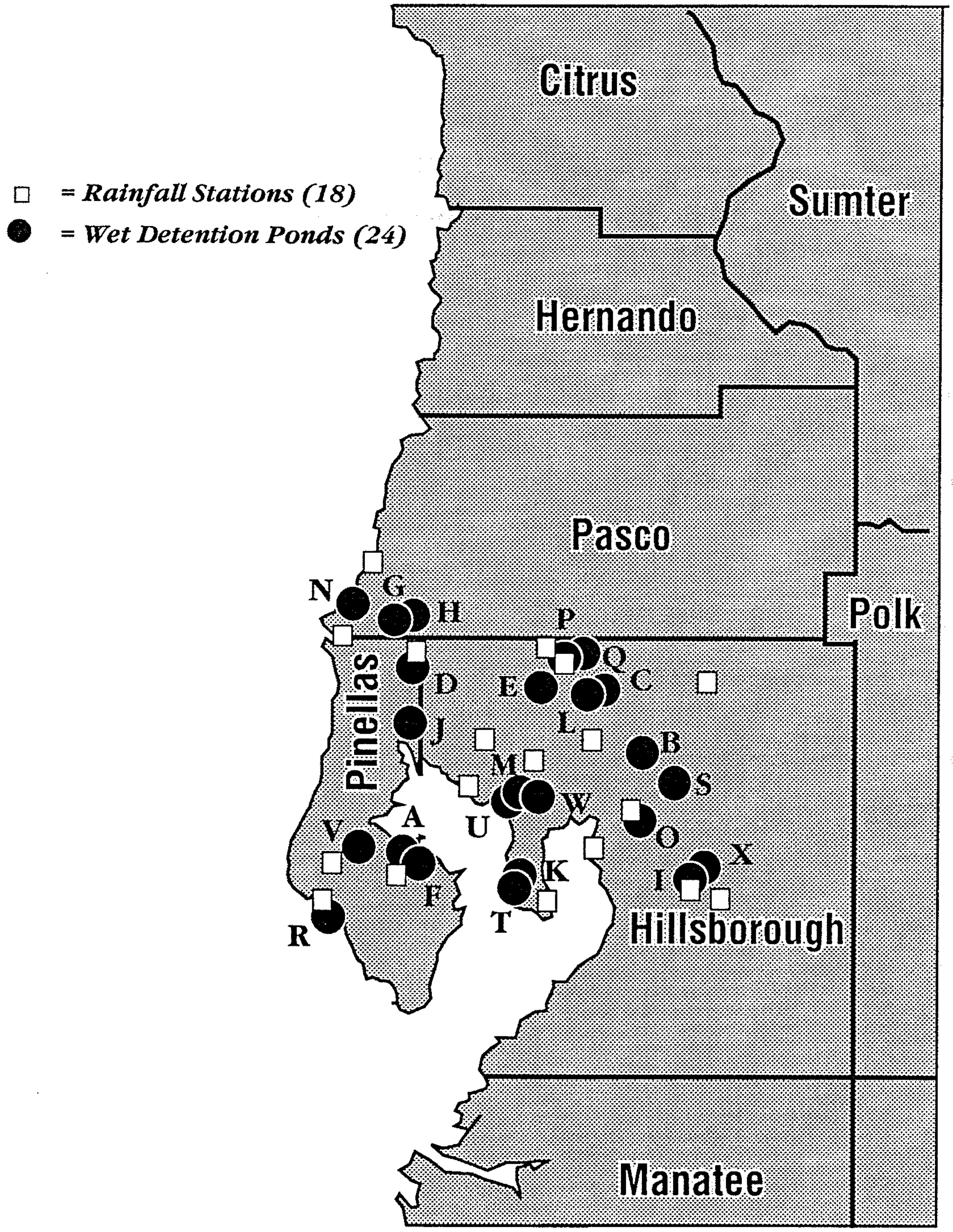


Figure 1. Locations of Wet Detention Ponds and Rainfall Stations.

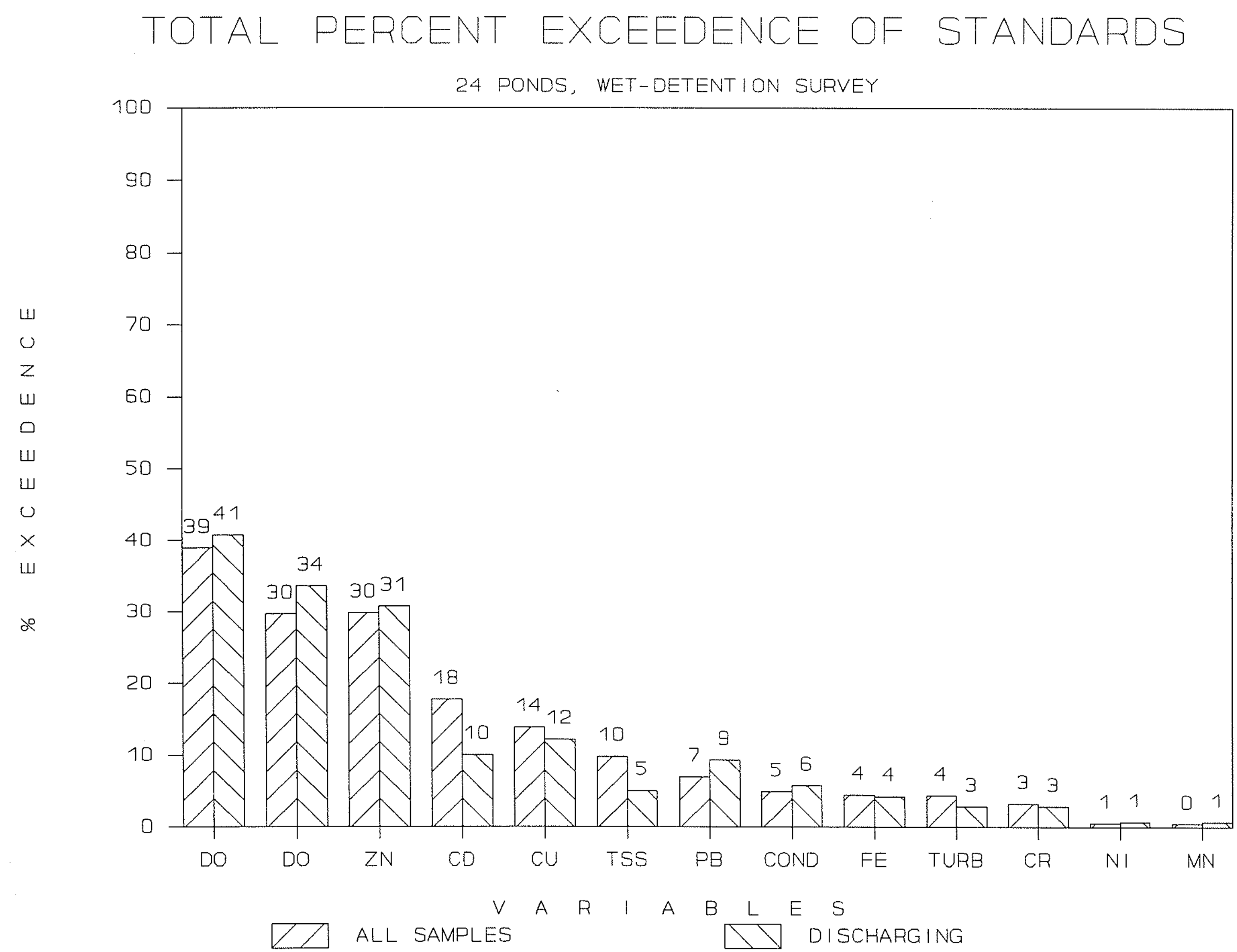


Figure 2. Total Percent Exceedence (%E) of Water-Quality Standards for all Samples and for Samples when Ponds Discharged in the 24-Pond Survey (1988 - 1989).

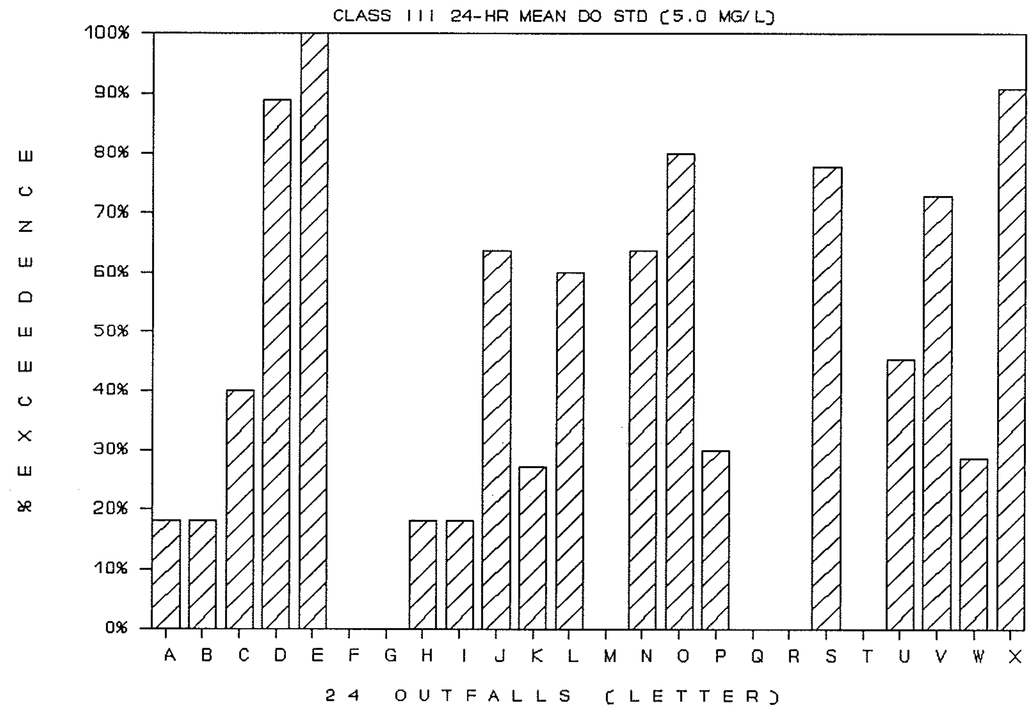


Figure 3. Total Percent Exceedence of the Class III Dissolved Oxygen Standard for each Outfall.

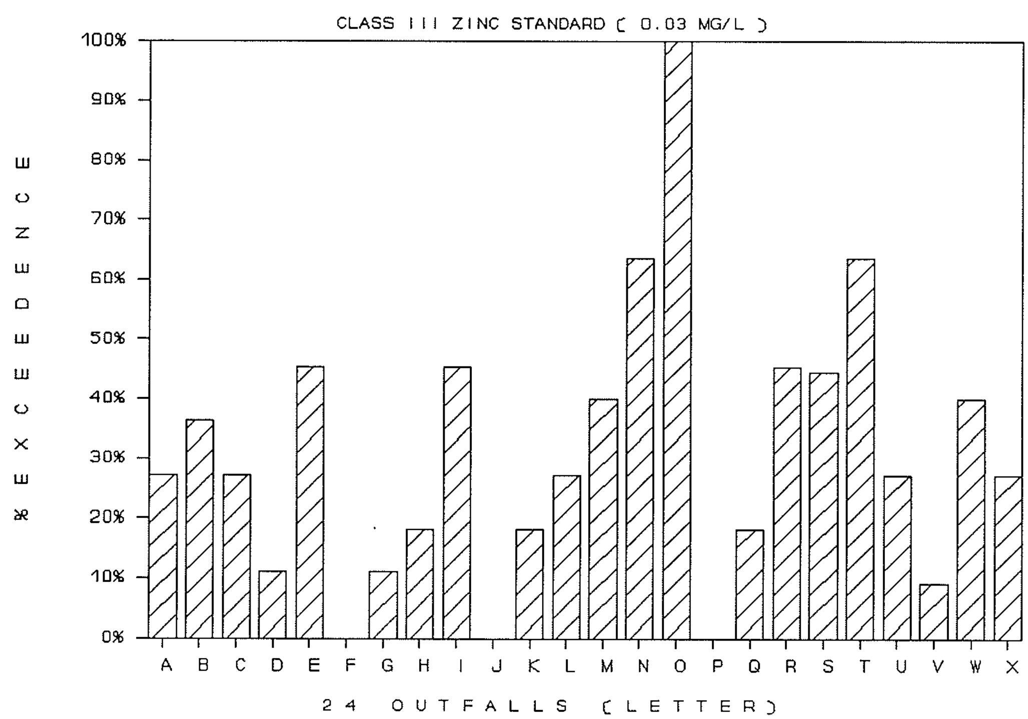


Figure 4. Total Percent Exceedence of the Class III Zinc Standard for each Outfall.

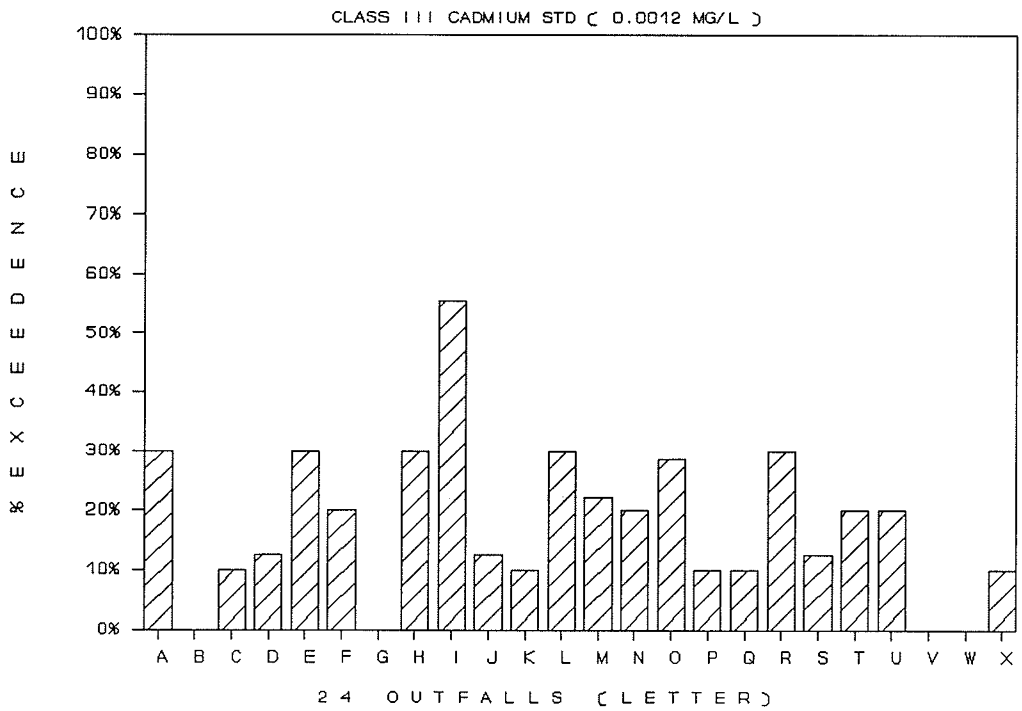


Figure 5. Total Percent Exceedence of the Class III Cadmium Standard for each Outfall.

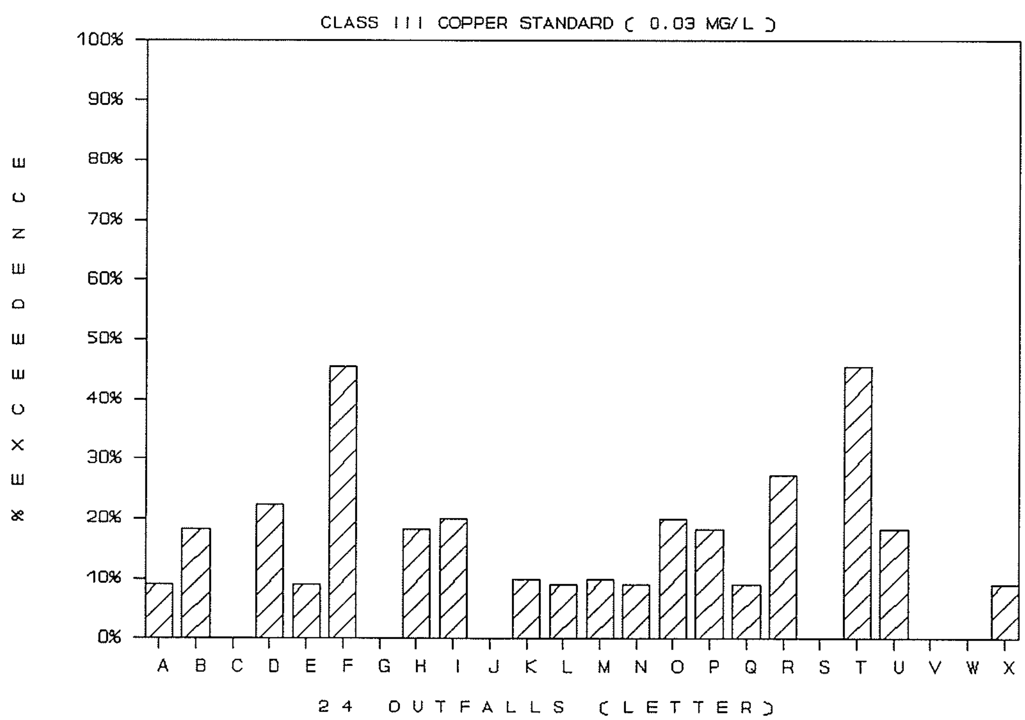


Figure 6. Total Percent Exceedence of the Class III Copper Standard for each Outfall.

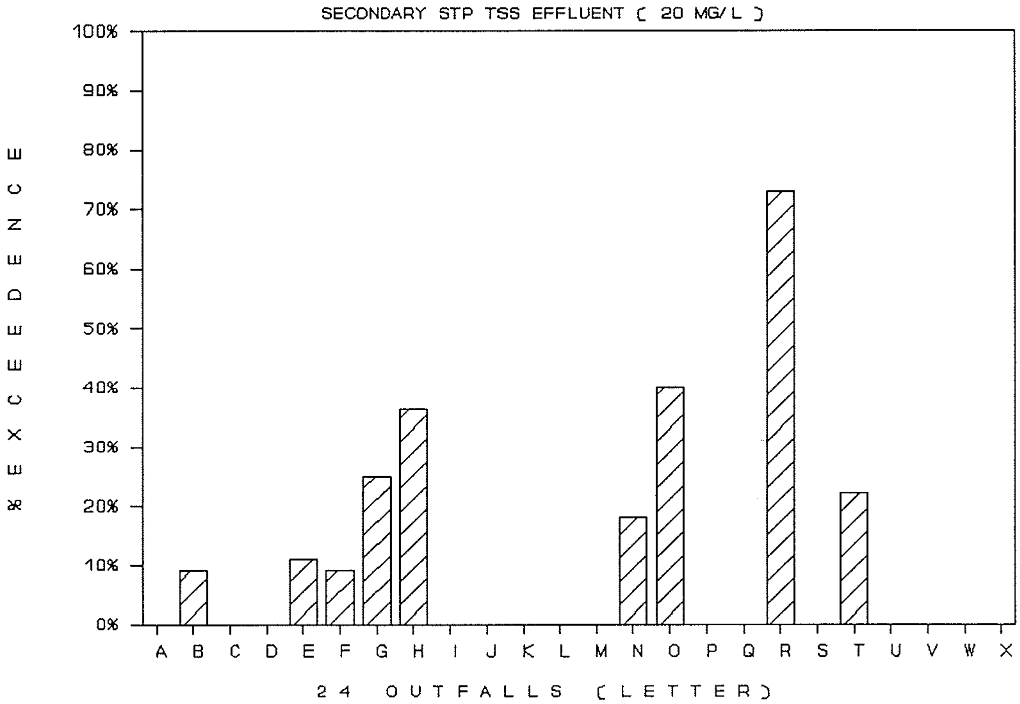


Figure 7. Total Percent Exceedence of the Secondary STP TSS Standard for each Outfall.

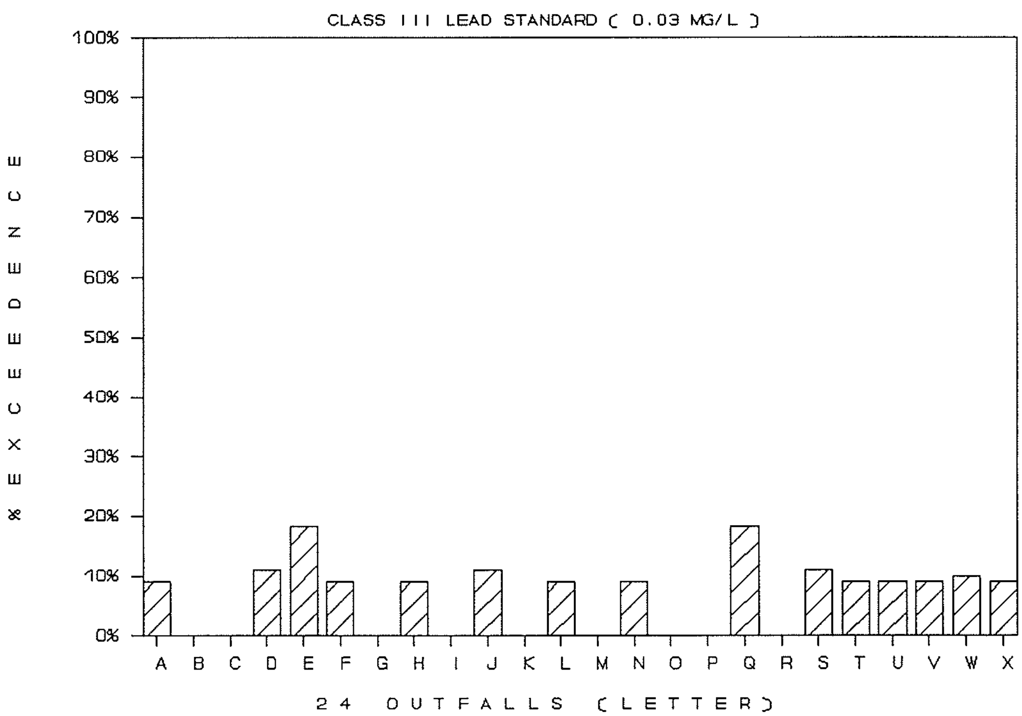


Figure 8. Total Percent Exceedence of the Class III Lead Standard for each Outfall.

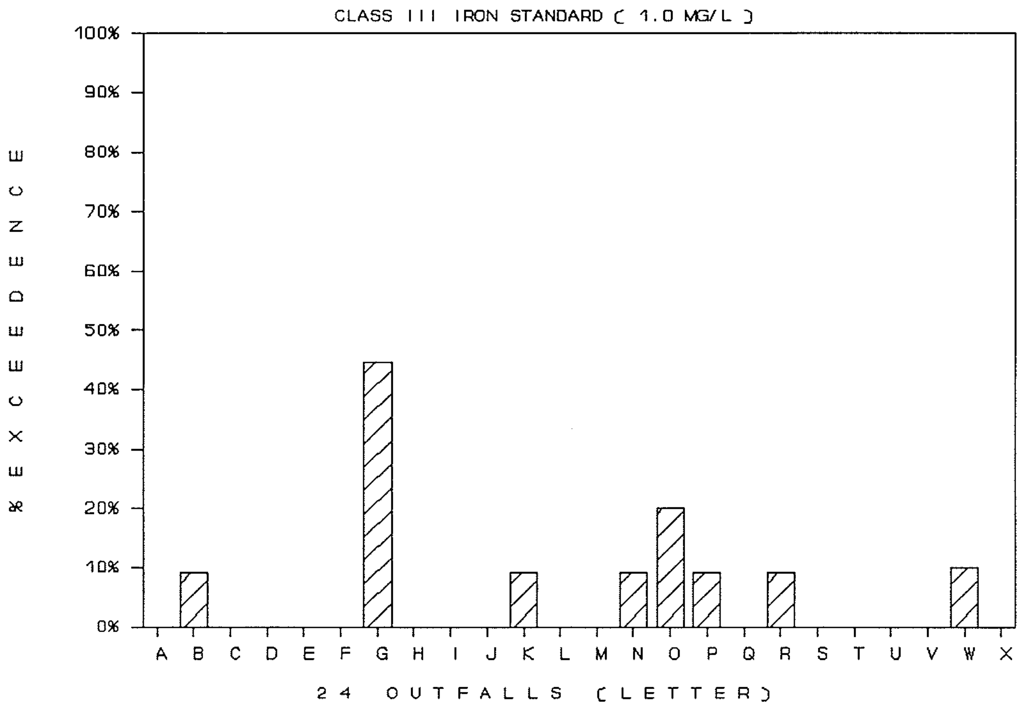


Figure 9. Total Percent Exceedence of the Class III Iron Standard for each Outfall.

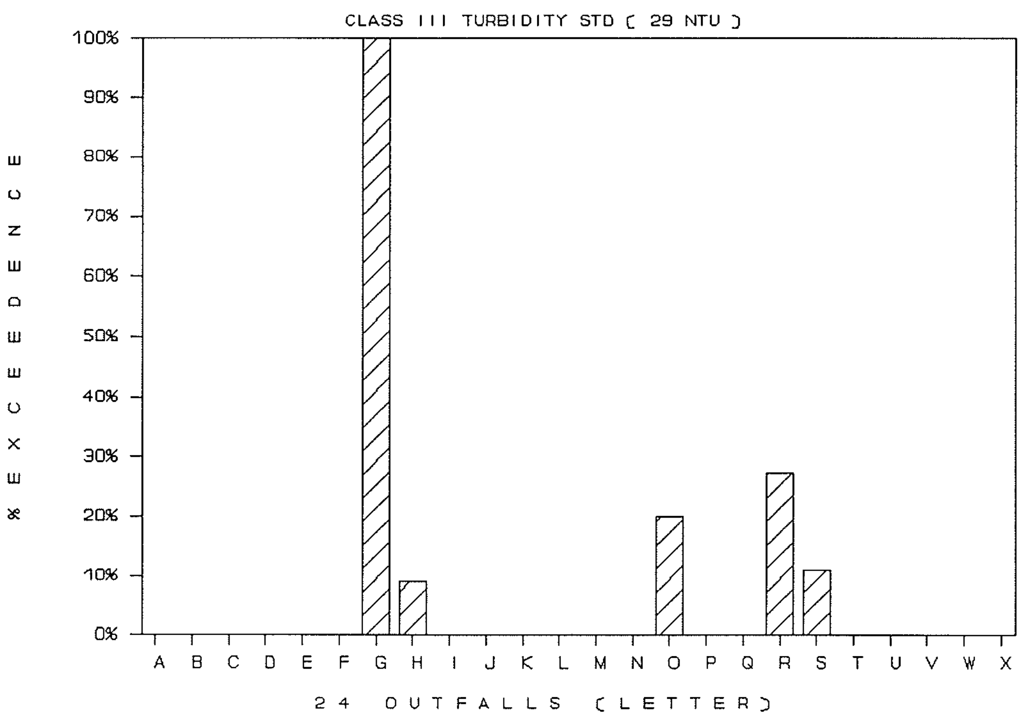


Figure 10. Total Percent Exceedence of the Class III Turbidity Standard for each Outfall.

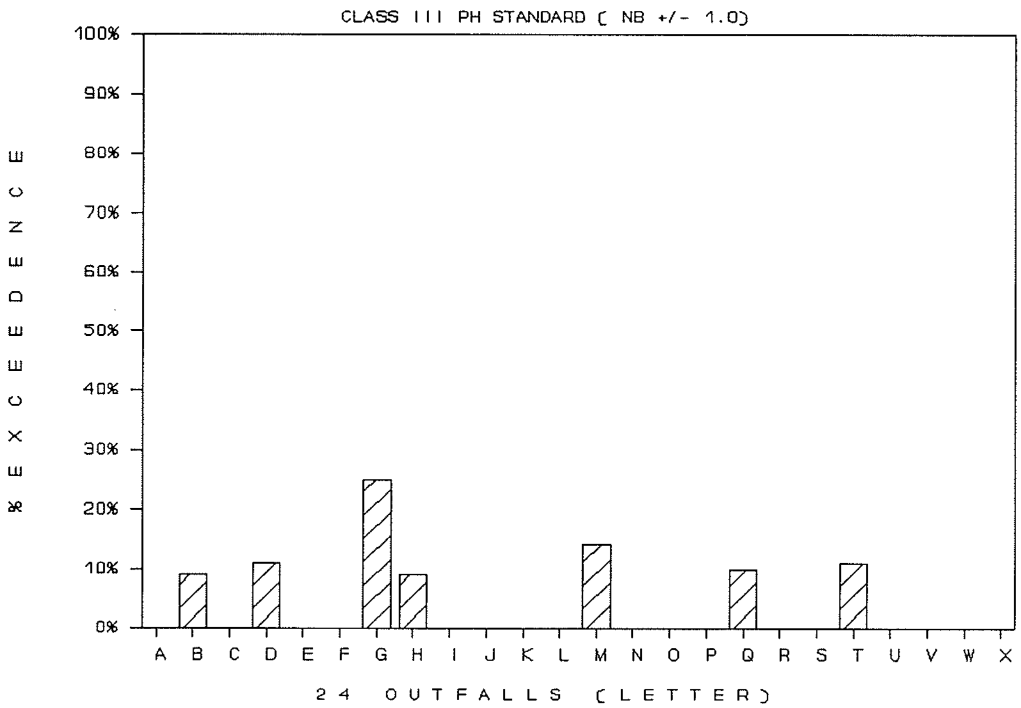


Figure 11. Total Percent Exceedence of the Class III pH Standard for each Outfall.

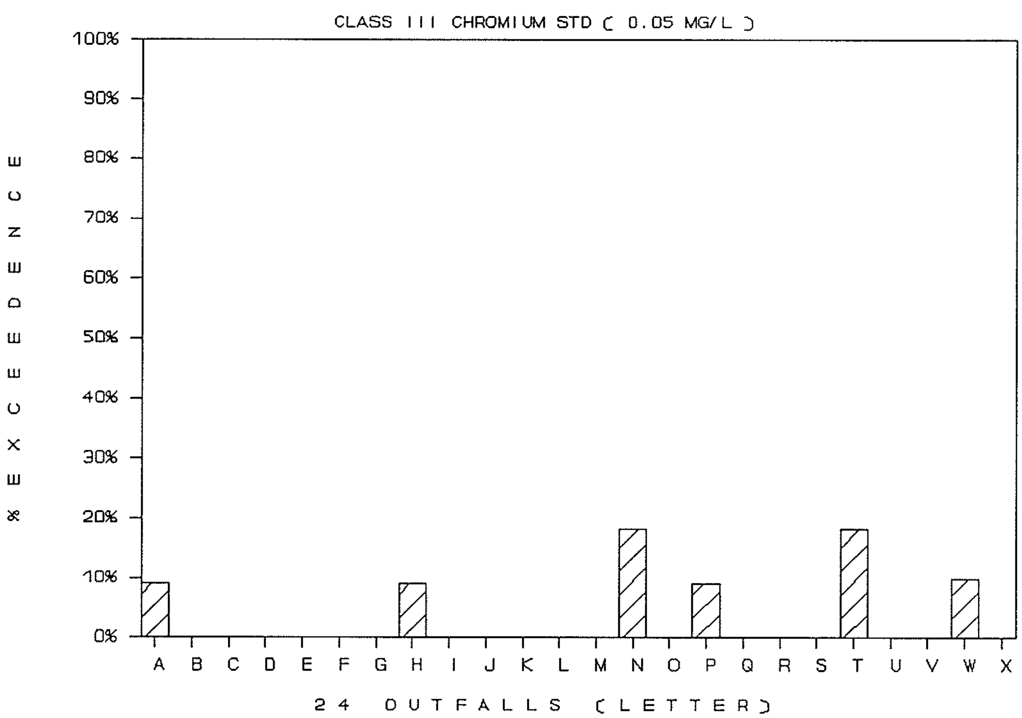


Figure 12. Total Percent Exceedence of the Class III Chromium Standard for each Outfall.

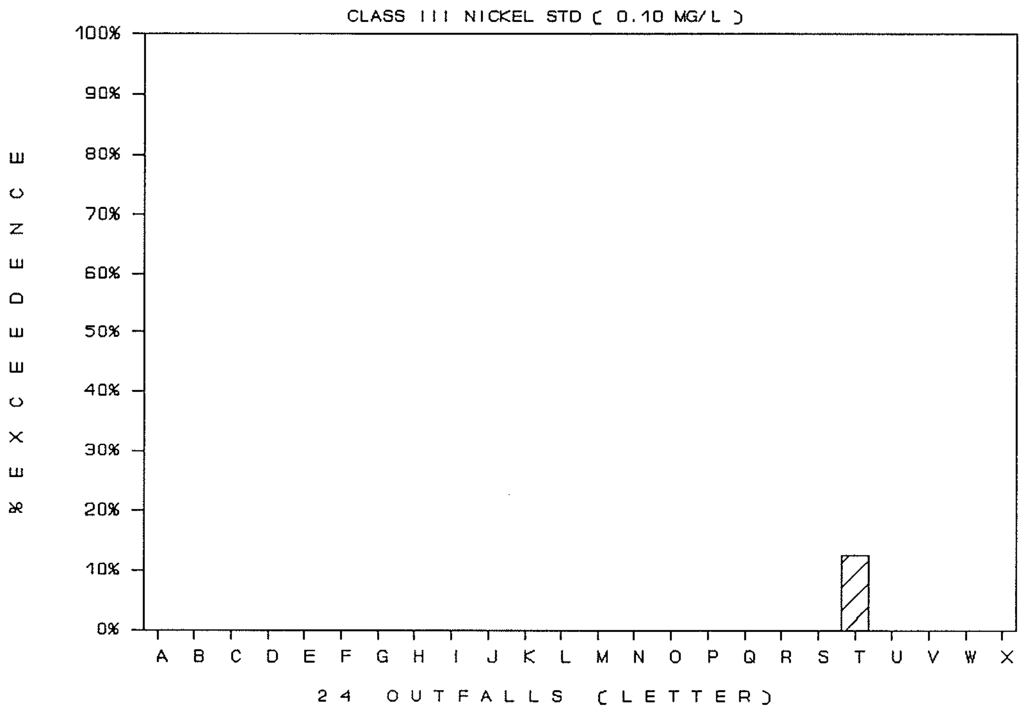


Figure 13. Total Percent Exceedence of the Class III Nickel Standard for each Outfall.

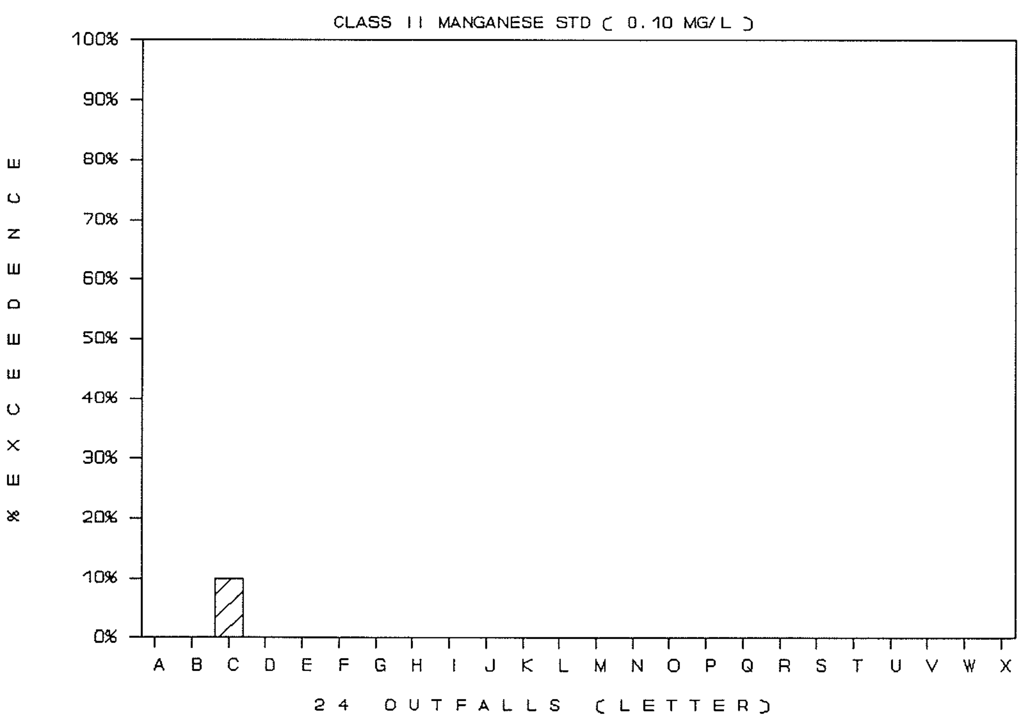


Figure 14. Total Percent Exceedence of the Class II Manganese Standard for each Outfall.

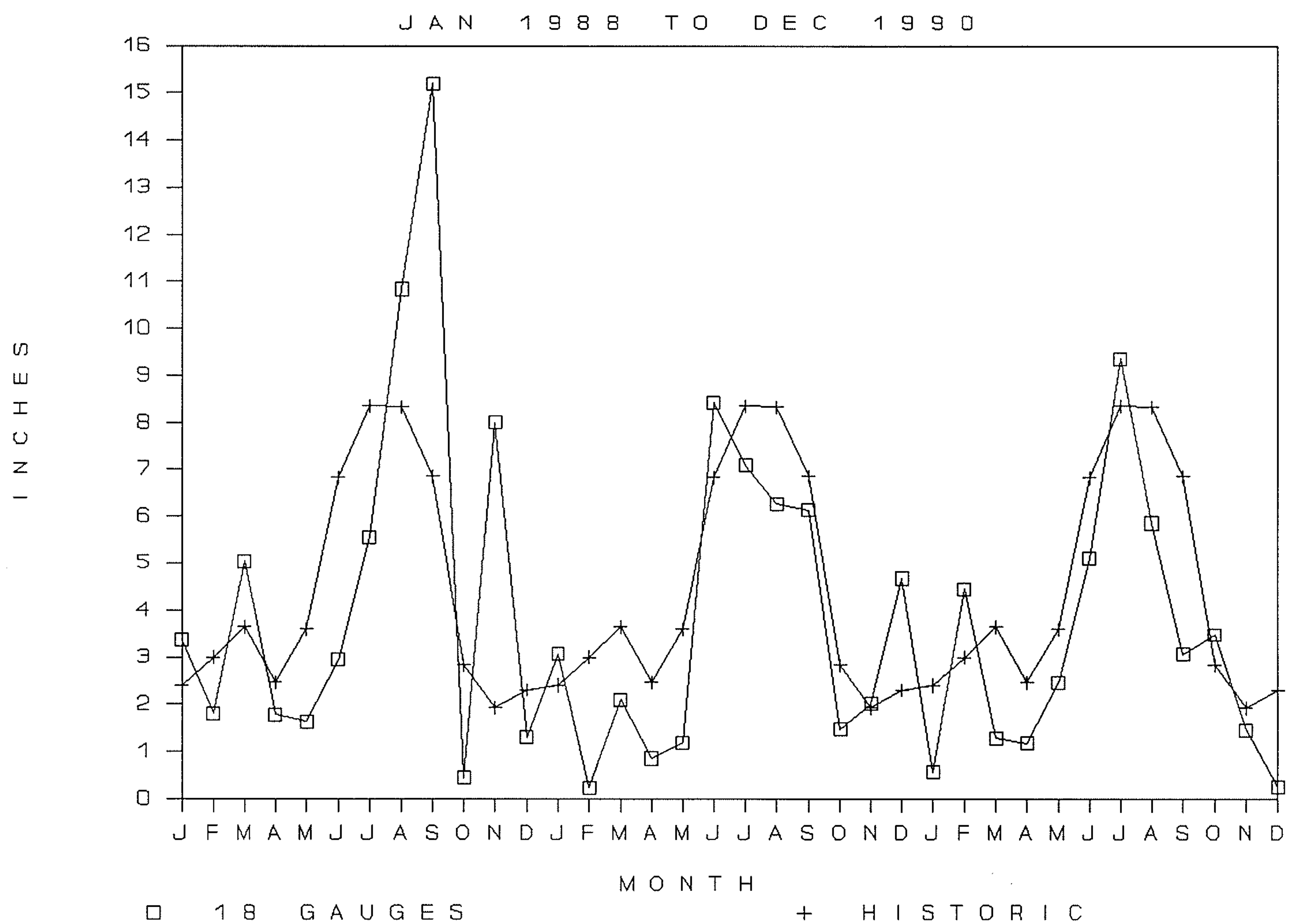


Figure 15. Mean Monthly Rainfall for Five District Basins (Historic) and for Eighteen Gauges in the Tampa Region, during a Three-Year Period that includes the survey.

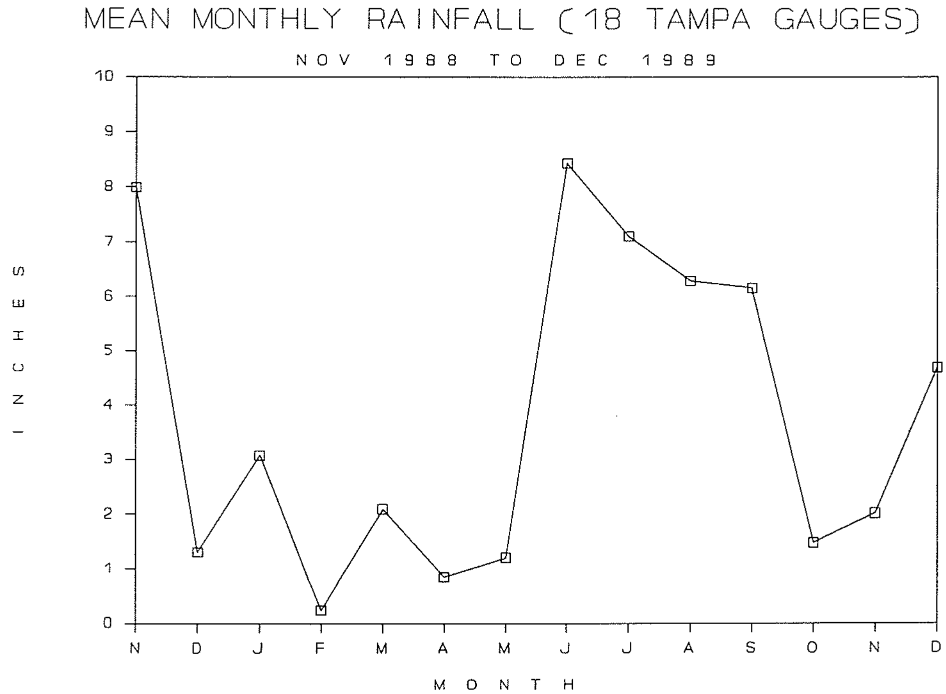


Figure 16. Mean Monthly Rainfall for Eighteen Gauges During Survey.

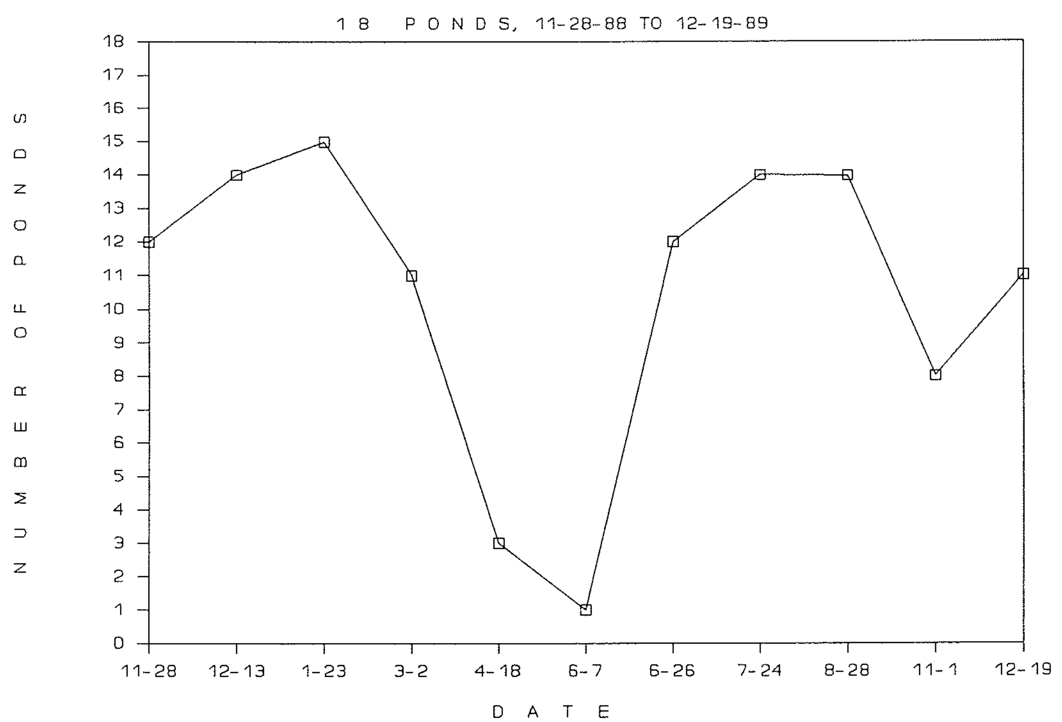


Figure 17. Discharge Frequency (#Ponds Discharging) Versus Date for 18 Ponds.

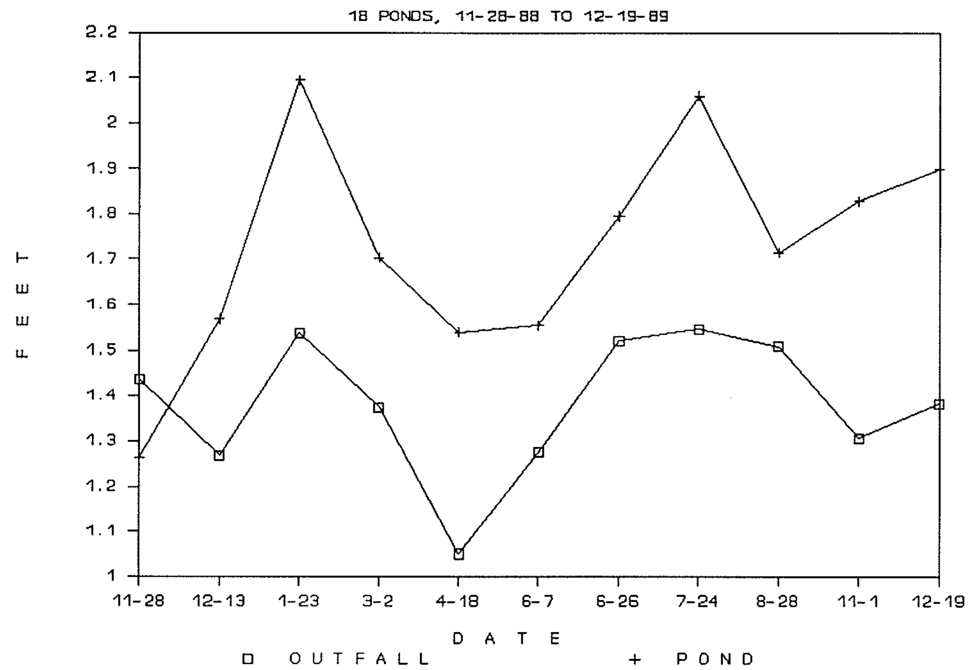


Figure 18. Mean Bottom Depth Versus Date at Two Stations for 18 Ponds.

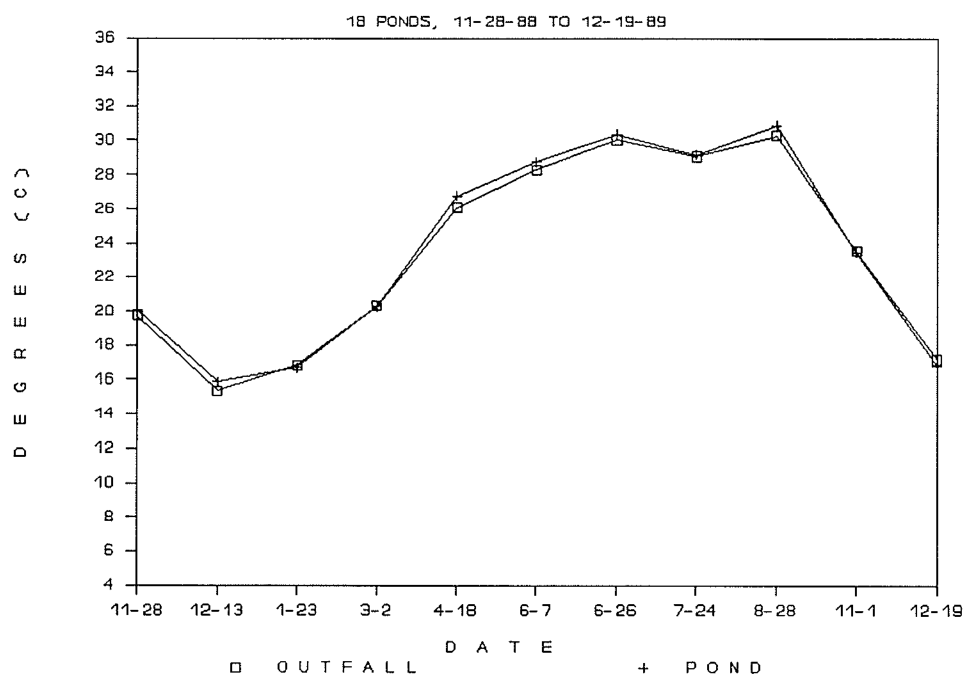


Figure 19. Mean Temperature Versus Date at Two Stations for 18 Ponds.

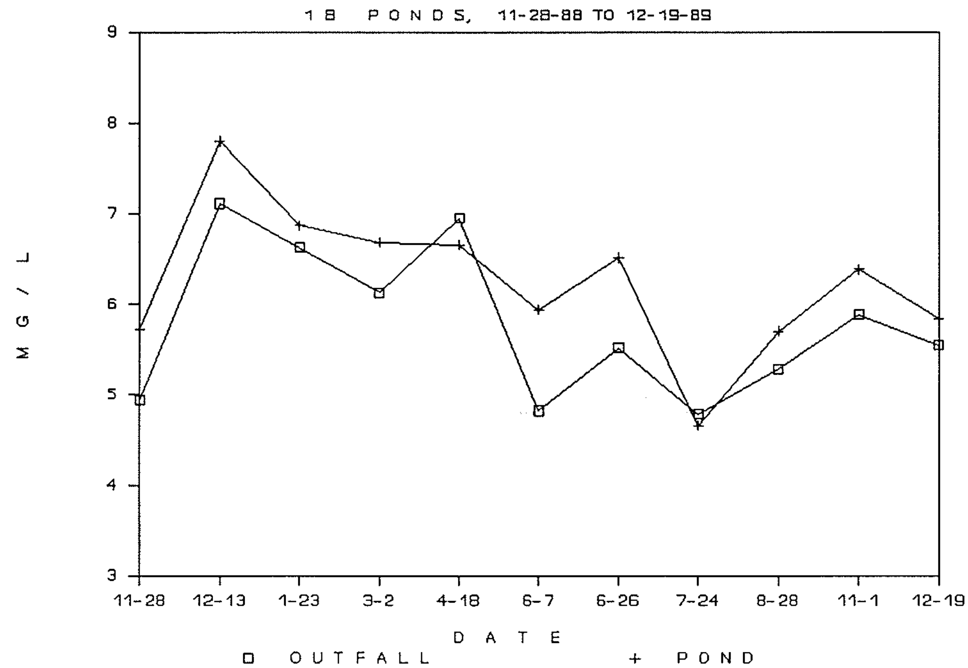


Figure 20. Mean Dissolved Oxygen Versus Date for 18 Ponds (2 Stations) [Class III 24-HR Mean = 5.0 mg/L].

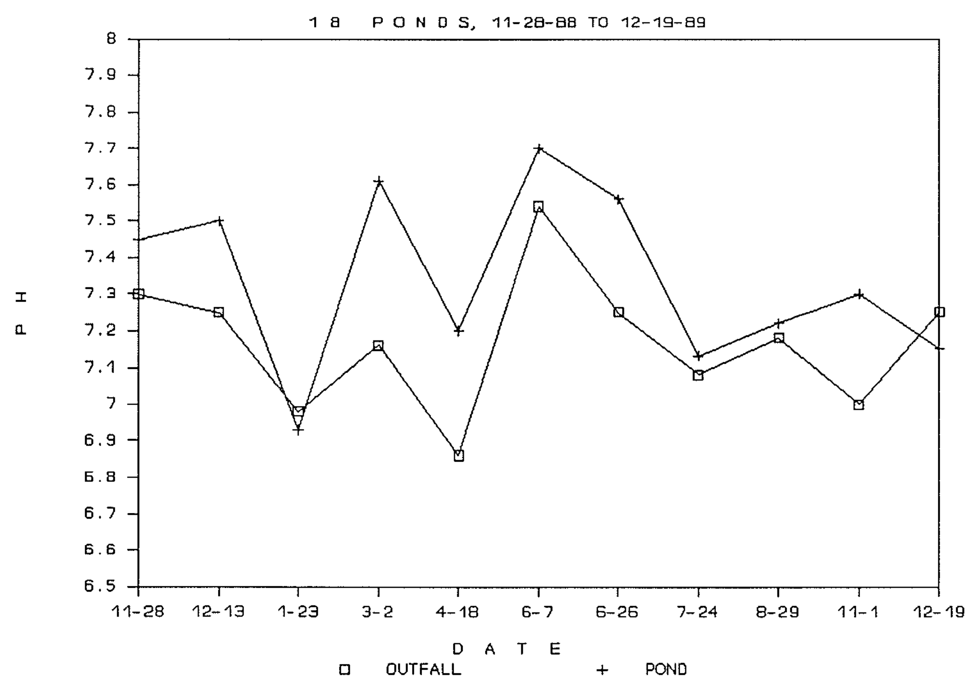


Figure 21. "Median" pH Versus Date for 18 Ponds (2 Stations) [Class III = Natural Background + or - 1.0].

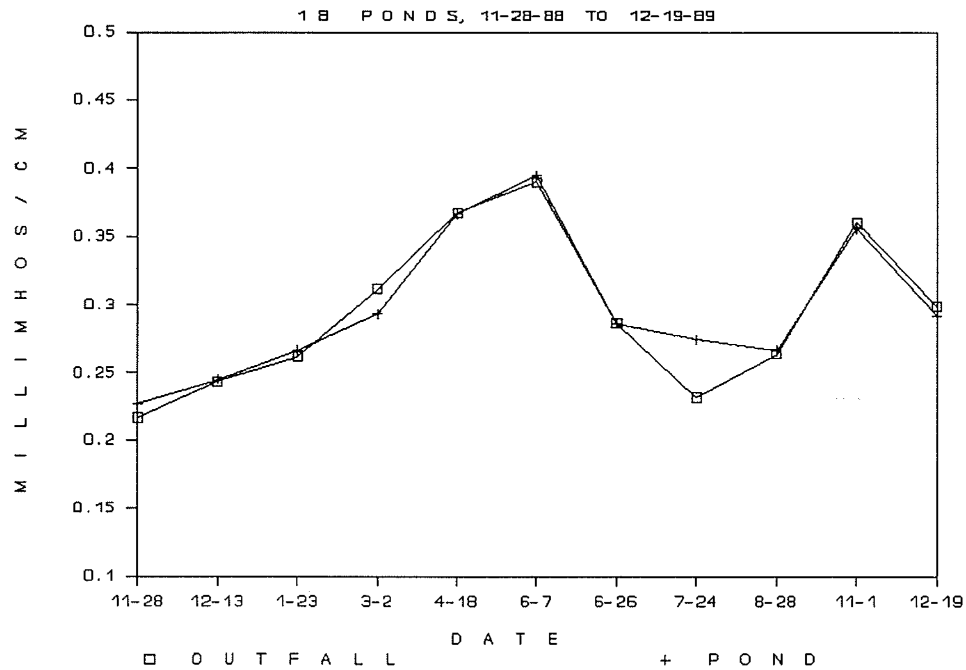


Figure 22. Mean Specific Conductance Versus Date for 18 Ponds (2 Stations) [Class III = 1.275 millimhos / cm].

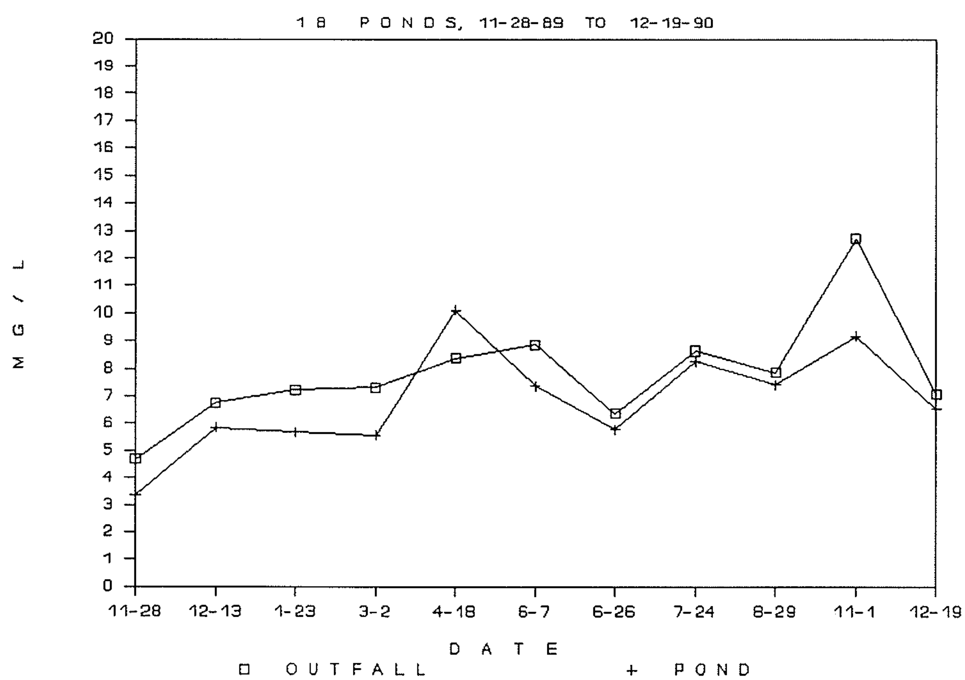


Figure 23. Mean Total Suspended Solids Versus Date for 18 Ponds (2 Stations) [Secondary STP Effluent = 20.0 mg/L].

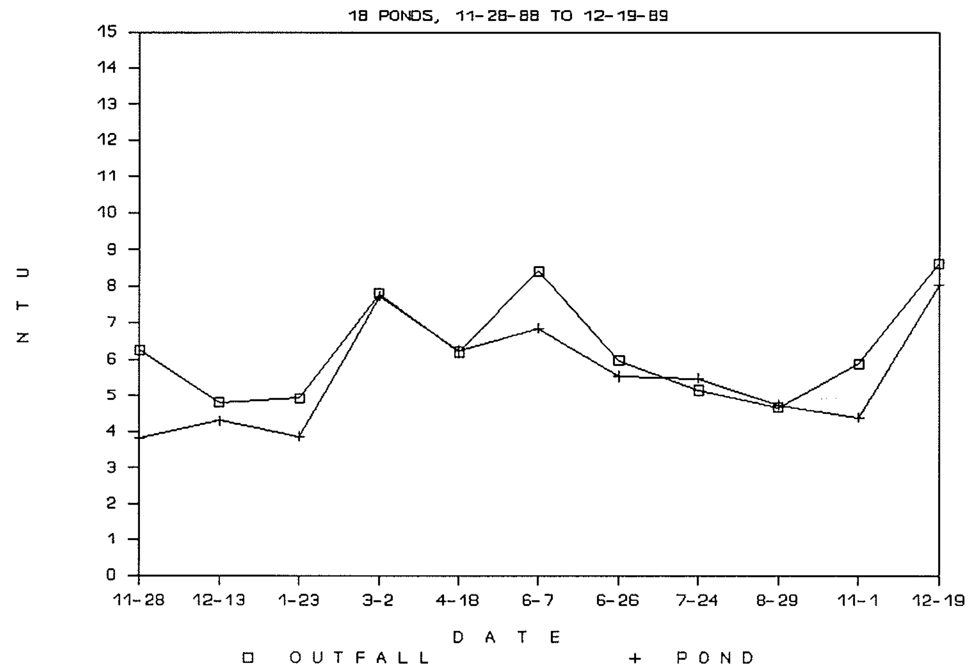


Figure 24. Mean Turbidity Versus Date for 18 Ponds (2 Stations) [Class III = 29.0 NTU].

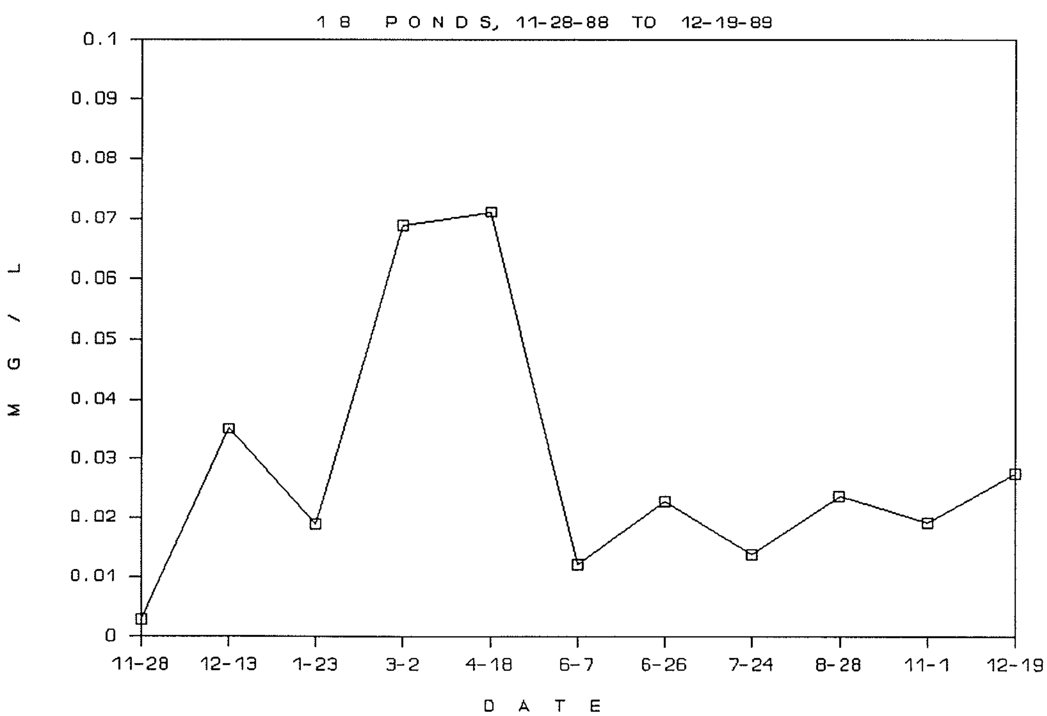


Figure 25. Mean Zinc Versus Date for 18 Ponds [Class III = 0.03 mg/L].

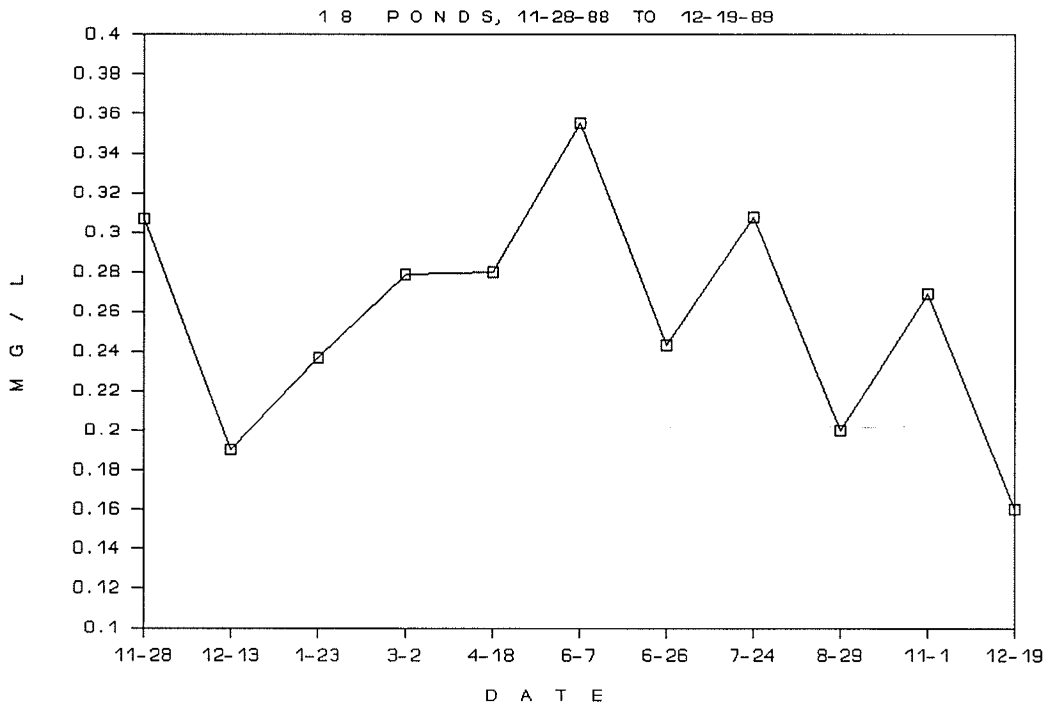


Figure 26. Mean Iron Versus Date for 18 Ponds [Class III = 1.0 mg/L].

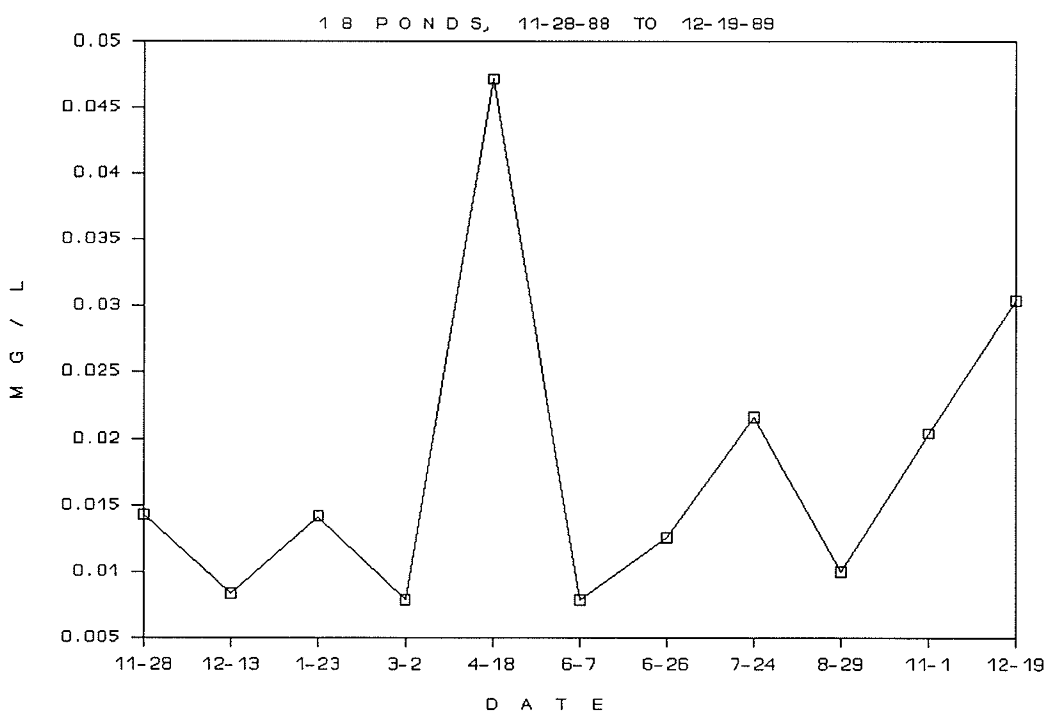


Figure 27. Mean Copper Versus Date for 18 Ponds [Class III = 0.03 mg/L].

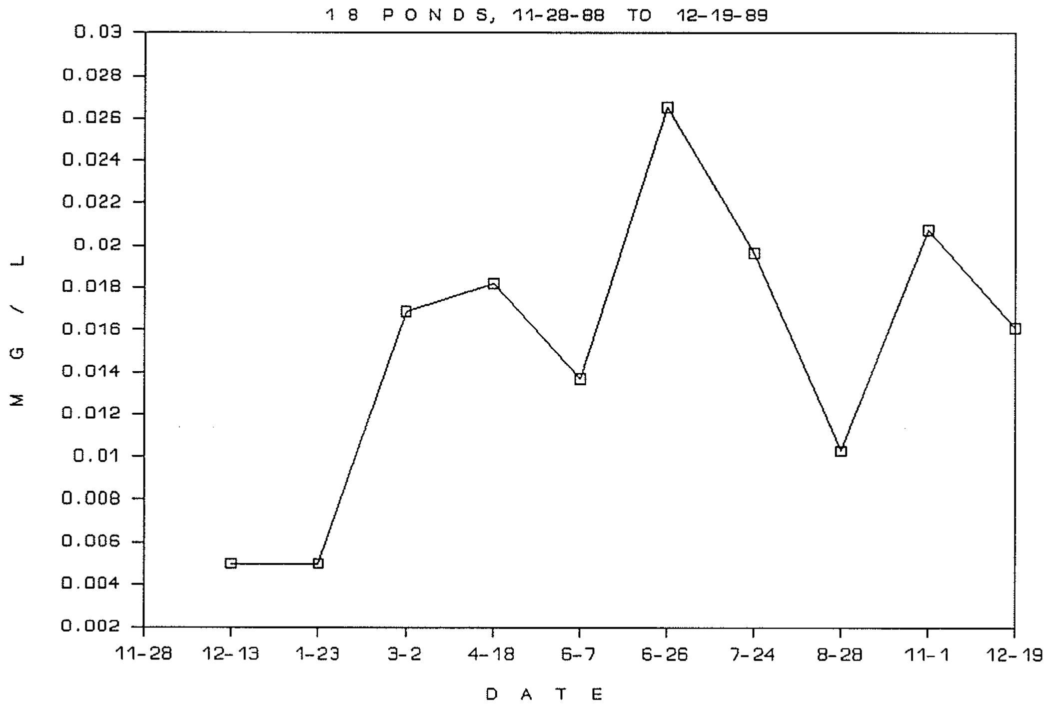


Figure 28. Mean Manganese Versus Date for 18 Ponds [Class II = 0.10 mg/L – No Class III Standard].

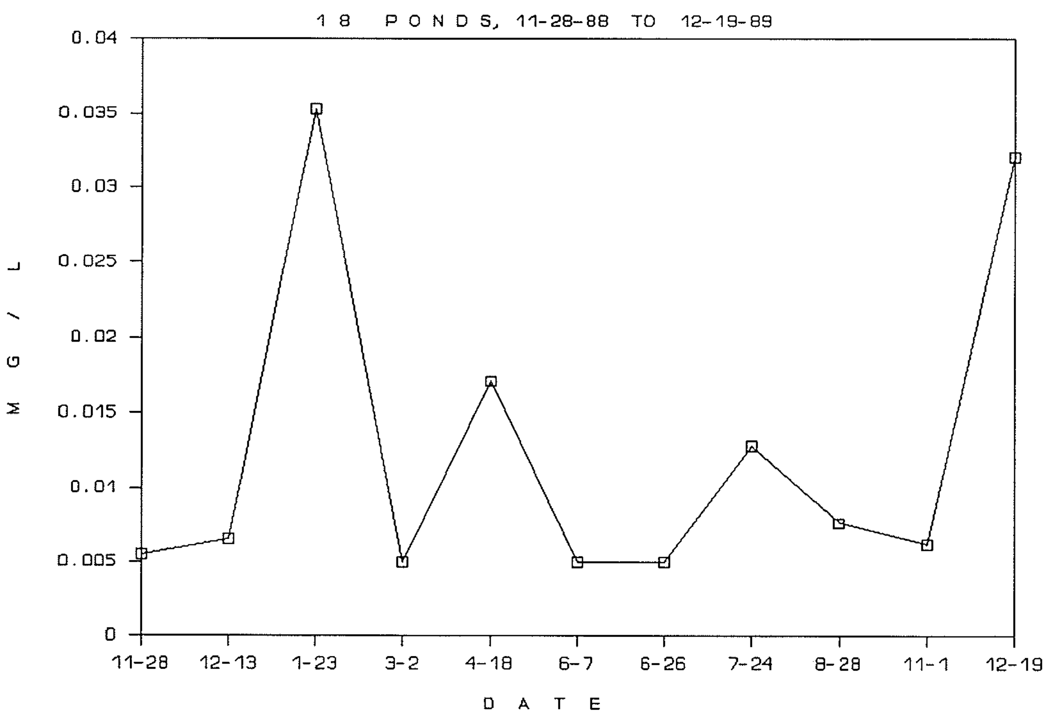


Figure 29. Mean Lead Versus Date for 18 Ponds [Class III = 0.03 mg/L].

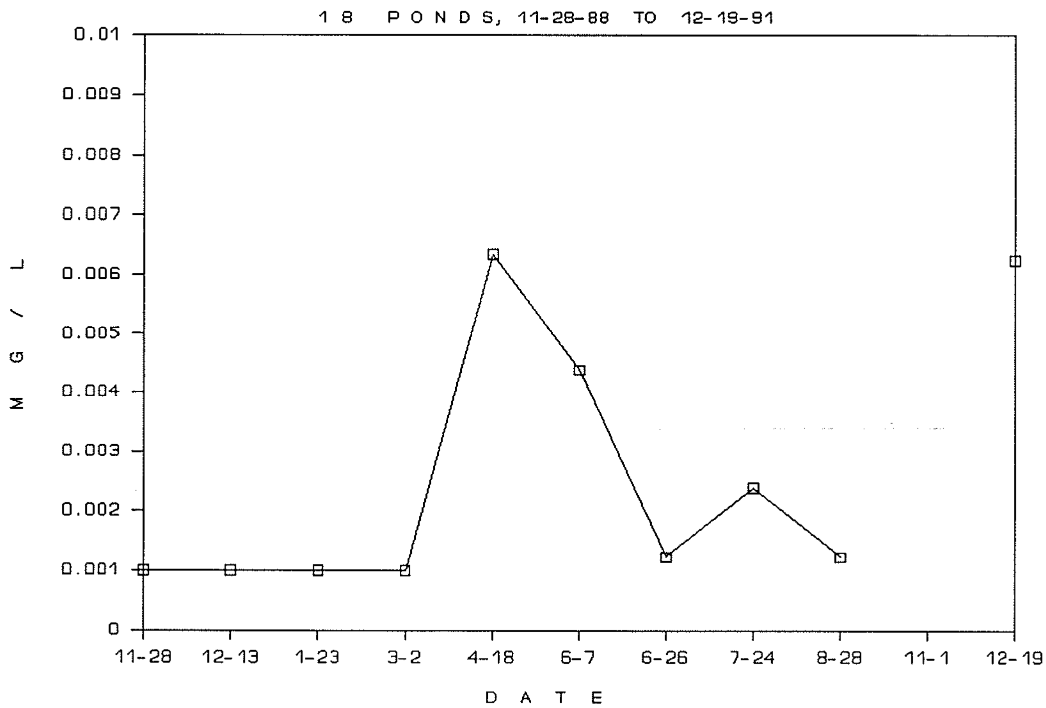


Figure 30. Mean Cadmium Versus Date for 18 Ponds [Class III = 0.0012 mg/L].

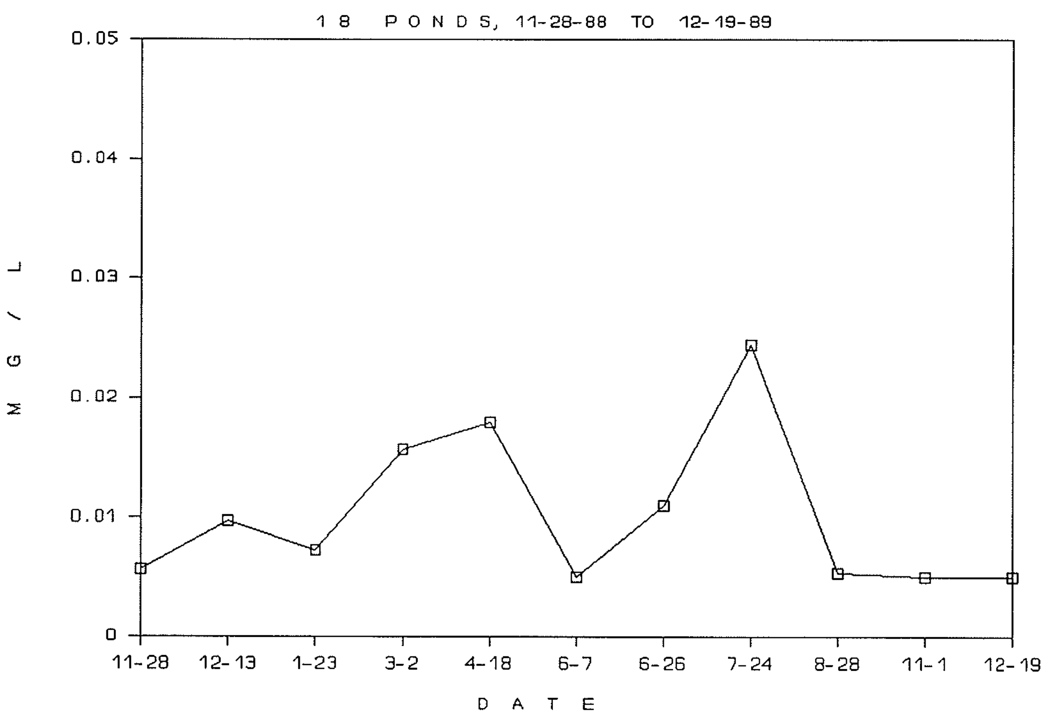


Figure 31. Mean Chromium Versus Date for 18 Ponds [Class III = 0.05 mg/L].

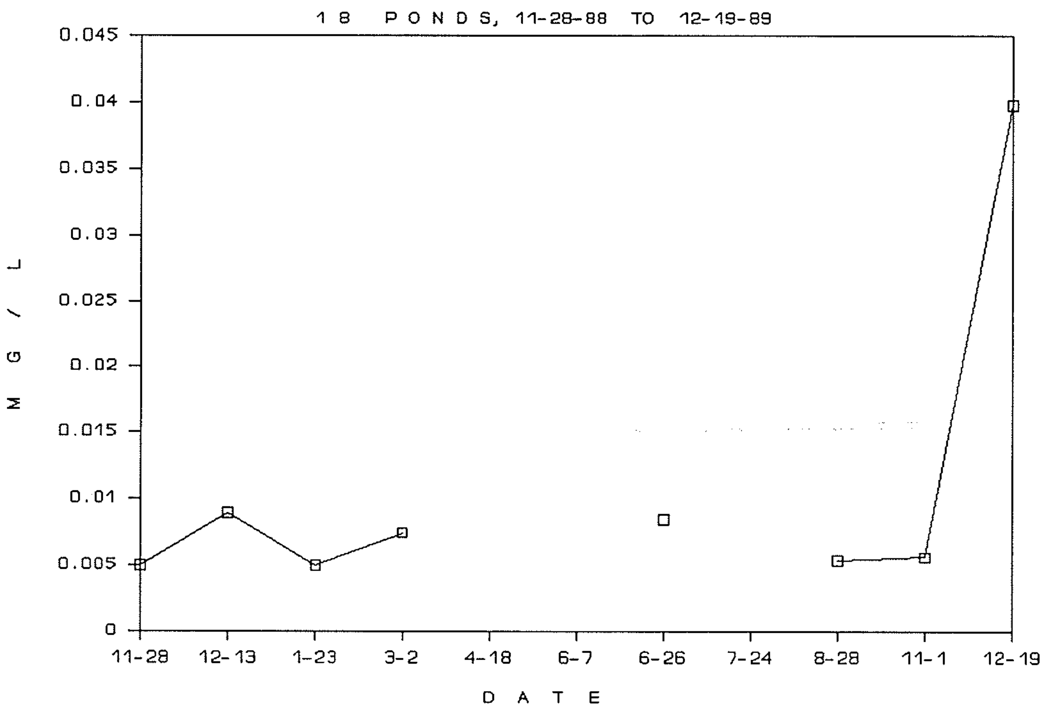


Figure 32. Mean Nickel Versus Date for 18 Ponds [Class III = 0.10 mg/L].

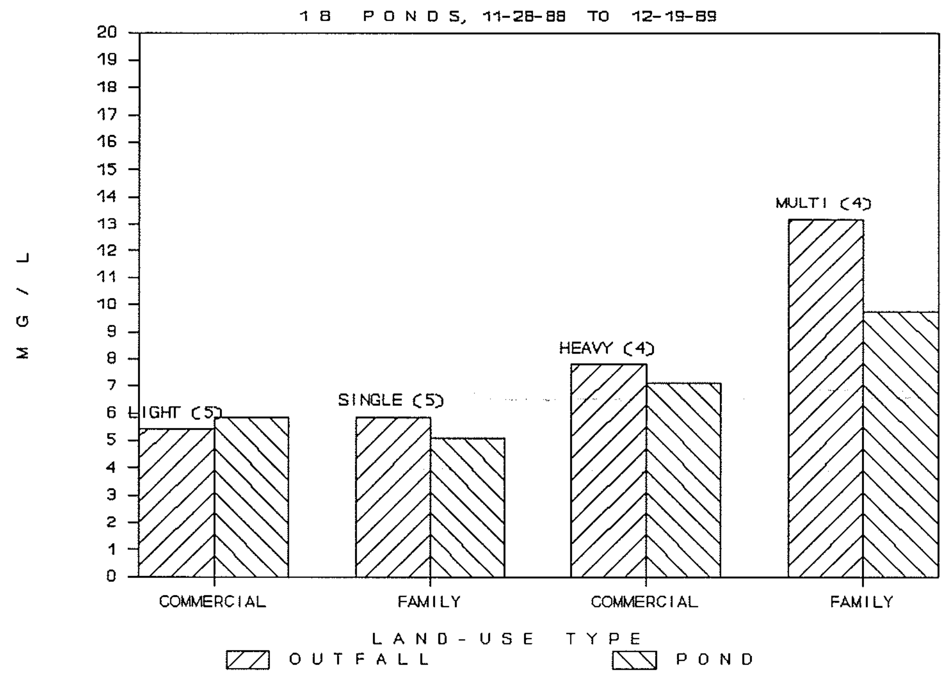


Figure 33. Mean TSS by Four Land-Use Types. Number of ponds in parenthesis.

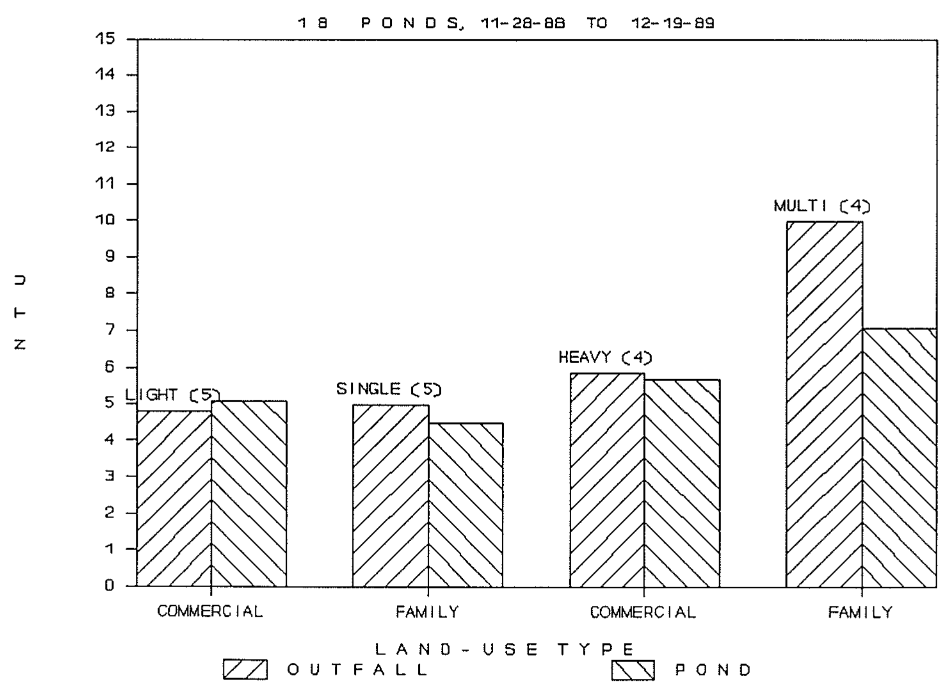


Figure 34. Mean Turbidity by Four Land-Use Types. Number of ponds in parenthesis.

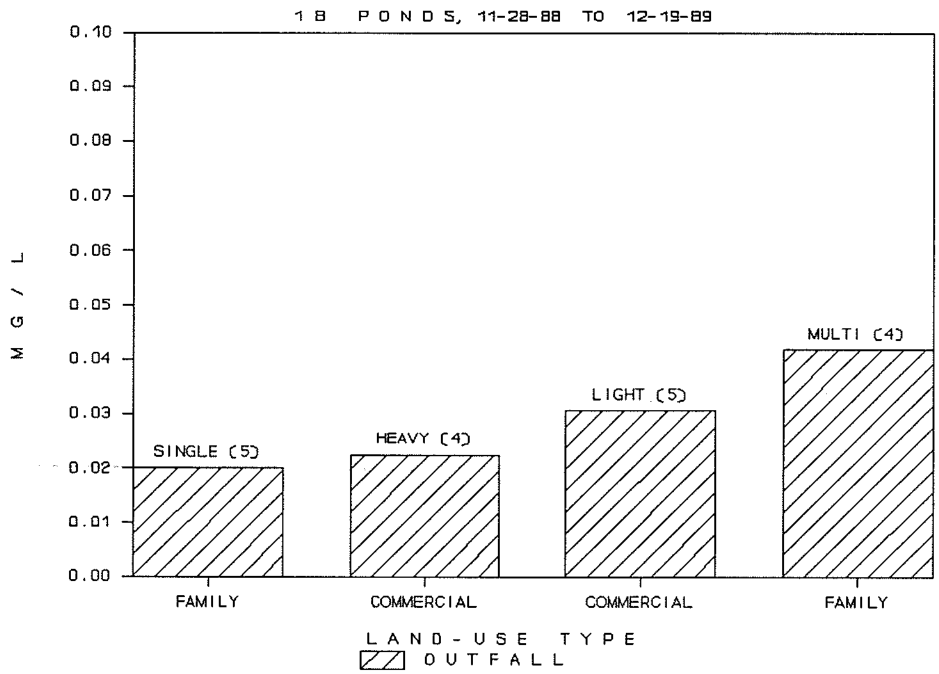


Figure 35. Mean Outfall Zinc by Four Land-Use Types. Number of ponds in parenthesis.

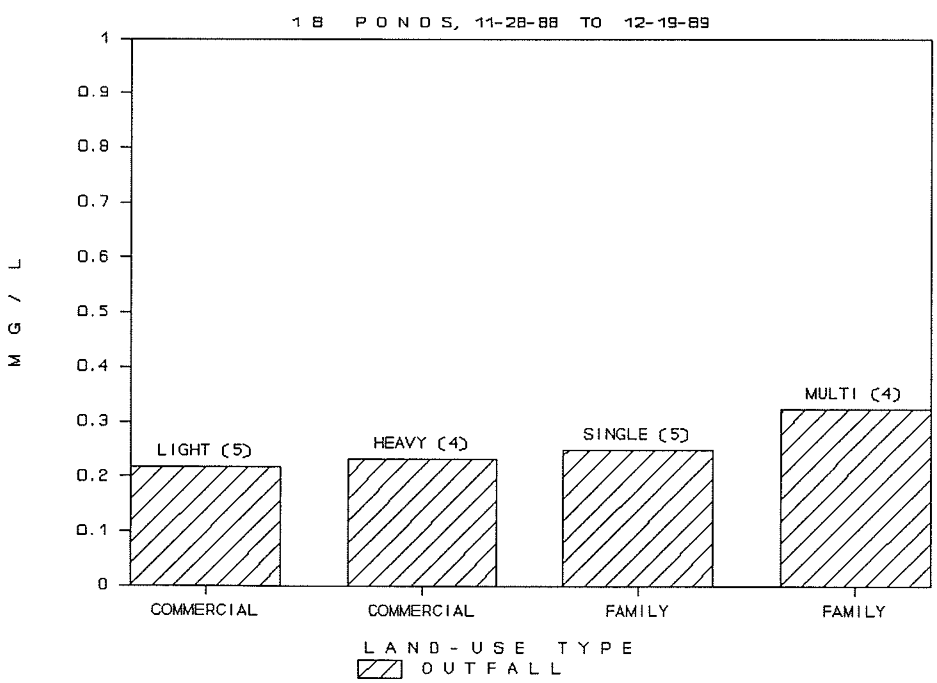


Figure 36. Mean Outfall Iron by Four Land-Use Types. Number of ponds in parenthesis.

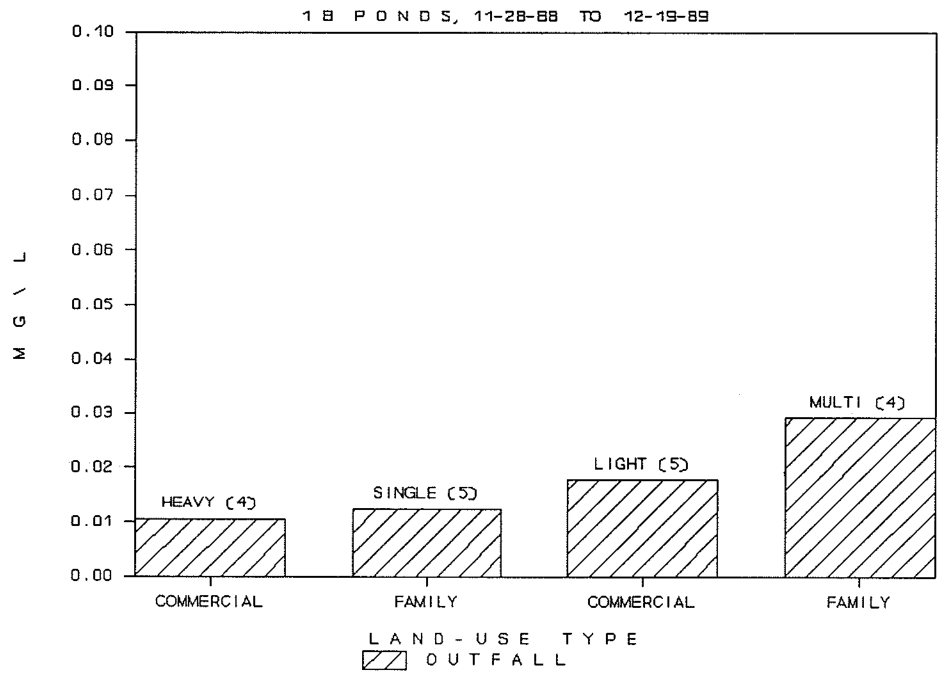


Figure 37. Mean Outfall Copper by Four Land-Use Types. Number of ponds in parenthesis.

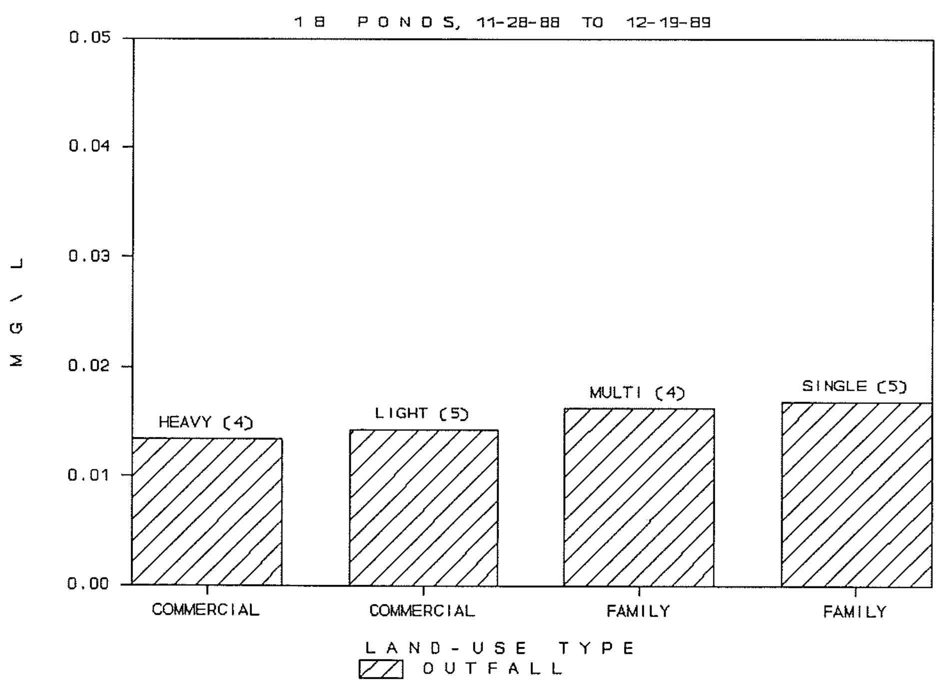


Figure 38. Mean Outfall Manganese by Four Land-Use Types. Number of ponds in parenthesis.

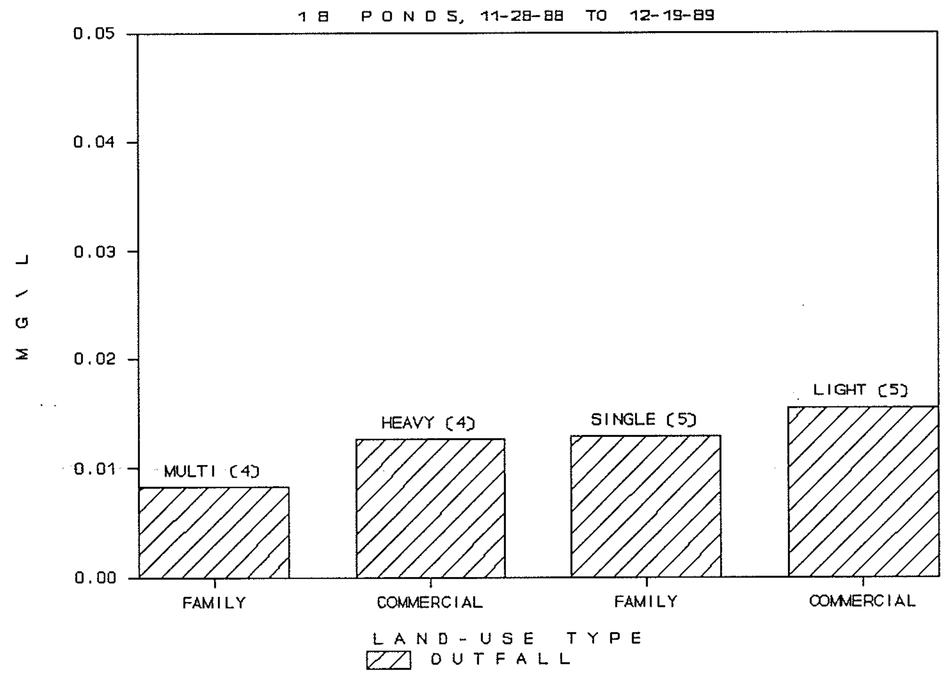


Figure 39. Mean Outfall Lead by Four Land-Use Types. Number of ponds in parenthesis.

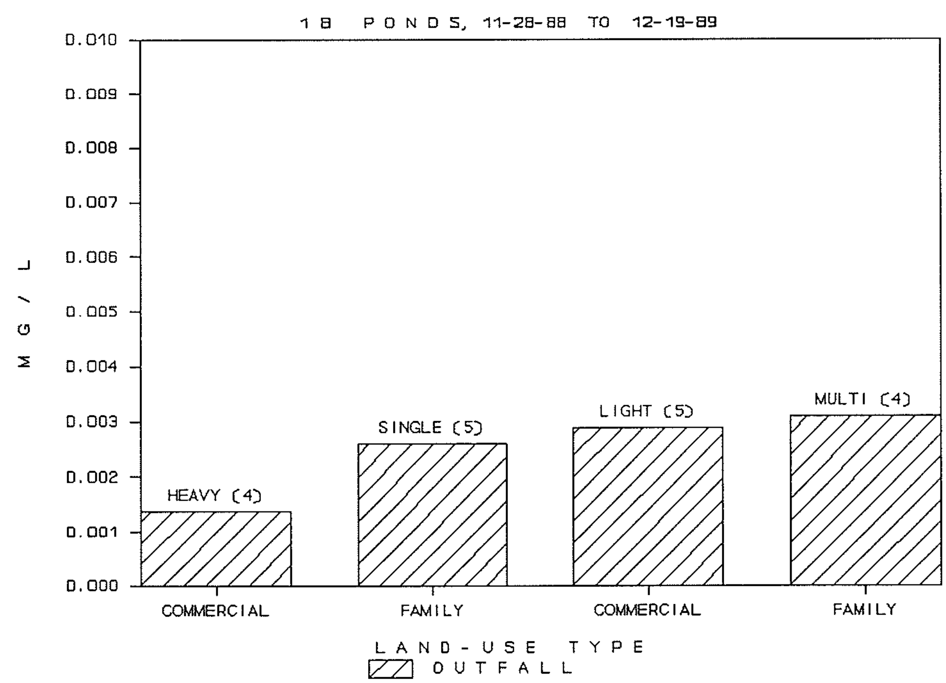


Figure 40. Mean Outfall Cadmium by Four Land-Uses. Number of ponds in parenthesis.

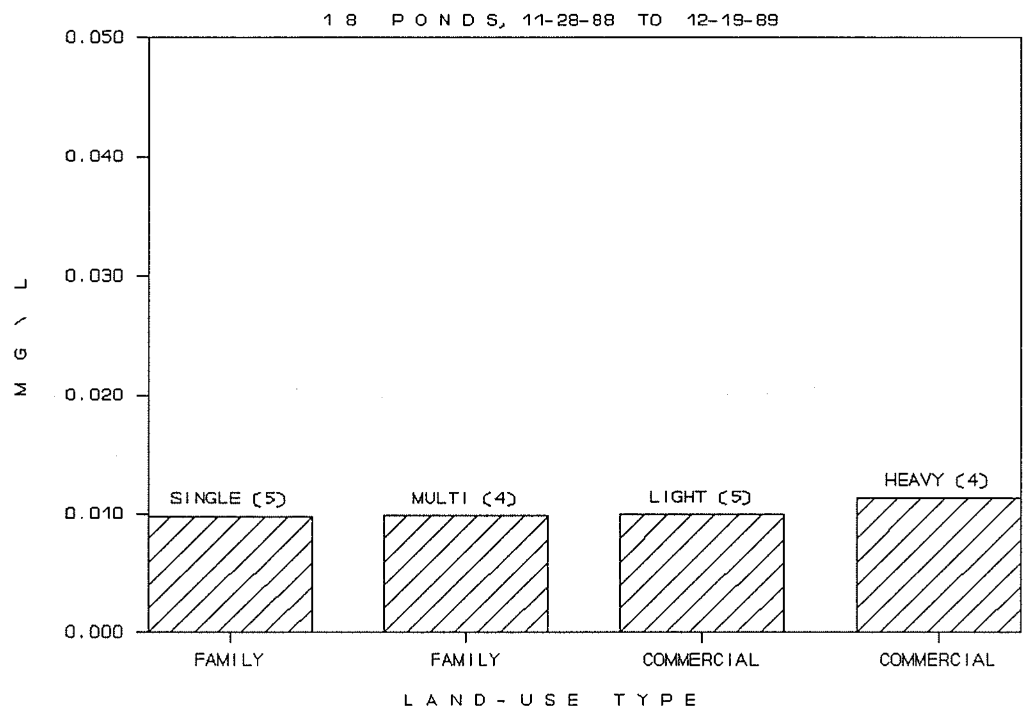


Figure 41. Mean Outfall Chromium by Four Land-Uses. Number of ponds in parenthesis.

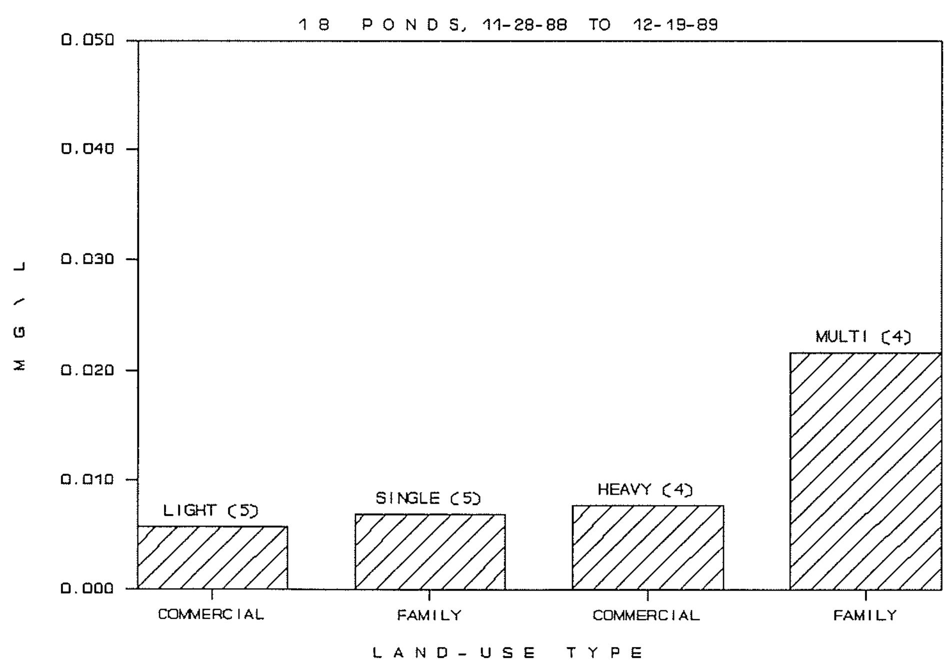


Figure 42. Mean Nickel by Four Land-Use Types. Number of ponds in parenthesis.

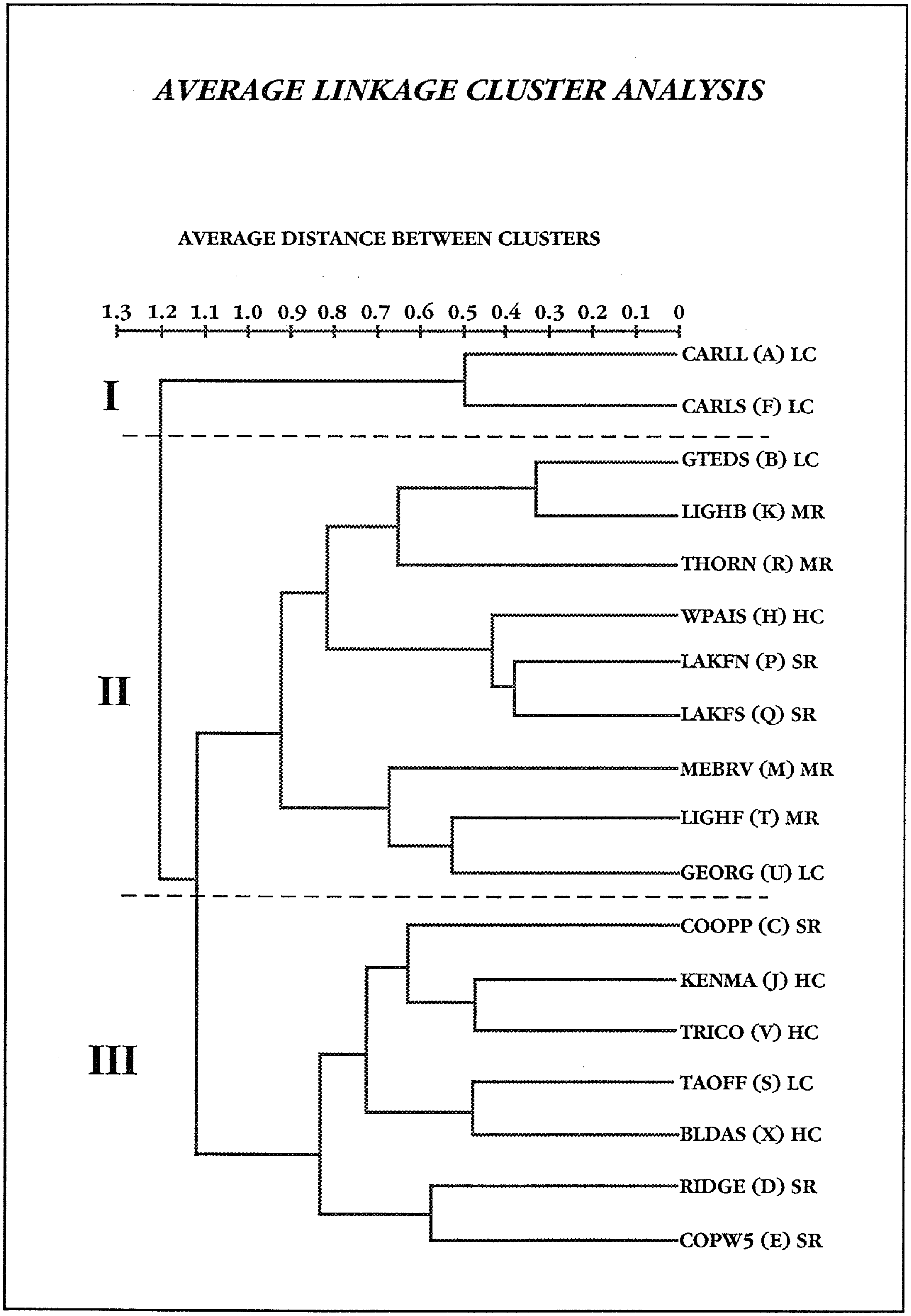


Figure 43 Cluster Analysis (10 Variables) for 18 Wet Detention Ponds. Pseudonym, letter, and land use abbreviation for each pond are shown (Clusters I,II & II).

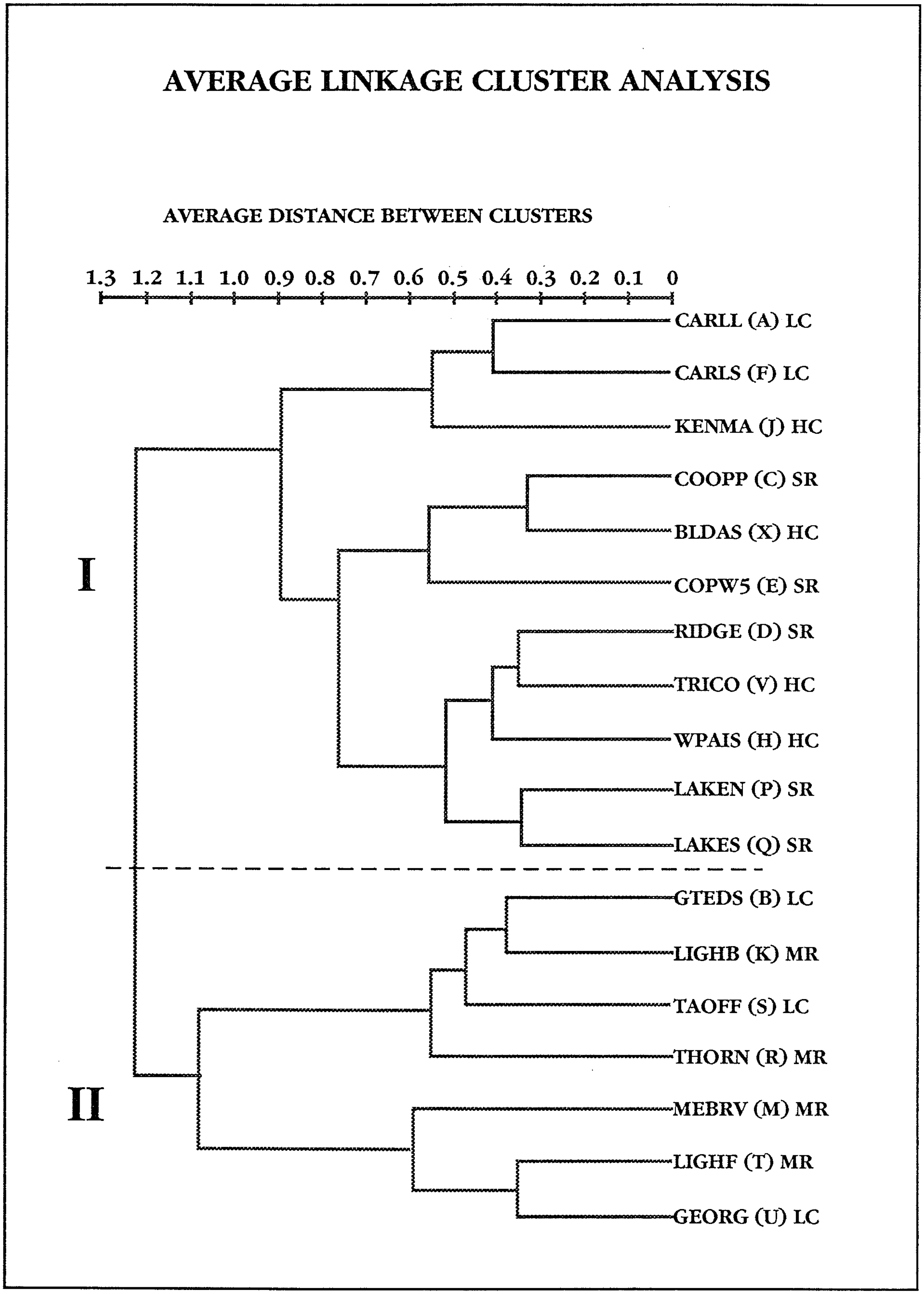


Figure 44 Cluster Analysis (7 Variables) for 18 Wet Detention Ponds. Pseudonym, letter, and land use abbreviation for each pond are shown (Clusters I & II).

TABLES

Table 1: PERMIT INFORMATION FOR THE TWENTY-FOUR, STORMWATER WET-DETENTION PONDS. (From Rushton et. al., 1989).

POND// PSEUDONYM	LETTER	TYPE LC,HC SR,MR	PROJECT AREA (ACRES)	AREA DRAINED (ACRES)	IMPER VIOUS (%)	POND AREA (ACRES)	BASIN AREA (ACRES)	INLETS/ OUTLETS (NO.)	MAX. DEPTH (FT)	WATER TABLE (FT)	VOLUME (ACRE-FEET)	LITTORAL ZONE		
												SLOPE	%COVER	DEPTH (FT)
CARLL	A	LC	180.0	180.0	75	21.10	154.7	2/1	8.5	-2	15.45	8:1	35	.
GTEDS	B	LC	49.9	54.0	42	3.69	45.9	3/1	10	-6.8	5.03	10:1	35	0-3
COOPP	C	SR	19.5	39.0	40	3.50	39.0	2/1	14	-2	0.82	20:1	31	0-2.5
RIDGE	D	SR	78.3	78.3	55	2.95	34.3	4/1	4.5	-2.3	1.42	10:1	35	0-3
COPW5	E	SR	37.1	37.1	40	2.73	28.0	2/1	14	-2.5	1.36	4:1	36	0-3
CARLS	F	LC	180.0	180.0	75	2.30	25.3	1/1	8.5	-2	1.08	.	80	0-3
WPAIL	G	HC	63.6	64.2	66	2.20	23.8	1/1	7	-2	1.10	6:1	46	0-2
WPAIS	H	HC	63.6	64.2	66	1.84	7.4	1/1	7	-2	0.31	6:1	63	0-3
BLDAL	I	HC	19.0	19.0	44	1.64	17.6	4/1	12.0	-2.4	.	6:1	50	.
KENMA	J	HC	7.6	7.6	36	1.60	7.6	2/1	>3	-9.5	0.32	15:1	38	0-2
LIGHB	K	MR	11.8	11.8	57	1.44	11.9	2/1	9	-6	0.56	8:1	35	.
LASHV	L	MR	13.0	11.7	25	1.20	11.7	1/1	5.9	-10	0.55	.	100	1.5
MEBRV	M	MR	50.0	45.4	.	1.14	10.8	3/1	9.9	.	0.45	4:1	42	0-3
MARWA	N	MR	13.7	15.0	60	0.96	15.1	2/1	4	-2.5	0.63	.	40	0-3
EASTS	O	LC	7.5	12.0	7	0.80	12.0	2/1	2.5	.	0.55	4:1	35	0-1
LAKFN	P	SR	13.0	13.0	15	0.78	7.0	1/1	7.5	-4	0.30	4:1	0	.
LAKFS	Q	SR	13.0	13.0	15	0.76	6.0	1/1	7.5	-4	0.30	4:1	0	.
THORN	R	MR	3.6	3.6	41	0.60	3.6	2/1	3	-3.5	0.16	4:1	45	0-3
TAOFF	S	LC	9.5	6.3	30	0.35	6.3	1/1	3	-0.5	0.32	8:1	100	0-3
LIGHF	T	MR	5.2	4.8	76	0.32	4.9	2/1	2	-3.3	0.20	8:1	33	0-2
GEORG	U	LC	11.8	11.8	57	0.31	3.1	2/1	9	-6	0.19	8:1	35	.
TRICO	V	HC	1.8	1.8	71	0.15	1.8	3/1	2.23	-1.2	0.08	.	100	0-0.4
LIWAF	W	HC	4.8	3.4	47	0.12	1.9	1/1	2.3	-1.2	0.08	6:1	35	0-2.3
BLDAS	X	HC	19.0	19.0	44	0.04	1.4	2/1	5.2	-2.4	.	5:1	50	0-3

LEGEND "LC" = LIGHT COMMERCIAL "HC" = HEAVY COMMERCIAL "." = MISSING DATA
"SR" = SINGLE FAMILY RESIDENTIAL "MR" = MULTIFAMILY RESIDENTIAL

Table 2: TWENTY-FOUR POND SURVEY VARIABLES, PSEUDONYNS/TRANSFORMS, AND UNITS.

VARIABLE	PSEUDONYM// TRANSFORM	UNITS
FIELD MEASUREMENTS		
WATER TEMPERATURE	TEMP1	DEGREES CELSIUS (°C)
DISSOLVED OXYGEN	DO1, LOGDO	MG/L, LOG MG/L
PH	PH	STANDARD UNITS
SPECIFIC CONDUCTANCE	COND1, LGCOND_K	MILLIMHOS, LOG MICROMHOS
BOTTOM DEPTH (@ SAMPLE)	DEPTHCM, LGDPTHCM	CENTIMETERS (CM),LOG CM
DISCHARGE FREQUENCY	DCHARGE1	NUMBER OR PERCENT
LABORATORY ANALYSES		
TOTAL SUSPENDED SOLIDS	TSS1, LOGTSSU	MG/L, LOG UG/L
TURBIDITY	TURB1, LOGTURB	NEPHELOMETRIC TURBIDITY UNITS (NTU)
TOTAL ZINC	ZINC1, LOGZNU	MG/L, LOG UG/L
TOTAL IRON	IRON1, LOGFEU	MG/L, LOG UG/L
TOTAL COPPER	COPPER1, LOGCUU	MG/L, LOG UG/L
TOTAL MANGANESE	MN1, LOGMNU	MG/L, LOG UG/L
TOTAL LEAD	LEAD1, LOGPBU	MG/L, LOG UG/L
TOTAL CADMIUM	CADMIUM1, LOGCDU	MG/L, LOG UG/L
TOTAL CHROMIUM	CR1, LOGCRU	MG/L, LOG UG/L
TOTAL NICKEL	NICKEL1, LOGNIU	MG/L, LOG UG/L
PERMIT INFORMATION		
POND SIZE	PS_M2, LGPS_M2	M^2, LOG M^2
MAXIMUM DEPTH	ZMAXCM, SQZMAXCM	CENTIMETERS (CM)
TREATMENT VOLUME	VOL_M3, LGVOL_M3	M^3, LOG_M^3

LEGEND: MG/L = MILLIGRAMS PER LITER M^2 = SQUARE METERS
UG/L = MICROGRAMS PER LITER M^3 = CUBIC METERS

Table 3. WATER-QUALITY STANDARDS FOR SEVERAL CRITERIA APPLICABLE TO STATE WATERS (17-302), DRINKING WATER (17-550) OR SEWAGE TREATMENT (STP). SWFWMD LABORATORY DETECTION LIMITS (DL) FOR METALS ALSO GIVEN. ALL VALUES ARE mg/L UNLESS INDICATED. (F.A.C. Chapters 17-302 and 17-550).

	Criteria						
	Chapter 17-302 Class			Chapter 17-550		STP	
Parameter	I	II	III	1'	2'	2'	Lab DL
Zinc (Zn)	0.03	1.0	0.03 "F" 0.1 "M"	----	5.0	----	0.005
Cadmiun (Cd)	0.0008 "FS" 0.0012 "FH"	0.005	0.0008 "FS" 0.0012 "FH" 0.005 "M"	0.01	----	----	0.002
Copper (Cu)	0.03	0.015	0.03 "F" 0.015 "M"	----	1.0	----	0.01
Lead (Pb)	0.03	0.05	0.03 "F" 0.05 "M"	0.05	----	----	0.01
Iron (Fe)	0.3	0.3	1.0 "F" 0.3 "M"	----	0.3	----	0.02
Nickel (Ni)	0.1	0.1	0.1	----	----	----	0.01
Manganese (Mn)	----	0.1	----	----	0.05	----	0.01
Chromium (Cr)	0.05	0.05	0.05	0.05	----	----	0.01
Dissolved Oxygen (DO)	5.0	5.0/24 HR Mean 4.0/24 HR Lowest	5.0 "F" 5.0/24 HR Mean "M" 4.0/24 HR Lowest "M"	----	----	----	----
pH (Standard Units)	6.0 to 8.5 NB +/- 1.0	6.5 to 8.5 NB +/- 1.0	6.0 "F", 6.5 "M" to 8.5 NB +/- 1.0	----	[6.5 to 8.5]	----	----
Total Suspended Solids (TSS)	----	----	----	----	----	20.0	0.05
Turbidity (NTU)	29.0	29.0	29.0	1.0	----	----	----
Conductivity (umhos/cm)	1275	1275	1275 "F"	----	----	----	----

Legend:

DL = Detection Limit
"F" = Freshwater
"FS" = Freshwater (Soft, under 150 mg/L CaCO3)
"FH" = Freshwater (Hard, above 150 mg/L CaCO3)
"M" = Marine

NB = Natural Background
STP = Sewage Treatment Plant
---- = Not Established or Not Given
1' = Primary
2' = Secondary

TABLE 4. MEDIAN ANNUAL OUTFALL CONCENTRATIONS AND PERCENT EXCEEDENCE (%E) OF WATER-QUALITY STANDARDS (BY POND) FOR THE SURVEY OF 24 WET-DETENTION PONDS, 1988-1989. TOTAL %E AND DETECTION LIMITS ALSO GIVEN FOR EACH VARIABLE. ALL STANDARDS ARE CHAPTER 17-302, AND ALL VALUES ARE mg/L UNLESS INDICATED.

POND\\ Pseudonym	Ltr	DO	%E	Zn	%E	Cd	%E	Cu	%E	TSS	%E	Pb	%E	CONDUCTIVITY mmhos/ cm (a)	%E	Fe	%E	TURBIDITY NTU (b)	%E	pH SU (c)	%E	Cr	%E	Ni	%E	Mn	%E	DF (%) (d)
CARLL	A	7.30	18	0.021	27	<	30	<	9	1.78	0	<	9	0.700	0	0.076	0	1.8	0	7.50	0	<	9	<	0	<	0	91
GTEDS	B	5.72	18	0.027	36	<	0	0.010	18	6.45	9	<	0	0.323	0	0.230	9	3.3	0	7.30	9	<	0	<	0	<	0	90
COOPP	C	6.60	40	0.018	27	<	10	<	0	3.25	0	<	0	0.200	0	0.170	0	2.2	0	6.60	0	<	0	<	0	0.010	10	70
RIDGE	D	2.70	89	0.015	11	<	13	0.019	22	4.08	0	<	11	0.246	0	0.260	0	6.9	0	6.70	11	<	0	<	0	<	0	73
COPW5	E	2.40	100	0.003	45	<	30	<	9	5.10	11	<	18	0.253	0	0.140	0	2.0	0	6.55	0	<	0	<	0	0.010	0	36
CARLS	F	8.36	0	0.011	0	<	20	0.019	45	2.50	9	<	9	0.383	0	0.093	0	2.0	0	7.90	0	<	0	<	0	0.010	0	73
WPAIL	G	7.00	0	0.010	11	<	0	<	0	7.01	25	<	0	0.086	0	0.940	44	57.5	100	7.24	25	0.01	0	<	0	<	0	18
WPAIS	H	6.50	18	0.014	18	<	30	<	18	8.54	36	<	9	0.231	0	0.229	0	11.3	9	7.60	9	<	9	<	0	<	0	36
BLDAL	I	6.53	18	0.026	45	0.003	56	0.010	20	3.62	0	<	0	0.159	0	0.195	0	7.3	0	6.66	0	<	0	<	0	<	0	.
KENMA	J	2.90	64	0.012	0	<	13	<	0	3.66	0	<	11	0.178	0	0.116	0	1.7	0	6.52	0	<	0	<	0	<	0	30
LIGHB	K	6.51	27	0.020	18	<	10	0.011	10	7.80	0	<	0	0.319	0	0.330	9	5.1	0	7.47	0	<	0	<	0	0.027	0	50
LASHV	L	4.80	60	0.021	27	<	30	<	9	8.41	0	<	9	0.117	0	0.171	0	4.4	0	6.99	0	<	0	<	0	<	0	55
MEBRV	M	6.70	0	0.021	40	<	22	<	10	3.20	0	<	0	0.126	0	0.127	0	2.0	0	7.50	14	<	0	<	0	0.012	0	55
MARWA	N	3.60	64	0.037	64	<	20	<	9	12.62	18	<	9	11.540	100	0.276	9	6.5	0	8.00	0	<	18	<	0	0.029	0	80
EASTS	O	3.30	80	0.074	100	<	29	<	20	11.40	40	<	0	0.137	0	0.235	20	4.3	20	6.96	0	<	0	<	0	0.012	0	50
LAKFN	P	6.96	30	0.012	0	<	10	<	18	3.38	0	<	0	0.152	0	0.200	9	2.1	0	7.26	0	<	9	<	0	<	0	78
LAKFS	Q	7.75	0	0.005	18	<	10	<	9	8.44	0	<	18	0.176	0	0.302	0	5.7	0	7.65	10	<	0	<	0	<	0	67
THORN	R	8.30	0	0.025	45	<	30	0.019	27	23.50	73	<	0	0.347	0	0.392	9	21.0	27	8.10	0	<	0	<	0	<	0	0
TAOFF	S	2.80	78	0.028	44	<	13	<	0	6.06	0	<	11	0.392	0	0.287	0	5.3	11	7.04	0	<	0	<	0	0.015	0	73
LIGHF	T	8.00	0	0.041	64	<	20	0.026	45	11.56	22	<	9	0.255	0	0.232	0	7.7	0	7.90	11	<	18	<	13	0.012	0	55
GEORG	U	5.10	45	0.021	27	<	20	<	18	3.46	0	<	9	0.259	0	0.210	0	3.9	0	6.98	0	<	0	<	0	0.012	0	100
TRICO	V	3.28	73	0.019	9	<	0	<	0	5.00	0	<	9	0.143	0	0.220	0	3.1	0	6.68	0	<	0	<	0	0.011	0	73
LIWAF	W	7.17	29	0.019	40	<	0	<	0	5.19	0	<	10	0.133	0	0.206	10	8.4	0	7.50	0	<	10	<	0	<	0	40
BLDAS	X	3.14	91	0.016	27	<	10	<	9	3.87	0	<	9	0.225	0	0.260	0	3.8	0	7.00	0	<	0	<	0	0.019	0	89
Total %E			38.9		29.8		17.7		13.8		9.8		6.9		4.9		4.5		4.4		3.1		3.3		0.6		0.4 //	59
# Ponds			18		21		20		18		9		15		1		8		5		7		5		1		1	
Standard			5.0		0.03		0.0012		0.03		(f) 20.0		0.03		1.275		1.0		29.0		6.0 - 8.5		0.05		0.1		(g) 0.1	
DL (e)			----		0.005		0.002		0.01		----		0.01		----		0.02		----		----		0.01		0.01		0.01	

Legend: (a) Millimhos per centimeter @ 25 degrees Centigrade.
(b) Nephelometric turbidity unit(s).
(c) Standard unit(s).
(d) Discharge frequency (percent).
"." = Missing data.
(e) DL = SWFWMD Lab Detection Limit.
(f) 20 mg/L TSS represents efficient 2' sewage treatment.
(g) Chapter 17-3 Class II standard for Mn.
"----" = Not established or not given.
"<" = Less than the Detection Limit (DL)

Table 5: **W:Normal and Prob < W Statistics for SAS Proc Univariate** procedure for variable means for 11 sample dates, using 18 ponds. Null Hypothesis, Ho : The data are from a normal distribution. (SAS Release 6.03, 1988.)

Chemical\Physical Variables	W:Normal	Prob<W
Chemical Variables		
Total Suspended Solids (TSS1)	0.88	0.11
LOG TSS1 (LOGTSSU)	0.94	0.47
Iron (IRON1)	0.96	0.96
LOG Iron (LOGFEU)	0.94	0.54
Zinc (ZINC1)	0.83	0.02
LOG Zinc (LOGZNU)	0.91	0.25
Manganese (MN1)	0.98	0.96
LOG Manganese (LOGMNU)	0.87	0.12
Copper (COPPER1)	0.81	0.01
LOG Copper (LOGCUU)	0.93	0.37
Dissolved Oxygen (DO1)	0.93	0.36
Hydrogen ion (H)	0.96	0.81
pH	0.94	0.50
Physical Variables		
Turbidity (TURB1)	0.88	0.11
LOG Turbidity (LOGTURB)	0.91	0.22
Specific Conductance (COND1)	0.94	0.53
LOG COND1 (LGCOND_K)	0.96	0.74
Temperature (TEMP1)	0.91	0.25
Water-Level Variables		
Depth (DPTHCM)	0.91	0.21
LOG Depth (LGDPTHCM)	0.88	0.10
Discharge Frequency (DCHARGE1)	0.75	0.0028

Table 6: W:Normal and Prob<W Statistics for SAS Proc Univariate procedure using variable means for 18 ponds. Null Hypothesis, Ho : The data are from a normal distribution. (SAS Release 6.03, 1988.)

Chemical\Physical Variables	W:Normal	Prob<W
Chemical Variables		
Total Suspended Solids (TSS1)	0.80	0.0012
LOG TSS (LOGTSSU)	0.97	0.76
Iron (IRON1)	0.97	0.81
LOG Iron (LOGFEU)	0.93	0.21
Zinc (ZINC1)	0.92	0.16
LOG Zinc (LOGZNU)	0.92	0.13
Manganese (MN1)	0.85	0.0087
LOG Manganese (LOGMNU)	0.92	0.13
Copper (COPPER1)	0.66	0.0001
LOG Copper (LOGCUU)	0.95	0.45
Dissolved Oxygen (DO1)	0.92	0.12
Hydrogen ion (H)	0.84	0.0043
pH	0.97	0.71
Physical Variables		
Turbidity (TURB1)	0.75	0.0002
LOG Turbidity (LOGTURB)	0.94	0.34
Specific Conductance (COND1)	0.86	0.0092
LOG COND1 (LGCOND_K)	0.98	0.97
Temperature (TEMP1)	0.93	0.20
Water-Level and Pond-Dimension Variables		
Depth (DPTHCM)	0.94	0.29
LOG Depth(LGDPTHCM)	0.95	0.48
Discharge Frequency(DCHARGE1)	0.94	0.26
Pond Size (PS_M2)	0.47	0.0001
LOG PS (LGPS_M2)	0.97	0.82
Volume (VOL_M3)	0.42	0.0001
LOG Volume (LGVOL_M3)	0.91	0.084
Maximum Depth (ZMAX)	0.94	0.31
Square Root ZMAX (SQZMAXCM)	0.95	0.38

Table 7: **SAS CORRELATION ANALYSIS FOR OUTFALL DATE MEANS;** Pearson Correlation Coefficients (r) / Prob (p) > ¦R¦ under Ho: Rho=0 / Number of Observations (n) = 11 Sample Dates. (SAS Release 6.03, 1988).

LOGTSSU

	LOGTSSU	LGCOND_K	LOGCDU	LOGZNU	DCHARGE1	TEMP1	DPTHCM
r	1.00000	0.64991	0.52703	0.35384	-0.35190	0.31480	-0.28751
p	0.0	0.0304	0.1175	0.2857	0.2886	0.3457	0.3913
n	11	11	10	11	11	11	11

LOGTURB

	LOGTURB	LOGNIU	DCHARGE1	LGCOND_K	LOGCDU	PH	DPTHCM
r	1.00000	0.66396	-0.61641	0.55105	0.54568	0.39701	-0.32061
p	0.0	0.0726	0.0434	0.0789	0.1028	0.2267	0.3364
n	11	8	11	11	10	11	11

LGCOND_K

	LGCOND_K	DCHARGE1	LOGTSSU	LOGCDU	DPTHCM	LOGTURB	LOGZNU
r	1.00000	-0.85478	0.64991	0.64777	-0.63862	0.55105	0.45459
p	0.0	0.0008	0.0304	0.0428	0.0344	0.0789	0.1601
n	11	11	11	10	11	11	11

PH

	PH	LOGCUU	LOGNIU	LOGCRU	LOGPBU	LOGTURB	LOGDO
r	1.00000	-0.57640	0.57495	-0.46118	-0.42640	0.39701	-0.36003
p	0.0	0.0634	0.1360	0.1534	0.1910	0.2267	0.2768
n	11	11	8	11	11	11	11

LOGDO

	LOGDO	LOGZNU	TEMP1	DPTHCM	IRON1	PH	LOGPBU
r	1.00000	0.68160	-0.53208	-0.47870	-0.40793	-0.36003	0.29318
p	0.0	0.0209	0.0920	0.1363	0.2130	0.2768	0.3816
n	11	11	11	11	11	11	11

TEMP1

	TEMP1	LOGDO	MN1	IRON1	LOGPBU	LOGTSSU	LOGNIU
r	1.00000	-0.53208	0.42074	0.38002	-0.36454	0.31480	-0.31287
p	0.0	0.0920	0.2595	0.2490	0.2704	0.3457	0.4505
n	11	11	9	11	11	11	8

IRON1

	IRON1	LOGNIU	DCHARGE1	LOGDO	LOGPBU	TEMP1	LOGZNU
r	1.00000	-0.67525	-0.48740	-0.40793	-0.38611	0.38002	-0.36508
p	0.0	0.0661	0.1283	0.2130	0.2408	0.2490	0.2696
n	11	8	11	11	11	11	11

LOGZNU

	LOGZNU	LOGDO	LGCOND_K	LOGCRU	DPTHCM	IRON1	LOGTSSU
r	1.00000	0.68160	0.45459	0.44293	-0.43292	-0.36508	0.35384
p	0.0	0.0209	0.1601	0.1725	0.1835	0.2696	0.2857
n	11	11	11	11	11	11	11

Table 7: **SAS CORRELATION ANALYSIS FOR OUTFALL DATE MEANS;** (Continued)

MN1

	MN1	LOGPBU	TEMP1	LOGCRU	LOGCUU	LOGNIU	LOGTURB
r	1.00000	-0.47678	0.42074	0.36970	0.23525	0.21813	0.20089
p	0.0	0.1944	0.2595	0.3274	0.5423	0.6780	0.6043
n	9	9	9	9	9	6	9

LOGCUU

	LOGCUU	LOGCDU	LOGPBU	PH	LOGNIU	DPTHCM	MN1
r	1.00000	0.66419	0.62305	-0.57640	0.54838	-0.32607	0.23525
p	0.0	0.0362	0.0406	0.0634	0.1593	0.3278	0.5423
n	11	10	11	11	8	11	9

LOGNIU

	LOGNIU	LOGCDU	IRON1	LOGTURB	PH	LOGCUU	LOGPBU
r	1.00000	0.93620	-0.67525	0.66396	0.57495	0.54838	0.45698
p	0.0	0.0019	0.0661	0.0726	0.1360	0.1593	0.2550
n	8	7	8	8	8	8	8

LOGPBU

	LOGPBU	LOGCUU	MN1	LOGNIU	PH	LOGCDU	IRON1
r	1.00000	0.62305	-0.47678	0.45698	-0.42640	0.40470	-0.38611
p	0.0	0.0406	0.1944	0.2550	0.1910	0.2460	0.2408
n	11	11	9	8	11	10	11

LOGCDU

	LOGCDU	LOGNIU	DCHARGE1	LOGCUU	LGCOND_K	DPTHCM	LOGTURB
r	1.00000	0.93620	-0.69140	0.66419	0.64777	-0.55554	0.54568
p	0.0	0.0019	0.0268	0.0362	0.0428	0.0955	0.1028
n	10	7	10	10	10	10	10

	LOGTSSU	LOGPBU	LOGZNU	TEMP1	MN1	PH	LOGDO
r	0.52703	0.40470	0.21128	0.18582	0.17354	0.12659	-0.11074
p	0.1175	0.2460	0.5579	0.6073	0.6811	0.7275	0.7607
n	10	10	10	10	8	10	10

LOGCRU

	LOGCRU	PH	LOGZNU	MN1	IRON1	LOGDO	LOGCUU
r	1.00000	-0.46118	0.44293	0.36970	0.25733	0.22380	0.22034
p	0.0	0.1534	0.1725	0.3274	0.4449	0.5083	0.5150
n	11	11	11	9	11	11	11

DPTHCM

	DPTHCM	DCHARGE1	LGCOND_K	LOGCDU	LOGDO	LOGZNU	LOGCUU
r	1.00000	0.72596	-0.63862	-0.55554	-0.47870	-0.43292	-0.32607
p	0.0	0.0114	0.0344	0.0955	0.1363	0.1835	0.3278
n	11	11	11	10	11	11	11

DCHARGE1

	DCHARGE1	LGCOND_K	DPTHCM	LOGCDU	LOGTURB	IRON1	LOGTSSU
r	1.00000	-0.85478	0.72596	-0.69140	-0.61641	-0.48740	-0.35190
p	0.0	0.0008	0.0114	0.0268	0.0434	0.1283	0.2886
n	11	11	11	10	11	11	11

Table 8: SAS CORRELATION ANALYSIS FOR OUTFALL ANNUAL MEANS; Pearson Correlation Coefficients (r) / Prob (p) > ¦R¦ under Ho: Rho=0. Note: n = 18 Outfalls (SAS Release 6.03, 1988).

LOGTSSU

	LOGTSSU	LOGTURB	DCHARGE1	IRON1	PH	ZINC1	SQZMAXCM
r	1.00000	0.82465	-0.62135	0.59528	0.40778	0.39034	-0.38165
p	0.0	0.0001	0.0059	0.0092	0.0930	0.1093	0.1181

	LGVOL_M3	LOGCUU	LGDPTHCM	LGPS_M2	LOGNIU	DO1	TEMP1
r	-0.34474	0.30524	-0.29446	-0.26810	0.22340	0.19468	-0.12276
p	0.1612	0.2181	0.2356	0.2821	0.3729	0.4389	0.6275

LOGTURB

	LOGTURB	LOGTSSU	IRON1	PH	DCHARGE1	SQZMAXCM	LOGCUU
r	1.00000	0.82465	0.58745	0.45398	-0.43822	-0.41699	0.33058
p	0.0	0.0001	0.0104	0.0584	0.0689	0.0851	0.1803

LGCOND_K

	LGCOND_K	LGVOL_M3	LGPS_M2	TEMP1	LOGPBU	PH	LOGTURB
r	1.00000	0.52653	0.31920	0.28841	0.28438	0.28065	0.23074
p	0.0	0.0248	0.1967	0.2458	0.2527	0.2593	0.3570

PH

	PH	DO1	LOGCUU	LOGTURB	TEMP1	LOGCRU	LOGTSSU
r	1.00000	0.82255	0.58948	0.45398	0.44755	0.41142	0.40778
p	0.0	0.0001	0.0100	0.0584	0.0626	0.0898	0.0930

DO1

	DO1	PH	TEMP1	LOGCUU	LOGCRU	LOGPBU	LOGCDU
r	1.00000	0.82255	0.68745	0.52019	0.42504	-0.33636	0.31711
p	0.0	0.0001	0.0016	0.0269	0.0787	0.1723	0.1998

TEMP1

	TEMP1	DO1	PH	LOGCRU	LOGCUU	LOGPBU	LGDPTHCM
r	1.00000	0.68745	0.44755	0.42070	0.39691	-0.30949	0.30868
p	0.0	0.0016	0.0626	0.0821	0.1029	0.2114	0.2126

IRON1

	IRON1	LOGTSSU	LOGTURB	LOGCDU	LGPS_M2	LGVOL_M3	LOGPBU
r	1.00000	0.59528	0.58745	-0.57053	-0.33629	-0.32419	-0.30256
p	0.0	0.0092	0.0104	0.0134	0.1724	0.1894	0.2223

ZINC1

	ZINC1	LOGTSSU	LOGNIU	LOGCUU	LOGMNU	LGPS_M2	IRON1
r	1.00000	0.39034	0.36703	0.35104	0.33358	-0.28655	0.27888
p	0.0	0.1093	0.1341	0.1532	0.1761	0.2490	0.2624

LOGMNU

	LOGMNU	LOGCRU	ZINC1	SQZMAXCM	DCHARGE1	LGDPTHCM	LGCOND_K
r	1.00000	-0.48376	0.33358	0.31842	0.25578	0.17299	0.16122
p	0.0	0.0419	0.1761	0.1978	0.3056	0.4924	0.5228

Table 8: SAS CORRELATION ANALYSIS FOR OUTFALL ANNUAL MEANS; (Continued).

LOGCUU

	LOGCUU	LOGNIU	PH	DO1	TEMP1	LOGCRU	ZINC1
r	1.00000	0.66676	0.58948	0.52019	0.39691	0.38942	0.35104
p	0.0	0.0025	0.0100	0.0269	0.1029	0.1102	0.1532

LOGNIU

	LOGNIU	LOGCUU	SQZMAXCM	LGPS_M2	LOGCRU	ZINC1	PH
r	1.00000	0.66676	-0.37974	-0.37868	0.37849	0.36703	0.29667
p	0.0	0.0025	0.1201	0.1212	0.1214	0.1341	0.2319

LOGPBU

	LOGPBU	LGDPTHCM	DO1	TEMP1	IRON1	LGCOND_K	SQZMAXCM
r	1.00000	-0.42111	-0.33636	-0.30949	-0.30256	0.28438	-0.27928
p	0.0	0.0818	0.1723	0.2114	0.2223	0.2527	0.2617

LOGCDU

	LOGCDU	IRON1	LGDPTHCM	LGVOL_M3	LGPS_M2	SQZMAXCM	PH
r	1.00000	-0.57053	-0.51770	0.39788	0.37758	0.37275	0.31947
p	0.0	0.0134	0.0278	0.1020	0.1224	0.1276	0.1963

LOGCRU

	LOGCRU	LOGMNU	DO1	TEMP1	PH	LOGCUU	LOGNIU
r	1.00000	-0.48376	0.42504	0.42070	0.41142	0.38942	0.37849
p	0.0	0.0419	0.0787	0.0821	0.0898	0.1102	0.1214

LGDPTHCM

	LGDPTHCM	LOGCDU	LOGPBU	TEMP1	IRON1	LOGTSSU	LOGCRU
r	1.00000	-0.51770	-0.42111	0.30868	0.29870	-0.29446	-0.28655
p	0.0	0.0278	0.0818	0.2126	0.2286	0.2356	0.2490

DCHARGE1

	DCHARGE1	LOGTSSU	LOGTURB	TEMP1	LGDPTHCM	LOGMNU	IRON1
r	1.00000	-0.62135	-0.43822	0.30219	0.27285	0.25578	-0.22091
p	0.0	0.0059	0.0689	0.2229	0.2733	0.3056	0.3784

LGPS_M2

	LGPS_M2	LGVOL_M3	SQZMAXCM	LOGNIU	LOGCDU	IRON1	LGCOND_K
r	1.00000	0.88796	0.55360	-0.37868	0.37758	-0.33629	0.31920
p	0.0	0.0001	0.0171	0.1212	0.1224	0.1724	0.1967

LGVOL_M3

	LGVOL_M3	LGPS_M2	SQZMAXCM	LGCOND_K	LOGCDU	LOGTSSU	IRON1
r	1.00000	0.88796	0.56995	0.52653	0.39788	-0.34474	-0.32419
p	0.0	0.0001	0.0135	0.0248	0.1020	0.1612	0.1894

SQZMAXCM

	SQZMAXCM	LGVOL_M3	LGPS_M2	LOGTURB	LOGTSSU	LOGNIU	LOGCDU
r	1.00000	0.56995	0.55360	-0.41699	-0.38165	-0.37974	0.37275
p	0.0	0.0135	0.0171	0.0851	0.1181	0.1201	0.1276

Table 9: RESULTS OF SAS PROC REG, STEPWISE MULTIPLE REGRESSION PERFORMED ON THE MEANS FOR 11 SAMPLE DATES CALCULATED FOR 18 OUTFALLS.

	DEPENDENT VARIABLES								
REGRESSORS	LOGDO {0.28}	PH {NS}	LGCOND_K {0.87}	LOGTSSU {0.61}	LOGTURB {0.38}	LOGZN {0.46}	IRON1 {NS}	LOGCUU {0.33}	MN1 {NS}
LOGDO	NC	.	.	.	.	(+)	.	.	.
PH	.	NC	.	.	.	.	.	(+)	.
LGCOND_K	.	.	NC	(+)	.	.	.	.	.
LOGTSSU	.	.	(+)	NC	.	.	.	.	.
LOGTURB	.	.	.	(-)	NC	.	.	.	.
LOGZN	NC	NC	NC	NC	NC	NC	.	.	.
IRON1	NC	NC	NC	NC	NC	.	NC	.	.
LOGCUU	NC	NC	NC	NC	NC	.	.	NC	.
MN1	NC	NC	NC	NC	NC	.	.	.	NC
TEMP1	(-)	.	.	.	.	.	.	.	.
DPTHCM	.	.	.	.	.	.	.	.	.
DCHARGE1	.	.	(-)	.	(-)	.	.	.	.

LEGEND:
(+) = POSITIVE REGRESSION EFFECT AT P=0.10 LEVEL.
(-) = NEGATIVE REGRESSION EFFECT AT P=0.10 LEVEL.
{NS} = NO SIGNIFICANT REGRESSORS NOTED FOR THE VARIABLE
NC = NOT CONSIDERED IN THE MODEL
"." = REGRESSOR NOT SIGNIFICANT AT P=0.10 LEVEL
{ } = MODEL R-SQUARE

Table 10: RESULTS OF SAS PROC REG, STEPWISE MULTIPLE REGRESSION PERFORMED ON MEANS FOR 18 OUTFALLS CALCULATED WITH 11 SAMPLES (DATES).

	DEPENDENT VARIABLES								
REGRESSORS	DO1 {0.94}	PH {0.78}	LGCOND_K {0.45}	LOGTSSU {0.76}	LOGTURB {0.93}	ZINC1 {0.29}	IRON1 {0.60}	LOGCUU {0.35}	LOGMNU {NS}
DO1	NC	(+)	.	.	.	.	.	.	.
PH	(+)	NC	.	.	.	.	.	(+)	.
LGCOND_K	(-)	.	NC	.	(+)	.	.	.	.
LOGTSSU	.	.	.	NC	(+)	(+)	(+)	.	.
LOGTURB	.	.	.	(+)	NC	.	.	.	.
ZINC1	.	.	.	NC	NC	NC	.	.	.
IRON1	.	.	.	NC	NC	.	NC	.	.
LOGCUU	.	.	.	NC	NC	.	.	NC	.
LOGMNU	.	.	.	NC	NC	(+)	.	.	NC
TEMP1	(+)	.	.	.	.	.	.	.	.
LGDPTHCM	.	.	.	.	.	.	(+)	.	.
DCHARGE1	.	.	.	(-)	(+)	.	.	.	.
LGVOL_M3	.	.	(+)	.	(-)	.	.	.	.
LGPS_M2	(+)	(-)	.	.	(+)	.	.	.	.
SQZMAXCM	.	.	(-)	.	.	.	.	.	.

LEGEND:
(+) = POSITIVE REGRESSION EFFECT AT P=0.10 LEVEL
(-) = NEGATIVE REGRESSION EFFECT AT P=0.10 LEVEL
{NS} = NO SIGNIFICANT REGRESSORS NOTED FOR THE VARIABLE
NC = NOT CONSIDERED IN THE MODEL
"." = REGRESSOR NOT SIGNIFICANT AT P=0.10 LEVEL
{ } = MODEL R-SQUARE

Table 11: SELECTED OUTPUT FROM SAS PROC FACTOR (FACTOR ANALYSIS) CONDUCTED ON OUTFALL ANNUAL MEANS FOR 15 VARIABLES. (SAS Release 6.03, 1988).

Initial Factor Method: Principal Components
Prior Communality Estimates: ONE
Eigenvalues of the Correlation Matrix: Total = 15 Average = 1

	1	2	3	4	5
Eigenvalue	3.991729	3.001134	2.059830	1.558669	1.181311
Difference	0.990596	0.941304	0.501161	0.377357	0.070789
Proportion	0.2661	0.2001	0.1373	0.1039	0.0788
Cumulative	0.2661	0.4662	0.6035	0.7074	0.7862
	6	7	8	9	10
Eigenvalue	1.110522	0.580957	0.509958	0.323139	0.259851
Difference	0.529564	0.070999	0.186819	0.063288	0.068698
Proportion	0.0740	0.0387	0.0340	0.0215	0.0173
Cumulative	0.8602	0.8989	0.9329	0.9545	0.9718
	11	12	13	14	15
Eigenvalue	0.191152	0.108033	0.099613	0.022241	0.001861
Difference	0.083119	0.008420	0.077372	0.020380	
Proportion	0.0127	0.0072	0.0066	0.0015	0.0001
Cumulative	0.9846	0.9918	0.9984	0.9999	1.0000

6 factors will be retained by the MINEIGEN criterion.

Factor Pattern

	FACTOR1	FACTOR2	FACTOR3	FACTOR4	FACTOR5	FACTOR6
LOGTSSU	86 *	-8	-31	24	0	15
LOGTURB	82 *	0	-26	20	29	-9
IRONU	64 *	-12	22	28	46 *	26
PH	63 *	62 *	0	-24	1	-3
LOGCUU	51 *	51 *	16	-11	-31	-21
SQZMAXCM	-60 *	33	-3	29	-10	54 *
DO1	36	79 *	1	-32	-10	30
TEMP1	7	76 *	45 *	-14	-3	8
LGVOL_M3	-57 *	63 *	-36	25	16	-3
LGDPTHCM	-6	1	70 *	-27	54 *	25
DCHARGE1	-48 *	16	61 *	4	-5	-40 *
LGPS_M2	-51 *	52 *	-59 *	7	18	15
LOGMNU	-15	3	47 *	69 *	3	14
ZINCU	41 *	18	24	61 *	-49 *	2
LGCOND_K	-1	55 *	-9	34	43 *	-56 *

NOTE: Printed values are multiplied by 100 and rounded to the nearest integer. Values greater than 0.378641 have been flagged by an ''.*

Variance explained by each factor (Modified SAS output).

FACTOR1	FACTOR2	FACTOR3	FACTOR4	FACTOR5	FACTOR6	TOTAL
(3.991729	+3.001134	+2.059830	+1.558669	+1.181311	+1.110522)=	12.90

Proportion of variance explained by each factor:

0.31	0.23	0.16	0.12	0.09	0.09

Variance explained by each factor eliminating other factors (Modified output).

FACTOR1	FACTOR2	FACTOR3	FACTOR4	FACTOR5	FACTOR6	TOTAL
(2.301413	+2.600991	+2.233227	+1.589122	+1.423366	+1.324416)=	11.47

Proportion of variance explained by each factor:

0.20	0.23	0.19	0.14	0.12	0.12

Table 11: CONTINUED

Rotation Method: Promax

Factor Structure (Correlations)

	FACTOR1	FACTOR2	FACTOR3	FACTOR4	FACTOR5	FACTOR6
LOGTSSU	93 *	26	-40 *	10	-33	1
LOGTURB	87 *	26	-42 *	0	-18	33
IRONU	67 *	10	-38	31	39	10
DCHARGE1	-75 *	-3	2	31	32	28
DO1	20	91 *	20	-7	3	3
TEMP1	-21	75 *	16	26	32	22
PH	41 *	86 *	-16	-7	-7	28
LOGCUU	19	76 *	-28	15	-22	25
LGPS_M2	-18	3	91 *	-31	-17	19
LGVOL_M3	-34	8	87 *	-6	-10	40
SQZMAXCM	-39	-7	80 *	28	15	-26
ZINCU	24	33	-24	77 *	-27	6
LOGMNU	-15	-14	8	80 *	32	10
LGDPTHCM	-20	5	-10	9	93 *	-3
LGCOND_K	0	23	20	8	-2	94 *

NOTE: Printed values are multiplied by 100 and rounded to the nearest integer. Values greater than 0.399092 have been flagged by an ''.*

Variance explained by each factor ignoring other factors (Modified SAS output).

FACTOR1	FACTOR2	FACTOR3	FACTOR4	FACTOR5	FACTOR6	TOTAL
(3.358726	+3.060866	+2.977945	+1.728175	+1.657108	+1.551886)=	14.35
Proportion of variance explained by each factor:						
0.23	0.21	0.21	0.12	0.12	0.11	

Scoring Coefficients Estimated by Regression
Standardized Scoring Coefficients

	FACTOR1	FACTOR2	FACTOR3	FACTOR4	FACTOR5	FACTOR6
LOGTSSU	0.29904	0.03036	-0.02744	0.06833	-0.11223	-0.04284
LOGTURB	0.28041	0.00040	-0.07146	-0.02426	-0.00697	0.22545
IRONU	0.26401	-0.04936	-0.00776	0.14830	0.34626	0.05497
DCHARGE1	-0.30178	0.02003	-0.14259	0.14555	0.07185	0.24962
DO1	0.04692	0.32900	0.12892	-0.06567	0.05181	-0.16413
TEMP1	-0.10422	0.27378	0.03885	0.10214	0.16441	0.02142
PH	0.07847	0.27641	-0.03250	-0.08515	-0.01071	0.08089
LOGCUU	-0.04830	0.27229	-0.14414	0.05605	-0.18067	0.08301
LGPS_M2	0.04996	-0.00268	0.35373	-0.14495	-0.04184	0.05565
LGVOL_M3	-0.02590	0.00630	0.29206	-0.01021	-0.04163	0.21072
SQZMAXCM	-0.01797	-0.00064	0.35719	0.21900	0.09814	-0.30092
ZINCU	0.01767	0.10426	-0.07467	0.47893	-0.23677	-0.05154
LOGMNU	-0.00985	-0.08177	0.04976	0.47790	0.15975	0.04589
LGDPTHCM	-0.02911	0.00742	-0.00329	-0.01764	0.60965	-0.01344

Table 12: SELECTED OUTPUT FROM SAS PROC VARCLUS (CLUSTER ANALYSIS) CONDUCTED ON OUTFALL ANNUAL MEANS FOR 15 VARIABLES. (SAS Release 6.03, 1988).

Oblique Principal Component Cluster Analysis

18 Observations PROPORTION = 0

15 Variables MAXEIGEN = 0

Cluster summary for 6 cluster(s) (* Modified to show Proportion of Total Explained).

Cluster	Members	Cluster Variation	Variation Explained	Proportion Explained	Proportion of Total Explained*	Second Eigenvalue
1	4	4.00000	2.68635	0.6716	0.24	0.7961
2	4	4.00000	2.75329	0.6883	0.25	0.6539
3	3	3.00000	2.35410	0.7847	0.21	0.5341
4	2	2.00000	1.33358	0.6668	0.12	0.6664
5	1	1.00000	1.00000	1.0000	0.09	.
6	1	1.00000	+ 1.00000	1.0000	0.09	.

Total variation explained = 11.12733 Proportion = 0.7418

	Variable	R-squared with Own Cluster	R-squared with Next Closest	1-R**2 Ratio
Cluster 1				
	LOGTSSU	0.8929	0.1366	0.1240
	LOGTURB	0.7981	0.1174	0.2288
	IRONU	0.5378	0.1278	0.5299
	DCHARGE1	0.4575	0.0744	0.5861
Cluster 2				
	LOGCUU	0.5500	0.0544	0.4759
	PH	0.7704	0.1606	0.2735
	DO1	0.8615	0.0352	0.1435
	TEMP1	0.5713	0.0953	0.4738
Cluster 3				
	LGPS_M2	0.8703	0.1019	0.1444
	LGVOL_M3	0.8809	0.2772	0.1648
	SQZMAXCM	0.6029	0.1581	0.4717
Cluster 4				
	ZINCU	0.6668	0.0811	0.3626
	LOGMNU	0.6668	0.0299	0.3435
Cluster 5				
	LGDPTHCM	1.0000	0.0253	0.0000
Cluster 6				
	LGCOND_K	1.0000	0.1031	0.0000

TABLE 12: CONTINUED

Oblique Principal Component Cluster Analysis
Standardized Scoring Coefficients

Cluster	1	2	3	4	5	6
LOGTSSU	0.35176	0.00000	0.00000	0.00000	0.00000	0.00000
LOGTURB	0.33255	0.00000	0.00000	0.00000	0.00000	0.00000
IRONU	0.27300	0.00000	0.00000	0.00000	0.00000	0.00000
ZINCU	0.00000	0.00000	0.00000	0.61231	0.00000	0.00000
LOGMNU	0.00000	0.00000	0.00000	0.61231	0.00000	0.00000
LOGCUU	0.00000	0.26935	0.00000	0.00000	0.00000	0.00000
LGCOND_K	0.00000	0.00000	0.00000	0.00000	0.00000	1.00000
PH	0.00000	0.31880	0.00000	0.00000	0.00000	0.00000
DO1	0.00000	0.33712	0.00000	0.00000	0.00000	0.00000
TEMP1	0.00000	0.27454	0.00000	0.00000	0.00000	0.00000
LGDPTHCM	0.00000	0.00000	0.00000	0.00000	1.00000	0.00000
DCHARGE1	-0.25179	0.00000	0.00000	0.00000	0.00000	0.00000
LGPS_M2	0.00000	0.00000	0.39629	0.00000	0.00000	0.00000
LGVOL_M3	0.00000	0.00000	0.39869	0.00000	0.00000	0.00000
SQZMAXCM	0.00000	0.00000	0.32983	0.00000	0.00000	0.00000

Cluster Structure

Cluster	1	2	3	4	5	6
LOGTSSU	0.94496	0.24415	-0.36957	0.17147	-0.29446	-0.05608
LOGTURB	0.89334	0.25769	-0.34257	0.06011	-0.13696	0.23074
IRONU	0.73338	0.12568	-0.35748	0.25243	0.29870	-0.00486
ZINCU	0.28478	0.26674	-0.15177	0.81657	-0.23483	0.08411
LOGMNU	-0.10653	-0.09649	0.07489	0.81657	0.17299	0.16122
LOGCUU	0.23319	0.74161	-0.14261	0.16352	-0.02513	0.16202
LGCOND_K	0.01644	0.24680	0.32102	0.15022	-0.03975	1.00000
PH	0.40069	0.87774	-0.12530	0.03376	0.00887	0.28065
DO1	0.18755	0.92819	0.18261	-0.01301	0.07035	0.10237
TEMP1	-0.14647	0.75588	0.17701	0.19605	0.30868	0.28841
LGDPTHCM	-0.13628	0.10452	-0.15910	-0.03786	1.00000	-0.03975
DCHARGE1	-0.67639	-0.03050	0.12331	0.15916	0.27285	0.15584
LGPS_M2	-0.23857	0.04404	0.93291	-0.25693	-0.24542	0.31920
LGVOL_M3	-0.36842	0.08706	0.93857	-0.03152	-0.19873	0.52653
SQZMAXCM	-0.39759	-0.06173	0.77645	0.20407	0.05272	-0.04668

Inter-Cluster Correlations

Cluster	1	2	3	4	5	6
1	1.00000	0.21356	-0.37257	0.10915	-0.13628	0.01644
2	0.21356	1.00000	0.03180	0.10425	0.10452	0.24680
3	-0.37257	0.03180	1.00000	-0.04708	-0.15910	0.32102
4	0.10915	0.10425	-0.04708	1.00000	-0.03786	0.15022
5	-0.13628	0.10452	-0.15910	-0.03786	1.00000	-0.03975
6	0.01644	0.24680	0.32102	0.15022	-0.03975	1.00000

Table 13: ANNUAL OUTFALL MEANS OF THE TEN VARIABLES USED TO FORM THE THREE-CLUSTER STRUCTURE IN FIGURE 43. ALSO SHOWN ARE THE ANNUAL CLUSTER MEANS (**MEDIANS FOR pH), THE LAND-USE ABBREVIATION (LC, HC, SR OR MR) FOR EACH POND. THE CLUSTER NUMERICAL RANK AND DUNCAN MUTIPLE RANGE TEST RESULTS (ALPHA = 0.05) ARE INCLUDED HERE AND IN ADDENDUM. CLUSTERS WITH THE SAME LETTER HAVE STATISTICALLY EQUAL MEANS.

POND			10 VARIABLES									
PSEUDONYM	LTR	USE	TEMP	DO	pH	TSS	TURB	COND	ZINC	COPPER	IRON	MANGANESE
							CLUSTER I					
CARLL	A	LC	24.62	7.04	7.50	2.18	2.20	0.689	0.0188	0.0109	0.0770	0.0103
CARLS	F	LC	24.09	9.08	7.90	4.10	3.90	0.390	0.0112	0.0269	0.0860	0.0168
		MEAN	24.36	8.06	7.70**	3.14	3.05	0.540	0.0150	0.0189	0.0815	0.0136
							CLUSTER II					
GTEDS	B	LC	24.36	5.78	7.30	9.24	4.30	0.331	0.0418	0.0149	0.3720	0.0163
WPAIS	H	HC	23.01	7.01	7.60	15.25	13.80	0.221	0.0226	0.0121	0.2570	0.0066
LIGHB	K	MR	24.11	6.46	7.47	7.33	5.10	0.326	0.0346	0.0151	0.4290	0.0271
MEBRV	M	MR	22.40	7.39	7.50	5.92	2.30	0.126	0.0458	0.0091	0.1540	0.0137
LAKFN	P	SR	23.09	6.37	7.26	3.66	2.30	0.150	0.0117	0.0166	0.2940	0.0086
LAKFS	Q	SR	23.43	7.73	7.65	7.26	6.50	0.178	0.0146	0.0103	0.3360	0.0116
THORN	R	MR	23.26	8.75	8.10	23.06	21.40	0.350	0.0372	0.0232	0.4420	0.0101
LIGHF	T	MR	23.82	7.81	7.90	13.87	8.00	0.273	0.0502	0.0715	0.2500	0.0138
GEORG	U	LC	24.67	5.94	6.98	4.38	4.90	0.286	0.0491	0.0295	0.2180	0.0109
		MEAN	23.57	7.03	7.50**	10.00	7.62	0.249	0.0342	0.0225	0.3058	0.0132
							CLUSTER III					
COOPP	C	SR	23.35	5.62	6.60	4.17	3.70	0.210	0.0314	0.0077	0.2110	0.0359
RIDGE	D	SR	20.34	3.00	6.70	5.93	8.20	0.235	0.0140	0.0193	0.2550	0.0102
COPW5	E	SR	20.67	2.60	6.55	8.36	4.40	0.269	0.0279	0.0112	0.1410	0.0167
KENMA	J	HC	22.17	3.49	6.52	3.71	2.00	0.189	0.0139	0.0050	0.1610	0.0075
TAOFF	S	LC	21.30	2.88	7.04	7.54	9.30	0.450	0.0321	0.0050	0.3420	0.0177
TRICO	V	HC	22.93	3.64	6.68	7.46	3.60	0.178	0.0186	0.0088	0.2120	0.0127
BLDAS	X	HC	22.72	3.18	7.00	4.79	3.90	0.252	0.0333	0.0118	0.2820	0.0256
		MEAN	21.93	3.49	6.68**	5.99	5.01	0.255	0.0245	0.0098	0.2291	0.0180
							CLUSTER RANK BY VARIABLE					
LOWEST			III A	III A	III A	I B	I B	II B	I A	III B	I B	II A
			II A	II B	II B	III B	III B	III B	III A	I AB	III A	I A
HIGHEST			I A	I B	I B	II A	II A	I A	II A	II A	II A	III A

Table 14: ANNUAL OUTFALL MEANS OF THE SEVEN VARIABLES USED TO FORM THE TWO-CLUSTER STRUCTURE IN FIGURE 44. ALSO SHOWN ARE THE ANNUAL CLUSTER MEANS AND THE LAND-USE ABBREVIATION (LC, HC, SR OR MR) FOR EACH POND. THE CLUSTER NUMERICAL RANK AND DUNCAN MUTIPLE RANGE TEST RESULTS (ALPHA = 0.05) ARE INCLUDED HERE AND IN ADDENDUM. CLUSTERS WITH THE SAME LETTER HAVE STATISTICALLY EQUAL MEANS.

POND			7 VARIABLES						
PSEUDONYM/LTR/USE			TSS	TURB	COND	ZINC	COPPER	IRON	MANGANESE
						CLUSTER I			
CARLL	A	LC	2.18	2.20	0.069	0.0188	0.0109	0.0770	0.0103
COOPP	C	SR	4.17	3.70	0.210	0.0314	0.0077	0.2110	0.0359
RIDGE	D	SR	5.93	8.20	0.235	0.0140	0.0193	0.2550	0.0102
COPW5	E	SR	8.36	4.40	0.269	0.0279	0.0112	0.1410	0.0167
CARLS	F	LC	4.10	3.90	0.390	0.0112	0.0269	0.0860	0.0168
WPAIS	H	HC	15.25	13.80	0.221	0.0226	0.0121	0.2570	0.0066
KENMA	J	HC	3.71	2.00	0.189	0.0139	0.0050	0.1610	0.0075
LAKFN	P	SR	3.66	2.30	0.150	0.0117	0.0166	0.2940	0.0086
LAKFS	Q	SR	7.26	6.50	0.178	0.0146	0.0103	0.3360	0.0116
TRICO	V	HC	7.46	3.60	0.178	0.0186	0.0088	0.2120	0.0127
BLDAS	X	HC	4.79	3.90	0.252	0.0333	0.0118	0.2820	0.0256
		MEAN	6.08	4.95	0.213	0.0198	0.0128	0.2102	0.0148
						CLUSTER II			
GTEDS	B	LC	9.24	4.30	0.331	0.0418	0.0149	0.3720	0.0163
LIGHB	K	MR	7.33	5.10	0.326	0.0346	0.0151	0.4290	0.0271
MEBRV	M	MR	5.92	2.30	0.126	0.0458	0.0091	0.1540	0.0137
THORN	R	MR	23.06	21.40	0.350	0.0372	0.0232	0.4420	0.0101
TAOFF	S	LC	7.54	9.30	0.450	0.0321	0.0050	0.3420	0.0177
LIGHF	T	MR	13.87	8.00	0.273	0.0502	0.0715	0.2500	0.0138
GEORG	U	LC	4.38	4.90	0.286	0.0491	0.0295	0.2180	0.0109
		MEAN	10.19	7.90	0.306	0.0415	0.0240	0.3153	0.0157
						CLUSTER RANK BY VARIABLE			
LOWEST			I B	I B	I A	I B	I B	I B	I A
HIGHEST			II A	II A	II A	II A	II A	II A	II A

APPENDIX

TABLE A: BOTTOM DEPTH (FEET) AT SAMPLE LOCATION DURING WATER-QUALITY SURVEY (1988 - 1989) OF 24 STORMWATER, WET-DETENTION PONDS.

POND\			DATE																			
PSEUDONYM	Ltr	Station	101888	110288	112388	112888	121388	012389	030289	041889	060789	062689	072489	082889	110189	121989	MEDIAN	MEAN	STD	VAR	MIN	MAX	n
			DEPTH (FEET)																				
CARLL	A	OUTFALL	.	.	2.08	0.75	0.75	1.17	0.75	0.92	0.75	1.29	1.58	1.08	1.08	1.17	1.08	1.03	0.26	0.07	0.75	1.58	11
GTEDS	B	OUTFALL	0.91	.	.	2.33	0.79	1.58	1.67	1.50	1.13	1.25	1.67	2.33	1.04	2.67	1.58	1.63	0.57	0.32	0.79	2.67	11
COOPP	C	OUTFALL	.	0.61	.	1.42	1.54	1.50	1.00	0.75	.	1.25	1.79	1.83	1.04	1.08	1.34	1.32	0.34	0.11	0.75	1.83	10
RIDGE	D	OUTFALL	0.97	.	1.29	1.42	1.29	1.67	1.08	.	.	1.67	1.58	1.25	0.67	1.42	1.42	1.34	0.30	0.09	0.67	1.67	9
COPW5	E	OUTFALL	.	2.29	0.88	1.13	0.54	1.00	0.67	0.33	.	0.75	0.79	0.75	0.63	0.54	0.71	0.71	0.22	0.05	0.33	1.13	10
CARLS	F	OUTFALL	.	1.90	3.83	2.33	1.50	2.08	2.75	1.25	1.54	2.08	2.08	1.54	1.83	1.54	1.83	1.87	0.42	0.18	1.25	2.75	11
WPAIL	G	OUTFALL	.	.	1.17	1.04	0.63	1.04	2.17	.	.	.	.	.	.	.	1.04	1.22	0.57	0.33	0.63	2.17	4
WPAIS	H	OUTFALL	.	.	0.98	1.00	1.08	1.13	0.75	0.46	0.63	1.00	1.00	0.83	2.33	0.67	1.00	0.99	0.47	0.22	0.46	2.33	11
BLDAL	I	OUTFALL	4.10	.	.	3.08	3.00	3.33	2.75	1.92	1.96	3.13	3.71	3.17	4.17	5.00	3.13	3.20	0.85	0.72	1.92	5.00	11
KENMA	J	OUTFALL	.	0.35	2.44	1.52	1.33	1.75	0.79	1.79	1.25	2.04	2.08	1.92	1.38	1.63	1.63	1.59	0.37	0.14	0.79	2.08	11
LIGHB	K	OUTFALL	1.12	.	.	1.25	1.33	1.96	1.92	1.04	1.42	1.83	1.75	2.50	1.79	1.50	1.75	1.66	0.39	0.15	1.04	2.50	11
LASHV	L	OUTFALL	.	.	.	1.76	2.17	1.29	0.67	.	.	.	.	.	.	1.25	1.29	1.43	0.51	0.26	0.67	2.17	5
MEBRV	M	OUTFALL	.	.	1.08	0.79	0.67	1.00	.	.	.	.	1.42	0.79	0.96	1.00	0.96	0.95	0.23	0.05	0.67	1.42	7
MARWA	N	OUTFALL	1.40	.	2.88	2.38	1.83	1.29	1.13	0.83	1.83	1.67	1.58	1.79	1.08	1.33	1.58	1.52	0.42	0.18	0.83	2.38	11
EASTS	O	OUTFALL	.	.	.	.	0.79	0.50	0.58	.	.	.	.	0.38	.	0.46	0.50	0.54	0.14	0.02	0.38	0.79	5
LAKFN	P	OUTFALL	.	.	.	2.13	2.21	2.08	1.58	0.83	.	1.42	1.42	1.79	1.00	1.42	1.50	1.59	0.44	0.20	0.83	2.21	10
LAKFS	Q	OUTFALL	.	.	.	1.29	1.83	2.50	1.58	0.83	.	1.71	1.33	1.42	2.33	1.88	1.65	1.67	0.47	0.22	0.83	2.50	10
THORN	R	OUTFALL	.	0.58	.	1.75	1.50	1.58	1.58	0.92	1.50	1.63	1.67	1.79	1.17	1.17	1.58	1.48	0.26	0.07	0.92	1.79	11
TAOFF	S	OUTFALL	0.47	.	.	1.08	0.64	1.00	0.75	.	.	1.25	1.00	1.00	0.71	1.42	1.00	0.98	0.24	0.06	0.64	1.42	9
LIGHF	T	OUTFALL	0.42	.	.	0.71	0.50	0.88	0.67	.	.	0.42	0.92	1.00	0.79	0.71	0.71	0.73	0.18	0.03	0.42	1.00	9
GEORG	U	OUTFALL	.	1.32	1.94	1.54	1.29	1.67	1.67	1.50	1.50	1.50	1.75	1.50	1.46	1.50	1.50	1.53	0.12	0.01	1.29	1.75	11
TRICO	V	OUTFALL	.	.	1.19	1.00	1.04	1.25	1.33	0.50	0.79	1.88	1.33	1.33	0.75	1.25	1.25	1.13	0.36	0.13	0.50	1.88	11
LIWAF	W	OUTFALL	.	.	0.71	0.54	0.50	0.92	0.25	.	.	1.17	.	1.17	0.75	1.04	0.84	0.79	0.32	0.10	0.25	1.17	8
BLDAS	X	OUTFALL	2.00	.	.	2.42	3.00	1.88	2.83	2.08	2.25	2.88	2.67	2.50	2.58	2.33	2.50	2.49	0.33	0.11	1.88	3.00	11
																							N = 228
		MEDIAN				1.42	1.29	1.40	1.13	0.92	1.46	1.57	1.58	1.46	1.08	1.33							
		MEAN				1.51	1.32	1.50	1.34	1.09	1.38	1.59	1.66	1.53	1.41	1.48			P_mean	1.45			
		STD				0.65	0.71	0.60	0.73	0.51	0.48	0.62	0.64	0.66	0.84	0.90			P_std	0.70			
		VAR				0.43	0.51	0.36	0.53	0.26	0.23	0.39	0.41	0.44	0.71	0.82			P_var	0.50			
		MIN				0.54	0.50	0.50	0.25	0.33	0.63	0.42	0.79	0.38	0.63	0.46			P_min	0.25			
		MAX				3.08	3.00	3.33	2.83	2.08	2.25	3.13	3.71	3.17	4.17	5.00			P_max	5.00			
		n				23	24	24	23	16	12	20	20	22	21	23	// N = 228		_N	228			

Legend: "." = No Data "P_" = Population statistic "n" = number of observations

TABLE A: CONTINUED.

POND\ PSEUDONYM	Ltr	Station	101888	110288	112388	112888	121388	012389	030289	041889	060789	062689	072489	082889	110189	121989	MEDIAN	MEAN	STD	VAR	MIN	MAX	n
			DATE: DEPTH (FEET)																				
CARLL	A	POND	.	1.03	1.50	1.25	1.38	1.92	1.83	1.33	1.13	1.63	2.08	1.71	1.63	1.04	1.63	1.54	0.32	0.10	1.04	2.08	11
GTEDS	B	POND	.	.	.	1.38	0.63	2.00	1.92	1.50	1.33	1.42	1.63	1.21	1.00	1.25	1.38	1.39	0.37	0.14	0.63	2.00	11
COOPP	C	POND	.	1.74	.	1.00	1.54	1.71	1.50	1.17	1.17	1.71	1.67	1.33	.	1.58	1.52	1.44	0.24	0.06	1.00	1.71	10
RIDGE	D	POND	1.71	.	1.13	0.83	.	0.46	1.67	2.42	1.79	1.71	1.58	1.63	2.58	1.96	1.69	1.66	0.61	0.37	0.46	2.58	10
COPW5	E	POND	.	.	2.58	0.54	2.25	3.00	1.92	1.63	1.50	2.04	1.88	1.96	2.17	1.83	1.92	1.88	0.57	0.32	0.54	3.00	11
CARLS	F	POND	.	2.30	1.44	1.67	1.92	3.33	2.08	1.83	1.75	2.33	3.08	2.29	1.92	2.21	2.08	2.22	0.51	0.26	1.67	3.33	11
WPAIL	G	POND	1.43	.	0.88	1.50	1.50	1.88	2.00	1.13	1.17	1.46	0.83	0.92	0.83	0.67	1.17	1.26	0.42	0.18	0.67	2.00	11
WPAIS	H	POND	1.14	.	1.17	1.04	2.08	1.83	0.92	1.50	1.29	1.50	1.21	0.58	1.04	0.71	1.21	1.25	0.44	0.19	0.58	2.08	11
BLDAL	I	POND	.	.	.	1.46	1.42	1.92	1.42	1.67	1.75	3.58	2.08	2.58	2.96	2.38	1.92	2.11	0.67	0.45	1.42	3.58	11
KENMA	J	POND	.	0.67	1.19	1.58	1.38	2.50	2.33	2.50	1.67	2.54	2.17	2.17	2.50	2.67	2.33	2.18	0.42	0.18	1.38	2.67	11
LIGHB	K	POND	.	.	.	1.32	1.38	2.83	1.83	1.33	2.25	1.79	2.08	2.00	1.50	1.83	1.83	1.83	0.44	0.19	1.32	2.83	11
LASHV	L	POND	.	.	.	1.46	1.83	1.29	1.50	1.00	1.17	1.71	2.19	2.00	1.08	1.58	1.50	1.53	0.36	0.13	1.00	2.19	11
MEBRV	M	POND	.	1.79	1.46	2.13	0.58	2.08	2.00	1.71	2.33	2.17	3.17	2.42	2.67	2.67	2.17	2.18	0.63	0.40	0.58	3.17	11
MARWA	N	POND	.	.	1.02	1.54	1.23	1.04	1.00	1.67	1.67	1.13	1.17	1.58	1.67	1.00	1.23	1.34	0.27	0.08	1.00	1.67	11
EASTS	O	POND	.	.	.	.	0.23	0.38	0.33	.	.	.	.	.	.	0.38	0.36	0.33	0.06	0.00	0.23	0.38	4
LAKFN	P	POND	1.47	.	.	1.32	2.33	2.50	2.04	1.08	1.63	1.79	3.50	1.79	2.88	3.88	2.04	2.25	0.84	0.71	1.08	3.88	11
LAKFS	Q	POND	0.82	.	.	0.98	2.75	2.67	1.79	1.50	1.00	2.25	2.50	2.42	2.83	2.50	2.42	2.11	0.65	0.42	0.98	2.83	11
THORN	R	POND	.	1.54	.	1.50	2.67	2.92	2.42	1.83	1.38	2.21	3.00	2.42	1.83	2.17	2.21	2.21	0.51	0.26	1.38	3.00	11
TAOFF	S	POND	.	.	.	0.79	0.63	0.71	0.50	.	.	0.79	0.88	0.92	0.42	0.96	0.79	0.73	0.18	0.03	0.42	0.96	9
LIGHF	T	POND	.	.	.	1.17	1.08	1.83	1.00	1.42	2.00	1.38	1.71	1.13	1.63	1.67	1.42	1.46	0.32	0.10	1.00	2.00	11
GEORG	U	POND	.	1.21	0.52	1.21	1.04	1.50	1.29	1.00	1.17	1.17	1.25	1.25	1.17	1.25	1.21	1.21	0.13	0.02	1.00	1.50	11
TRICO	V	POND	.	0.46	1.35	1.29	1.38	1.58	1.54	0.92	1.21	1.96	1.67	1.54	1.25	1.79	1.54	1.47	0.28	0.08	0.92	1.96	11
LIWAF	W	POND	.	.	0.67	1.67	1.65	0.79	.	.	0.71	1.29	3.08	2.42	2.04	2.83	1.67	1.83	0.79	0.63	0.71	3.08	9
BLDAS	X	POND	.	.	.	1.75	1.67	2.33	2.08	1.50	1.83	1.92	2.00	2.08	2.04	2.21	2.00	1.95	0.23	0.05	1.50	2.33	11
		MEDIAN				1.32	1.42	1.90	1.79	1.50	1.44	1.71	2.00	1.79	1.75	1.81							N = 251
		MEAN				1.32	1.50	1.88	1.60	1.51	1.50	1.80	2.02	1.75	1.80	1.79			P_mean	1.68			
		STD				0.35	0.64	0.79	0.54	0.41	0.40	0.56	0.73	0.56	0.71	0.80			P_std	0.64			
		VAR				0.12	0.41	0.63	0.29	0.17	0.16	0.32	0.54	0.31	0.51	0.64			P_var	0.42			
		MIN				0.54	0.23	0.38	0.33	0.92	0.71	0.79	0.83	0.58	0.42	0.38			P_min	0.38			
		MAX				2.13	2.75	3.33	2.42	2.50	2.33	3.58	3.50	2.58	2.96	3.88			P_max	3.88			
		n				23	23	24	23	21	22	23	23	23	22	24	// N = 251		_N	251			

Legend: "." = No Data "P_" = Population statistic "n" = number of observations

TABLE A: CONTINUED.

POND\ PSEUDONYM	Ltr	Station	101888	110288	112388	112888	121388	012389	DATE 030289	041889	060789	062689	072489	082889	110189	121989	MEDIAN	MEAN	STD	VAR	MIN	MAX	n
									DEPTH (FEET)														
CARLL	A	RECEIVE	.	.	1.26	0.88	0.75	0.96	1.58	0.96	1.50	1.50	1.46	1.17	1.21	1.04	1.17	1.18	0.28	0.08	0.75	1.58	11
GTEDS	B	RECEIVE	0.24	.	.	2.69	1.29	1.50	1.25	1.00	2.67	4.58	1.58	0.88	0.83	1.00	1.29	1.75	1.09	1.18	0.83	4.58	11
COOPP	C	RECEIVE	.	0.46	.	0.75	0.46	0.42	0.75	.	.	0.63	0.75	1.04	1.58	0.38	0.75	0.75	0.35	0.12	0.38	1.58	9
RIDGE	D	RECEIVE	.	.	0.50	0.17	0.50	2.42	0.83	.	.	.	0.38	0.54	0.58	0.67	0.56	0.76	0.65	0.43	0.17	2.42	8
CARLS	F	RECEIVE	.	1.45	0.98	1.42	1.42	1.50	1.67	0.92	1.08	1.58	2.25	1.08	1.17	1.79	1.42	1.44	0.36	0.13	0.92	2.25	11
WPAIL	G	RECEIVE	0.42	.	1.00	0.42	0.33	0.50	0.50	.	.	0.33	.	.	.	1.33	0.46	0.57	0.35	0.12	0.33	1.33	6
WPAIS	H	RECEIVE	.	.	0.54	0.83	0.92	0.83	0.79	0.58	0.63	0.79	0.29	3.00	.	0.71	0.79	0.94	0.71	0.50	0.29	3.00	10
BLDAL	I	RECEIVE	1.10	.	.	1.17	0.85	1.17	0.83	0.58	.	1.38	2.25	1.17	1.17	1.58	1.17	1.21	0.44	0.19	0.58	2.25	10
KENMA	J	RECEIVE	.	.	2.08	0.82	0.96	1.08	0.75	.	.	.	1.25	1.21	.	.	1.02	1.01	0.19	0.03	0.75	1.25	6
LASHV	L	RECEIVE	.	.	.	2.50	2.08	1.92	0.83	.	2.00	2.71	0.92	1.83	1.17	1.46	1.88	1.74	0.60	0.36	0.83	2.71	10
MARWA	N	RECEIVE	1.95	.	2.17	0.92	1.00	2.58	2.83	1.83	1.54	1.50	2.25	1.83	1.42	1.33	1.54	1.73	0.58	0.34	0.92	2.83	11
TAOFF	S	RECEIVE	0.73	.	.	0.83	0.90	1.17	2.17	.	.	1.13	1.17	2.17	0.92	1.79	1.17	1.36	0.51	0.26	0.83	2.17	9
LIWAF	W	RECEIVE	.	.	1.97	0.58	0.79	2.50	2.08	.	2.21	2.50	2.08	1.96	2.46	2.50	2.15	1.97	0.67	0.45	0.58	2.50	10
BLDAS	S	RECEIVE	1.10	.	.	1.17	0.85	1.17	0.83	0.58	.	1.38	2.25	1.17	1.17	1.58	1.17	1.21	0.44	0.19	0.58	2.25	10
																							N = 132
		MEDIAN				0.86	0.88	1.17	0.83	0.92	1.54	1.44	1.46	1.17	1.17	1.33							
		MEAN				1.08	0.94	1.41	1.26	0.92	1.66	1.67	1.45	1.47	1.24	1.32			P_mean	1.31			
		STD				0.69	0.43	0.68	0.67	0.41	0.64	1.10	0.70	0.63	0.46	0.54			P_std	0.70			
		VAR				0.47	0.18	0.46	0.45	0.17	0.41	1.20	0.49	0.40	0.21	0.30			P_var	0.49			
		MIN				0.17	0.33	0.42	0.50	0.58	0.63	0.33	0.29	0.54	0.58	0.38			P_min	0.17			
		MAX				2.69	2.08	2.58	2.83	1.83	2.67	4.58	2.25	3.00	2.46	2.50			P_max	4.58			
		n				14	14	14	14	7	7	12	13	13	11	13	// N = 132		_N	132			

Legend: "." = No Data "P_" = Population statistic "n" = number of observations

TABLE B: CALCULATION OF DISCHARGE FREQUENCY AT THE OUTFALL STUCTURE DURING THE WATER-QUALITY SURVEY (1988 - 1989) OF 24 WET-DETENTION PONDS.
Discharge Frequency (DF) = (nd) or (nd/n) is based on water flowing over the control structure (wier) or through its bleeddown orifice.

POND\ Pseudonym	Ltr	Station	101888	110288	112388	112888	121388	012389	030289	041889	060789	062689	072489	082889	110189	121989	nd	n	DF
			DATE																
			Dishcharging (1=yes, 0=no)																
CARLL	A	OUTFALL	.	.	1	1	1	1	1	1	0	1	1	1	1	1	10	11	0.91
GTEDS	B	OUTFALL	.	.	.	0	1	1	1	.	1	1	1	1	1	1	9	10	0.90
COOPP	C	OUTFALL	.	.	.	0	1	1	1	.	0	1	1	1	1	0	7	10	0.70
RIDGE	D	OUTFALL	.	.	1	1	1	1	1	0	0	1	1	1	0	1	8	11	0.73
COPW5	E	OUTFALL	.	.	1	1	1	1	0	0	0	0	0	1	0	0	4	11	0.36
CARLS	F	OUTFALL	.	.	1	1	1	1	1	0	0	1	1	1	0	1	8	11	0.73
WPAIL	G	OUTFALL	.	.	1	1	1	0	0	0	0	0	0	0	0	0	2	11	0.18
WPAIS	H	OUTFALL	.	.	1	1	1	1	0	0	0	1	0	0	0	0	4	11	0.36
BLDAL	I	OUTFALL	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
KENMA	J	OUTFALL	.	.	1	1	0	1	0	0	0	0	1	0	.	0	3	10	0.30
LIGHB	K	OUTFALL	.	.	.	1	0	1	0	0	0	0	1	1	1	.	5	10	0.50
LASHV	L	OUTFALL	.	.	.	1	1	1	1	0	0	0	0	0	1	1	6	11	0.55
MEBRV	M	OUTFALL	.	.	1	1	1	1	0	0	0	0	1	1	1	0	6	11	0.55
MARWA	N	OUTFALL	.	.	1	1	1	.	1	0	1	1	1	1	0	1	8	10	0.80
EASTS	O	OUTFALL	.	.	.	.	1	1	1	0	0	0	0	1	0	1	5	10	0.50
LAKFN	P	OUTFALL	.	.	.	.	1	1	1	0	0	1	1	1	.	1	7	9	0.78
LAKFS	Q	OUTFALL	.	.	.	1	1	0	1	0	0	1	.	1	.	1	6	9	0.67
THORN	R	OUTFALL	.	.	.	0	0	0	0	0	0	0	0	0	0	0	0	11	0.00
TAOFF	S	OUTFALL	.	.	.	0	1	1	1	0	0	1	1	1	1	1	8	11	0.73
LIGHF	T	OUTFALL	.	.	.	1	1	0	0	0	0	0	1	1	1	1	6	11	0.55
GEORG	U	OUTFALL	.	.	1	.	.	1	1	1	.	1	1	1	1	1	8	8	1.00
TRICO	V	OUTFALL	.	.	1	1	1	1	1	0	0	1	1	1	0	1	8	11	0.73
LIWAF	W	OUTFALL	.	.	1	0	1	1	0	0	0	1	0	.	0	1	4	10	0.40
BLDAS	X	OUTFALL	.	.	.	1	1	1	1	1	0	1	1	.	.	1	8	9	0.89
																	140	237	0.59
		n				20	22	22	23	21	22	23	22	21	19	22 //	237		
		nd				15	19	18	14	3	2	14	15	16	9	15 //	140		
		DF				0.75	0.86	0.82	0.61	0.14	0.09	0.61	0.68	0.76	0.47	0.68 //	0.59		

Legend: No Data = "."
Discharge Frequency = "DF"
Number of Observations = "n"
Number discharging = "nd"

TABLE C: WATER TEMPERATURE (DEGREES CENTIGRADE) TAKEN DURING THE WATER-QUALITY SURVEY (1988 - 1989) OF 24 WET-DETENTION PONDS.

POND\ Pseudonym	Ltr	Station	DATE 101888	110288	112388	112888	121388	012389	030289	041889	060789	062689	072489	082889	110189	121989	MEDIAN	MEAN	STD	VAR	MIN	MAX	n
			TEMPERATURE (DEGREES C)																				
CARLL	A	OUTFALL	.	.	12.00	21.90	17.50	21.15	25.25	25.00	27.20	29.50	32.37	28.09	24.10	18.80	25.00	24.62	4.34	18.85	17.50	32.37	11
GTEDS	B	OUTFALL	27.24	.	.	20.00	18.00	16.05	18.98	26.80	31.03	32.84	32.11	29.48	25.70	17.00	25.70	24.36	6.19	38.37	16.05	32.84	11
COOPP	C	OUTFALL	.	20.60	.	21.70	16.90	14.69	18.21	31.30	.	31.03	27.82	28.32	27.10	16.40	24.40	23.35	6.12	37.50	14.69	31.30	10
RIDGE	D	OUTFALL	23.85	.	12.50	15.40	13.30	16.96	18.07	.	.	27.27	26.11	28.81	21.40	15.70	18.07	20.34	5.44	29.58	13.30	28.81	9
COPW5	E	OUTFALL	.	.	14.00	14.90	13.20	15.48	22.32	.	.	28.05	25.80	28.72	20.40	17.20	20.40	20.67	5.54	30.72	13.20	28.72	9
CARLS	F	OUTFALL	.	21.60	13.20	21.90	17.00	17.80	20.99	24.00	28.53	30.26	29.83	30.73	26.80	17.10	24.00	24.09	5.18	26.84	17.00	30.73	11
WPAIL	G	OUTFALL	.	.	10.50	18.50	16.10	17.73	18.26	.	.	.	.	.	.	.	18.00	17.65	0.94	0.88	16.10	18.50	4
WPAIS	H	OUTFALL	.	.	11.50	17.40	14.20	18.21	17.97	29.60	28.34	28.65	28.53	32.76	22.10	15.30	22.10	23.01	6.37	40.63	14.20	32.76	11
BLDAL	I	OUTFALL	24.39	.	.	22.50	17.20	16.77	19.46	26.89	29.58	30.00	30.24	29.99	23.30	16.80	23.30	23.88	5.43	29.44	16.77	30.24	11
KENMA	J	OUTFALL	.	18.20	15.10	16.70	14.30	17.10	20.46	23.50	26.87	28.95	28.51	29.69	22.10	15.70	22.10	22.17	5.47	29.90	14.30	29.69	11
LIGHB	K	OUTFALL	26.79	.	.	21.90	16.80	17.89	20.45	25.13	28.53	30.71	31.03	30.49	24.90	17.40	24.90	24.11	5.30	28.07	16.80	31.03	11
LASHV	L	OUTFALL	.	.	.	21.80	15.90	14.64	18.55	.	.	.	.	.	.	17.60	17.60	17.70	2.46	6.03	14.64	21.80	5
MEBRV	M	OUTFALL	.	.	9.80	18.20	15.10	17.98	.	.	.	.	29.78	34.12	23.50	18.10	18.20	22.40	6.57	43.14	15.10	34.12	7
MARWA	N	OUTFALL	23.68	.	15.00	16.90	15.25	19.62	17.88	28.30	30.00	28.73	28.18	30.71	22.80	17.00	22.80	23.22	5.77	33.33	15.25	30.71	11
EASTS	O	OUTFALL	.	.	.	.	12.30	13.66	19.10	.	.	.	.	28.99	.	17.90	17.90	18.39	5.87	34.51	12.30	28.99	5
LAKFN	P	OUTFALL	.	.	.	18.60	16.50	16.94	23.38	23.32	.	33.54	28.38	32.15	20.60	17.50	21.96	23.09	5.99	35.83	16.50	33.54	10
LAKFS	Q	OUTFALL	.	.	.	18.60	16.20	16.88	22.85	24.25	.	34.29	29.15	32.92	22.00	17.20	22.43	23.43	6.33	40.11	16.20	34.29	10
THORN	R	OUTFALL	.	21.90	.	21.30	15.30	16.33	21.77	27.00	26.93	28.94	29.38	29.06	23.60	16.30	23.60	23.26	5.19	26.98	15.30	29.38	11
TAOFF	S	OUTFALL	20.85	.	.	21.60	13.40	13.60	18.39	.	.	28.72	26.74	27.33	24.10	17.80	21.60	21.30	5.49	30.15	13.40	28.72	9
LIGHF	T	OUTFALL	28.51	.	.	22.40	13.50	16.81	21.09	.	.	30.78	31.40	32.80	26.90	18.70	22.40	23.82	6.56	43.04	13.50	32.80	9
GEORG	U	OUTFALL	.	24.40	10.00	22.60	14.90	19.74	25.00	24.37	28.01	31.50	29.17	32.72	24.70	18.70	24.70	24.67	5.25	27.52	14.90	32.72	11
TRICO	V	OUTFALL	.	.	14.50	21.60	15.60	17.18	20.22	28.00	27.31	26.39	28.16	28.30	23.20	16.30	23.20	22.93	4.80	23.00	15.60	28.30	11
LIWAF	W	OUTFALL	.	.	10.50	15.20	14.80	15.45	.	.	.	32.20	.	31.50	23.00	17.40	17.40	21.36	7.12	50.66	14.80	32.20	7
BLDAS	X	OUTFALL	23.69	.	.	22.50	15.20	15.35	18.82	24.33	27.24	28.67	29.00	28.90	22.70	17.20	22.70	22.72	5.16	26.60	15.20	29.00	11
																							N = 226
		MEDIAN				21.30	15.28	16.91	19.84	25.13	28.18	29.75	29.08	29.84	23.30	17.20							
		MEAN				19.74	15.35	16.83	20.34	26.12	28.30	30.05	29.08	30.30	23.57	17.18				P_mean	22.76		
		STD				2.59	1.50	1.80	2.21	2.31	1.27	2.02	1.75	1.88	1.88	0.92				P_std	5.83		
		VAR				6.70	2.24	3.24	4.89	5.35	1.62	4.09	3.06	3.53	3.54	0.85				P_var	34.01		
		MIN				14.90	12.30	13.60	17.88	23.32	26.87	26.39	25.80	27.33	20.40	15.30				P_min	12.30		
		MAX				22.60	18.00	21.15	25.25	31.30	31.03	34.29	32.37	34.12	27.10	18.80				P_max	34.29		
		n				23	24	24	22	15	12	20	20	22	21	23	// N = 226			N	226		

LEGEND: "." = No Data or Not Calculated "P_" = Population statistic "n" = number of observations

TABLE C: CONTINUED.

POND\ Pseudonym	Ltr	Station	101888	110288	112388	112888	121388	012389	030289	041889	060789	062689	072489	082889	110189	121989	MEDIAN	MEAN	STD	VAR	MIN	MAX	n
			DATE																				
			TEMPERATURE (DEGREES C)																				
CARLL	A	POND	.	24.40	13.00	22.20	18.60	19.39	20.11	28.00	28.91	29.96	30.95	30.71	24.50	16.50	24.50	24.53	5.14	26.47	16.50	30.95	11
GTEDS	B	POND	.	.	.	20.50	18.90	16.43	18.82	26.35	30.95	31.62	31.47	29.64	24.90	17.10	24.90	24.24	5.80	33.61	16.43	31.62	11
COOPP	C	POND	.	22.00	.	21.50	17.50	14.49	18.23	27.70	27.13	31.56	27.59	28.37	.	16.60	24.32	23.07	5.75	33.09	14.49	31.56	10
RIDGE	D	POND	25.15	.	13.00	18.40	16.00	17.33	18.55	33.00	30.27	30.26	30.02	32.73	22.40	14.60	22.40	23.96	6.96	48.40	14.60	33.00	11
COPW5	E	POND	.	21.70	12.00	19.40	17.90	16.69	22.79	23.78	28.90	30.28	27.72	28.80	22.10	16.90	22.79	23.21	4.87	23.70	16.69	30.28	11
CARLS	F	POND	.	23.10	15.00	22.50	16.80	17.38	21.71	27.00	28.54	30.14	29.74	30.62	24.00	17.30	24.00	24.16	5.15	26.53	16.80	30.62	11
WPAIL	G	POND	29.03	.	.	18.80	15.60	18.59	18.29	29.90	29.50	28.76	28.74	34.10	22.60	15.20	22.60	23.64	6.39	40.88	15.20	34.10	11
WPAIS	H	POND	24.94	.	11.00	17.30	15.00	17.55	18.25	26.90	27.84	28.55	28.28	36.60	20.70	15.00	20.70	22.91	6.74	45.48	15.00	36.60	11
BLDAL	I	POND	.	.	.	22.40	17.30	17.34	20.00	27.07	29.52	29.69	31.26	30.43	23.30	17.20	23.30	24.14	5.40	29.15	17.20	31.26	11
KENMA	J	POND	.	.	14.50	18.30	15.90	16.98	19.07	28.00	28.44	29.82	28.57	29.70	23.30	15.70	23.30	23.07	5.68	32.23	15.70	29.82	11
LIGHB	K	POND	.	.	.	22.00	16.50	16.89	20.30	25.10	28.35	30.69	30.70	31.64	24.10	16.80	24.10	23.92	5.60	31.31	16.50	31.64	11
LASHV	L	POND	.	.	.	21.80	15.90	13.75	18.66	26.92	26.46	31.19	28.68	28.51	24.90	17.50	24.90	23.12	5.62	31.55	13.75	31.19	11
MEBRV	M	POND	.	23.90	11.00	18.70	16.70	17.05	23.67	24.59	29.01	30.64	29.25	31.66	22.60	16.10	23.67	23.63	5.63	31.68	16.10	31.66	11
MARWA	N	POND	.	.	12.00	14.60	12.80	.	17.66	29.50	30.33	30.67	28.70	33.65	23.40	17.90	26.05	23.92	7.22	52.15	12.80	33.65	10
EASTS	O	POND	.	.	.	.	12.50	15.38	19.27	.	.	.	.	.	.	18.10	16.74	16.31	2.61	6.84	12.50	19.27	4
LAKFN	P	POND	25.98	.	.	18.70	16.20	16.72	22.48	24.43	29.75	33.29	28.86	32.20	22.00	15.60	22.48	23.66	6.24	38.90	15.60	33.29	11
LAKFS	Q	POND	26.54	.	.	18.80	16.00	16.84	23.09	24.44	30.00	32.16	28.95	32.00	21.80	17.20	23.09	23.75	5.91	34.98	16.00	32.16	11
THORN	R	POND	.	21.90	.	21.30	14.90	16.21	19.18	27.00	26.95	28.98	29.28	29.38	23.00	16.00	23.00	22.93	5.44	29.60	14.90	29.38	11
TAOFF	S	POND	21.83	.	.	22.30	14.20	14.58	18.61	.	.	29.89	26.76	27.77	28.20	17.60	22.30	22.21	5.80	33.68	14.20	29.89	9
LIGHF	T	POND	.	.	.	22.10	13.40	16.40	20.78	25.00	28.41	31.00	30.71	32.70	26.00	18.30	25.00	24.07	6.11	37.34	13.40	32.70	11
GEORG	U	POND	.	25.00	9.90	21.40	15.00	19.97	24.97	24.37	28.24	31.66	29.57	33.00	24.60	18.70	24.60	24.68	5.37	28.83	15.00	33.00	11
TRICO	V	POND	.	22.40	12.50	21.40	14.50	16.59	19.81	28.00	27.13	27.11	27.78	28.37	22.80	15.70	22.80	22.65	5.12	26.25	14.50	28.37	11
LIWAF	W	POND	.	.	9.90	16.40	17.70	16.56	24.20	.	31.05	31.52	28.26	28.90	22.90	17.10	23.55	23.46	5.89	34.71	16.40	31.52	10
BLDAS	X	POND	.	.	.	22.20	14.90	15.24	19.40	25.25	27.24	28.73	28.84	28.75	22.70	18.10	22.70	22.85	5.10	26.03	14.90	28.84	11
																							N = 252
		MEDIAN				21.30	15.95	16.72	19.61	26.92	28.72	30.28	28.86	30.62	23.15	17.00							
		MEAN				20.13	15.86	16.71	20.33	26.78	28.77	30.36	29.16	30.88	23.49	16.78				P_mean	23.45		
		STD				2.17	1.66	1.42	2.09	2.19	1.28	1.34	1.22	2.21	1.58	1.08				P_std	5.87		
		VAR				4.69	2.75	2.01	4.36	4.78	1.65	1.80	1.48	4.88	2.49	1.17				P_var	34.46		
		MIN				14.60	12.50	13.75	17.66	23.78	26.46	27.11	26.76	27.77	20.70	14.60				P_min	12.50		
		MAX				22.50	18.90	19.97	24.97	33.00	31.05	33.29	31.47	36.60	28.20	18.70				P_max	36.60		
		n				23	24	23	24	21	22	23	23	23	22	24	// N = 252			N	252		

LEGEND: "." = No Data or Not Calculated "P_" = Population statistic "n" = number of observations

TABLE C: CONTINUED.

POND\ Pseudonym	Ltr	Station	101888	110288	112388	112888	121388	012389	030289	041889	060789	062689	072489	082889	110189	121989	MEDIAN	MEAN	STD	VAR	MIN	MAX	n
			TEMPERATURE (DEGREES C)																				
CARLL	A	RECEIVE	.	.	14.00	22.40	16.30	19.75	23.75	27.50	27.30	30.77	30.51	29.53	27.40	18.80	27.30	24.91	4.78	22.85	16.30	30.77	11
GTEDS	B	RECEIVE	23.33	.	.	20.00	15.70	14.79	16.46	24.90	28.71	28.26	28.83	28.82	23.30	15.50	23.30	22.30	5.68	32.28	14.79	28.83	11
COOPP	C	RECEIVE	.	19.90	.	20.60	16.00	12.05	17.38	.	.	37.19	26.43	26.48	24.10	16.00	20.60	21.80	7.22	52.09	12.05	37.19	9
RIDGE	D	RECEIVE	.	.	14.50	14.70	12.60	17.82	17.21	.	.	.	26.91	27.33	20.10	14.40	17.52	18.88	5.22	27.28	12.60	27.33	8
CARLS	F	RECEIVE	.	19.90	12.00	22.10	17.30	18.03	21.97	25.50	27.21	28.00	28.60	39.60	26.50	17.70	25.50	24.77	6.18	38.24	17.30	39.60	11
WPAIL	G	RECEIVE	22.93	.	15.00	12.20	9.30	14.37	16.88	.	.	24.87	.	.	.	15.10	14.74	15.45	4.84	23.41	9.30	24.87	6
WPAIS	H	RECEIVE	.	.	9.50	12.90	10.20	18.67	17.44	25.30	30.71	27.05	26.60	30.69	.	15.50	21.99	21.51	7.09	50.27	10.20	30.71	10
BLDAL	I	RECEIVE	23.21	.	.	21.80	15.10	17.17	21.13	23.56	.	29.25	28.98	28.49	22.50	18.60	22.15	22.66	4.74	22.51	15.10	29.25	10
KENMA	J	RECEIVE	.	.	13.80	14.40	12.30	16.02	18.39	.	.	.	26.53	27.85	.	.	17.21	19.25	5.92	34.99	12.30	27.85	6
LASHV	L	RECEIVE	.	.	.	22.20	18.30	16.62	17.89	.	28.80	31.20	29.10	30.26	25.80	16.80	24.00	23.70	5.67	32.18	16.62	31.20	10
MARWA	N	RECEIVE	24.63	.	12.00	17.00	14.70	17.83	18.23	26.80	28.72	29.63	28.76	31.75	23.70	17.00	23.70	23.10	5.97	35.60	14.70	31.75	11
TAOFF	S	RECEIVE	21.67	.	.	21.60	14.10	15.06	19.52	.	.	28.16	27.45	27.33	22.90	17.40	21.60	21.50	5.08	25.85	14.10	28.16	9
LIWAF	W	RECEIVE	.	.	11.00	20.10	14.90	19.64	22.26	.	30.11	30.92	30.52	31.07	23.40	17.50	22.83	24.04	5.83	34.04	14.90	31.07	10
BLDAS	X	RECEIVE	23.21	.	.	21.80	15.10	17.17	21.13	23.56	.	29.25	28.98	28.49	22.50	18.60	22.15	22.66	4.74	22.51	15.10	29.25	10
																							N = 132
		MEDIAN				20.35	15.00	17.17	18.31	25.30	28.72	29.25	28.76	28.82	23.40	17.00							
		MEAN				18.84	14.42	16.79	19.26	25.30	28.79	29.55	28.32	29.82	23.84	16.84				P_mean	22.28		
		STD				3.64	2.45	2.08	2.26	1.38	1.20	2.87	1.36	3.21	1.97	1.38				P_std	6.12		
		VAR				13.24	6.01	4.31	5.13	1.91	1.45	8.23	1.86	10.30	3.88	1.91				P_var	37.50		
		MIN				12.20	9.30	12.05	16.46	23.56	27.21	24.87	26.43	26.48	20.10	14.40				P_min	9.30		
		MAX				22.40	18.30	19.75	23.75	27.50	30.71	37.19	30.52	39.60	27.40	18.80				P_max	39.60		
		n				14	14	14	14	7	7	12	13	13	11	13 // N = 132				N	132		

LEGEND: "." = No Data or Not Calculated "P_" = Population statistic "n" = number of observations

TABLE D: DISSOLVED OXYGEN CONCENTRATIONS (DO -- mg/L) TAKEN DURING WATER-QUALITY SURVEY (1988 - 1989) OF 24 WET-DETENTION PONDS.

POND/ Pseudonym	Ltr	Station	101888	110288	112388	112888	121388	012389	DATE 030289	041889	060789	062689	072489	082889	110189	121989	MEDIAN	MEAN	VAR	STD	MIN	MAX	n	n <4	n <5	% <4	% <5
									DISSOLVED OXYGEN (mg/L)																		
CARLL	A	OUTFALL	.	.	.	8.20	11.20	7.50	9.00	6.30	4.00	5.50	9.64	1.81	7.00	7.30	7.30	7.04	6.28	2.51	1.81	11.2	11	1	2	9	18
GTEDS	B	OUTFALL	7.17	.	.	2.80	6.40	5.72	6.86	5.65	5.65	5.05	6.90	4.86	6.20	7.50	5.72	5.78	1.48	1.21	2.80	7.5	11	1	2	9	18
COOPP	C	OUTFALL	.	9.20	.	2.20	9.10	6.40	4.96	10.10	.	8.00	0.25	0.29	8.10	6.80	6.60	5.62	11.5	3.40	0.25	10.1	10	3	4	30	40
RIDGE	D	OUTFALL	2.53	.	.	3.80	5.90	2.45	3.67	.	.	3.37	1.25	1.92	1.90	2.70	2.70	3.00	1.72	1.31	1.25	5.9	9	8	8	89	89
COPW5	E	OUTFALL	.	.	.	2.40	1.80	3.03	3.80	.	.	1.73	0.70	3.45	4.20	2.30	2.40	2.60	1.12	1.06	0.70	4.2	9	8	9	89	100
CARLS	F	OUTFALL	.	3.50	.	8.20	12.10	11.63	8.60	9.40	7.15	7.87	8.36	8.06	12.50	6.00	8.36	9.08	4.06	2.01	6.00	12.5	11	0	0	0	0
WPAIL	G	OUTFALL	.	.	.	6.00	8.10	5.00	8.00	.	.	.	.	.	.	.	7.00	6.78	1.75	1.32	5.00	8.1	4	0	0	0	0
WPAIS	H	OUTFALL	.	.	.	6.00	7.70	7.20	5.90	13.70	6.64	4.35	5.80	9.23	6.50	4.10	6.50	7.01	6.35	2.52	4.10	13.7	11	0	2	0	18
BLDAL	I	OUTFALL	7.60	.	.	4.10	7.00	6.56	6.53	7.39	6.60	5.40	2.99	5.66	6.50	6.90	6.53	5.97	1.64	1.28	2.99	7.4	11	1	2	9	18
KENMA	J	OUTFALL	.	3.00	.	2.90	6.40	5.50	8.40	3.80	5.80	1.04	1.42	0.98	0.70	1.40	2.90	3.49	6.47	2.54	0.70	8.4	11	7	7	64	64
LIGHB	K	OUTFALL	5.20	.	.	5.60	4.50	8.20	7.80	6.90	4.52	6.51	3.76	7.55	9.40	6.30	6.51	6.46	2.77	1.67	3.76	9.4	11	1	3	9	27
LASHV	L	OUTFALL	.	.	.	4.80	5.50	0.77	3.00	.	.	.	.	.	.	8.70	4.80	4.55	6.98	2.64	0.77	8.7	5	2	3	40	60
MEBRV	M	OUTFALL	.	.	.	6.70	7.60	5.57	.	.	.	.	6.90	13.17	5.20	6.60	6.70	7.39	6.13	2.48	5.20	13.2	7	0	0	0	0
MARWA	N	OUTFALL	7.13	.	.	6.40	7.40	8.02	3.60	9.40	4.90	2.13	2.20	3.41	1.90	1.20	3.60	4.60	7.18	2.68	1.20	9.4	11	6	7	55	64
EASTS	O	OUTFALL	.	.	.	.	3.30	3.95	2.80	.	.	.	.	3.23	.	6.00	3.30	3.86	1.28	1.13	2.80	6.0	5	4	4	80	80
LAKFN	P	OUTFALL	.	.	.	7.00	9.60	7.11	9.06	4.10	.	6.92	5.04	7.23	3.80	3.80	6.96	6.37	3.98	1.99	3.80	9.6	10	2	3	20	30
LAKFS	Q	OUTFALL	.	.	.	5.10	9.60	8.24	9.12	7.50	.	7.99	6.21	7.35	7.50	8.70	7.75	7.73	1.62	1.27	5.10	9.6	10	0	0	0	0
THORN	R	OUTFALL	.	8.50	.	6.80	9.80	11.70	6.20	11.10	7.75	7.24	9.93	7.00	8.30	10.40	8.30	8.75	3.30	1.82	6.20	11.7	11	0	0	0	0
TAOFF	S	OUTFALL	1.29	.	.	0.50	3.80	5.29	2.80	.	.	1.26	0.88	1.71	3.60	6.10	2.80	2.88	3.47	1.86	0.50	6.1	9	7	7	78	78
LIGHF	T	OUTFALL	9.82	.	.	7.60	8.50	8.00	5.18	.	.	9.66	6.62	5.50	9.50	9.70	8.00	7.81	2.68	1.64	5.18	9.7	9	0	0	0	0
GEORG	U	OUTFALL	.	5.80	.	4.90	4.20	6.75	7.50	4.18	4.13	6.70	6.90	11.00	4.00	5.10	5.10	5.94	4.10	2.03	4.00	11.0	11	0	5	0	45
TRICO	V	OUTFALL	.	.	.	3.70	7.40	3.80	3.28	5.10	1.85	5.85	2.46	0.51	3.00	3.10	3.28	3.64	3.31	1.82	0.51	7.4	11	8	8	73	73
LIWAF	W	OUTFALL	.	.	.	3.90	4.00	5.00	.	.	.	7.17	.	9.64	8.10	8.00	7.17	6.54	4.34	2.08	3.90	9.6	7	1	2	14	29
BLDAS	X	OUTFALL	6.30	.	.	4.50	2.40	5.16	2.05	2.50	0.75	4.74	3.14	3.43	4.40	1.90	3.14	3.18	1.78	1.33	0.75	5.2	11	7	10	64	91
		MEDIAN				4.90	7.20	6.06	6.05	6.90	5.28	5.68	4.40	5.18	6.20	6.10							226	67	88	30	39
		MEAN				4.96	6.80	6.19	5.82	7.14	4.98	5.42	4.57	5.32	5.82	5.68			P_mean		5.71						
		VAR				3.97	7.19	6.20	5.49	9.05	4.04	5.79	8.86	12.30	8.34	6.89			P_std		2.77						
		STD				1.99	2.68	2.49	2.34	3.01	2.01	2.41	2.98	3.51	2.89	2.62			P_var		7.66						
		MIN				0.50	1.80	0.77	2.05	2.50	0.75	1.04	0.25	0.29	0.70	1.20			P_min		0.25						
		MAX				8.20	12.10	11.70	9.12	13.70	7.75	9.66	9.93	13.17	12.50	10.40			P_max		13.7						
		n				23	24	24	22	15	12	20	20	22	21	23 //	226		N		226						
		n<4.0				8	4	5	8	2	2	5	10	10	6	7 //	67										
		n<5.0				12	7	5	9	4	6	7	10	11	9	8 //	88										
		%(n<4.0)				35	17	21	36	13	17	25	50	45	29	30											
		%(n<5.0)				52	29	21	41	27	50	35	50	50	43	35											

LEGEND: "." = No data or Not Calculated
"P_" = Population statistic
"n" = number of observations

Chapter 17-302 standard:
Class I and Class II (Freshwater) = 5.0 mg/L

Class III = 5.0 mg/L (24 hour Mean)
= 4.0 mg/L (24-hour Lowest)
Class II (Marine) = 5.0 mg/L (24 hour Mean)
= 4.0 mg/L (24-hour Lowest)

TABLE D: CONTINUED.

POND/ Pseudonym	Ltr	Station	101888	110288	112388	112888	121388	012389	030289	041889	060789	062689	072489	082889	110189	121989	MEDIAN	MEAN	VAR	STD	MIN	MAX	n	n <4	n <5	% <4	% <5
									DISSOLVED OXYGEN (mg/L)																		
CARLL	A	POND	.	7.30	.	7.20	12.50	10.50	9.07	10.80	7.43	6.80	8.03	9.23	9.30	4.80	9.07	8.70	4.18	6.00	4.80	12.5	11	0	1	0	9
GTEDS	B	POND	.	.	.	5.40	11.10	6.12	5.65	6.40	8.00	8.95	4.10	5.01	14.60	6.70	6.40	7.46	8.64	2.94	4.10	14.6	11	0	1	0	9
COOPP	C	POND	.	7.00	.	2.20	8.80	4.02	2.30	6.30	0.64	2.60	1.05	0.67	.	3.60	2.45	3.22	6.15	2.48	0.64	8.8	10	7	8	70	80
RIDGE	D	POND	5.48	.	.	6.10	7.90	1.02	7.95	.	7.40	6.22	0.29	9.38	7.30	7.20	7.25	6.08	8.13	2.85	0.29	9.4	10	2	2	20	20
COPW5	E	POND	.	1.60	.	3.70	6.50	4.85	7.07	0.90	4.30	2.85	0.17	0.42	0.90	2.00	2.85	3.06	5.35	2.31	0.17	7.1	11	7	9	64	82
CARLS	F	POND	.	4.60	.	7.00	10.10	7.00	9.10	8.40	7.04	7.40	8.27	1.68	5.30	7.20	7.20	7.14	4.44	2.11	1.68	10.1	11	1	1	9	9
WPAIL	G	POND	9.08	.	.	6.60	7.80	7.69	8.40	5.80	7.32	7.08	5.65	10.30	8.30	8.70	7.69	7.60	1.64	1.28	5.65	10.3	11	0	0	0	0
WPAIS	H	POND	8.68	.	.	6.10	7.80	9.60	7.20	10.20	6.45	5.20	3.90	5.07	0.80	2.60	6.10	5.90	7.26	2.70	0.80	10.2	11	3	3	27	27
BLDAL	I	POND	.	.	.	4.00	7.20	6.68	6.80	7.00	7.25	7.46	6.75	7.30	6.10	5.90	6.80	6.59	0.89	0.94	4.00	7.5	11	0	1	0	9
KENMA	J	POND	.	.	.	6.00	7.60	7.13	7.02	4.00	6.09	5.20	5.71	4.05	5.90	8.10	6.00	6.07	1.62	1.27	4.00	8.1	11	0	2	0	18
LIGHB	K	POND	.	.	.	5.40	4.20	8.00	7.08	7.18	5.10	7.35	3.06	5.30	8.70	5.90	5.90	6.12	2.64	1.63	3.06	8.7	11	1	2	9	18
LASHV	L	POND	.	.	.	4.60	3.20	2.00	2.60	5.28	1.26	6.58	2.29	3.66	10.20	8.90	3.66	4.60	7.67	2.77	1.26	10.2	11	6	7	55	64
MEBRV	M	POND	.	5.80	.	8.50	7.80	8.03	8.70	7.77	7.76	7.83	5.24	6.70	6.20	4.60	7.77	7.19	1.63	1.27	4.60	8.7	11	0	1	0	9
MARWA	N	POND	.	.	.	8.30	13.90	9.50	4.70	12.50	10.41	6.87	4.60	13.84	3.80	0.50	8.30	8.08	17.7	4.21	0.50	13.9	11	2	4	18	36
EASTS	O	POND	.	.	.	.	3.40	6.45	2.60	.	.	.	.	.	.	5.20	4.30	4.41	2.27	1.51	2.60	6.5	4	2	2	50	50
LAKFN	P	POND	8.60	.	.	7.70	10.40	8.26	8.40	4.38	8.70	8.70	5.00	10.10	6.00	7.40	8.26	7.73	3.38	1.84	4.38	10.4	11	0	1	0	9
LAKFS	Q	POND	8.72	.	.	7.00	10.10	8.53	9.50	7.85	9.50	9.40	5.78	7.71	7.70	8.30	8.30	8.31	1.48	1.22	5.78	10.1	11	0	0	0	0
THORN	R	POND	.	5.90	.	7.00	9.50	9.30	8.40	10.00	7.05	7.90	8.67	4.87	8.10	10.20	8.40	8.27	2.21	1.49	4.87	10.2	11	0	1	0	9
TAOFF	S	POND	1.31	.	.	5.80	4.20	7.15	2.58	.	.	5.89	2.72	3.15	8.30	6.30	5.80	5.12	3.74	1.93	2.58	8.3	9	3	4	33	44
LIGHF	T	POND	.	.	.	7.80	9.40	10.14	6.82	10.50	7.55	7.70	8.28	10.60	9.30	9.50	9.30	8.87	1.54	1.24	6.82	10.6	11	0	0	0	0
GEORG	U	POND	.	6.20	.	5.00	5.30	4.60	7.50	4.14	4.06	6.32	7.25	12.50	3.60	6.40	5.30	6.06	5.70	2.39	3.60	12.5	11	1	4	9	36
TRICO	V	POND	.	9.00	.	2.20	3.40	3.83	2.39	4.20	1.75	6.10	2.73	1.65	2.90	1.50	2.73	2.97	1.69	1.30	1.50	6.1	11	9	10	82	91
LIWAF	W	POND	.	.	.	4.60	6.60	3.70	3.81	.	7.81	6.80	4.45	6.02	1.20	5.60	5.10	5.06	3.31	1.82	1.20	7.8	10	3	5	30	50
BLDAS	X	POND	.	.	.	2.80	3.80	5.60	3.50	3.40	2.16	4.74	3.66	4.54	3.50	2.60	3.50	3.66	0.91	0.95	2.16	5.6	11	8	10	73	91
		MEDIAN				6.00	7.80	7.07	7.14	6.35	7.05	6.80	4.60	5.30	6.15	6.10							252	55	79	22	31
		MEAN				5.70	7.60	6.65	6.21	6.85	6.14	6.61	4.68	6.25	6.27	5.82			P_mean		6.25						
		VAR				3.24	8.53	6.17	5.89	8.32	6.93	2.74	6.01	13.30	10.99	6.65			P_std		2.76						
		STD				1.80	2.92	2.48	2.43	2.88	2.63	1.65	2.45	3.65	3.31	2.58			P_var		7.63						
		MIN				2.20	3.20	1.02	2.30	0.90	0.64	2.60	0.17	0.42	0.80	0.50			P_min		0.17						
		MAX				8.50	13.90	10.50	9.50	12.50	10.41	9.40	8.67	13.84	14.60	10.20			P_max		8.50						
		n				23	24	24	24	20	22	23	23	23	22	24 //	252		N		252						
		n<4.0				4	4	4	7	2	4	2	9	6	7	6 //	55										
		n<5.0				7	6	7	8	6	6	3	12	9	7	8 //	79										
		%(n<4.0)				17	17	17	29	10	18	9	39	26	32	25											
		%(n<5.0)				30	25	29	33	30	27	13	52	39	32	33											

LEGEND: "." = No data or Not Calculated
"P_" = Population statistic
"n" = number of observations

Chapter 17-302 standard:
Class I and Class II (Freshwater) = 5.0 mg/L

Class III = 5.0 mg/L (24 hour Mean)
= 4.0 mg/L (24-hour Lowest)
Class II (Marine) = 5.0 mg/L (24 hour Mean)
= 4.0 mg/L (24-hour Lowest)

TABLE D: CONTINUED.

POND/ Pseudonym	Ltr	Station	101888	110288	112388	112888	121388	012389	DATE 030289	041889	060789	062689	072489	082889	110189	121989	MEDIAN	MEAN	VAR	STD	MIN	MAX	n	n <4	n <5	% <4	% <5
									DISSOLVED OXYGEN (mg/L)																		
CARLL	A	RECEIVE	.	.	.	6.80	9.70	9.30	7.00	5.50	1.43	3.20	5.20	2.83	7.50	7.50	6.80	6.00	6.40	2.53	1.43	9.7	11	3	3	27	27
GTEDS	B	RECEIVE	3.54	.	.	2.40	3.30	5.46	6.77	8.10	8.50	7.35	8.50	3.23	6.80	4.60	6.77	5.91	4.55	2.13	2.40	8.5	11	3	4	27	36
COOPP	C	RECEIVE	.	6.60	.	2.10	7.90	3.36	5.27	.	.	4.90	0.98	0.52	1.90	5.20	3.36	3.57	5.23	2.29	0.52	7.9	9	5	6	56	67
RIDGE	D	RECEIVE	.	.	.	3.70	3.40	4.80	3.11	.	.	.	0.84	0.53	0.50	1.40	2.26	2.29	2.42	1.56	0.50	4.8	8	7	8	88	100
CARLS	F	RECEIVE	.	2.10	.	0.70	10.20	4.17	5.20	8.00	4.83	5.89	1.35	2.02	6.20	7.50	5.20	5.10	7.81	2.79	0.70	10.2	11	3	5	27	45
WPAIL	G	RECEIVE	2.31	.	.	2.50	2.70	2.22	2.80	.	.	0.54	.	.	.	4.10	2.60	2.48	1.10	1.05	0.54	4.1	6	5	6	83	100
WPAIS	H	RECEIVE	.	.	.	2.50	3.20	8.80	1.70	4.80	2.60	1.67	3.80	1.14	.	2.50	2.55	3.27	4.44	2.11	1.14	8.8	10	8	9	80	90
BLDAL	I	RECEIVE	6.56	.	.	6.70	10.10	8.20	7.52	7.60	.	5.74	4.86	4.11	6.00	6.00	6.35	6.68	2.73	1.65	4.11	10.1	10	0	2	0	20
KENMA	J	RECEIVE	.	.	.	1.30	3.20	0.90	1.21	.	.	.	0.13	0.53	.	.	1.06	1.21	0.95	0.97	0.13	3.2	6	6	6	100	100
LASHV	L	RECEIVE	.	.	.	3.20	5.60	3.87	2.32	.	5.20	4.65	5.90	4.95	9.40	8.50	5.08	5.36	4.34	2.08	2.32	9.4	10	3	5	30	50
MARWA	N	RECEIVE	5.60	.	.	4.70	7.70	7.40	5.12	9.20	5.80	4.03	3.63	5.30	5.70	7.80	5.70	6.03	2.81	1.68	3.63	9.2	11	1	3	9	27
TAOFF	S	RECEIVE	2.07	.	.	2.70	2.60	5.45	4.70	.	.	2.42	0.93	0.56	3.10	4.80	2.70	3.03	2.55	1.60	0.56	5.5	9	6	8	67	89
LIWAF	W	RECEIVE	.	.	.	3.80	3.20	5.60	7.77	.	7.68	6.55	4.73	5.00	5.80	5.30	5.45	5.54	2.02	1.42	3.20	7.8	10	2	3	20	30
																							122	52	68	43	56
		MEDIAN				2.70	3.40	5.45	5.12	7.80	5.20	4.65	3.72	2.43	5.90	5.25											
		MEAN				3.32	5.60	5.35	4.65	7.20	5.15	4.27	3.40	2.56	5.29	5.43			P_avg		4.60						
		VAR				3.14	8.67	5.95	4.67	2.38	5.50	4.12	6.08	3.40	6.50	4.31			P_std		2.54						
		STD				1.77	2.94	2.44	2.16	1.54	2.34	2.03	2.47	1.84	2.55	2.08			P_var		6.44						
		MIN				0.70	2.60	0.90	1.21	4.80	1.43	0.54	0.13	0.52	0.50	1.40			P_min		0.13						
		MAX				6.80	10.20	9.30	7.77	9.20	8.50	7.35	8.50	5.30	9.40	8.50			P_max		10.2						
		n				13	13	13	13	6	7	11	12	12	10	12	// 122		N		122						
		n<4.0				10	7	4	5	0	2	4	7	8	3	2	// 52										
		n<5.0				11	7	6	6	1	3	7	9	10	3	5	// 68										
		%(n<4.0)				77	54	31	38	0	29	36	58	67	30	17											
		%(n<5.0)				85	54	46	46	17	43	64	75	83	30	42											

LEGEND: "." = No data or Not Calculated
"P_" = Population statistic
"n" = number of observations

Chapter 17-302 standard:
Class I and Class II (Freshwater) = 5.0 mg/L

Class III = 5.0 mg/L (24 hour Mean)
= 4.0 mg/L (24-hour Lowest)
Class II (Marine) = 5.0 mg/L (24 hour Mean)
= 4.0 mg/L (24-hour Lowest)

TABLE E: pH MEASUREMENTS (STANDARD UNITS) TAKEN DURING THE WATER-QUALITY SURVEY (1988 - 1989) OF 24 WET-DETENTION PONDS.

POND\ Pseudonym	Ltr	Station	101888	110288	112388	112888	121388	012389	DATE 030289	041889	060789	062689	072489	082989	110189	121989	Median	Min	Mid	Max	n	n<=NB +/- 1.0 pH unit	%n<=NB +/- 1.0 pH unit
									pH														
CARLL	A	OUTFALL	.	.	.	7.40	8.40	7.75	7.60	6.55	7.72	7.25	8.00	7.01	7.00	7.50	7.50	6.55	7.48	8.40	11	0	0.0
GTEDS	B	OUTFALL	7.36	.	.	*6.10	7.30	7.30	7.16	7.19	7.52	7.41	7.11	6.85	7.30	7.40	7.30	6.10	6.81	7.52	11	1	9.1
COOPP	C	OUTFALL	.	6.90	.	6.00	6.90	6.33	6.44	6.57	.	6.64	6.44	6.81	6.90	7.00	6.60	6.00	6.50	7.00	10	0	0.0
RIDGE	D	OUTFALL	6.73	.	.	7.50	*8.50	6.36	6.65	.	.	6.98	6.53	6.77	6.70	6.70	6.70	6.36	7.43	8.50	9	1	11.1
COPW5	E	OUTFALL	.	.	.	7.30	7.20	6.32	6.26	.	.	6.55	6.18	6.30	7.10	6.70	6.55	6.18	6.74	7.30	9	0	0.0
CARLS	F	OUTFALL	.	6.80	.	7.70	7.90	8.05	7.89	7.60	8.41	8.24	8.30	7.88	8.60	7.60	7.90	7.60	8.10	8.60	11	0	0.0
WPAIL	G	OUTFALL	.	.	.	7.60	7.40	*5.81	7.13	.	.	.	.	.	.	.	7.24	5.81	6.71	7.60	4	1	25.0
WPAIS	H	OUTFALL	.	.	.	7.80	7.60	7.98	7.22	*8.90	8.05	7.23	7.73	7.60	7.40	7.20	7.60	7.20	8.05	8.90	11	1	9.1
BLDAL	I	OUTFALL	5.74	.	.	6.30	7.00	6.22	6.15	6.28	6.76	6.66	6.33	6.86	7.00	7.00	6.66	6.15	6.58	7.00	11	0	0.0
KENMA	J	OUTFALL	.	6.02	.	7.30	6.30	6.46	6.69	5.75	7.12	6.51	6.52	6.55	6.30	6.60	6.52	5.75	6.53	7.30	11	0	0.0
LIGHB	K	OUTFALL	6.94	.	.	7.10	7.20	7.50	7.50	7.49	7.57	7.47	7.16	7.32	7.70	7.40	7.47	7.10	7.40	7.70	11	0	0.0
LASHV	L	OUTFALL	.	.	.	6.30	7.30	6.63	6.98	7.00	.	.	.	.	.	8.10	6.99	6.30	7.20	8.10	6	0	0.0
MEBRV	M	OUTFALL	.	.	.	8.00	7.80	6.96	.	.	.	.	7.39	*9.25	6.90	7.50	7.50	6.90	8.08	9.25	7	1	14.3
MARWA	N	OUTFALL	8.38	.	.	8.40	8.40	8.34	7.13	8.30	8.22	8.00	7.98	7.71	7.60	7.20	8.00	7.13	7.77	8.40	11	0	0.0
EASTS	O	OUTFALL	.	.	.	.	7.20	6.40	6.36	.	.	.	.	6.96	.	7.50	6.96	6.36	6.93	7.50	5	0	0.0
LAKFN	P	OUTFALL	.	.	.	7.50	7.60	6.55	7.83	6.70	.	7.89	6.81	7.69	6.80	7.10	7.26	6.55	7.22	7.89	10	0	0.0
LAKFS	Q	OUTFALL	.	.	.	7.70	8.50	*6.52	7.45	7.78	.	8.46	7.27	7.77	7.40	7.60	7.65	6.52	7.51	8.50	10	1	10.0
THORN	R	OUTFALL	.	7.90	.	8.10	7.20	8.32	7.97	7.40	8.66	8.10	8.49	8.79	7.50	8.10	8.10	7.20	8.00	8.79	11	0	0.0
TAOFF	S	OUTFALL	6.93	.	.	6.80	7.00	7.06	6.91	.	.	7.25	7.04	7.20	6.90	7.30	7.04	6.80	7.05	7.30	9	0	0.0
LIGHF	T	OUTFALL	8.06	.	.	7.20	7.90	7.76	8.54	.	.	*8.93	7.95	7.44	7.90	8.10	7.90	7.20	8.07	8.93	9	1	11.1
GEORG	U	OUTFALL	.	6.90	.	6.90	7.00	6.70	6.98	6.86	7.37	7.24	6.84	7.15	7.00	6.70	6.98	6.70	7.04	7.37	11	0	0.0
TRICO	V	OUTFALL	.	.	.	6.70	6.80	6.60	6.68	6.65	7.32	6.86	6.50	6.64	6.60	6.80	6.68	6.50	6.91	7.32	11	0	0.0
LIWAF	W	OUTFALL	.	.	.	7.50	7.50	6.63	.	.	.	7.82	.	8.31	7.20	7.40	7.50	6.63	7.47	8.31	7	0	0.0
BLDAS	X	OUTFALL	7.06	.	.	6.80	7.20	7.01	6.85	6.80	7.12	7.30	6.98	6.96	7.00	7.10	7.00	6.80	7.05	7.30	11	0	0.0
		Median				7.30	7.30	6.66	7.05	7.08	7.54	7.27	7.07	7.17	7.00	7.30				N =	227	7	3.1
		Min				6.00	6.30	5.81	6.15	5.75	6.76	6.51	6.18	6.30	6.30	6.60							
		Mid				7.20	7.40	7.08	7.35	7.33	7.71	7.72	7.34	7.78	7.45	7.35			P_min		5.75		
		Max				8.40	8.50	8.34	8.54	8.90	8.66	8.93	8.49	9.25	8.60	8.10			P_max		9.25		
		n				23	24	24	22	16	12	20	20	22	21	23	//N = 227		N		227		
		(n<=NB +/- 1.0)				1	1	2	0	1	0	1	0	1	0	0	7						
		%(n<=NB +/- 1.0)				4	4	8	0	6	0	5	0	5	0	0							

LEGEND: "." = No Data or Not Calculated. "P_" = Population statistic. Chapter 17-3 standard: Class II and III = (NB+/- 1.0 pH unit if 6.0 to 8.5).
"n" = number of observations "NB" = Natural Background (equated to median pH) "*" = Violation based on NB = median.

TABLE E: CONTINUED.

POND\ Acronym	Ltr	Station	101888	110288	112388	112888	121388	012389	DATE 030289	041889	060789	062689	072489	082989	110189	121989	Median	Min	Mid	Max	n	n<=NB +/- 1.0 pH unit	%n<=NB +/- 1.0 pH unit
									pH														
CARLL	A	POND	.	7.70	.	7.70	8.40	7.88	7.98	*6.90	8.59	8.14	8.07	8.42	8.20	7.60	8.07	6.90	7.75	8.59	11	1	9.1
GTEDS	B	POND	.	.	.	6.70	8.00	7.17	7.20	7.27	7.70	8.06	7.94	7.07	8.00	7.20	7.27	6.70	7.38	8.06	11	0	0.0
COOPP	C	POND	.	6.30	.	5.90	7.00	6.01	6.03	6.28	6.38	6.40	6.65	6.67	.	6.70	6.39	5.90	6.45	7.00	10	0	0.0
RIDGE	D	POND	6.80	.	.	7.60	7.20	*5.88	7.02	7.20	7.70	7.11	7.17	7.68	6.60	7.00	7.17	5.88	6.79	7.70	11	1	9.1
COPW5	E	POND	.	7.10	.	7.40	7.70	6.46	6.96	6.29	7.32	6.94	6.31	6.20	6.70	6.90	6.90	6.20	6.95	7.70	11	0	0.0
CARLS	F	POND	.	7.20	.	7.70	7.70	7.85	7.93	7.20	8.10	8.11	8.16	7.23	7.30	7.50	7.70	7.20	7.68	8.16	11	0	0.0
WPAIL	G	POND	7.94	.	.	6.80	7.40	6.85	7.18	*8.20	7.46	7.09	6.68	*8.97	7.20	6.80	7.18	6.68	7.83	8.97	11	2	18.2
WPAIS	H	POND	8.12	.	.	7.80	7.60	7.76	7.59	8.40	7.99	7.37	7.33	6.90	6.70	7.00	7.59	6.70	7.55	8.40	11	0	0.0
BLDAL	I	POND	.	.	.	6.10	7.20	6.18	6.20	6.25	6.72	7.40	6.86	7.19	6.80	7.00	6.80	6.10	6.75	7.40	11	0	0.0
KENMA	J	POND	.	.	.	7.40	6.70	6.76	6.99	7.05	7.67	7.02	7.01	6.82	6.80	6.80	6.99	6.70	7.19	7.67	11	0	0.0
LIGHB	K	POND	.	.	.	7.10	7.20	7.44	7.42	7.55	7.47	7.54	7.08	7.21	7.70	7.30	7.42	7.08	7.39	7.70	11	0	0.0
LASHV	L	POND	.	.	.	*6.40	7.40	6.56	6.79	.	7.64	*8.68	7.32	7.46	8.00	8.20	7.43	6.40	7.54	8.68	10	2	20.0
MEBRV	M	POND	.	7.10	.	7.80	7.60	6.94	7.66	7.52	8.24	8.47	7.07	7.34	7.50	7.10	7.52	6.94	7.71	8.47	11	0	0.0
MARWA	N	POND	.	.	.	8.80	*9.20	.	8.51	*9.10	8.56	*8.87	8.74	*9.27	*8.90	*6.60	8.83	6.60	7.94	9.27	10	6	60.0
EASTS	O	POND	.	.	.	.	7.40	6.61	6.64	.	.	.	.	.	.	7.40	6.87	6.61	7.01	7.40	4	0	0.0
LAKFN	P	POND	8.17	.	.	7.70	7.30	6.56	7.51	7.04	*8.45	*8.73	6.81	*8.95	7.10	7.30	7.30	6.56	7.76	8.95	11	3	27.3
LAKFS	Q	POND	7.90	.	.	7.50	7.50	*6.53	7.70	7.72	*8.88	*8.86	7.21	7.73	7.30	7.60	7.60	6.53	7.71	8.88	11	3	27.3
THORN	R	POND	.	7.60	.	7.70	7.90	7.75	7.83	7.65	8.22	8.35	8.25	7.54	7.80	8.10	7.83	7.54	7.95	8.35	11	0	0.0
TAOFF	S	POND	6.90	.	.	7.10	7.20	7.21	6.95	.	.	7.57	7.25	7.37	7.30	7.40	7.25	6.95	7.26	7.57	9	0	0.0
LIGHF	T	POND	.	.	.	7.60	7.80	8.01	8.68	8.75	8.69	8.60	8.21	8.18	7.90	8.00	8.18	7.60	8.18	8.75	11	0	0.0
GEORG	U	POND	.	6.90	.	7.30	6.80	6.66	6.99	6.78	7.31	7.10	6.73	6.80	6.90	7.10	6.90	6.66	6.99	7.31	11	0	0.0
TRICO	V	POND	.	6.60	.	6.40	6.50	6.37	6.43	6.55	7.19	6.90	6.50	6.62	6.60	6.70	6.55	6.37	6.78	7.19	11	0	0.0
LIWAF	W	POND	.	.	.	7.40	7.30	6.65	6.73	.	8.20	7.76	6.97	7.30	6.80	7.20	7.25	6.65	7.43	8.20	10	0	0.0
BLDAS	X	POND	.	.	.	6.80	7.50	6.92	7.01	6.87	7.13	7.13	6.84	6.95	6.90	7.00	6.95	6.80	7.15	7.50	11	0	0.0
		Median				7.40	7.40	6.76	7.09	7.20	7.70	7.57	7.08	7.30	7.25	7.15				N =	251	19	7.6
		Min				5.90	6.50	5.88	6.03	6.25	6.38	6.40	6.31	6.20	6.60	6.60							
		Mid				7.35	7.85	6.95	7.36	7.68	7.63	7.64	7.53	7.74	7.75	7.40			P_min		5.88		
		Max				8.80	9.20	8.01	8.68	9.10	8.88	8.87	8.74	9.27	8.90	8.20			P_max		9.27		
		n				23	24	23	24	20	22	23	23	23	22	24 //	251		N		251		
		(n<=NB +/- 1.0)				1	1	2	0	3	2	4	0	3	1	1	19						
		%(n<=NB +/- 1.0)				4	4	9	0	15	9	17	0	13	5	4							

LEGEND: "." = No Data or Not Calculated. "P_" = Population statistic. Chapter 17-3 standard: Class II and III = (NB+/- 1.0 pH unit if 6.0 to 8.5).
"n" = number of observations "NB" = Natural Background (equated to median pH) "*" = Violation based on NB = median.

TABLE E: CONTINUED.

POND\ Acronym	Ltr	Station	101888	110288	112388	112888	121388	012389	DATE 030289	041889	060789	062689	072489	082989	110189	121989	Median	Min	Mid	Max	n	n<=NB +/- 1.0 pH unit	%n<=NB +/- 1.0 pH unit
									pH														
CARLL	A	RECEIVE	.	.	.	7.10	*8.70	7.18	7.03	6.50	7.17	7.14	7.33	7.03	7.20	7.20	7.17	6.50	7.60	8.70	11	1	9.1
GTEDS	B	RECEIVE	6.78	.	.	6.40	7.20	6.65	7.08	7.54	7.98	7.29	6.91	6.95	7.60	6.70	7.08	6.40	7.19	7.98	11	0	0.0
COOPP	C	RECEIVE	.	5.90	.	5.80	7.00	5.77	5.56	.	.	5.61	6.00	6.68	6.40	6.00	6.00	5.56	6.28	7.00	9	0	0.0
RIDGE	D	RECEIVE	.	.	.	*7.40	*6.90	6.73	*5.35	.	.	.	*4.74	6.25	*5.30	*5.50	5.73	4.74	6.07	7.40	8	6	75.0
CARLS	F	RECEIVE	.	6.60	.	7.60	7.40	6.87	7.12	6.60	7.68	7.50	6.82	7.13	7.40	7.30	7.30	6.60	7.14	7.68	11	0	0.0
WPAIL	G	RECEIVE	5.49	.	.	5.50	*7.50	*4.95	*4.98	.	.	5.15	.	.	.	4.70	5.07	4.70	6.10	7.50	6	0	0.0
WPAIS	H	RECEIVE	.	.	.	7.40	7.00	7.53	6.78	7.70	8.07	7.23	6.90	7.44	.	7.10	7.32	6.78	7.43	8.07	10	0	0.0
BLDAL	I	RECEIVE	6.51	.	.	6.30	7.50	6.52	6.81	6.86	.	6.77	6.52	6.60	6.80	6.60	6.69	6.30	6.90	7.50	10	1	10.0
KENMA	J	RECEIVE	.	.	.	7.10	*8.60	6.12	6.41	.	.	.	6.33	6.50	.	.	6.45	6.12	7.36	8.60	6	0	0.0
LASHV	L	RECEIVE	.	.	.	6.50	7.60	6.75	6.71	.	7.70	7.50	7.60	7.49	8.00	8.00	7.55	6.50	7.25	8.00	10	0	0.0
MARWA	N	RECEIVE	7.57	.	.	7.20	7.20	7.26	7.18	8.20	7.79	7.71	7.66	7.83	7.50	7.50	7.50	7.18	7.69	8.20	11	0	0.0
TAOFF	S	RECEIVE	6.90	.	.	6.90	7.00	7.10	7.22	.	.	7.13	7.01	6.96	6.90	7.20	7.01	6.90	7.06	7.22	9	0	0.0
LIWAF	W	RECEIVE	.	.	.	7.40	7.40	7.13	7.62	.	8.35	8.00	7.45	7.17	7.40	7.40	7.40	7.13	7.74	8.35	10	0	0.0
BLDAS	X	RECEIVE	6.51	.	.	6.30	7.50	6.52	6.81	6.86	.	6.77	6.52	6.60	6.80	6.60	6.69	6.30	6.90	7.50	10	0	0.0
		Median				6.99	7.40	6.74	6.81	6.86	7.79	7.18	6.90	6.96	7.20	7.10				N=	132	8	6.1
		Min				5.50	6.90	4.95	4.98	6.50	7.17	5.15	4.74	6.25	5.30	4.70							
		Mid				6.55	7.80	6.24	6.30	7.35	7.76	6.58	6.20	7.04	6.65	6.35			P_min		4.70		
		Max				7.60	8.70	7.53	7.62	8.20	8.35	8.00	7.66	7.83	8.00	8.00			P_max		8.70		
		n				14	14	14	14	7	7	12	13	13	11	13	//N = 132		_N		132		
		(n<=NB +/- 1.0)				1	4	1	2	0	0	0	1	0	1	2	12						
		%(n<=NB +/- 1.0)				7	29	7	14	0	0	0	8	0	9	15							

LEGEND: "." = No Data or Not Calculated. "P_" = Population statistic. Chapter 17-3 standard: Class II and III = (NB+/- 1.0 pH unit if 6.0 to 8.5).
"n" = number of observations "NB" = Natural Background (equated to median pH) "*" = Violation based on NB = median.

TABLE F: SPECIFIC CONDUCTANCE (mmhos/cm) FROM WATER-QUALITY SURVEY OF 24 WET-DETENTION PONDS, 1988 TO 1989.

POND\ Pseudonym	Ltr	Station	DATE 101888	110288	112388	112888	121388	012389	030289	041889	060789	062689	072489	082889	110189	121989	Median	Mean	Std	Var	Min	Max	n	n> 1.275	%n> 1.275
			Conductivity (mmhos/cm)																						
CARLL	A	OUTFALL	.	.	0.302	0.530	0.590	0.643	0.683	0.800	0.700	0.714	0.626	0.718	0.803	0.775	0.700	0.689	0.083	0.007	0.530	0.803	11	0	0
GTEDS	B	OUTFALL	0.430	.	.	0.131	0.323	0.354	0.564	0.538	0.262	0.340	0.209	0.246	0.405	0.274	0.323	0.331	0.126	0.016	0.131	0.564	11	0	0
COOPP	C	OUTFALL	.	0.283	.	0.154	0.202	0.170	0.222	0.296	.	0.115	0.191	0.198	0.271	0.278	0.200	0.210	0.055	0.003	0.115	0.296	10	0	0
RIDGE	D	OUTFALL	0.195	.	0.052	0.148	0.148	0.168	0.209	.	.	0.318	0.246	0.285	0.314	0.278	0.246	0.235	0.065	0.004	0.148	0.318	9	0	0
COPW5	E	OUTFALL	.	.	0.095	0.174	0.187	0.215	0.263	.	.	0.317	0.253	0.245	0.390	0.377	0.253	0.269	0.073	0.005	0.174	0.390	9	0	0
CARLS	F	OUTFALL	.	0.455	0.241	0.392	0.432	0.417	0.383	0.370	0.471	0.378	0.279	0.350	0.371	0.445	0.383	0.390	0.050	0.002	0.279	0.471	11	0	0
WPAIL	G	OUTFALL	.	.	0.045	0.074	0.082	0.089	0.099	.	.	.	.	.	.	.	0.086	0.086	0.009	0.000	0.074	0.099	4	0	0
WPAIS	H	OUTFALL	.	.	0.089	0.155	0.180	0.202	0.231	0.192	0.229	0.231	0.232	0.246	0.271	0.265	0.231	0.221	0.034	0.001	0.155	0.271	11	0	0
BLDAL	I	OUTFALL	0.122	.	.	0.122	0.134	0.150	0.151	0.159	0.225	0.173	0.135	0.241	0.181	0.197	0.159	0.170	0.036	0.001	0.122	0.241	11	0	0
KENMA	J	OUTFALL	.	0.142	0.030	0.112	0.122	0.142	0.166	0.220	0.360	0.199	0.150	0.191	0.178	0.239	0.178	0.189	0.066	0.004	0.112	0.360	11	0	0
LIGHB	K	OUTFALL	0.246	.	.	0.231	0.251	0.305	0.319	0.389	0.402	0.379	0.270	0.288	0.372	0.383	0.319	0.326	0.058	0.003	0.231	0.402	11	0	0
LASHV	L	OUTFALL	.	.	.	0.091	0.097	0.148	0.202	.	.	.	.	.	.	0.117	0.117	0.131	0.041	0.002	0.091	0.202	5	0	0
MEBRV	M	OUTFALL	.	.	0.040	0.084	0.099	0.126	.	.	.	.	0.130	0.158	0.173	0.115	0.126	0.126	0.029	0.001	0.084	0.173	7	0	0
MARWA	N	OUTFALL	6.66	.	2.00	6.18	6.27	4.46	4.30	26.90	26.20	17.00	11.54	27.00	19.12	11.50	11.54	14.59	8.71	75.82	4.30	27.00	11	11	100
EASTS	O	OUTFALL	.	.	.	.	0.091	0.137	0.097	.	.	.	.	0.250	.	0.155	0.137	0.146	0.057	0.003	0.091	0.250	5	0	0
LAKFN	P	OUTFALL	.	.	.	0.145	0.160	0.161	0.173	0.185	.	0.142	0.112	0.120	0.140	0.159	0.152	0.150	0.021	0.000	0.112	0.185	10	0	0
LAKFS	Q	OUTFALL	.	.	.	0.201	0.163	0.184	0.197	0.199	.	0.176	0.149	0.158	0.177	0.173	0.177	0.178	0.017	0.000	0.149	0.201	10	0	0
THORN	R	OUTFALL	.	0.450	.	0.253	0.279	0.286	0.351	0.380	0.477	0.436	0.316	0.347	0.390	0.330	0.347	0.350	0.065	0.004	0.253	0.477	11	0	0
TAOFF	S	OUTFALL	0.531	.	.	0.438	0.392	0.535	0.693	.	.	0.330	0.342	0.241	0.718	0.360	0.392	0.450	0.156	0.024	0.241	0.718	9	0	0
LIGHF	T	OUTFALL	0.451	.	.	0.213	0.255	0.210	0.201	.	.	0.271	0.187	0.300	0.507	0.313	0.255	0.273	0.093	0.009	0.187	0.507	9	0	0
GEORG	U	OUTFALL	.	0.552	0.050	0.137	0.274	0.316	0.205	0.438	0.305	0.216	0.203	0.259	0.534	0.257	0.259	0.286	0.108	0.012	0.137	0.534	11	0	0
TRICO	V	OUTFALL	.	.	0.038	0.101	0.102	0.101	0.138	0.310	0.381	0.106	0.143	0.186	0.207	0.180	0.143	0.178	0.088	0.008	0.101	0.381	11	0	0
LIWAF	W	OUTFALL	.	.	0.032	0.133	0.122	0.120	.	.	.	0.155	.	0.139	0.218	0.117	0.133	0.143	0.033	0.001	0.117	0.218	7	0	0
BLDAS	X	OUTFALL	0.280	.	.	0.304	0.225	0.180	0.301	0.460	0.313	0.203	0.137	0.212	0.260	0.173	0.225	0.252	0.086	0.007	0.137	0.460	11	0	0
		Median				0.154	0.184	0.182	0.216	0.370	0.371	0.251	0.206	0.246	0.314	0.265						N =	226	11	5
		Mean				0.457	0.466	0.409	0.461	2.122	2.527	1.110	0.793	1.472	1.238	0.759									
		Std				1.226	1.216	0.855	0.854	6.624	7.139	3.648	2.468	5.572	4.002	2.294			P_mean		0.963				
		Var				1.502	1.479	0.732	0.729	43.878	50.962	13.308	6.092	31.047	16.018	5.264			P_std		3.634				
		Min				0.074	0.082	0.089	0.097	0.159	0.225	0.106	0.112	0.120	0.140	0.115			P_var		13.21				
		Max				6.180	6.270	4.460	4.300	26.900	26.200	17.000	11.540	27.000	19.120	11.500			P_min		0.074				
		n				23	24	24	22	15	12	20	20	22	21	23	//N = 226		P_max		27.00				
		n>1.275				1	1	1	1	1	1	1	1	1	1	1	11								

Legend: "." = No data or Not Calculated. "n" = numbers of observations
"P_" = Population Chapter 17-3 standard (Class I, II and III) = 1.275 mmhos/cm @ 25 degrees Centigrade.

TABLE F: CONTINUED.

POND\ Pseudonym	Ltr	Station	DATE 101888	110288	112388	112888	121388	012389	030289	041889	060789	062689	072489	082889	110189	121989	Median	Mean	Std	Var	Min	Max	n	n> 1.275	%n> 1.275
									Conductivity (mmhos/cm)																
CARLL	A	POND	.	0.552	0.305	0.535	0.597	0.650	0.678	0.800	0.792	0.713	0.630	0.668	0.707	0.779	0.678	0.686	0.080	0.006	0.535	0.800	11	0	0
GTEDS	B	POND	.	.	.	0.270	0.318	0.354	0.495	0.599	0.636	0.337	0.330	0.233	0.392	0.237	0.337	0.382	0.131	0.017	0.233	0.636	11	0	0
COOPP	C	POND	.	0.159	.	0.142	0.156	0.179	0.195	0.273	0.823	0.196	0.166	0.207	.	0.246	0.196	0.258	0.192	0.037	0.142	0.823	10	0	0
RIDGE	D	POND	0.150	.	0.065	0.117	0.120	0.160	0.154	0.350	0.214	0.217	0.786	0.203	0.195	0.203	0.203	0.247	0.181	0.033	0.117	0.786	11	0	0
COPW5	E	POND	.	0.236	0.110	0.165	0.175	0.223	0.253	0.320	0.470	0.359	0.325	0.270	0.396	0.420	0.320	0.307	0.095	0.009	0.165	0.470	11	0	0
CARLS	F	POND	.	0.453	0.215	0.426	0.451	0.422	0.373	0.385	0.472	0.371	0.287	0.383	0.372	0.440	0.385	0.398	0.049	0.002	0.287	0.472	11	0	0
WPAIL	G	POND	0.084	.	0.025	0.074	0.082	0.098	0.097	0.091	0.119	0.128	0.107	0.126	0.102	0.101	0.101	0.102	0.016	0.000	0.074	0.128	11	0	0
WPAIS	H	POND	0.203	.	0.080	0.156	0.176	0.202	0.229	0.209	0.228	0.226	0.234	0.300	0.275	0.250	0.228	0.226	0.039	0.002	0.156	0.300	11	0	0
BLDAL	I	POND	.	.	.	0.122	0.134	0.149	0.153	0.158	0.224	0.149	0.113	0.222	0.161	0.149	0.149	0.158	0.034	0.001	0.113	0.224	11	0	0
KENMA	J	POND	.	.	0.045	0.096	0.128	0.138	0.153	0.300	0.198	0.170	0.122	0.153	0.160	0.162	0.153	0.162	0.051	0.003	0.096	0.300	11	0	0
LIGHB	K	POND	.	.	.	0.232	0.249	0.307	0.321	0.388	0.408	0.371	0.270	0.290	0.374	0.388	0.321	0.327	0.059	0.003	0.232	0.408	11	0	0
LASHV	L	POND	.	.	.	0.087	0.094	0.137	0.195	0.258	0.212	0.149	0.181	0.180	0.228	0.112	0.180	0.167	0.053	0.003	0.087	0.258	11	0	0
MEBRV	M	POND	.	0.123	0.040	0.084	0.098	0.125	0.146	0.175	0.252	0.184	0.130	0.165	0.173	0.158	0.158	0.154	0.044	0.002	0.084	0.252	11	0	0
MARWA	N	POND	.	.	2.05	4.11	5.06	.	3.52	9.36	24.70	18.20	11.68	9.99	9.20	16.38	9.68	11.22	6.44	41.41	3.52	24.70	10	10	100
EASTS	O	POND	.	.	.	.	0.098	0.158	0.116	.	.	.	.	.	.	0.143	0.130	0.129	0.023	0.001	0.098	0.158	4	0	0
LAKFN	P	POND	0.172	.	.	0.137	0.146	0.153	0.173	0.186	0.241	0.137	0.110	0.118	0.139	0.131	0.139	0.152	0.035	0.001	0.110	0.241	11	0	0
LAKFS	Q	POND	0.188	.	.	0.138	0.163	0.179	0.197	0.199	0.251	0.169	0.148	0.160	0.177	0.175	0.175	0.178	0.029	0.001	0.138	0.251	11	0	0
THORN	R	POND	.	0.466	.	0.327	0.280	0.380	0.422	0.425	0.515	0.497	0.420	0.428	0.476	0.471	0.425	0.422	0.068	0.005	0.280	0.515	11	0	0
TAOFF	S	POND	0.577	.	.	0.530	0.486	0.528	0.743	.	.	0.398	0.333	0.273	0.706	0.347	0.486	0.483	0.154	0.024	0.273	0.743	9	0	0
LIGHF	T	POND	.	.	.	0.210	0.254	0.217	0.212	0.354	0.283	0.278	0.187	0.299	0.504	0.314	0.278	0.283	0.085	0.007	0.187	0.504	11	0	0
GEORG	U	POND	.	0.553	0.050	0.138	0.295	0.316	0.204	0.435	0.310	0.213	0.197	0.265	0.537	0.189	0.265	0.282	0.112	0.013	0.138	0.537	11	0	0
TRICO	V	POND	.	0.197	0.028	0.088	0.101	0.088	0.131	0.380	0.305	0.122	0.138	0.183	0.204	0.175	0.138	0.174	0.089	0.008	0.088	0.380	11	0	0
LIWAF	W	POND	.	.	0.040	0.132	0.352	0.195	0.233	.	0.477	0.152	0.080	0.093	0.153	0.089	0.153	0.196	0.122	0.015	0.080	0.477	10	0	0
BLDAS	X	POND	.	.	.	0.305	0.223	0.182	0.204	0.456	0.309	0.200	0.125	0.201	0.258	0.158	0.204	0.238	0.087	0.008	0.125	0.456	11	0	0
		Median				0.142	0.176	0.182	0.204	0.350	0.307	0.213	0.187	0.222	0.267	0.196						N =	252	10	4
		Mean				0.375	0.427	0.241	0.400	0.767	1.475	1.041	0.743	0.670	0.722	0.926			P_mean		0.703				
		Std				0.807	0.975	0.140	0.671	1.928	5.072	3.661	2.338	1.991	1.858	3.226			P_std		2.498				
		Var				0.652	0.951	0.020	0.450	3.717	25.721	13.403	5.465	3.963	3.453	10.408			P_var		6.239				
		Min				0.074	0.082	0.088	0.097	0.091	0.119	0.122	0.080	0.093	0.102	0.089			P_min		0.074				
		Max				4.110	5.060	0.650	3.520	9.360	24.700	18.200	11.680	9.990	9.200	16.380			P_max		24.70				
		n				23	24	23	24	21	22	23	23	23	22	24	//N = 252		N		252				
		n>1.275				1	1	0	1	1	1	1	1	1	1	1	10								

Legend: "." = No data or Not Calculated. "n" = numbers of observations
"P_" = Population Chapter 17-3 standard (Class I, II and III) = 1.275 mmhos/cm @ 25 degrees Centigrade.

TABLE F: CONTINUED.

POND\ Pseudonym	Ltr	Station	101888	110288	112388	112888	121388	012389	030289	041889	060789	062689	072489	082889	110189	121989	Median	Mean	Std	Var	Min	Max	n	n> 1.275	%n> 1.275
									Conductivity (mmhos/cm)																
CARLL	A	RECEIVE	.	.	0.650	0.977	5.200	2.810	8.370	1.500	36.300	26.800	2.470	18.700	19.670	9.430	8.370	12.02	11.23	126.0	0.977	36.30	11	NA	NA
GTEDS	B	RECEIVE	0.274	.	.	0.124	0.182	0.202	0.364	0.353	0.368	0.450	0.209	0.251	0.346	0.314	0.314	0.288	0.095	0.009	0.124	0.450	11	0	0
COOPP	C	RECEIVE	.	0.178	.	0.118	0.184	0.132	0.131	.	.	0.238	0.133	0.229	0.257	0.222	0.184	0.183	0.052	0.003	0.118	0.257	9	0	0
RIDGE	D	RECEIVE	.	.	0.059	0.141	0.140	0.141	0.169	.	.	.	0.225	0.266	0.247	0.239	0.197	0.196	0.050	0.003	0.140	0.266	8	0	0
CARLS	F	RECEIVE	.	1.046	0.245	0.998	0.936	0.926	0.824	1.900	1.278	0.586	0.723	0.807	0.988	0.925	0.926	0.990	0.333	0.111	0.586	1.900	11	NA	NA
WPAIL	G	RECEIVE	0.085	.	0.015	0.053	0.056	0.072	0.083	.	.	0.095	.	.	.	0.189	0.078	0.091	0.046	0.002	0.053	0.189	6	0	0
WPAIS	H	RECEIVE	.	.	0.070	0.211	0.361	0.218	0.265	0.327	0.223	0.311	0.233	0.262	.	0.203	0.248	0.261	0.052	0.003	0.203	0.361	10	0	0
BLDAL	I	RECEIVE	0.229	.	.	0.192	0.203	0.217	0.252	0.237	.	0.239	0.203	0.233	0.288	0.302	0.235	0.237	0.034	0.001	0.192	0.302	10	0	0
KENMA	J	RECEIVE	.	.	0.065	0.142	0.190	0.213	0.349	.	.	.	0.169	0.187	.	.	0.189	0.208	0.067	0.004	0.142	0.349	6	0	0
LASHV	L	RECEIVE	.	.	.	0.179	0.172	0.188	0.139	.	0.320	0.342	0.355	0.366	0.352	0.324	0.322	0.274	0.087	0.008	0.139	0.366	10	0	0
MARWA	N	RECEIVE	22.50	.	4.75	18.32	16.93	22.30	30.50	37.90	34.00	37.70	34.90	36.00	26.60	21.80	30.50	28.81	7.55	57.07	16.93	37.90	11	NA	NA
TAOFF	S	RECEIVE	0.521	.	.	0.481	0.596	0.656	0.462	.	.	0.561	0.465	0.402	0.572	0.460	0.481	0.517	0.077	0.006	0.402	0.656	9	0	0
LIWAF	W	RECEIVE	.	.	0.180	0.328	0.146	0.394	0.446	.	0.565	0.497	0.423	0.411	0.467	0.443	0.433	0.412	0.107	0.011	0.146	0.565	10	0	0
BLDAS	X	RECEIVE	0.229	.	.	0.192	0.203	0.217	0.252	0.237	.	0.239	0.203	0.233	0.288	0.302	0.235	0.237	0.034	0.001	0.192	0.302	10	0	0
		Median				0.192	0.197	0.217	0.307	0.353	0.565	0.396	0.233	0.266	0.352	0.314						N =	132	0	0
		Mean				1.60	1.82	2.05	3.04	6.06	10.44	5.67	3.13	4.49	4.55	2.70			P_mean		3.690				
		Std				4.65	4.38	5.66	7.89	13.01	15.65	12.09	9.19	10.32	8.89	6.02			P_std		9.112				
		Var				21.58	19.20	32.01	62.30	169.31	244.79	146.25	84.46	106.56	78.96	36.23			P_var		83.03				
		Min				0.05	0.06	0.07	0.08	0.24	0.22	0.10	0.13	0.19	0.25	0.19			P_min		0.053				
		Max				18.32	16.93	22.30	30.50	37.90	36.30	37.70	34.90	36.00	26.60	21.80			P_max		37.90				
		n				14	14	14	14	7	7	12	13	13	11	13	//N = 132		N		132				
		n>1.275				1	2	2	2	3	3	2	2	2	2	2	23								

Legend: "." = No data or Not Calculated. "n" = numbers of observations "NA" = Not Applicable.
"P_" = Population Chapter 17-3 standard (Class I, II and III) = 1.275 mmhos/cm @ 25 degrees Centigrade.

TABLE G: TOTAL SUSPENDED SOLIDS (TSS -- MG/L) OF SAMPLES COLLECTED DURING THE WATER-QUALITY SURVEY (1988 - 1989) OF 24 WET-DETENTION PONDS

POND\ Pseudonym	Ltr	Station	DATE 101888	110288	112388	112888	121388	012389	030289	041889	060789	062689	072489	082989	110189	121989	MEDIAN	MEAN	STD	VAR	MIN	MAX	n	(a) n>20	%n >20
									Total Suspended Solids (mg/L)																
CARLL	A	OUTFALL	.	.	3.80	1.50	0.90	3.16	1.78	3.30	1.30	3.70	3.30	0.76	3.10	1.18	1.8	2.2	1.1	1.2	0.8	3.7	11	0	0
GTEDS	B	OUTFALL	19.08	.	.	1.40	14.65	9.24	37.48	3.15	6.45	1.80	3.64	15.30	1.30	7.19	6.5	9.2	10.1	102.2	1.3	37.5	11	1	9
COOPP	C	OUTFALL	.	1.69	.	10.30	1.50	2.22	1.23	1.40	.	4.58	7.48	4.28	2.00	6.69	3.3	4.2	2.9	8.7	1.2	10.3	10	0	0
RIDGE	D	OUTFALL	8.48	.	5.00	3.00	5.30	4.08	2.42	.	.	2.06	4.84	1.96	15.50	14.18	4.1	5.9	4.9	24.0	2.0	15.5	9	0	0
COPW5	E	OUTFALL	.	.	6.50	0.70	22.30	3.06	2.30	6.20	.	14.63	3.88	.	5.10	17.11	5.1	8.4	7.2	52.1	0.7	22.3	9	1	11
CARLS	F	OUTFALL	.	3.07	2.70	5.90	2.00	4.26	0.98	2.50	2.60	2.50	1.28	0.98	20.40	1.67	2.5	4.1	5.3	28.6	1.0	20.4	11	1	9
WPAIL	G	OUTFALL	.	.	19.70	5.70	5.60	8.32	39.95	.	.	.	.	.	.	.	7.0	14.9	14.5	210.5	5.6	40.0	4	1	25
WPAIS	H	OUTFALL	.	.	32.00	5.40	6.60	14.16	6.30	4.40	29.80	8.54	35.08	29.02	21.10	7.38	8.5	15.3	10.9	118.8	4.4	35.1	11	4	36
BLDAL	I	OUTFALL	22.71	.	.	2.90	11.30	10.78	2.36	1.86	5.60	3.16	3.22	4.79	6.00	3.62	3.6	5.1	3.1	9.5	1.9	11.3	11	0	0
KENMA	J	OUTFALL	.	19.38	1.80	1.30	1.90	1.46	0.28	4.50	5.40	4.90	3.66	3.88	10.30	3.22	3.7	3.7	2.6	6.8	0.3	10.3	11	0	0
LIGHB	K	OUTFALL	11.68	.	.	8.10	4.80	5.90	5.42	11.20	7.80	8.46	4.08	8.46	14.55	1.84	7.8	7.3	3.3	11.2	1.8	14.6	11	0	0
LASHV	L	OUTFALL	.	.	.	3.30	11.50	3.60	8.41	.	.	.	.	.	.	14.12	8.4	8.2	4.3	18.2	3.3	14.1	5	0	0
MEBRV	M	OUTFALL	.	.	2.30	3.20	13.50	2.48	.	.	.	.	2.82	1.62	13.90	3.91	3.2	5.9	5.0	24.6	1.6	13.9	7	0	0
MARWA	N	OUTFALL	27.78	.	13.40	4.20	7.70	12.62	12.56	50.10	13.65	27.84	14.32	14.14	10.70	9.22	12.6	16.1	12.1	147.3	4.2	50.1	11	2	18
EASTS	O	OUTFALL	.	.	.	.	11.40	6.60	9.74	.	.	.	.	120.46	.	45.74	11.4	38.8	43.2	1869.7	6.6	120.5	5	2	40
LAKFN	P	OUTFALL	.	.	.	4.40	1.80	3.00	.	3.80	.	3.28	7.72	3.38	3.80	1.78	3.4	3.7	1.7	2.7	1.8	7.7	9	0	0
LAKFS	Q	OUTFALL	.	.	.	4.00	2.00	8.80	3.60	9.05	.	8.60	15.40	8.28	10.20	2.62	8.4	7.3	4.0	15.7	2.0	15.4	10	0	0
THORN	R	OUTFALL	.	22.51	.	10.60	15.20	31.55	21.66	37.00	23.50	23.66	21.38	7.96	34.70	26.46	23.5	23.1	8.9	78.5	8.0	37.0	11	8	73
TAOFF	S	OUTFALL	79.77	.	.	1.70	4.10	10.57	17.11	.	.	1.98	3.14	6.06	10.55	12.69	6.1	7.5	5.1	26.1	1.7	17.1	9	0	0
LIGHF	T	OUTFALL	20.94	.	.	13.10	5.80	14.42	8.88	.	.	11.56	7.92	28.41	31.20	3.53	11.6	13.9	9.1	83.4	3.5	31.2	9	2	22
GEORG	U	OUTFALL	.	4.68	1.50	2.30	7.10	2.72	2.24	8.00	4.20	2.28	.	4.20	1.10	9.62	3.5	4.4	2.7	7.5	1.1	9.6	10	0	0
TRICO	V	OUTFALL	.	.	2.30	4.70	8.70	5.44	0.92	16.40	5.00	2.10	17.28	3.38	15.80	2.33	5.0	7.5	5.9	34.5	0.9	17.3	11	0	0
LIWAF	W	OUTFALL	.	.	4.30	.	2.70	8.00	12.72	.	.	5.86	4.52	11.18	3.60	4.49	5.2	6.6	3.4	11.7	2.7	12.7	8	0	0
BLDAS	X	OUTFALL	13.28	.	.	2.30	3.30	3.26	4.22	6.25	2.50	3.24	3.87	5.54	14.20	4.00	3.9	4.8	3.2	10.1	2.3	14.2	11	0	0
		MEDIAN				3.65	5.70	5.67	4.82	5.35	5.50	4.14	4.30	5.54	10.55	4.49						N =	225	22	9.8
		MEAN				4.55	7.15	7.49	9.21	10.57	8.98	7.24	8.44	13.53	11.86	8.90			P_mean		8.8				
		STD				3.24	5.34	6.31	10.85	13.22	8.56	7.09	8.18	25.12	9.06	9.92			P_std		11.4				
		VAR				10.50	28.56	39.87	117.72	174.75	73.21	50.26	66.98	631.09	82.02	98.50			P_var		128.9				
		MIN				0.70	0.90	1.46	0.28	1.40	1.30	1.80	1.28	0.76	1.10	1.18			P_min		0.3				
		MAX				13.10	22.30	31.55	39.95	50.10	29.80	27.84	35.08	120.46	34.70	45.74			P_max		120.5				
		n				22	24	24	22	16	12	20	20	21	21	23	//N = 225		N		225				
		n>20				0	1	1	3	2	2	2	2	3	4	2	22								
		%n>20				0	4	4	14	13	17	10	10	14	19	9									

LEGEND: "." = No Data or Not Calculated "P_" = Population statistic "n" = number of observations (a) Secondary STP standard

TABLE G: CONTINUED.

POND\ Pseudonym	Ltr	Station	101888	110288	112388	112888	121388	012389	DATE 030289	041889	060789	062689	072489	082989	110189	121989	MEDIAN	MEAN	STD	VAR	MIN	MAX	n	(a) n>20	%n >20
									Total Suspended Solids (mg/L)																
CARLL	A	POND	.	2.17	3.60	3.00	0.40	4.04	4.22	3.90	10.20	5.94	5.24	5.39	11.00	7.89	5.2	5.6	3.0	8.8	0.4	11.0	11	0	0
GTEDS	B	POND	.	.	.	3.40	2.60	6.46	2.72	3.40	3.60	4.62	4.48	3.94	13.00	4.91	3.9	4.8	2.8	7.8	2.6	13.0	11	0	0
COOPP	C	POND	.	0.60	.	1.10	5.50	2.56	0.42	0.80	3.40	3.08	2.60	1.18	1.80	4.09	2.6	2.4	1.5	2.2	0.4	5.5	11	0	0
RIDGE	D	POND	7.30	.	6.50	2.70	6.00	5.54	1.64	5.20	3.90	4.66	9.86	3.82	6.40	5.89	5.2	5.1	2.1	4.3	1.6	9.9	11	0	0
COPW5	E	POND	.	17.03	3.60	3.20	7.60	9.26	.	7.40	2.80	1.62	14.90	13.82	9.10	3.76	7.5	7.3	4.4	18.9	1.6	14.9	10	0	0
CARLS	F	POND	.	2.49	3.00	3.40	2.00	5.60	0.90	2.60	2.50	2.12	1.58	7.18	5.90	1.18	2.5	3.2	2.0	4.0	0.9	7.2	11	0	0
WPAIL	G	POND	11.94	.	24.60	6.80	5.60	6.66	8.32	7.30	56.40	12.78	16.16	23.10	12.50	32.62	12.5	17.1	14.7	216.6	5.6	56.4	11	3	27
WPAIS	H	POND	5.88	.	28.40	7.90	6.10	11.16	6.48	5.20	26.30	11.30	26.40	11.02	13.00	7.44	11.0	12.0	7.2	51.3	5.2	26.4	11	2	18
BLDAL	I	POND	.	.	.	3.40	8.00	16.14	.	1.93	4.80	8.80	4.36	4.14	4.90	3.38	4.6	6.0	3.9	15.4	1.9	16.1	10	0	0
KENMA	J	POND	.	5.83	2.30	1.60	3.30	2.06	0.76	1.40	3.80	2.32	3.76	1.00	2.30	2.60	2.3	2.3	1.0	1.0	0.8	3.8	11	0	0
LIGHB	K	POND	.	.	.	4.30	7.60	5.24	3.86	12.20	7.30	8.66	3.20	7.60	9.85	2.18	7.3	6.5	2.9	8.6	2.2	12.2	11	0	0
LASHV	L	POND	.	.	.	4.30	3.70	3.56	3.34	2.00	7.30	4.40	2.09	7.52	17.10	6.93	4.3	5.7	4.1	16.5	2.0	17.1	11	0	0
MEBRV	M	POND	.	3.95	2.30	2.00	13.20	3.36	0.14	2.50	9.40	4.18	2.92	4.76	5.40	2.78	3.4	4.6	3.5	12.4	0.1	13.2	11	0	0
MARWA	N	POND	.	.	13.80	4.60	5.10	9.02	7.00	8.60	13.00	22.08	12.52	11.58	28.80	7.56	9.0	11.8	7.1	50.2	4.6	28.8	11	2	18
EASTS	O	POND	.	.	.	.	62.90	2.74	1.34	.	.	.	.	.	.	69.88	32.8	34.2	32.3	1041.6	1.3	69.9	4	2	50
LAKFN	P	POND	6.13	.	.	4.10	2.20	4.96	.	7.80	3.60	3.32	2.58	3.34	1.90	3.09	3.3	3.7	1.6	2.6	1.9	7.8	10	0	0
LAKFS	Q	POND	15.11	.	.	2.30	2.30	3.54	.	5.20	9.10	8.08	19.86	9.34	8.70	3.84	6.6	7.2	5.0	24.8	2.3	19.9	10	0	0
THORN	R	POND	.	9.48	.	3.90	14.20	11.18	15.26	13.10	15.90	17.25	6.70	7.06	16.20	18.86	14.2	12.7	4.6	21.6	3.9	18.9	11	0	0
TAOFF	S	POND	.	.	.	3.70	4.60	7.34	18.00	.	.	4.38	5.22	6.62	18.10	34.96	6.6	11.4	9.9	97.3	3.7	35.0	9	1	11
LIGHF	T	POND	.	.	.	8.10	6.30	7.16	12.28	81.60	8.70	13.30	6.34	9.49	10.00	2.82	8.7	15.1	21.2	449.9	2.8	81.6	11	1	9
GEORG	U	POND	.	12.61	1.40	2.40	3.00	3.22	2.84	8.70	4.60	3.34	19.82	3.70	1.40	3.93	3.3	5.2	5.0	24.6	1.4	19.8	11	0	0
TRICO	V	POND	.	248.50	3.20	1.50	3.30	3.30	1.38	4.40	4.40	3.42	5.87	9.88	18.90	1.51	3.4	5.3	4.9	24.0	1.4	18.9	11	0	0
LIWAF	W	POND	.	.	7.00	1.70	2.60	51.74	.	.	2.20	6.16	6.34	6.22	7.40	8.60	6.2	10.3	14.8	219.7	1.7	51.7	9	1	11
BLDAS	X	POND	.	.	.	1.40	15.00	6.04	12.34	6.30	5.50	2.46	7.40	24.06	11.80	5.91	6.3	8.9	6.2	38.4	1.4	24.1	11	1	9
		MEDIAN				3.40	5.30	5.57	3.34	5.20	5.15	4.62	5.87	7.06	9.85	4.50							N= 249	13	5.22
		MEAN				3.51	8.05	8.00	5.43	9.12	9.49	6.88	8.27	8.08	10.24	10.28			P_mean		7.97				
		STD				1.88	12.04	9.69	5.26	16.53	11.58	5.17	6.63	5.74	6.48	15.13			P_std		9.98				
		VAR				3.54	144.88	93.93	27.71	273.38	134.18	26.78	43.91	32.96	42.03	228.94			P_var		99.64				
		MIN				1.10	0.40	2.06	0.14	0.80	2.20	1.62	1.58	1.00	1.40	1.18			P_min		0.14				
		MAX				8.10	62.90	51.74	18.00	81.60	56.40	22.08	26.40	24.06	28.80	69.88			P_max		81.60				
		n				23	24	24	19	21	22	23	23	23	23	24	//N = 249		_N		249				
		n>20				0	1	1	0	1	2	1	1	2	1	3	13								
		%n>20				0	4	4	0	5	9	4	4	9	4	13									

LEGEND: "." = No Data or Not Calculated "P_" = Population statistic "n" = number of observations (a) Secondary STP standard

TABLE G: CONTINUED.

POND\ Pseudonym	Ltr	Station	101888	110288	112388	112888	121388	012389	DATE 030289	041889	060789	062689	072489	082989	110189	121989	MEDIAN	MEAN	STD	VAR	MIN	MAX	n	(a) n>20	%n >20
									Total Suspended Solids (mg/L)																
CARLL	A	RECEIVE	.	.	10.50	8.10	10.10	18.30	5.22	18.20	14.20	28.24	15.32	15.64	16.00	6.00	15.3	14.1	6.3	39.8	5.2	28.2	11	1	9
GTEDS	B	RECEIVE	2.87	.	.	2.10	1.30	3.10	7.66	3.40	1.90	1.72	7.43	.	17.80	9.86	3.3	5.6	5.0	24.5	1.3	17.8	10	0	0
COOPP	C	RECEIVE	.	34.85	.	3.90	1.20	8.40	7.28	.	.	3.82	10.62	19.90	.	3.88	5.6	7.4	5.5	30.4	1.2	19.9	8	0	0
RIDGE	D	RECEIVE	.	.	4.30	9.60	6.20	3.46	2.02	.	.	.	2.48	10.75	9.50	6.82	6.5	6.4	3.2	10.3	2.0	10.8	8	0	0
CARLS	F	RECEIVE	.	10.49	6.00	2.20	2.00	6.78	3.28	9.20	3.30	12.91	2.71	5.16	7.70	3.53	3.5	5.3	3.3	10.9	2.0	12.9	11	0	0
WPAIL	G	RECEIVE	5.74	.	15.00	6.10	3.70	7.40	.	.	.	2.94	.	.	.	1.41	3.7	4.3	2.2	4.7	1.4	7.4	5	0	0
WPAIS	H	RECEIVE	46.28	.	37.50	4.30	2.70	2.24	4.04	3.70	37.00	8.50	6.70	9.78	.	2.51	4.2	8.1	9.9	98.5	2.2	37.0	10	1	10
BLDAL	I	RECEIVE	4.11	.	.	1.30	1.60	5.74	0.92	11.00	.	1.04	6.22	1.40	5.50	2.09	1.8	3.7	3.2	10.0	0.9	11.0	10	0	0
KENMA	J	RECEIVE	.	.	2.10	1.80	1.70	5.78	18.14	.	.	.	1.72	1.64	.	.	1.8	5.1	6.0	36.1	1.6	18.1	6	0	0
LASHV	L	RECEIVE	.	.	.	0.60	1.90	3.12	7.90	.	3.60	7.50	13.24	21.68	10.30	12.89	7.7	8.3	6.2	37.8	0.6	21.7	10	1	10
MARWA	N	RECEIVE	18.35	.	24.30	7.60	8.40	12.34	12.16	12.60	28.40	31.00	.	25.80	3.90	14.02	12.5	15.6	8.9	79.2	3.9	31.0	10	3	30
TAOFF	S	RECEIVE	4.94	.	.	13.40	46.80	33.62	17.40	.	.	9.08	10.92	23.71	16.40	18.62	17.4	21.1	11.4	130.4	9.1	46.8	9	3	33
LIWAF	W	RECEIVE	.	.	5.60	4.30	7.60	8.28	2.18	.	5.50	3.68	.	5.52	3.50	4.29	4.3	5.0	1.9	3.4	2.2	8.3	9	0	0
BLDAS	X	RECEIVE	4.11	.	.	1.30	1.60	5.74	0.92	11.00	.	1.04	6.22	1.40	5.50	2.09	1.8	3.7	3.2	10.0	0.9	11.0	10	0	0
																						N=	127	9	7
		MEDIAN				4.10	2.35	6.28	5.22	11.00	5.50	5.66	6.70	10.27	8.60	4.29									
		MEAN				4.76	6.91	8.88	6.86	9.87	13.41	9.29	7.60	11.87	9.61	6.77			P_mean		8.36				
		STD				3.62	11.43	7.97	5.60	4.78	12.96	9.76	4.27	8.78	5.12	5.23			P_std		8.03				
		VAR				13.14	130.67	63.52	31.36	22.82	167.90	95.21	18.26	77.00	26.19	27.40			P_var		64.43				
		MIN				0.60	1.20	2.24	0.92	3.40	1.90	1.04	1.72	1.40	3.50	1.41			P_min		0.60				
		MAX				13.40	46.80	33.62	18.14	18.20	37.00	31.00	15.32	25.80	17.80	18.62			P_max		46.80				
		n				14	14	14	13	7	7	12	11	12	10	13	//N = 127		_N		127				
		n>20				0	1	1	0	0	2	2	0	3	0	0	9								
		%n>20				0.0	7.1	7.1	0.0	0.0	28.6	16.7	0.0	25.0	0.0	0.0									

LEGEND: "." = No Data or Not Calculated "P_" = Population statistic "n" = number of observations (a) Secondary STP standard

TABLE H: TURBIDITY (NEPHELOMETRIC TURBIDITY UNITS--NTU) OF SAMPLES COLLECTED DURING THE WATER-QUALITY SURVEY (1988 - 1989) OF 24 WET-DETENTION PONDS.

POND\ PSEUDONYM	Ltr	Station	DATE 101888	110288	112388	112888	121388	012389	030289	041889	060789	062689	072489	082989	110189	121989	MEDIAN	MEAN	STD	VAR	MIN	MAX	n	n> 29	%n> 29
									Turbidity (NTU)																
CARLL	A	OUTFALL	.	.	3.4	1.6	1.1	1.8	3.1	2.6	2.2	5.4	1.5	2.3	1.5	1.6	1.8	2.2	1.1	1.3	1.1	5.4	11	0	0
GTEDS	B	OUTFALL	3.5	.	.	3.3	4.2	3.6	13.6	1.9	0.9	1.4	2.1	8.8	0.6	7.2	3.3	4.3	3.8	14.6	0.6	13.6	11	0	0
COOPP	C	OUTFALL	.	1.2	.	13.7	1.5	1.9	2.4	1.0	.	1.8	4.7	3.5	1.3	4.8	2.2	3.7	3.6	12.9	1.0	13.7	10	0	0
RIDGE	D	OUTFALL	1.4	.	8.5	10.9	15.1	8.7	6.5	.	.	3.0	3.2	3.9	6.9	15.9	6.9	8.2	4.6	21.1	3.0	15.9	9	0	0
COPW5	E	OUTFALL	.	.	6.8	1.4	9.3	1.4	1.6	2.0	.	11.5	3.8	.	1.1	7.2	2.0	4.4	3.7	13.9	1.1	11.5	9	0	0
CARLS	F	OUTFALL	.	3.9	4.2	13.1	1.9	2.9	2.8	1.8	2.0	1.6	0.8	1.4	3.0	12.0	2.0	3.9	4.1	16.9	0.8	13.1	11	0	0
WPAIL	G	OUTFALL	.	.	84.0	58.0	58.0	45.0	57.0	.	.	.	.	.	.	.	57.5	54.5	5.5	30.3	45.0	58.0	4	4	100
WPAIS	H	OUTFALL	.	.	56.0	11.3	7.5	9.5	9.2	3.2	41.0	15.5	18.0	6.4	14.4	15.3	11.3	13.8	9.6	92.3	3.2	41.0	11	1	9
BLDAL	I	OUTFALL	10.9	.	.	11.0	10.1	11.9	7.3	7.3	8.9	3.3	2.9	3.5	5.1	3.3	7.3	6.8	3.2	10.3	2.9	11.9	11	0	0
KENMA	J	OUTFALL	.	8.7	3.6	1.1	0.8	1.5	1.6	2.6	3.4	3.0	1.7	2.6	1.4	2.5	1.7	2.0	0.8	0.6	0.8	3.4	11	0	0
LIGHB	K	OUTFALL	3.7	.	.	5.9	3.2	4.2	5.1	7.2	7.4	6.2	4.0	5.6	4.7	2.2	5.1	5.1	1.5	2.4	2.2	7.4	11	0	0
LASHV	L	OUTFALL	.	.	.	4.7	1.4	1.1	4.4	.	.	.	.	.	.	13.8	4.4	5.1	4.6	21.2	1.1	13.8	5	0	0
MEBRV	M	OUTFALL	.	.	3.1	2.9	3.9	1.6	.	.	.	.	2.0	1.3	1.9	2.2	2.1	2.3	0.8	0.7	1.3	3.9	7	0	0
MARWA	N	OUTFALL	8.0	.	9.8	7.3	4.3	6.7	7.5	12.5	5.1	9.9	6.5	3.9	4.0	6.0	6.5	6.7	2.5	6.3	3.9	12.5	11	0	0
EASTS	O	OUTFALL	.	.	.	.	4.3	2.4	4.2	.	.	.	.	43.0	.	24.0	4.3	15.6	15.8	250.6	2.4	43.0	5	1	20
LAKFN	P	OUTFALL	.	.	.	3.8	2.0	2.0	1.4	3.0	.	2.1	3.2	3.2	0.7	1.8	2.1	2.3	0.9	0.8	0.7	3.8	10	0	0
LAKFS	Q	OUTFALL	.	.	.	3.8	2.0	3.0	6.1	7.2	.	5.3	17.0	8.7	7.9	3.5	5.7	6.5	4.1	16.8	2.0	17.0	10	0	0
THORN	R	OUTFALL	.	18.8	.	21.0	14.7	27.0	21.0	34.0	17.1	22.0	13.3	4.1	30.0	31.0	21.0	21.4	8.4	71.4	4.1	34.0	11	3	27
TAOFF	S	OUTFALL	10.1	.	.	3.0	5.0	7.1	32.0	.	.	1.8	2.3	6.3	5.3	21.0	5.3	9.3	9.7	93.9	1.8	32.0	9	1	11
LIGHF	T	OUTFALL	2.2	.	.	7.8	4.6	6.3	10.3	.	.	7.7	5.0	11.8	13.3	4.9	7.7	8.0	3.0	9.0	4.6	13.3	9	0	0
GEORG	U	OUTFALL	.	4.5	3.0	2.4	3.9	2.6	4.9	8.4	4.0	6.5	2.8	2.7	1.0	15.1	3.9	4.9	3.8	14.2	1.0	15.1	11	0	0
TRICO	V	OUTFALL	.	.	2.4	2.2	3.0	2.3	4.6	7.4	4.0	2.5	4.6	3.1	4.8	1.5	3.1	3.6	1.6	2.5	1.5	7.4	11	0	0
LIWAF	W	OUTFALL	.	.	5.9	2.0	4.0	8.4	13.3	.	.	14.5	3.0	11.9	4.3	9.1	8.4	7.8	4.4	19.7	2.0	14.5	9	0	0
BLDAS	X	OUTFALL	3.5	.	.	3.6	2.9	1.5	6.3	4.6	2.1	4.1	2.9	3.8	6.0	5.5	3.8	3.9	1.5	2.2	1.5	6.3	11	0	0
		MEDIAN				3.8	4.0	3.0	6.1	3.9	4.0	4.7	3.2	3.9	4.3	6.0						N=	228	10	4.4
		MEAN				8.5	7.0	6.9	9.8	6.7	8.2	6.5	5.0	6.8	5.7	9.2			P_mean		7.3				
		STD				11.7	11.3	9.6	12.2	7.7	10.8	5.5	4.8	8.6	6.6	7.9			P_std		9.3				
		VAR				135.9	127.5	92.8	148.2	59.3	115.8	29.8	22.7	74.6	43.3	62.2			P_var		86.0				
		MIN				1.1	0.8	1.1	1.4	1.0	0.9	1.4	0.8	1.3	0.6	1.5			P_min		0.6				
		MAX				58.0	58.0	45.0	57.0	34.0	41.0	22.0	18.0	43.0	30.0	31.0			P_max		58.0				
		n				23	24	24	23	16	12	20	21	21	21	23	//N = 228		_N		228				
		n>29				1	1	1	2	1	1	0	0	1	1	1	10								
		%n>29				4	4	4	9	6	8	0	0	5	5	4									

LEGEND: "." = No Data or Not Calculated "P_" = Population statistic "n" = number of observations
Class III = 29.0 Nephelometric Turbidity Units (NTU)

TABLE H: CONTINUED.

POND\ PSEUDONYM	Ltr	Station	101888	110288	112388	112888	121388	012389	DATE 030289	041889	060789	062689	072489	082989	110189	121989	MEDIAN	MEAN	STD	VAR	MIN	MAX	n	n> 29	%n> 29
									Turbidity (NTU)																
CARLL	A	POND	.	4.8	3.6	2.7	1.9	2.4	4.5	2.2	5.2	4.0	2.8	14.2	6.6	10.7	4.0	5.2	3.8	14.1	1.9	14.2	11	0	0
GTEDS	B	POND	.	.	.	3.4	2.2	4.8	4.0	2.0	2.9	3.1	2.9	3.5	2.0	6.1	3.1	3.4	1.2	1.4	2.0	6.1	11	0	0
COPP	C	POND	.	0.8	.	4.2	1.3	1.3	1.9	0.8	3.8	1.5	2.1	1.6	0.9	3.2	1.6	2.1	1.1	1.2	0.8	4.2	11	0	0
RIDGE	D	POND	13.2	.	12.1	9.3	11.7	7.2	9.7	.	4.2	.	9.3	3.0	7.9	14.0	9.3	8.5	3.2	10.4	3.0	14.0	9	0	0
COPW5	E	POND	.	10.9	5.0	3.6	3.3	4.4	.	1.8	2.3	2.5	6.0	3.7	5.0	3.7	3.7	3.6	1.2	1.5	1.8	6.0	10	0	0
CARLS	F	POND	.	2.3	3.3	2.9	1.8	3.1	3.0	2.0	2.1	1.5	1.1	1.5	1.6	1.3	1.8	2.0	0.7	0.5	1.1	3.1	11	0	0
WPAIL	G	POND	81.0	.	84.0	58.0	59.0	44.0	46.0	24.0	80.0	65.0	46.0	41.0	59.0	122.0	58.0	58.5	24.4	596.1	24.0	122.0	11	10	91
WPAIS	H	POND	4.6	.	72.0	5.7	6.5	9.7	9.4	3.8	37.0	25.0	14.9	7.4	3.6	18.2	9.4	12.8	9.9	97.6	3.6	37.0	11	1	9
BLDAL	I	POND	.	.	.	10.7	9.6	8.1	6.5	7.8	8.1	4.1	3.7	3.8	4.1	4.6	6.5	6.5	2.4	5.8	3.7	10.7	11	0	0
KENMA	J	POND	.	5.4	3.3	1.1	4.0	2.2	4.5	1.3	4.4	2.8	1.9	2.0	2.1	3.7	2.2	2.7	1.2	1.4	1.1	4.5	11	0	0
LIGHB	K	POND	.	.	.	3.6	4.3	3.3	4.7	7.7	7.3	5.1	3.7	4.6	5.1	2.5	4.6	4.7	1.5	2.3	2.5	7.7	11	0	0
LASHV	L	POND	.	.	.	1.3	1.8	0.7	4.2	1.5	15.0	2.5	1.8	8.1	7.2	14.4	2.5	5.3	5.0	24.9	0.7	15.0	11	0	0
MEBRV	M	POND	.	3.8	3.2	2.3	2.7	2.4	1.5	2.8	4.5	4.5	2.0	2.2	1.4	2.8	2.4	2.6	1.0	1.0	1.4	4.5	11	0	0
MARWA	N	POND	.	.	9.3	5.2	3.2	3.6	6.1	4.4	2.9	5.5	5.3	5.3	1.3	6.7	5.2	4.5	1.5	2.3	1.3	6.7	11	0	0
EASTS	O	POND	.	.	.	.	6.5	1.8	2.7	.	.	.	.	.	.	18.0	4.6	7.3	6.5	41.6	1.8	18.0	4	0	0
LAKFN	P	POND	1.7	.	.	4.8	2.8	2.3	1.4	2.6	4.1	2.2	2.2	3.0	1.1	2.4	2.4	2.6	1.0	1.0	1.1	4.8	11	0	0
LAKFS	Q	POND	5.9	.	.	3.4	2.7	2.4	.	4.5	6.7	4.8	20.0	8.4	8.3	2.8	4.7	6.4	5.0	25.0	2.4	20.0	10	0	0
THORN	R	POND	.	6.3	.	4.6	14.0	7.0	12.9	11.3	14.8	14.0	4.2	4.3	13.5	22.0	12.9	11.1	5.3	28.3	4.2	22.0	11	0	0
TAOFF	S	POND	.	.	.	5.2	6.5	6.0	38.0	.	.	2.4	4.7	7.2	6.3	31.0	6.3	11.9	12.2	150.0	2.4	38.0	9	2	22
LIGHF	T	POND	.	.	.	5.7	4.8	4.2	11.6	44.0	6.8	9.9	4.7	5.5	5.1	4.9	5.5	9.7	11.1	122.3	4.2	44.0	11	1	9
GEORG	U	POND	.	7.2	3.1	2.1	2.4	2.1	5.0	7.1	4.3	4.3	8.5	2.4	1.2	7.2	4.3	4.2	2.4	5.5	1.2	8.5	11	0	0
TRICO	V	POND	.	189.0	2.5	1.9	1.2	2.0	4.5	1.8	2.7	2.6	2.5	2.5	3.7	1.6	2.5	2.5	0.9	0.8	1.2	4.5	11	0	0
LIWAF	W	POND	.	.	10.8	1.9	4.2	85.0	.	.	3.8	11.9	4.8	6.3	12.7	8.6	6.3	15.5	24.8	616.4	1.9	85.0	9	1	11
BLDAS	X	POND	.	.	.	2.5	3.4	2.8	7.2	4.2	3.3	4.0	5.3	8.4	3.6	6.6	4.0	4.7	1.9	3.4	2.5	8.4	11	0	0
		MEDIAN				3.6	3.4	3.2	4.7	3.3	4.4	4.1	4.2	4.3	4.1	6.4						N =	249	15	6
		MEAN				6.4	6.7	8.9	9.0	6.9	10.3	8.3	7.0	6.5	7.1	13.3			P_mean		8.2				
		STD				11.2	11.4	17.9	11.2	9.9	16.9	13.4	9.4	7.9	11.6	23.8			P_std		14.1				
		VAR				126.5	129.0	321.4	125.4	98.7	285.9	180.9	88.1	62.6	134.0	567.8			P_var		200.0				
		MIN				1.1	1.2	0.7	1.4	0.8	2.1	1.5	1.1	1.5	0.9	1.3			P_min		0.7				
		MAX				58.0	59.0	85.0	46.0	44.0	80.0	65.0	46.0	41.0	59.0	122.0			P_max		122.0				
		n				23	24	24	21	20	22	22	23	23	23	24	//N = 249		N		249				
		n>29				1	1	2	2	1	2	1	1	1	1	2	15								
		%n>29				4	4	8	10	5	9	5	4	4	4	8									

LEGEND: "." = No Data or Not Calculated "P_" = Population statistic "n" = number of observations
Class III = 29.0 Nephelometric Turbidity Units (NTU)

TABLE H: CONTINUED.

POND\ PSEUDONYM	Ltr	Station	101888	110288	112388	112888	121388	012389	DATE 030289	041889	060789	062689	072489	082989	110189	121989	MEDIAN	MEAN	STD	VAR	MIN	MAX	n	n> 29	%n> 29
									Turbidity (NTU)																
CARLL	A	RECEIVE	.	.	9.1	9.9	8.2	11.9	5.0	6.8	5.0	6.7	11.5	5.3	5.2	3.4	6.7	7.2	2.7	7.4	3.4	11.9	11	0	0
GTEDS	B	RECEIVE	1.2	.	.	2.5	0.9	2.7	2.4	2.0	1.3	1.5	1.4	.	3.1	8.3	2.2	2.6	2.0	4.0	0.9	8.3	10	0	0
COOPP	C	RECEIVE	.	11.5	.	1.3	1.0	1.9	1.1	.	.	2.4	1.7	8.8	.	3.7	1.8	2.7	2.4	5.9	1.0	8.8	8	0	0
RIDGE	D	RECEIVE	.	.	8.9	13.5	7.1	2.3	1.7	.	.	.	2.1	3.6	11.6	6.8	5.2	6.1	4.2	17.8	1.7	13.5	8	0	0
CARLS	F	RECEIVE	.	8.3	6.2	2.8	1.9	2.6	3.9	5.2	3.7	11.0	7.5	2.8	4.5	3.2	3.7	4.5	2.5	6.4	1.9	11.0	11	0	0
WPAIL	G	RECEIVE	5.7	.	32.0	37.0	29.0	3.9	1.9	.	.	13.8	.	.	.	2.2	8.9	14.6	13.8	189.9	1.9	37.0	6	1	17
WPAIS	H	RECEIVE	3.2	.	45.0	11.1	4.3	9.6	11.0	1.6	63.0	23.0	3.5	9.0	.	1.6	9.3	13.8	17.5	305.5	1.6	63.0	10	1	10
BLDAL	I	RECEIVE	1.9	.	.	2.8	1.8	4.1	1.9	4.0	.	1.1	3.0	1.2	4.5	2.0	2.4	2.6	1.2	1.4	1.1	4.5	10	0	0
KENMA	J	RECEIVE	.	.	3.5	1.7	1.0	1.9	2.9	.	.	.	1.5	1.7	.	.	1.7	1.8	0.6	0.3	1.0	2.9	6	0	0
LASHV	L	RECEIVE	.	.	.	4.2	0.6	1.0	2.6	.	2.6	11.1	15.9	29.0	6.5	26.0	5.4	10.0	9.9	97.8	0.6	29.0	10	0	0
MARWA	N	RECEIVE	1.6	.	15.5	6.1	1.7	2.6	3.0	3.0	4.1	4.5	5.2	5.0	6.5	5.5	4.5	4.3	1.5	2.2	1.7	6.5	11	0	0
TAOFF	S	RECEIVE	5.9	.	.	38.0	29.0	16.7	17.0	.	.	8.8	6.1	20.0	1.8	23.0	17.0	17.8	10.8	115.7	1.8	38.0	9	1	11
LIWAF	W	RECEIVE	.	.	5.3	4.0	6.1	.	3.4	.	3.5	3.5	.	3.5	2.0	4.8	3.5	3.9	1.1	1.2	2.0	6.1	8	0	0
BLDAS	X	RECEIVE	1.9	.	.	2.8	1.8	4.1	1.9	4.0	.	1.1	3.0	1.2	4.5	2.0	2.4	2.6	1.2	1.4	1.1	4.5	10	0	0
		MEDIAN				4.1	1.9	2.7	2.8	4.0	3.7	5.6	3.3	4.3	4.5	3.7						N =	128	3	2
		MEAN				9.8	6.7	5.0	4.3	3.8	11.9	7.4	5.2	7.6	5.0	7.1			P_mean		6.7				
		STD				11.9	9.4	4.5	4.2	1.7	20.9	6.3	4.3	8.2	2.7	7.7			P_std		8.7				
		VAR				140.5	88.2	20.6	18.0	2.8	436.6	39.7	18.6	66.6	7.2	58.9			P_var		75.9				
		MIN				1.3	0.6	1.0	1.1	1.6	1.3	1.1	1.4	1.2	1.8	1.6			P_min		0.6				
		MAX				38.0	29.0	16.7	17.0	6.8	63.0	23.0	15.9	29.0	11.6	26.0			P_max		63.0				
		n				14	14	13	14	7	7	12	12	12	10	13	//N = 128		_N		128				
		n>29				2	0	0	0	0	1	0	0	0	0	0	3								
		%n>29				14	0	0	0	0	14	0	0	0	0	0									

LEGEND: "." = No Data or Not Calculated "P_" = Population statistic "n" = number of observations
Class III = 29.0 Nephelometric Turbidity Units (NTU)

TABLE I: OUTFALL STATION ZINC (Zn) CONCENTRATIONS (mg\L) FROM THE WATER QUALITY SURVEY OF 24 WET-DETENTION PONDS, 1988 - 1989.
Sample statistics calculated by substitution of DL/2 (0.0025 mg/L) for "<" values.

POND/ Pseudonym	Ltr	101888	110288	112388	112888	121388	012389	DATE 030289	041889	060789	062689	072489	082889	110189	121989	MEDIAN	MEAN	STD	VAR	MIN	MAX	n	n> 0.03	%n> 0.03	n< DL	%n< DL
								Zn (mg/L)																		
CARLL	A	.	.	0.010	<	0.023	<	0.035	<	0.017	0.024	0.033	0.034	0.012	0.021	0.021	0.019	0.012	0.000	0.003	0.035	11	3	27	3	27
GTEDS	B	0.014	.	.	<	0.020	<	0.246	<	0.036	0.027	0.025	0.032	0.029	0.037	0.027	0.042	0.066	0.004	0.003	0.246	11	4	36	3	27
COOPP	C	.	0.010	.	<	0.155	0.021	0.032	0.072	0.007	<	0.006	0.021	0.008	0.018	0.018	0.031	0.043	0.002	0.003	0.155	11	3	27	2	18
RIDGE	D	<	.	0.020	<	0.015	0.016	0.032	.	.	0.008	<	0.013	0.019	0.018	0.015	0.014	0.009	0.000	0.003	0.032	9	1	11	2	22
COPW5	E	.	<	0.010	<	<	<	0.047	0.077	<	<	<	0.042	0.078	0.048	<	0.028	0.030	0.001	0.003	0.078	11	5	45	6	55
CARLS	F	.	0.020	0.020	<	0.014	0.011	0.030	0.016	<	<	0.009	0.011	0.010	0.015	0.011	0.011	0.008	0.000	0.003	0.030	11	0	0	3	27
WPAIL	G	<	.	0.020	<	0.019	.	0.108	<	0.021	0.007	.	<	0.010	0.022	0.010	0.022	0.031	0.001	0.003	0.108	9	1	11	3	33
WPAIS	H	<	.	0.010	<	0.013	0.017	0.086	0.015	0.014	0.018	0.010	0.060	0.006	0.007	0.014	0.023	0.025	0.001	0.003	0.086	11	2	18	1	9
BLDAL	I	<	.	.	<	0.058	<	0.235	0.115	<	0.039	0.010	0.026	0.013	0.058	0.026	0.051	0.067	0.004	0.003	0.235	11	5	45	3	27
KENMA	J	.	0.020	0.010	.	0.012	<	0.022	.	0.009	0.026	0.010	0.009	0.017	0.018	0.012	0.014	0.007	0.000	0.003	0.026	9	0	0	1	11
LIGHB	K	0.019	.	.	<	0.032	0.012	0.026	0.215	0.010	<	0.020	0.018	0.022	0.021	0.020	0.035	0.058	0.003	0.003	0.215	11	2	18	2	18
LASHV	L	.	.	.	<	0.717	<	0.096	<	0.019	0.021	0.024	<	0.028	0.033	0.021	0.086	0.201	0.040	0.003	0.717	11	3	27	4	36
MEBRV	M	.	0.010	0.030	<	0.045	.	0.035	0.280	<	0.022	0.012	0.031	0.008	0.020	0.021	0.046	0.079	0.006	0.003	0.280	10	4	40	2	20
MARWA	N	0.042	.	0.020	<	0.040	0.051	0.038	0.253	0.029	0.033	0.013	0.482	0.015	0.037	0.037	0.090	0.140	0.020	0.003	0.482	11	7	64	1	9
EASTS	O	.	.	.	.	0.051	0.051	0.358	.	.	.	.	0.114	.	0.074	0.074	0.130	0.116	0.014	0.051	0.358	5	5	100	0	0
LAKFN	P	<	.	.	0.010	0.018	<	0.013	0.005	0.008	0.023	0.012	0.012	0.005	0.020	0.012	0.012	0.006	0.000	0.003	0.023	11	0	0	1	9
LAKFS	Q	<	.	.	<	0.016	0.019	0.029	<	0.005	<	<	0.031	<	0.048	0.005	0.015	0.015	0.000	0.003	0.048	11	2	18	5	45
THORN	R	.	0.020	.	<	0.021	0.017	0.128	0.033	0.014	0.090	<	0.044	0.025	0.032	0.025	0.037	0.037	0.001	0.003	0.128	11	5	45	2	18
TAOFF	S	0.032	.	.	<	0.033	<	0.139	.	.	0.028	0.041	0.006	0.006	0.031	0.028	0.032	0.040	0.002	0.003	0.139	9	4	44	2	22
LIGHF	T	0.014	.	.	<	0.092	0.168	0.057	0.041	0.021	0.054	0.026	0.013	0.042	0.036	0.041	0.050	0.044	0.002	0.003	0.168	11	7	64	1	9
GEORG	U	.	0.020	0.010	<	0.054	0.021	0.029	0.297	0.017	0.030	0.010	0.014	0.016	0.050	0.021	0.049	0.080	0.006	0.003	0.297	11	3	27	1	9
TRICO	V	.	1.125	0.020	<	0.019	<	0.058	0.005	0.012	0.020	0.016	0.026	0.023	0.021	0.019	0.019	0.015	0.000	0.003	0.058	11	1	9	2	18
LIWAF	W	.	.	0.040	<	0.022	<	0.151	0.005	.	0.069	0.016	0.067	0.012	0.067	0.019	0.041	0.045	0.002	0.003	0.151	10	4	40	2	20
BLDAS	X	<	.	.	<	0.048	<	0.196	<	0.017	0.028	0.010	0.010	0.016	0.034	0.016	0.033	0.053	0.003	0.003	0.196	11	3	27	3	27
		MEDIAN			<	0.023	0.007	0.052	0.016	0.013	0.023	0.011	0.024	0.015	0.032						N =	248	74	30	55	22
		MEAN			0.003	0.064	0.020	0.093	0.072	0.013	0.025	0.014	0.047	0.018	0.033											
		STD			0.002	0.140	0.035	0.087	0.100	0.009	0.021	0.010	0.094	0.016	0.017											
		VAR			0.000	0.020	0.001	0.008	0.010	0.000	0.000	0.000	0.009	0.000	0.000							P_mean		0.037		
		MIN			0.003	0.003	0.003	0.013	0.003	0.003	0.003	0.003	0.003	0.003	0.007							P_std		0.073		
		MAX			0.010	0.717	0.168	0.358	0.297	0.036	0.090	0.041	0.482	0.078	0.074							P_var		0.005		
		n			22	24	22	24	20	20	23	22	24	23	24	// 248						P_min		0.003		
		n>0.03			0	11	3	18	9	1	5	2	10	2	13	// 74						P_max		0.717		
		%(n>0.03)			0	46	14	75	45	5	22	9	42	9	54							N		248		
		n<DL			21	1	11	0	6	4	5	4	2	1	0	// 55										
		%n<DL			95	4	50	0	30	20	22	18	8	4	0											

Legend: "." = No Data. "<" = Below Detection Limits. Lab detection limit (DL) = 0.005 mg/L. "P_" = Population Statistic.
"n" = number of observations. Chapter 17-3 standard: Class I and III (onlȳ) = 0.03 mg/L.

TABLE J: OUTFALL STATION IRON (Fe) CONCENTRATIONS (mg/L) FROM THE WATER-QUALITY SURVEY OF 24 WET-DETENTION PONDS, 1988-1989.
Sample statistics calculated by substitution of DL/2 (0.05 mg/L) for only two "<" values. Assume Class III freshwater = 1.00 mg/L.

POND\ Pseudonym	Ltr	101888	110288	112388	112888	121388	012389	DATE 030289	041889	060789	062689	072489	082889	110189	121989	Median	Mean	Std	Var	Min	Max	n	n> 1.0	%n> 1.0	n< DL	%n< DL
								Fe (mg/L)																		
CARLL	A	.	.	0.180	0.080	0.066	0.072	.	0.107	0.040	0.026	0.160	0.100	0.086	0.033	0.076	0.077	0.038	0.001	0.026	0.160	10	0	0	0	0
GTEDS	B	0.445	.	.	0.290	0.401	0.191	1.183	0.150	0.950	0.230	0.230	0.300	0.098	0.070	0.230	0.372	0.343	0.118	0.070	1.183	11	1	9	0	0
COOPP	C	.	0.160	.	0.230	0.267	0.094	0.091	0.159	0.360	0.170	0.410	0.390	0.090	0.063	0.170	0.211	0.123	0.015	0.063	0.410	11	0	0	0	0
RIDGE	D	0.167	.	0.350	0.260	0.330	0.375	0.217	.	.	0.170	0.280	0.090	0.251	0.324	0.260	0.255	0.083	0.007	0.090	0.375	9	0	0	0	0
COPW5	E	.	0.440	0.240	0.120	0.118	0.089	0.122	0.151	0.140	0.220	0.140	0.090	0.194	0.164	0.140	0.141	0.039	0.001	0.089	0.220	11	0	0	0	0
CARLS	F	.	0.070	0.270	0.100	0.052	0.034	0.104	0.093	<	0.120	0.200	0.060	0.096	0.080	0.093	0.086	0.048	0.002	0.010	0.200	11	0	0	1	9
WPAIL	G	1.790	.	2.540	1.440	1.438	.	0.854	0.737	0.940	0.740	.	0.800	1.770	3.300	0.940	1.335	0.779	0.606	0.737	3.300	9	4	44	0	0
WPAIS	H	<	.	0.740	0.200	0.097	0.229	0.161	0.134	0.380	0.370	0.440	0.470	0.269	0.080	0.229	0.257	0.132	0.017	0.080	0.470	11	0	0	0	0
BLDAL	I	0.319	.	.	0.240	0.163	0.306	0.293	0.202	0.195	0.170	0.230	0.080	0.147	0.121	0.195	0.195	0.066	0.004	0.080	0.306	11	0	0	0	0
KENMA	J	.	0.190	0.360	.	0.041	0.052	0.090	.	0.340	0.280	0.160	0.090	0.276	0.116	0.116	0.161	0.104	0.011	0.041	0.340	9	0	0	0	0
LIGHB	K	0.202	.	.	0.370	0.293	0.281	0.314	0.405	0.230	0.330	0.360	0.330	1.567	0.234	0.330	0.429	0.364	0.132	0.230	1.567	11	1	9	0	0
LASHV	L	.	.	.	0.100	0.194	0.171	0.511	0.230	0.220	0.130	0.140	0.110	0.442	0.126	0.171	0.216	0.130	0.017	0.100	0.511	11	0	0	0	0
MEBRV	M	.	0.310	0.300	0.120	0.067	.	0.134	0.235	0.100	<	0.230	0.440	0.134	0.074	0.127	0.154	0.116	0.013	0.010	0.440	10	0	0	1	10
MARWA	N	0.586	.	0.470	0.380	0.222	0.276	0.375	1.741	0.250	0.300	0.490	0.210	0.217	0.270	0.276	0.430	0.422	0.178	0.210	1.741	11	1	9	0	0
EASTS	O	.	.	.	.	0.144	0.064	0.235	.	.	.	.	1.860	.	0.597	0.235	0.580	0.665	0.443	0.064	1.860	5	1	20	0	0
LAKFN	P	0.313	.	.	1.220	0.228	0.413	0.040	0.209	0.190	0.200	0.450	0.140	0.065	0.078	0.200	0.294	0.318	0.101	0.040	1.220	11	1	9	0	0
LAKFS	Q	0.366	.	.	0.430	0.302	0.621	0.545	0.269	0.530	0.140	0.430	0.190	0.165	0.071	0.302	0.336	0.177	0.031	0.071	0.621	11	0	0	0	0
THORN	R	.	0.330	.	0.300	0.233	0.511	0.401	0.654	1.290	0.290	0.230	0.070	0.392	0.489	0.392	0.442	0.308	0.095	0.070	1.290	11	1	9	0	0
TAOFF	S	1.475	.	.	0.300	0.250	0.216	0.615	.	.	0.486	0.480	0.240	0.203	0.287	0.287	0.342	0.139	0.019	0.203	0.615	9	0	0	0	0
LIGHF	T	0.138	.	.	0.400	0.053	0.328	0.232	0.663	0.110	0.220	0.280	0.100	0.276	0.085	0.232	0.250	0.168	0.028	0.053	0.663	11	0	0	0	0
GEORG	U	.	0.430	0.260	0.070	0.221	0.162	0.110	0.320	0.210	0.400	0.300	0.120	0.166	0.317	0.210	0.218	0.100	0.010	0.070	0.400	11	0	0	0	0
TRICO	V	.	0.040	0.460	0.270	0.099	0.130	0.129	0.237	0.280	0.220	0.340	0.230	0.217	0.176	0.220	0.212	0.070	0.005	0.099	0.340	11	0	0	0	0
LIWAF	W	.	.	0.230	0.220	0.154	0.191	0.940	0.097	.	1.700	0.250	0.250	0.127	0.154	0.206	0.408	0.489	0.239	0.097	1.700	10	1	10	0	0
BLDAS	X	0.136	.	.	0.460	0.313	0.222	0.251	0.414	0.180	0.260	0.410	0.150	0.301	0.140	0.260	0.282	0.104	0.011	0.140	0.460	11	0	0	0	0
	Median				0.265	0.208	0.204	0.235	0.232	0.225	0.220	0.280	0.170	0.203	0.133						N =	247	11	4.5	2	0.8
	Mean				0.345	0.239	0.229	0.346	0.360	0.347	0.312	0.302	0.288	0.328	0.310											
	Std				0.333	0.269	0.149	0.297	0.369	0.328	0.332	0.113	0.368	0.425	0.638				P_mean		0.309					
	Var				0.111	0.072	0.022	0.088	0.136	0.107	0.110	0.013	0.136	0.181	0.408				P_std		0.360					
	Min				0.070	0.041	0.034	0.040	0.093	0.010	0.010	0.140	0.060	0.065	0.033				P_var		0.129					
	Max				1.440	1.438	0.621	1.183	1.741	1.290	1.700	0.490	1.860	1.770	3.300				P_min		0.010					
	n				22	24	22	23	20	20	23	22	24	23	24	//N = 247			N		247					
	n>1.00				2	1	0	1	1	1	1	0	1	2	1	// 11										
	%n>1.00				9	4	0	4	5	5	4	0	4	9	4											
	n<DL				0	0	0	0	0	1	1	0	0	0	0	// 2										
	%n<DL				0	0	0	0	0	5	4	0	0	0	0											

Legend: "." = No Data.
"<" = Below Detection Limit.
"n" = number of observations

"P_" = Population Statistic
Detection limit (DL) = 0.020 mg/L.

Chapter 17-3 standard:
(Freshwater) Class I and II = 0.30 mg/L Class III = 1.00 mg/L
(Marine) Class I, II, and III = 0.30 mg/L

TABLE K: OUTFALL STATION COPPER (Cu) CONCENTRATIONS (mg/L) FROM THE WATER-QUALITY SURVEY OF 24 WET-DETENTION PONDS, 1988 - 1989.
Sample statistics calculated by substitution of DL/2 (0.005 mg/L) for "<" values.

POND/ Pseudonym	Ltr	DATE 101888	110288	112388	112888	121388	012389	030289	041889	060789	062689	072489	082889	110189	121989	Median	Mean	Std	Var	Min	Max	n	n> 0.03	%n> 0.03
								Cu (mg/L)																
CARLL	A	.	.	<	<	0.011	<	<	0.033	0.013	0.010	<	<	<	0.023	<	0.011	0.009	0.000	0.005	0.033	11	1	9
GTEDS	B	<	.	.	<	0.016	<	0.022	0.035	<	0.010	0.035	0.016	0.010	<	0.010	0.015	0.011	0.000	0.005	0.035	11	2	18
COOPP	C	.	<	.	0.017	<	<	<	0.023	<	<	<	<	<	<	<	0.008	0.006	0.000	0.005	0.023	11	0	0
RIDGE	D	0.016	.	0.011	0.016	0.014	<	<	.	.	0.019	0.040	0.020	0.019	0.036	0.019	0.019	0.011	0.000	0.005	0.040	9	2	22
COPW5	E	.	0.012	<	<	<	<	<	0.032	<	<	<	0.019	<	0.028	<	0.011	0.010	0.000	0.005	0.032	11	1	9
CARLS	F	.	0.046	0.011	0.012	0.011	0.016	0.015	0.033	0.015	0.042	0.045	0.033	0.019	0.055	0.019	0.027	0.015	0.000	0.011	0.055	11	5	45
WPAIL	G	0.070	.	0.016	<	<	.	<	0.025	<	<	.	<	<	<	<	0.007	0.006	0.000	0.005	0.025	9	0	0
WPAIS	H	0.028	.	0.016	<	<	<	<	0.040	<	<	0.043	<	0.010	<	<	0.012	0.014	0.000	0.005	0.043	11	2	18
BLDAL	I	<	.	.	0.024	<	<	<	0.032	<	0.014	0.034	.	<	0.016	0.010	0.015	0.011	0.000	0.005	0.034	10	2	20
KENMA	J	.	0.025	<	<	<	<	<	.	.	<	<	<	<	<	<	0.005	0.000	0.000	0.005	0.005	9	0	0
LIGHB	K	<	.	.	0.010	<	<	0.012	0.030	<	.	0.012	<	0.023	0.044	0.011	0.015	0.013	0.000	0.005	0.044	10	1	10
LASHV	L	.	.	.	<	0.021	<	<	0.027	<	<	0.038	<	0.024	0.022	<	0.015	0.011	0.000	0.005	0.038	11	1	9
MEBRV	M	.	<	<	<	<	.	<	<	<	<	0.033	<	<	0.018	<	0.009	0.009	0.000	0.005	0.033	10	1	10
MARWA	N	<	.	<	<	<	0.016	0.016	0.016	<	<	<	0.096	<	0.010	<	0.017	0.026	0.001	0.005	0.096	11	1	9
EASTS	O	.	.	.	.	<	<	<	.	.	.	.	0.032	.	<	<	0.010	0.011	0.000	0.005	0.032	5	1	20
LAKFN	P	<	.	.	<	<	<	<	0.075	<	<	0.036	<	0.024	0.013	<	0.017	0.021	0.000	0.005	0.075	11	2	18
LAKFS	Q	<	.	.	<	<	<	<	0.034	<	<	<	0.012	0.011	0.021	<	0.010	0.009	0.000	0.005	0.034	11	1	9
THORN	R	.	0.018	.	0.021	0.016	<	<	0.056	0.018	0.022	0.019	0.012	0.049	0.032	0.019	0.023	0.016	0.000	0.005	0.056	11	3	27
TAOFF	S	<	.	.	<	<	<	<	.	.	<	<	<	<	<	<	0.005	0.000	0.000	0.005	0.005	9	0	0
LIGHF	T	<	.	.	0.121	0.022	0.138	0.022	0.082	0.016	0.024	0.026	0.012	0.142	0.181	0.026	0.071	0.060	0.004	0.012	0.181	11	5	45
GEORG	U	.	<	<	<	<	<	<	0.195	<	0.025	0.017	<	0.021	0.036	<	0.029	0.053	0.003	0.005	0.195	11	2	18
TRICO	V	.	0.039	<	<	<	0.017	<	0.030	<	<	0.010	<	<	<	<	0.009	0.008	0.000	0.005	0.030	11	0	0
LIWAF	W	.	.	<	<	<	<	<	<	.	<	0.022	<	<	0.010	<	0.007	0.005	0.000	0.005	0.022	10	0	0
BLDAS	X	<	.	.	<	<	<	<	<	<	0.017	0.044	<	<	0.029	<	0.012	0.013	0.000	0.005	0.044	11	1	9
	Median				<	<	<	<	0.032	<	<	0.021	<	<	0.017							246	34	14
	Mean				0.013	0.008	0.013	0.008	0.041	0.007	0.011	0.022	0.014	0.018	0.026									
	Std				0.024	0.005	0.028	0.005	0.040	0.004	0.010	0.015	0.019	0.028	0.035				P_mean		0.016			
	Var				0.001	0.000	0.001	0.000	0.002	0.000	0.000	0.000	0.000	0.001	0.001				P_std		0.025			
	Min				0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005				P_var		0.001			
	Max				0.121	0.022	0.138	0.022	0.195	0.018	0.042	0.045	0.096	0.142	0.181				P_min		0.005			
	n				23	24	22	24	20	19	22	22	23	23	24	// 246			P_max		0.195			
	n>0.03				1	0	1	0	11	0	1	9	3	2	6	// 34			N		246			
	%n>0.03				4	0	5	0	55	0	5	41	13	9	25									
	n<DL				16	17	18	19	3	15	13	7	14	12	8	// 142								
	%n<DL				70	71	82	79	15	79	59	32	61	52	33									

Legend: "." = No Data.
"<" = Below Detection Limits.
"n" = number of observations

Detection limit (DL) = 0.010 mg/L.
"P_" = Population Statistic.

Chapter 17-3 standards: Class I = 0.030 mg/L Class II = 0.015 mg/L
Class III = 0.015 mg/L (marine) and 0.030 mg/L (freshwater).

TABLE L: OUTFALL STATION MANGANESE (Mn) CONCENTRATIONS (mg/L) FROM THE WATER-QUALITY SURVEY OF 24 WET-DETENTION PONDS, 1988 to 1989.
Sample stattistics calculated by substitution of DL/2 for "<" values. Class II standard only.

POND\ Pseudonym	Ltr	101888	110288	112388	112888	121388	012389	030289	041889	060789	062689	072489	082889	110189	121989	Median	Mean	Std	Var	Min	Max	n	n> 0.10	%n> 0.10	n< DL
								Mn (mg/L)																	
CARLL	A	.	.	.	.	<	<	0.0110	0.0320	0.0157	<	<	<	0.0143	<	<	0.010	0.008	0.000	0.005	0.032	10	0	0	6
GTEDS	B	.	.	.	.	<	<	0.0400	0.0200	<	0.0370	<	0.0113	<	0.0300	0.008	0.016	0.014	0.000	0.005	0.040	10	0	0	5
COOPP	C	.	.	.	.	<	<	<	<	0.0440	0.2210	0.0330	0.0151	<	0.0210	0.010	0.036	0.063	0.004	0.005	0.221	10	1	10	5
RIDGE	D	.	.	.	.	<	<	0.0120	.	.	<	0.0160	<	0.0237	0.0100	0.008	0.010	0.006	0.000	0.005	0.024	8	0	0	4
COPW5	E	.	.	.	.	<	<	0.0260	0.0180	<	<	0.0380	<	0.0157	0.0440	0.010	0.017	0.014	0.000	0.005	0.044	10	0	0	5
CARLS	F	.	.	.	.	<	<	0.0180	0.0140	0.0116	0.0100	0.0300	<	0.0642	<	0.011	0.017	0.017	0.000	0.005	0.064	10	0	0	4
WPAIL	G	.	.	.	.	<	.	<	<	<	0.0250	.	<	<	0.0110	<	0.008	0.007	0.000	0.005	0.025	8	0	0	6
WPAIS	H	.	.	.	.	<	<	<	<	<	<	<	<	<	0.0210	<	0.007	0.005	0.000	0.005	0.021	10	0	0	9
BLDAL	I	.	.	.	.	<	<	0.0110	<	<	0.0110	<	<	0.0166	<	<	0.007	0.004	0.000	0.005	0.017	10	0	0	7
KENMA	J	.	.	.	.	<	<	<	.	.	0.0180	<	<	<	0.0120	<	0.008	0.005	0.000	0.005	0.018	8	0	0	6
LIGHB	K	.	.	.	.	<	<	0.0360	0.0270	0.0288	0.0230	0.0510	0.0270	0.0494	0.0190	0.027	0.027	0.015	0.000	0.005	0.051	10	0	0	2
LASHV	L	.	.	.	.	<	<	0.0110	<	0.0118	0.0290	0.0170	<	0.0100	<	0.008	0.010	0.007	0.000	0.005	0.029	10	0	0	5
MEBRV	M	.	.	.	.	<	.	0.0120	0.0130	0.0278	<	<	0.0301	0.0152	0.0100	0.012	0.014	0.009	0.000	0.005	0.030	9	0	0	3
MARWA	N	.	.	.	.	<	<	0.0160	0.0300	0.0496	0.0520	0.0590	0.0424	0.0253	0.0280	0.029	0.031	0.018	0.000	0.005	0.059	10	0	0	2
EASTS	O	.	.	.	.	<	<	0.0130	.	.	.	.	0.0247	.	0.0120	0.012	0.012	0.007	0.000	0.005	0.025	5	0	0	2
LAKFN	P	.	.	.	.	<	<	0.0140	<	<	<	<	<	<	0.0320	<	0.009	0.008	0.000	0.005	0.032	10	0	0	8
LAKFS	Q	.	.	.	.	<	<	0.0180	0.0190	<	<	0.0280	<	0.0115	0.0140	0.008	0.012	0.008	0.000	0.005	0.028	10	0	0	5
THORN	R	.	.	.	.	<	<	0.0150	0.0110	<	0.0270	0.0180	<	<	<	<	0.010	0.007	0.000	0.005	0.027	10	0	0	6
TAOFF	S	.	.	.	.	<	<	0.0245	.	.	0.0350	0.0360	<	0.0142	0.0170	0.016	0.018	0.012	0.000	0.005	0.036	8	0	0	3
LIGHF	T	.	.	.	.	<	<	0.0180	0.0350	<	0.0100	0.0170	0.0149	0.0227	<	0.012	0.014	0.009	0.000	0.005	0.035	10	0	0	4
GEORG	U	.	.	.	.	<	<	0.0160	0.0120	<	0.0120	0.0180	<	0.0173	0.0140	0.012	0.011	0.005	0.000	0.005	0.018	10	0	0	4
TRICO	V	.	.	.	.	<	<	0.0130	0.0150	0.0127	0.0310	0.0240	0.0112	<	<	0.012	0.013	0.008	0.000	0.005	0.031	10	0	0	4
LIWAF	W	.	.	.	.	<	<	0.0390	<	.	0.0160	0.0190	<	<	0.0240	<	0.014	0.011	0.000	0.005	0.039	9	0	0	5
BLDAS	X	.	.	.	.	<	<	0.0150	0.0420	0.0250	0.0190	0.0140	0.0207	0.0894	0.0210	0.020	0.026	0.024	0.001	0.005	0.089	10	0	0	2
	Median					<	<	0.0145	0.0135	<	0.0160	0.0175	<	0.0142	0.0130							225	1	0.4	112
	Mean					0.0050	0.0050	0.0166	0.0162	0.0146	0.0266	0.0206	0.0114	0.0189	0.0156										
	Std					ERR	0.0000	0.0098	0.0113	0.0136	0.0433	0.0152	0.0101	0.0208	0.0102				P_mean		0.015				
	Var					*******	0.0000	0.0001	0.0001	0.0002	0.0019	0.0002	0.0001	0.0004	0.0001				P_std		0.019				
	Min					0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050				P_var		0.000				
	Max					0.0050	0.0050	0.0400	0.0420	0.0496	0.2210	0.0590	0.0424	0.0894	0.0440				P_min		0.005				
	n					24	22	24	20	19	23	22	24	23	24	// 225			P_max		0.221				
	n>0.10					0	0	0	0	0	1	0	0	0	0	// 1			N		225				
	n<DL					24	22	4	7	10	7	7	15	9	7	// 112									

Legend: "." = No Data. "<" = Below Detection Limits. Detection limit (DL) = 0.010 mg/L. "P_" = Population Statistic.
"n" = number of observations Chapter 17-3 standard = Class II (only) = 0.100 mg/L.

TABLE M: OUTFALL STATION LEAD (Pb) CONCENTRATIONS (mg/L) FROM THE WATER-QUALITY SURVEY OF 24 WET-DETENTION PONDS, 1988 to 1989.
Sample statistics calculated by substitution of DL/2 (0.005 mg/L) for "<" values.

POND\ Pseudonym	Ltr	DATE 101888	110288	112388	112888	121388	012389	030289	041889	060789	062689	072489	082889	110189	121989	Median	Mean	Std	Var	Min	Max	n	n> 0.03	%n> 0.03	n< DL	%n< DL
								Pb (mg/L)																		
CARLL	A	.	<	<	<	<	0.019	<	0.054	<	<	<	<	<	<	<	0.011	0.014	0.000	0.005	0.054	11	1	9	9	82
GTEDS	B	<	.	.	<	<	<	<	0.012	<	<	<	<	<	<	<	0.006	0.002	0.000	0.005	0.012	11	0	0	10	91
COOPP	C	.	<	.	<	<	<	<	<	<	<	<	<	<	<	<	0.005	0.000	0.000	0.005	0.005	11	0	0	11	100
RIDGE	D	<	.	<	<	<	<	<	.	.	<	<	<	<	0.035	<	0.008	0.009	0.000	0.005	0.035	9	1	11	8	89
COPW5	E	.	0.009	<	<	<	0.244	<	0.047	<	<	<	<	<	<	<	0.031	0.069	0.005	0.005	0.244	11	2	18	9	82
CARLS	F	.	.	<	<	<	0.011	<	<	<	<	0.145	<	<	<	<	0.018	0.040	0.002	0.005	0.145	11	1	9	9	82
WPAIL	G	<	.	<	<	0.011	.	<	0.012	.	<	.	<	<	0.016	<	0.008	0.004	0.000	0.005	0.016	8	0	0	5	63
WPAIS	H	<	.	<	<	<	0.016	<	0.033	<	<	<	0.025	<	<	<	0.010	0.009	0.000	0.005	0.033	11	1	9	8	73
BLDAL	I	<	.	.	<	<	<	<	0.024	.	<	<	<	<	<	<	0.007	0.006	0.000	0.005	0.024	10	0	0	9	90
KENMA	J	.	<	<	<	<	0.025	<	.	.	<	<	0.032	<	<	<	0.010	0.010	0.000	0.005	0.032	9	1	11	7	78
LIGHB	K	<	.	.	<	<	<	<	0.017	<	<	<	<	<	<	<	0.006	0.003	0.000	0.005	0.017	11	0	0	10	91
LASHV	L	.	.	.	<	<	<	<	0.020	<	<	<	<	0.014	0.036	<	0.010	0.009	0.000	0.005	0.036	11	1	9	8	73
MEBRV	M	.	<	<	<	<	.	<	<	<	<	<	<	<	<	<	0.005	0.000	0.000	0.005	0.005	10	0	0	10	100
MARWA	N	<	.	<	<	<	0.030	<	<	<	<	<	<	<	0.040	<	0.010	0.012	0.000	0.005	0.040	11	1	9	9	82
EASTS	O	.	.	.	.	<	0.020	<	.	.	.	.	0.015	.	<	<	0.010	0.006	0.000	0.005	0.020	5	0	0	3	60
LAKFN	P	<	.	.	<	<	0.014	<	<	<	<	<	<	<	<	<	0.006	0.003	0.000	0.005	0.014	11	0	0	10	91
LAKFS	Q	<	.	.	<	<	0.035	<	0.027	<	<	<	<	<	0.048	<	0.014	0.015	0.000	0.005	0.048	11	2	18	8	73
THORN	R	.	<	.	<	<	<	<	0.014	<	<	<	<	<	<	<	0.006	0.003	0.000	0.005	0.014	11	0	0	10	91
TAOFF	S	<	.	.	<	<	<	<	.	.	<	<	<	0.027	0.246	<	0.034	0.075	0.006	0.005	0.246	9	1	11	7	78
LIGHF	T	<	.	.	0.014	<	0.012	<	0.012	<	<	<	<	<	0.103	<	0.016	0.028	0.001	0.005	0.103	11	1	9	7	64
GEORG	U	.	<	<	<	<	<	<	<	<	<	<	<	<	0.080	<	0.012	0.022	0.000	0.005	0.080	11	1	9	10	91
TRICO	V	.	0.071	<	<	<	0.176	<	0.011	<	<	<	<	<	<	<	0.021	0.049	0.002	0.005	0.176	11	1	9	9	82
LIWAF	W	.	.	<	<	<	0.036	<	<	.	<	<	<	<	<	<	0.008	0.009	0.000	0.005	0.036	10	1	10	9	90
BLDAS	X	<	.	.	<	0.033	0.014	<	<	<	<	<	<	<	<	<	0.008	0.008	0.000	0.005	0.033	11	1	9	9	82
	Median				<	<	0.013	<	0.012	<	<	<	<	<	<							246	17	7	204	83
	Mean				0.005	0.006	0.032	0.005	0.016	0.005	0.005	0.011	0.007	0.006	0.029											
	Std				0.002	0.006	0.058	ERR	0.014	0.000	ERR	0.029	0.007	0.005	0.052				P_mean		0.012					
	Var				0.000	0.000	0.003	-0.000	0.000	0.000	-0.000	0.001	0.000	0.000	0.003				P_std		0.028					
	Min				0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005				P_var		0.001					
	Max				0.014	0.033	0.244	0.005	0.054	0.005	0.005	0.145	0.032	0.027	0.246				P_min		0.005					
	n				23	24	22	24	20	17	23	22	24	23	24 //	246			P_max		0.246					
	n>0.03				0	1	4	0	3	0	0	1	1	0	7 //	17			N		246					
	n<DL				22	22	9	24	8	17	23	21	21	21	16 //	204										

Legend: "." = No Data. "<" = Below Detection Limits. Detection limit (DL) = 0.010 mg/L. "P_" = Population Statistic.
"n" = number of observations Chapter 17-3 standard: Class I and III (only) = 0.030 mg/L.

TABLE N: OUTFALL STATION CADMIUM (Cd) CONCENTRATIONS (mg\L) FROM THE WATER-QUALITY SURVEY OF 24 WET-DETENTION PONDS, 1988 - 1989.
Sample Statistics calculated by substitution of DL/2 (0.001 mg/L) for "<" values. Assume Class III freshwater > 150 mg/L CaCO3.

POND/ Pseudonym	Ltr	DATE 101888	110288	112388	112888	121388	012389	030289	041889	060789	062689	072489	082889	110189	121989	Median	Mean	Std	Var	Min	Max	n	n> 0.0012	%n> 0.0012	n< DL	%n< DL
								Cd (mg/L)																		
CARLL	A	.	.	0.0040	<	<	<	<	0.0290	<	<	<	0.0020	.	0.0070	<	0.005	0.008	0.000	0.001	0.029	10	3	30	7	70
GTEDS	B	<	.	.	<	<	<	<	<	<	<	<	<	.	<	<	0.001	0.000	0.000	0.001	0.001	10	0	0	10	100
COOPP	C	.	0.0040	.	<	<	<	<	<	0.0070	<	<	<	.	<	<	0.002	0.002	0.000	0.001	0.007	10	1	10	9	90
RIDGE	D	.	.	0.0050	<	<	<	<	.	.	0.0020	<	<	.	<	<	0.001	0.000	0.000	0.001	0.002	8	1	13	7	88
COPW5	E	.	0.0060	0.0070	<	<	<	<	<	0.0110	<	0.0120	<	.	0.0400	<	0.007	0.012	0.000	0.001	0.040	10	3	30	7	70
CARLS	F	.	0.0040	0.0070	<	<	<	<	<	<	<	0.0150	<	.	0.0280	<	0.005	0.009	0.000	0.001	0.028	10	2	20	8	80
WPAIL	G	.	.	0.0030	<	<	.	<	<	<	<	.	<	.	<	<	0.001	ERR	******	0.001	0.001	8	0	0	8	100
WPAIS	H	.	.	0.0060	<	<	<	<	<	0.0060	<	<	0.0030	.	0.0060	<	0.002	0.002	0.000	0.001	0.006	10	3	30	7	70
BLDAL	I	.	.	.	<	<	<	<	0.0400	0.0030	0.0040	0.0200	.	.	0.0040	0.003	0.008	0.013	0.000	0.001	0.040	9	5	56	4	44
KENMA	J	.	<	<	.	<	<	<	.	<	<	<	<	.	0.0020	<	0.001	0.000	0.000	0.001	0.002	8	1	13	7	88
LIGHB	K	<	.	.	<	<	<	<	<	<	<	<	<	.	0.0020	<	0.001	0.000	0.000	0.001	0.002	10	1	10	9	90
LASHV	L	.	.	.	<	<	<	<	<	0.0130	0.0120	<	<	.	0.0080	<	0.004	0.005	0.000	0.001	0.013	10	3	30	7	70
MEBRV	M	.	0.0030	0.0050	<	<	.	<	0.0530	0.0060	<	<	<	.	<	<	0.007	0.016	0.000	0.001	0.053	9	2	22	7	78
MARWA	N	.	.	0.0050	<	<	<	<	<	0.0020	<	<	<	.	0.0020	<	0.001	0.000	0.000	0.001	0.002	10	2	20	8	80
EASTS	O	.	.	.	.	<	<	<	.	.	<	<	0.0030	.	0.0120	<	0.003	0.004	0.000	0.001	0.012	7	2	29	5	71
LAKFN	P	.	.	.	<	<	<	<	<	0.0040	<	<	<	.	<	<	0.001	0.001	0.000	0.001	0.004	10	1	10	9	90
LAKFS	Q	.	.	.	<	<	<	<	<	0.0070	<	<	<	.	<	<	0.002	0.002	0.000	0.001	0.007	10	1	10	9	90
THORN	R	.	0.0020	.	<	<	<	<	<	0.0100	0.0040	<	0.0020	.	<	<	0.002	0.003	0.000	0.001	0.010	10	3	30	7	70
TAOFF	S	.	.	.	<	<	<	<	.	.	<	<	<	.	0.0090	<	0.002	0.003	0.000	0.001	0.009	8	1	13	7	88
LIGHF	T	<	.	.	<	<	<	<	<	0.0070	<	<	<	.	0.0050	<	0.002	0.002	0.000	0.001	0.007	10	2	20	8	80
GEORG	U	.	0.0050	0.0090	<	<	<	<	<	0.0040	<	<	<	.	0.0040	<	0.002	0.001	0.000	0.001	0.004	10	2	20	8	80
TRICO	V	.	0.0070	0.0080	<	<	<	<	<	<	<	<	<	.	<	<	0.001	0.000	0.000	0.001	0.001	10	0	0	10	100
LIWAF	W	.	.	0.0030	<	<	<	<	<	.	<	<	<	.	<	<	0.001	ERR	******	0.001	0.001	9	0	0	9	100
BLDAS	X	.	.	.	<	<	<	<	<	0.0020	<	<	<	.	<	<	0.001	0.000	0.000	0.001	0.002	10	1	10	9	90
	Median				0.0010	<	<	<	<	0.0035	<	<	<		0.0020							226	40	18	186	82
	Mean				0.0010	0.0010	0.0010	0.0010	0.0070	0.0045	0.0018	0.0029	0.0013		0.0058											
	Std				0.0000	0.0000	0.0000	0.0000	0.0147	0.0037	0.0023	0.0051	0.0006		0.0092				P_mean		0.003					
	Var				0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000		0.0001				P_std		0.006					
	Min				0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010		0.0010				P_var		0.000					
	Max				0.0010	0.0010	0.0010	0.0010	0.0530	0.0130	0.0120	0.0200	0.0030		0.0400				P_min		0.001					
	n				22	24	22	24	20	20	24	23	23		24	// 226			P_max		0.053					
	n>0.0012				0	0	0	0	3	13	4	3	4		13	// 40			N		226					
	n<DL				22	24	22	24	17	7	20	20	19		11	// 186										

Legend: "." = No Data.
"P_" = Population Statistic.
"DL" = Detection limit (0.002 mg/L).
"<" = Below Detection Limits.
"n" = number of observations

Chapter 17-3 standard:
Freshwater (Class I and III) = 0.0008 mg/L or 0.0012 mg/L (< or > 150 mg/L CaCO3, respectively).
(Class II) = 0.005 mg/L. Marine (Class II and III only) = 0.005 mg/L.

TABLE O: OUTFALL STATION CHROMIUM (Cr) CONCENTRATIONS (mg/L) FROM THE WATER-QUALITY SURVEY OF 24 WET-DETENTION PONDS, 1988 - 1989.
Sample statistics calculated by substitution of DL/2 (0.005) for "<" values.

POND\		DATE																					n>
Pseudonym	Ltr	101888	110288	112388	112888	121388	012389	030289	041889	060789	062689	072489	082889	110189	121989	Median	Mean	Std	Var	Min	Max	n	0.05
								Cr (mg/L)															
CARLL	A	.	.	0.012	0.011	0.035	<	<	0.014	<	<	0.121	<	<	<	<	0.020	0.033	0.001	<	0.121	11	1
GTEDS	B	<	.	.	<	<	<	0.018	0.013	<	<	<	<	<	<	<	0.007	0.004	0.000	<	0.018	11	0
COOPP	C	.	<	.	<	<	<	<	<	<	<	<	<	<	<	<	<	0.000	0.000	<	<	11	0
RIDGE	D	0.050	.	0.058	<	<	<	<	.	.	<	<	<	<	<	<	<	0.000	0.000	<	<	9	0
COPW5	E	.	<	<	<	<	<	<	0.026	<	<	<	<	<	<	<	0.007	0.006	0.000	<	0.026	11	0
CARLS	F	.	<	<	<	<	<	<	<	<	<	0.047	<	<	<	<	0.009	0.012	0.000	<	0.047	11	0
WPAIL	G	<	.	0.017	<	0.010	.	0.013	0.019	<	<	.	<	0.017	0.031	0.010	0.012	0.008	0.000	<	0.031	9	0
WPAIS	H	<	.	<	<	<	<	<	0.011	<	<	0.181	<	<	<	<	0.022	0.050	0.003	<	0.181	11	1
BLDAL	I	<	.	.	<	<	<	<	0.046	<	<	<	<	<	<	<	0.009	0.012	0.000	<	0.046	11	0
KENMA	J	.	<	0.248	<	<	<	<	.	.	<	<	<	<	<	<	<	0.000	0.000	<	<	9	0
LIGHB	K	<	.	.	<	<	<	<	0.017	<	.	<	0.011	<	<	<	0.007	0.004	0.000	<	0.017	10	0
LASHV	L	.	.	.	<	0.016	<	<	<	<	<	<	.	<	<	<	0.006	0.003	0.000	<	0.016	10	0
MEBRV	M	.	<	<	<	0.011	.	<	<	<	<	<	<	.	<	<	0.006	0.002	0.000	<	0.011	9	0
MARWA	N	<	.	<	<	0.014	<	<	0.077	<	<	0.230	0.033	<	0.015	<	0.036	0.065	0.004	<	0.230	11	2
EASTS	O	.	.	.		<	<	<	.	.	.	.	0.011	.	<	<	0.006	0.002	0.000	<	0.011	5	0
LAKFN	P	<	.	.	<	0.020	<	0.179	<	<	<	<	<	<	<	<	0.022	0.050	0.003	<	0.179	11	1
LAKFS	Q	<	.	.	<	0.010	<	<	0.046	<	<	<	<	<	<	<	0.009	0.012	0.000	<	0.046	11	0
THORN	R	.	<	.	<	0.016	<	<	0.015	<	<	<	<	<	<	<	0.007	0.004	0.000	<	0.016	11	0
TAOFF	S	<	.	.	<	<	<	0.011	<	.	<	<	<	<	<	<	0.006	0.002	0.000	<	0.011	10	0
LIGHF	T	<	.	.	<	<	<	<	0.059	<	0.106	<	<	<	<	<	0.019	0.032	0.001	<	0.106	11	2
GEORG	U	.	<	<	<	0.010	<	<	0.038	<	<	<	<	<	<	<	0.008	0.009	0.000	<	0.038	11	0
TRICO	V	.	0.014	0.097	<	0.012	0.043	<	0.018	<	<	0.021	<	<	<	<	0.012	0.011	0.000	<	0.043	11	0
LIWAF	W	.	.	<	<	0.010	<	<	<	.	0.163	<	<	<	<	<	0.021	0.047	0.002	<	0.163	10	1
BLDAS	X	<	.	.	0.010	0.011	<	<	<	<	<	<	<	<	<	<	0.006	0.002	0.000	<	0.011	11	0
	Median				<	0.0075	<	<	0.014	<	<	<	<	<	<						N =	246	8
	Mean				0.006	0.010	0.007	0.013	0.021	<	0.017	0.031	0.007	0.006	0.007								
	Std				0.002	0.007	0.008	0.035	0.020	0.000	0.038	0.061	0.006	0.003	<				P_mean		0.012		
	Var				0.000	0.000	0.000	0.001	0.000	0.000	0.001	0.004	0.000	0.000	0.000				P_std		0.026		
	Min				<	<	<	<	<	<	<	<	<	<	<				P_var		0.001		
	Max				0.011	0.035	0.043	0.179	0.077	<	0.163	0.230	0.033	0.017	0.031				P_min		<		
	n				23	24	22	24	21	19	22	22	23	22	24	//N =	246		P_max		0.230		
	n<DL				21	12	21	20	8	19	20	17	20	21	22	//	201		N		246		
	%n<DL				91	50	95	83	38	100	91	77	87	95	92								
	n>0.05				0	0	0	1	2	0	2	3	0	0	0	//	8						
	%n>0.05				0	0	0	4	10	0	9	14	0	0	0								

Legend: "." = No Data. "<" = Below Detection Limits. Detection limit = 0.010 mg/L. Chapter 17-3 standard (Class I, II and III) = 0.05 mg/L.
"n" = number of observations

TABLE P: OUTFALL STATION NICKEL (Ni) CONCENTRATIONS (mg/L) FROM THE WATER-QUALITY SURVEY OF 24 WET-DETENTION PONDS, 1988 - 1989.
Sample statistics calculated by substitution of DL/2 (0.005 mg/L) for "<" values.

POND\ Pseudonym	Ltr	101888	110288	112388	112888	121388	012389	DATE 030289	041889	060789	062689	072489	082889	110189	121989	Median	Mean	Std	Var	Min	Max	n	n> 0.10	%n> 0.10	n< DL	%n< DL
								Ni (mg/L)																		
CARLL	A	.	.	.	<	<	<	<	.	.	<	.	<	<	<	<	<	0.000	0.000	<	<	8	0	0	8	100
GTEDS	B	<	.	.	<	<	<	0.0180	.	.	<	.	<	<	<	<	0.007	0.004	0.000	<	0.018	8	0	0	7	88
COOPP	C	.	.	.	<	<	<	<	.	.	<	.	<	<	<	<	<	0.000	0.000	<	<	8	0	0	8	100
RIDGE	D	<	.	.	<	<	<	<	.	.	0.0190	.	<	<	0.0100	<	0.007	0.005	0.000	<	0.019	8	0	0	6	75
COPW5	E	.	.	.	<	<	<	<	.	.	<	.	0.0110	<	<	<	0.006	0.002	0.000	<	0.011	8	0	0	7	88
CARLS	F	.	.	.	<	<	<	<	.	.	<	.	<	0.0100	<	<	0.006	0.002	0.000	<	0.010	8	0	0	7	88
WPAIL	G	<	.	.	<	<	.	0.0130	.	.	<	.	<	<	.	<	0.006	0.003	0.000	<	0.013	6	0	0	5	83
WPAIS	H	<	.	.	<	<	<	<	.	.	.	.	<	0.0110	.	<	0.006	0.002	0.000	<	0.011	6	0	0	5	83
BLDAL	I	<	.	.	0.0019	<	<	<	.	.	<	.	<	<	<	<	0.007	0.005	0.000	<	0.019	8	0	0	7	88
KENMA	J	.	.	.	<	<	<	<	.	.	<	.	<	<	<	<	<	0.000	0.000	<	<	8	0	0	8	100
LIGHB	K	<	.	.	<	<	<	0.0150	.	.	<	.	<	<	<	<	0.006	0.003	0.000	<	0.015	8	0	0	7	88
LASHV	L	.	.	.	<	<	<	0.0120	.	.	<	.	<	0.0110	<	<	0.007	0.003	0.000	<	0.012	8	0	0	6	75
MEBRV	M	.	.	.	<	<	.	0.0100	.	.	<	.	<	<	<	<	0.006	0.002	0.000	<	0.010	7	0	0	6	86
MARWA	N	<	.	.	<	<	<	<	.	.	<	.	0.0160	<	<	<	0.006	0.004	0.000	<	0.016	8	0	0	7	88
EASTS	O	.	.	.	.	<	<	0.0110	.	.	.	.	<	.	.	<	0.007	0.003	0.000	<	0.011	4	0	0	3	75
LAKFN	P	<	.	.	<	<	<	<	.	.	0.0490	.	<	<	<	<	0.011	0.015	0.000	<	0.049	8	0	0	7	88
LAKFS	Q	<	.	.	<	<	<	0.0110	.	.	<	.	<	<	<	<	0.006	0.002	0.000	<	0.011	8	0	0	7	88
THORN	R	.	.	.	<	<	<	<	.	.	<	.	<	<	.	<	<	.	******	<	<	7	0	0	7	100
TAOFF	S	<	.	.	<	<	<	<	.	.	<	.	<	<	.	<	<	.	******	<	<	7	0	0	7	100
LIGHF	T	<	.	.	<	<	<	0.0100	.	.	<	.	<	<	0.4830	<	0.065	0.158	0.025	<	0.483	8	1	13	6	75
GEORG	U	.	.	.	<	<	<	0.0100	.	.	<	.	<	<	0.0100	<	0.006	0.002	0.000	<	0.010	8	0	0	6	75
TRICO	V	.	.	.	<	<	<	<	.	.	<	.	<	<	.	<	<	.	******	<	<	7	0	0	7	100
LIWAF	W	.	.	.	<	<	<	<	.	.	0.0680	.	<	<	<	<	0.013	0.021	0.000	<	0.068	8	0	0	7	88
BLDAS	X	<	.	.	<	0.0760	<	<	.	.	<	.	<	<	<	<	0.014	0.023	0.001	<	0.076	8	0	0	7	88
	Median				<	<	<	<	.	.	<	.	<	<	<						N =	180	1	0.56	158	88
	Mean				0.0056	0.0080	0.0050	0.0077	.	.	0.0105	.	0.0057	0.0057	0.0321											
	Std				0.0029	0.0142	0.0000	0.0038	.	.	0.0157	.	0.0025	0.0019	0.1094				P_mean		0.009					
	Var				0.0000	0.0002	0.0000	0.0000	.	.	0.0002	.	0.0000	0.0000	0.0120				P_std		0.036					
	Min				0.0050	0.0050	0.0050	0.0050	.	.	0.0050	.	0.0050	0.0050	0.0050				P_var		0.001					
	Max				0.0190	0.0760	0.0050	0.0180	.	.	0.0680	.	0.0160	0.0110	0.4830				P_min		0.005					
	n				23	24	22	24	.	.	22	.	24	23	18	//N =	180		P_max		0.483					
	n>0.10				0	0	0	0	.	.	0	.	0	0	1	//	1		N		180					
	%n>0.10				0	0	0	0	.	.	0	.	0	0	6											
	n<DL				22	23	22	15	.	.	19	.	22	20	15	//	158									
	%n<DL				96	96	100	63	.	.	86	.	92	87	83											

Legend: "." = No Data. "<" = Below Detection Limits. Detection limit (DL) = 0.010 mg/L. "P_" = Population Statistic.
"n" = number of observations Chapter 17-3 standard: Class I, II and III = 0.100 mg/L.

TABLE Q: SAMPLING TIMES (24 HOUR) FOR WATER-QUALITY SURVEY (1988 - 1989) OF 24 WET-DETENTION PONDS.

POND\ Pseudonym	Ltr	Station	101888	110288	112388	112888	121388	012389	030289	041889	060789	062689	072489	082889	110189	121989	MEDIAN	MIN	MAX	n
			Time (24 Hour)																	
CARLL	A	OUTFALL	.	.	1250	1510	1420	1500	1345	1029	940	1349	1350	1018	1534	1512	1350	940	1534	11
GTEDS	B	OUTFALL	1528	.	.	1033	1300	953	1150	1340	1333	1430	1546	1114	1404	1424	1333	953	1546	11
COOPP	C	OUTFALL	.	1141	.	935	1523	830	1040	1452	.	1537	800	930	1500	1545	1246	800	1545	10
RIDGE	D	OUTFALL	1315	.	1103	953	1120	1244	1011	.	.	1114	1100	1323	1056	1152	1114	953	1323	9
COPW5	E	OUTFALL	.	.	1434	1141	1140	959	1530	917	.	1627	1129	1713	1018	949	1130	917	1713	10
CARLS	F	OUTFALL	.	1136	1302	1449	1403	1435	1323	1101	958	1328	1320	1030	1511	1442	1328	958	1511	11
WPAIL	G	OUTFALL	.	.	943	832	942	1558	831	.	.	.	.	.	.	.	907	831	1558	4
WPAIS	H	OUTFALL	.	.	951	819	927	1509	815	1359	1530	930	910	1513	852	912	927	815	1530	11
BLDAL	I	OUTFALL	1147	.	.	1204	920	1152	1442	1152	1118	1350	1436	1409	1228	1223	1223	920	1442	11
KENMA	J	OUTFALL	.	950	1131	1024	1200	1117	1045	1415	1224	1224	1220	1220	1138	1330	1220	1024	1415	11
LIGHB	K	OUTFALL	1406	.	.	1257	1010	1246	1539	1056	1032	1442	1600	1525	1627	1730	1442	1010	1730	11
LASHV	L	OUTFALL	.	.	.	1006	1210	905	1117	.	.	.	900	.	.	1522	1041	900	1522	6
MEBRV	M	OUTFALL	.	.	1354	1054	1055	1043	.	1000	.	.	1247	1623	1110	1045	1055	1000	1623	8
MARWA	N	OUTFALL	1055	.	927	908	1030	1342	913	1318	1620	1028	1015	1406	1008	1046	1030	908	1620	11
EASTS	O	OUTFALL	.	.	.	.	837	1112	1400	.	.	.	.	1325	.	1140	1140	837	1400	5
LAKFN	P	OUTFALL	.	.	.	1212	1553	910	1555	825	.	1612	1044	1545	934	902	1128	825	1612	10
LAKFS	Q	OUTFALL	.	.	.	1222	1602	926	1606	835	.	1622	1058	1554	940	918	1140	835	1622	10
THORN	R	OUTFALL	.	1327	.	1341	1313	1338	1210	1220	1034	1450	1445	1108	1433	1626	1338	1034	1626	11
TAOFF	S	OUTFALL	1017	.	.	1104	826	1026	1310	.	.	1220	1015	1148	1306	1346	1148	826	1346	9
LIGHF	T	OUTFALL	1353	.	.	1245	1000	1233	1528	.	.	1420	1540	1502	1615	1716	1502	1000	1716	9
GEORG	U	OUTFALL	.	1505	1336	1539	1035	1530	1413	1030	950	1511	1513	1559	1128	1005	1413	950	1559	11
TRICO	V	OUTFALL	.	1419	1228	1421	1338	1406	1138	1308	1113	1419	1410	1133	1224	1545	1338	1113	1545	11
LIWAF	W	OUTFALL	.	.	1408	1108	1110	1605	1459	.	.	1553	.	1640	1050	1023	1305	1023	1640	8
BLDAS	X	OUTFALL	1132	.	.	1155	910	1142	1430	1135	1108	1338	1412	1400	1219	1213	1213	910	1430	11
																				N = 230
		MEDIAN				1141	1115	1112	1323	1135	1110	1420	1247	1403	1219	1223				
		MIN				819	826	830	815	825	940	930	800	930	852	902				
		MAX				1539	1602	1605	1606	1452	1620	1627	1600	1713	1627	1730				
		n				23	24	24	23	17	12	20	21	22	21	23	//N = 230			

Legend: "." = No Data or Not Calculated "n" = number of observations

TABLE Q: CONTINUED.

POND\ Acronym	Ltr	Station	101888	110288	112388	112888	121388	012389	030289	041889	060789	062689	072489	082889	110189	121989	MEDIAN	MIN	MAX	n
									Time (24 Hour)											
CARLL	A	POND	.	1208	1315	1505	1414	1455	1338	1130	951	1343	1350	1041	1527	1502	1350	951	1527	11
GTEDS	B	POND	.	.	.	1036	1305	957	1156	1351	1328	1434	1559	1120	1410	1429	1328	957	1559	11
COOPP	C	POND	.	1153	.	948	1529	850	1050	1504	1213	1550	800	937	.	1558	1132	800	1558	10
RIDGE	D	POND	1325	.	1112	1002	1129	1249	1022	1454	1250	1121	1100	1330	1112	1207	1129	1002	1454	11
COPW5	E	POND	.	1004	1442	1148	1145	1021	1537	925	1337	1622	1138	1718	1024	958	1145	925	1718	11
CARLS	F	POND	.	1147	1307	1454	1407	1445	1330	1120	1006	1335	1320	1035	1519	1453	1335	1006	1519	11
WPAIL	G	POND	1528	.	943	837	953	1545	843	1421	1545	946	930	1450	912	935	946	837	1545	11
WPAIS	H	POND	1507	.	951	821	930	1530	823	1411	1535	936	910	1518	857	921	930	821	1535	11
BLDAL	I	POND	.	.	.	1207	925	1200	1450	1157	1121	1358	1454	1420	1234	1229	1229	925	1454	11
KENMA	J	POND	.	955	1132	1026	1201	1120	1048	1425	1227	1228	1220	1223	1142	1335	1220	1026	1425	11
LIGHB	K	POND	.	.	.	1259	1012	1250	1542	1100	1035	1444	1600	1528	1631	1736	1444	1012	1736	11
LASHV	L	POND	.	.	.	1010	1215	910	1120	1434	1150	1511	900	1046	1444	1526	1150	900	1526	11
MEBRV	M	POND	.	1557	1357	1058	1100	1047	1441	1000	1401	1540	1251	1626	1107	1050	1107	1000	1626	11
MARWA	N	POND	.	.	928	912	1034	1348	928	1321	1632	1032	1015	1410	1000	1038	1034	912	1632	11
EASTS	O	POND	.	.	.	.	840	1116	1405	.	.	.	.	1040	.	1147	1132	840	1405	4
LAKFN	P	POND	1410	.	.	1215	1556	916	1558	830	1445	1615	1048	1547	930	910	1215	830	1615	11
LAKFS	Q	POND	1429	.	.	1224	1604	930	1609	840	1455	1626	1101	1557	942	923	1224	840	1626	11
THORN	R	POND	.	1337	.	1350	1317	1342	1215	1241	1052	1446	1445	1112	1437	1633	1342	1052	1633	11
TAOFF	S	POND	1020	.	.	1116	825	1040	1327	.	.	1230	1015	1208	1341	1355	1208	825	1355	9
LIGHF	T	POND	.	.	.	1247	1003	1237	1532	1050	1025	1424	1540	1505	1617	1721	1424	1003	1721	11
GEORG	U	POND	.	1512	1337	1542	1037	1535	1415	1035	955	1513	1516	1602	1131	1009	1415	955	1602	11
TRICO	V	POND	.	.	1229	1424	1341	1410	1141	1316	1115	1421	1410	1135	1227	1548	1341	1115	1548	11
LIWAF	W	POND	.	.	1412	1113	1115	1613	.	.	1413	1559	1230	1647	1047	1034	1230	1034	1647	9
BLDAS	X	POND	.	.	.	1157	912	1146	1435	1140	1111	1342	1416	1403	1222	1215	1215	912	1435	11
																			N = 252	
		MEDIAN				1148	1122	1218	1330	1157	1220	1424	1230	1410	1202	1222				
		MIN				821	825	850	823	830	951	936	800	937	857	910				
		MAX				1542	1604	1613	1609	1504	1632	1626	1600	1718	1631	1736				
		n				23	24	24	23	21	22	23	23	23	22	24	//N = 252			

Legend: "." = No Data or Not Calculated "n" = number of observations

TABLE Q: CONTINUED.

POND\ Acronym	Ltr	Station	101888	110288	112388	112888	121388	012389	030289	041889	060789	062689	072489	082889	110189	121989	MEDIAN	MIN	MAX	n
			Time (24 Hour)																	
CARLL	A	RECEIVE	.	.	1256	1513	1424	1508	1351	1046	945	1357	1350	1023	1539	1520	1357	945	1539	11
GTEDS	B	RECEIVE	1540	.	.	1044	1310	1001	1200	1356	1324	1439	1552	1124	1417	1435	1324	1001	1552	11
COOPP	C	RECEIVE	.	1148	.	942	1525	840	1045	.	.	1543	800	933	1511	1552	1045	800	1552	9
RIDGE	D	RECEIVE	.	.	1110	958	1125	1259	1017	.	.	.	1100	1326	1106	1200	1115	958	1326	8
CARLS	F	RECEIVE	.	1142	1302	1452	1405	1439	1326	1111	1003	1331	1320	1033	1514	1445	1331	1003	1514	11
WPAIL	G	RECEIVE	1533	.	943	835	948	1551	840	.	.	953	.	.	.	948	948	835	1551	6
WPAIS	H	RECEIVE	.	.	956	820	932	1525	819	1405	1537	933	910	1516	.	917	933	819	1537	10
BLDAL	I	RECEIVE	1200	.	.	1210	925	1158	1447	1201	.	1354	1445	1415	1231	1226	1229	925	1447	10
KENMA	J	RECEIVE	.	.	1143	1036	1211	1131	1056	.	.	.	1220	1229	.	.	1151	1036	1229	6
LASHV	L	RECEIVE	.	.	.	1000	1220	920	1111	.	1200	1520	900	1054	1450	1534	1135	900	1534	10
MARWA	N	RECEIVE	1105	.	927	917	1040	1350	919	1327	1640	1037	1015	1415	1014	1052	1040	917	1640	11
TAOFF	S	RECEIVE	1008	.	.	1108	821	1032	1315	.	.	1225	1015	1152	1310	1350	1152	821	1350	9
LIWAF	W	RECEIVE	.	.	1408	1111	1116	1608	1504	.	1416	1555	1226	1644	1053	1027	1321	1027	1644	10
BLDAS	X	RECEIVE	1200	.	.	1210	925	1158	1447	1201	.	1354	1445	1415	1231	1226	1228	925	1447	10
																				N = 132
		MEDIAN				1040	1053	1158	1025	1201	1324	1354	1220	1229	1310	1226				
		MIN				820	821	840	819	1046	945	933	800	933	1014	917				
		MAX				1513	1525	1608	1504	1405	1640	1555	1552	1644	1539	1552				
		n				14	14	14	14	7	7	12	13	13	11	13	//N = 132			

Legend: "." = No Data or Not Calculated "n" = number of observations

ADDENDUM

TABLE I. DUNCAN MULTIPLE RANGE TEST FOR THE EQUALITY OF ANNUAL MEANS BY FOUR LANDUSE TYPES (MF, SF, LC AND HC). LEVEL OF SIGNIFICANCE IS 0.05. UNITS ARE MG/L UNLESS INDICATED.

DISSOLVED OXYGEN	HC	=	SF	<	LC	<	MF
	4.4		5.09		6.19		7.61
PH	SF	<	HC	=	LC	=	MF
	6.27		6.77		7.11		7.54
SPECIFIC CONDUCTANCE (MMHOS/CM)	HC	=	SF	=	MF	<	LC
	0.213		0.214		0.290		1.330
TSS	SF	=	HC	=	LC	<	MF
	5.7		7.1		7.2		11.3
TURBIDITY (N.T.U.)	SF	=	LC	=	HC	<	MF
	4.7		5.7		6.0		8.4
TOTAL ZINC	SF	=	HC	<=	LC	<=	MF
	0.020		0.023		0.031		0.042
TOTAL COPPER	HC	=	SF	=	LC	<	MF
	0.010		0.013		0.018		0.031
TOTAL IRON	LC	<=	HC	=	SF	<=	MF
	0.217		0.231		0.247		0.322
TEMPERATURE (CELSIUS)	HC	=	SF	=	MF	=	LC
	22.5		22.6		23.7		23.8
TOTAL MANGANESE	HC	=	LC	=	MF	=	SF
	0.014		0.015		0.018		0.018
TOTAL CADMIUM	HC	=	SF	=	LC	=	MF
	0.001		0.003		0.003		0.003
TOTAL LEAD	MF	=	HC	=	SF	=	LC
	0.008		0.013		0.013		0.015
TOTAL CHROMIUM	SF	=	MF	=	LC	=	HC
	0.010		0.010		0.010		0.011
TOTAL NICKEL	LC	=	SF	=	HC	=	MF
	0.006		0.007		0.008		0.022

TABLE II. DUNCAN MULTIPLE RANGE TEST FOR THE EQUALITY OF ANNUAL MEANS (3-CLUSTER STRUCTURE). LEVEL OF SIGNIFCANCE IS 0.05. UNITS ARE MG/L UNLESS INDICATED.

DISSOLVED OXYGEN	III	<	II	<	I
	3.51		7.00		8.06
PH (STANDARD UNITS)	III	<	II	=	I
	6.63		7.21		7.43
SPECIFIC CONDUCTANCE (MMHOS/CM)	III	<	II	<	I
	0.250		0.256		0.540
TEMPERATURE (CELSIUS)	III	=	II	=	I
	22.0		23.6		24.4
TOTAL SUSPENDED SOLIDS	I	=	III	<	II
	3.14		5.91		10.33
TURBIDITY (N.T.U.)	I	=	III	<	II
	3.09		4.85		7.90
TOTAL ZINC	I	=	III	=	II
	0.015		0.025		0.034
TOTAL COPPER	III	<=	I	<=	II
	0.010		0.019		0.023
TOTAL IRON	I	<	III	=	II
	0.082		0.227		0.307
TOTAL MANGANESE	II	=	I	=	III
	0.014		0.014		0.020

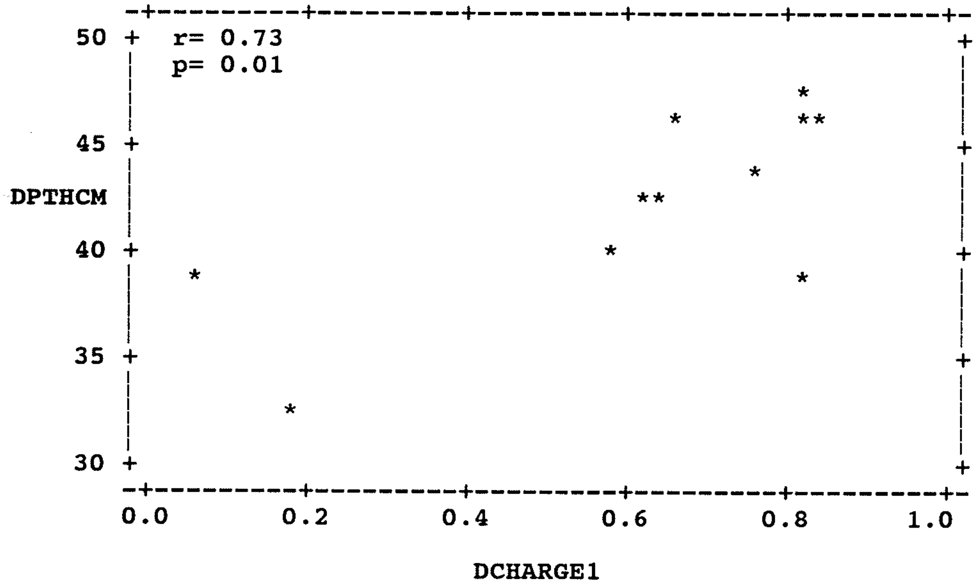
TABLE III. DUNCAN MULTIPLE RANGE TEST FOR THE EQUALITY OF ANNUAL MEANS (2-CLUSTER STRUCTURE). LEVEL OF SIGNIFICANCE IS 0.05. UNITS ARE MG/L UNLESS INDICATED.

SPECIFIC CONDUCTANCE (MMHOS/CM)	I	=	II
	0.313		0.272
TOTAL SUSPENDED SOLIDS	I	<	II
	6.09		10.51
TURBIDITY (N.T.U.)	I	<	II
	4.93		8.18
TOTAL ZINC	I	<	II
	0.020		0.042
TOTAL COPPER	I	<	II
	0.013		0.025
TOTAL IRON	I	<	II
	0.211		0.317
TOTAL MANGANESE	I	=	II
	0.016		0.017

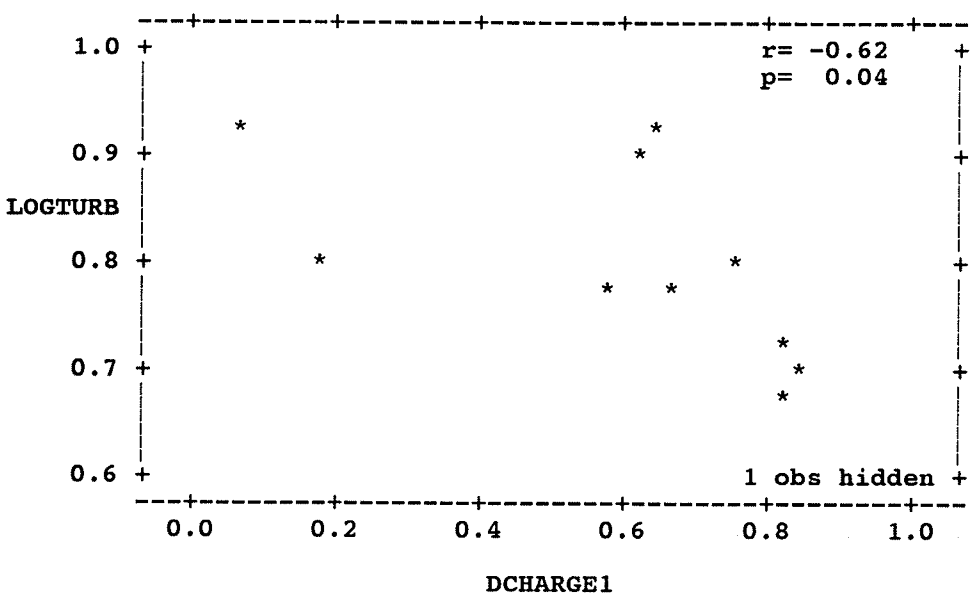
TABLE IV. DUNCAN MULTIPLE RANGE TEST FOR THE EQUALITY OF ANNUAL MEANS BY THREE SAMPLE STATIONS. LEVEL OF SIGNIFICANCE IS 0.05.

DISSOLVED OXYGEN (MG/L)	RECEIVE	<	OUTFALL	=	POND
	4.37		5.79		6.25
PH	RECEIVE	<	OUTFALL	=	POND
	6.21		6.90		6.95
SPECIFIC CONDUCTANCE (MMHOS/CM)	OUTFALL	=	POND	<	RECEIVE
	.288		.296		1.89
TEMPERATURE (CELSIUS)	RECEIVE	=	OUTFALL	=	POND
	22.2		23.1		23.5
TOTAL SUSPENDED SOLIDS (MG/L)	POND	=	OUTFALL	=	RECEIVE
	6.82		7.75		8.67
TURBIDITY (N.T.U.)	POND	=	OUTFALL	=	RECEIVE
	5.51		6.16		6.75

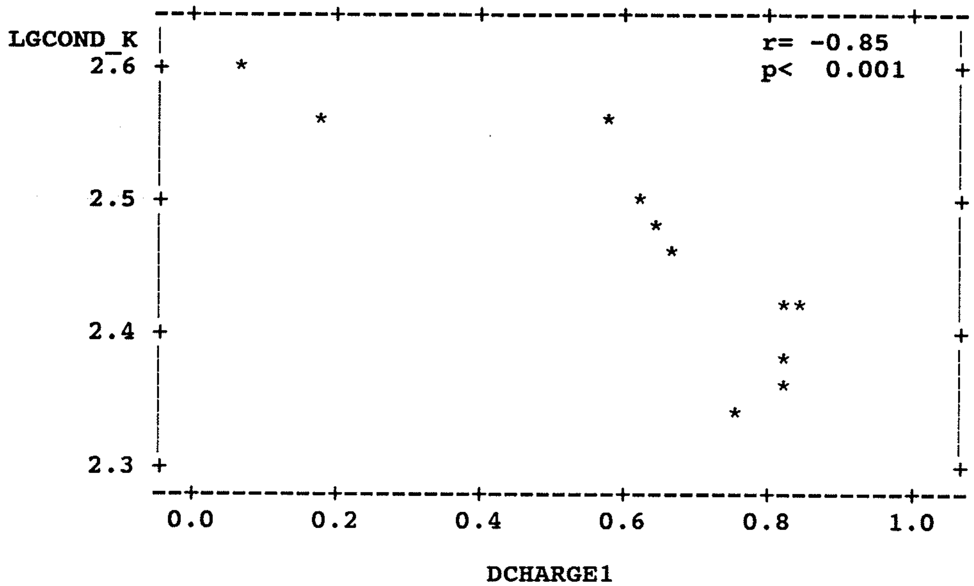
MEAN BOTTOM DEPTH (CM) VS. DISCHARGE FREQUENCY



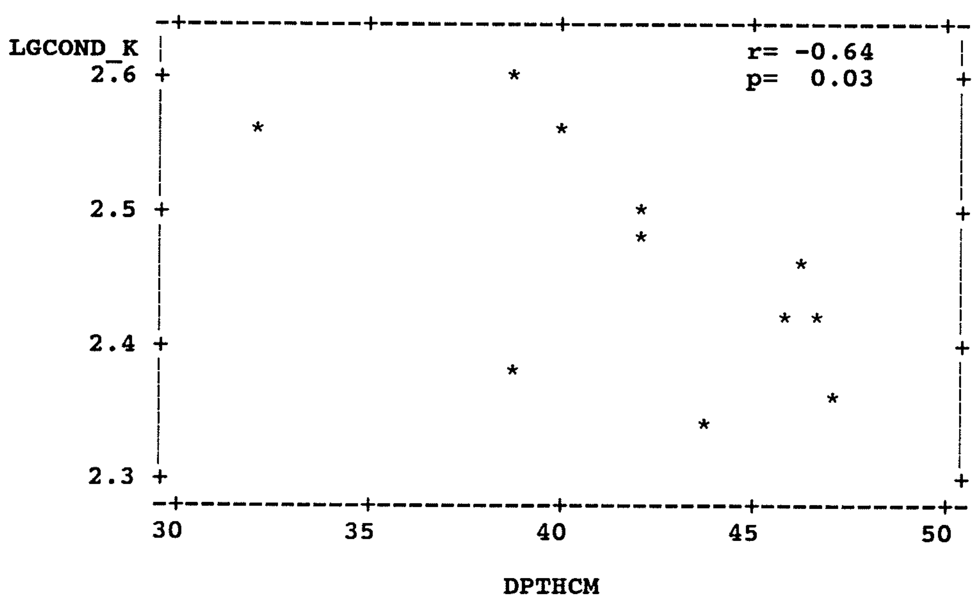
LOG MEAN TURBIDITY (N.T.U.) VS. DISCHARGE FREQUENCY



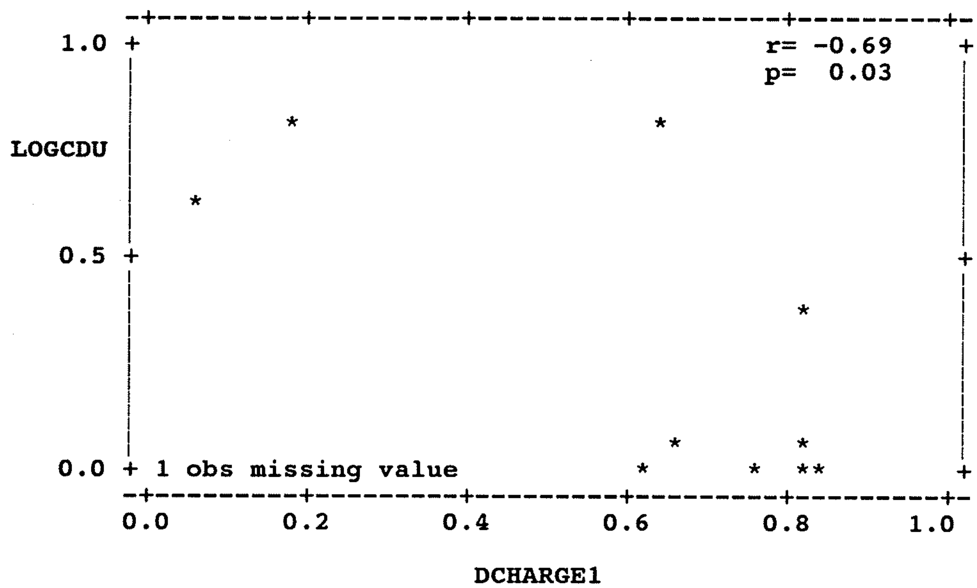
LOG MEAN CONDUCTIVITY (UMHOS/CM) VS. DISCHARGE FREQUENCY



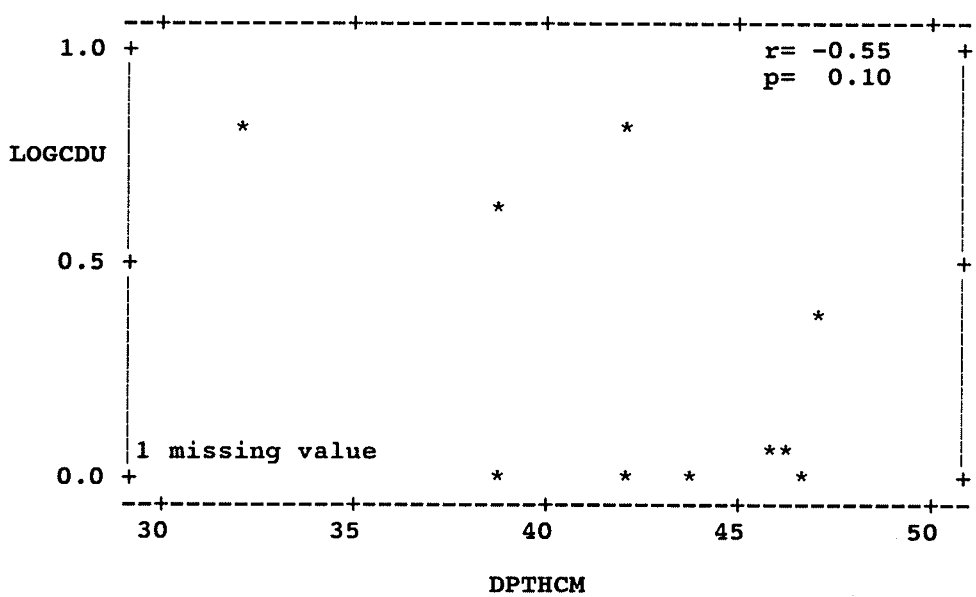
LOG MEAN CONDUCTIVITY (UMHOS/CM) VS. MEAN BOTTOM DEPTH (CM)



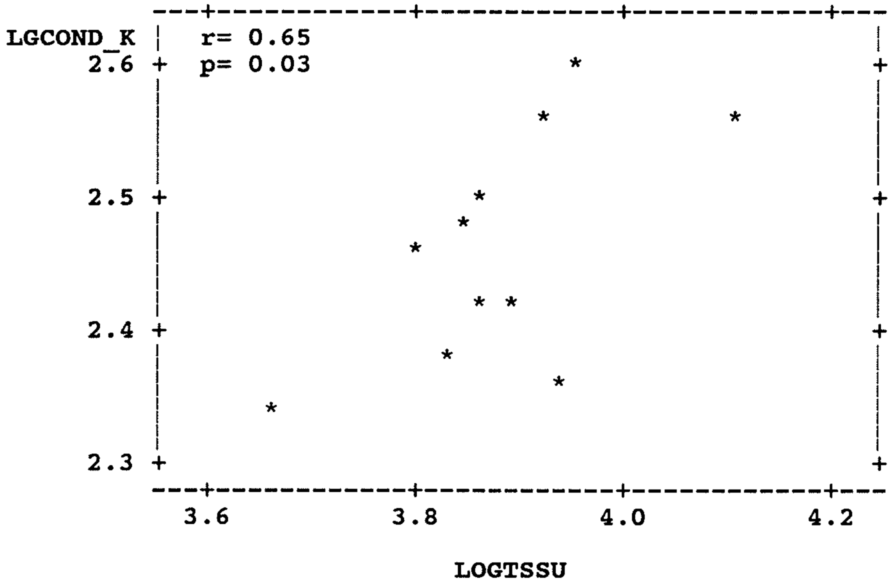
LOG MEAN TOTAL CADMIUM (UG/L) VS. DISCHARGE FREQUENCY



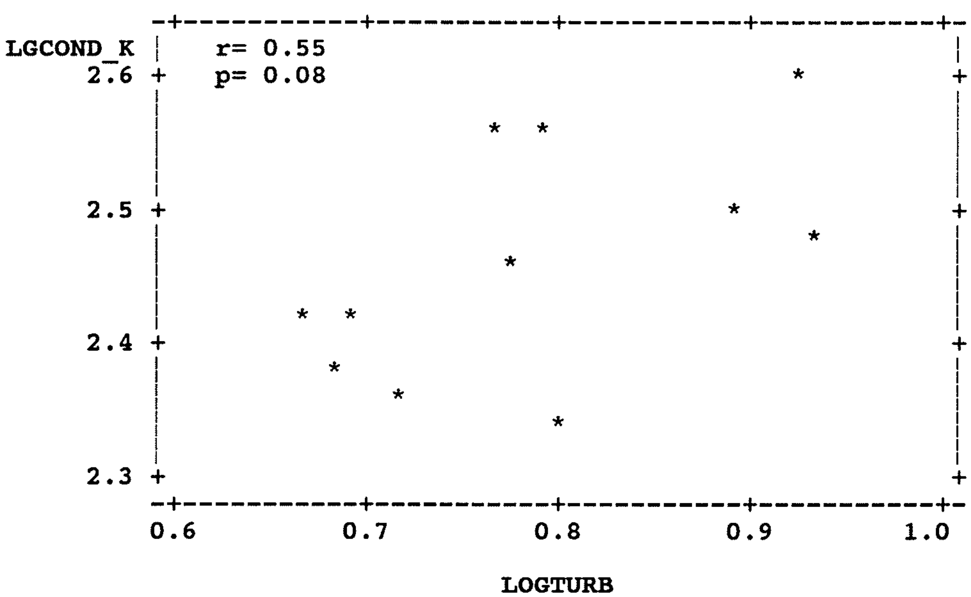
LOG MEAN TOTAL CADMIUM (UG/L) VS. MEAN BOTTOM DEPTH (CM)



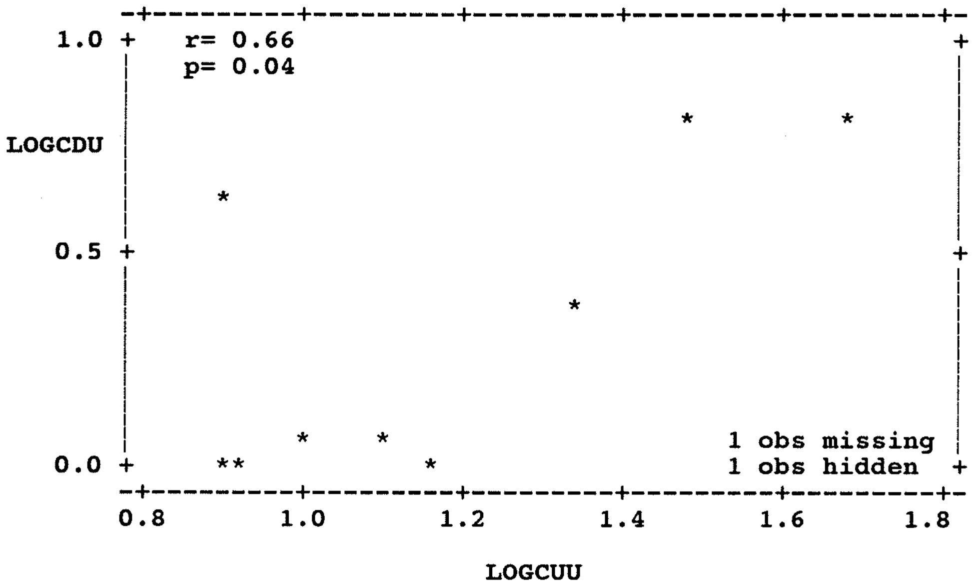
LOG MEAN CONDUCTIVITY (UMHOS/CM) VS. LOG MEAN
TOTAL SUSPENDED SOLIDS (UG/L)



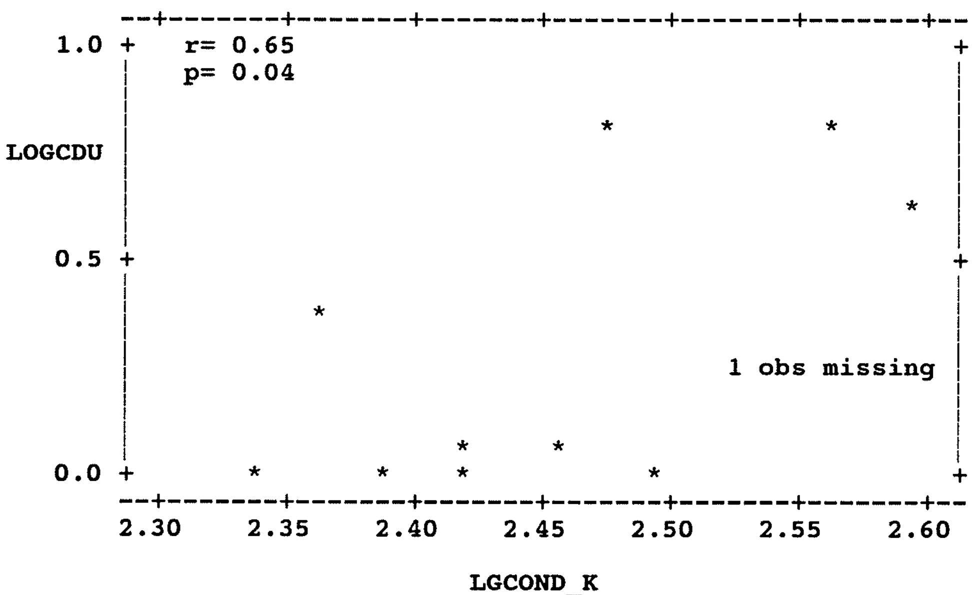
LOG MEAN CONDUCTIVITY (UMHOS/CM) VS. LOG MEAN TURBIDITY (N.T.U.)



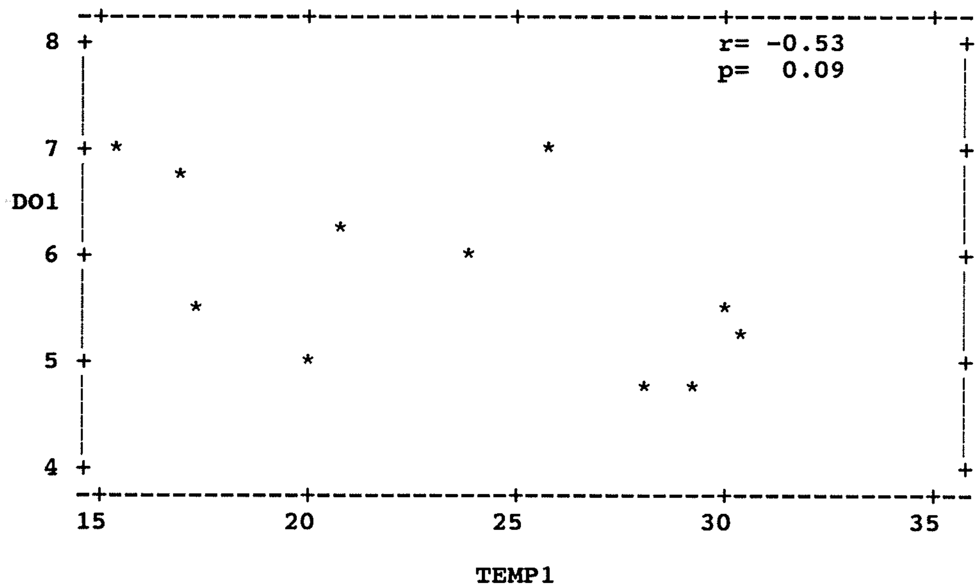
LOG MEAN TOTAL CADMIUM (UG/L) VS. LOG MEAN TOTAL COPPER (UG/L)



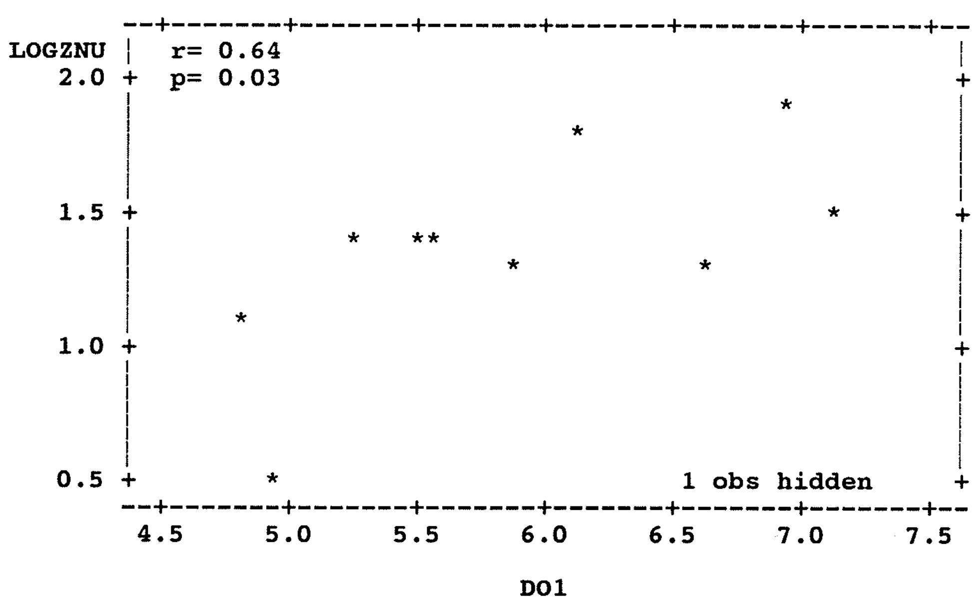
LOG MEAN TOTAL CADMIUM (UG/L) VS. LOG MEAN CONDUCTIVITY (UMHOS/CM)



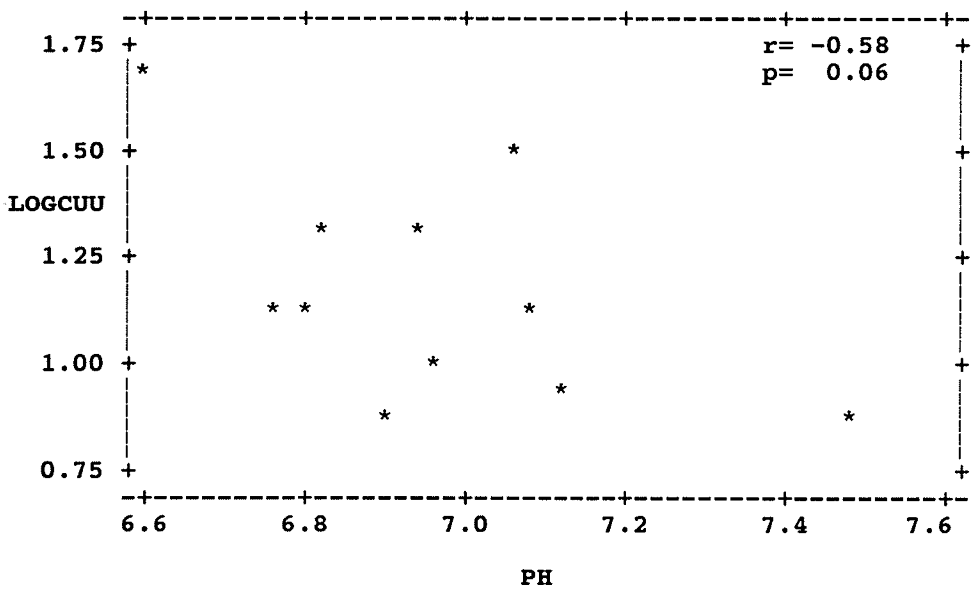
MEAN DISSOLVED OXYGEN (MG/L) VS. MEAN TEMPERATURE (CELSIUS)



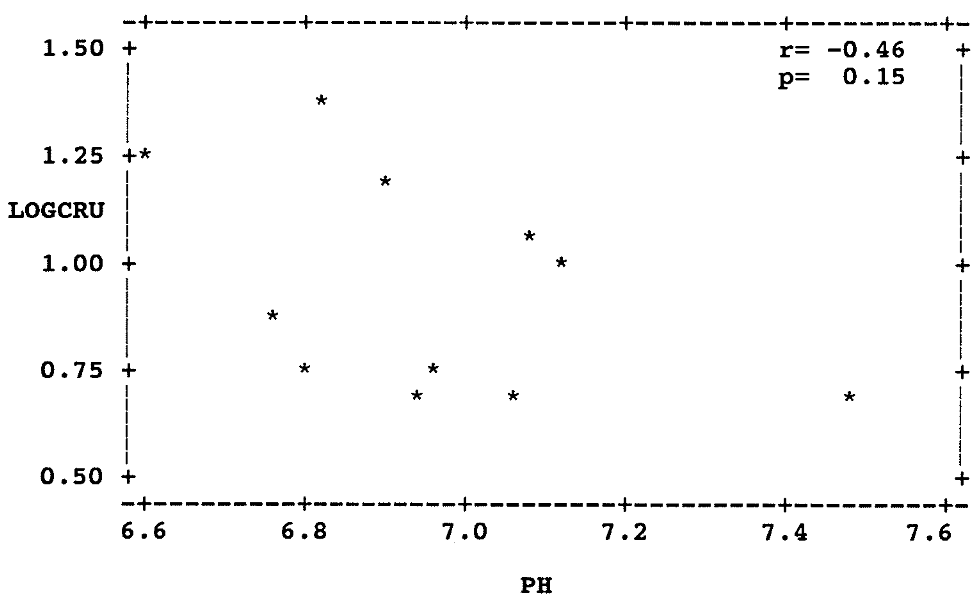
LOG MEAN TOTAL ZINC (UG/L) VS. MEAN DISSOLVED OXYGEN (MG/L)



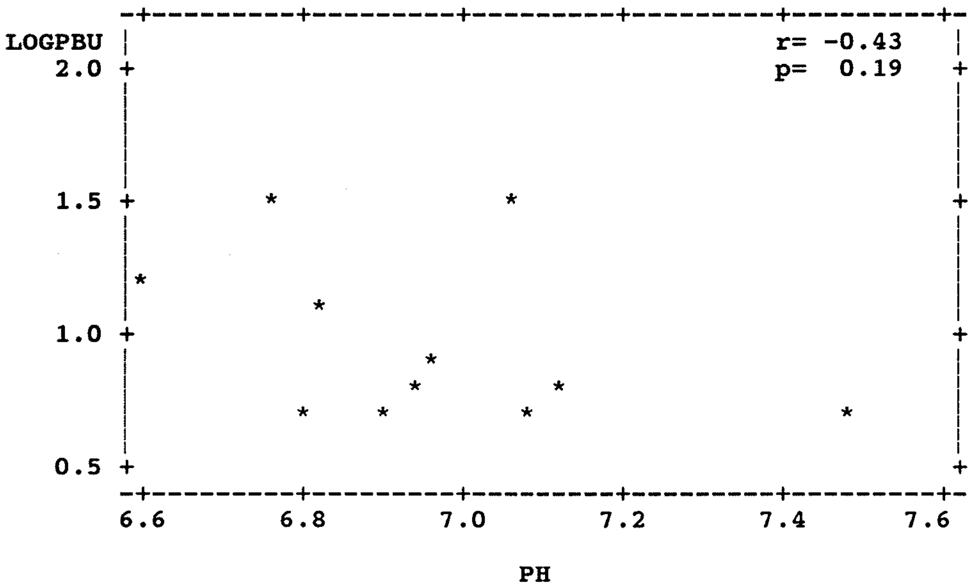
LOG MEAN TOTAL COPPER (UG/L) VS. MEAN PH



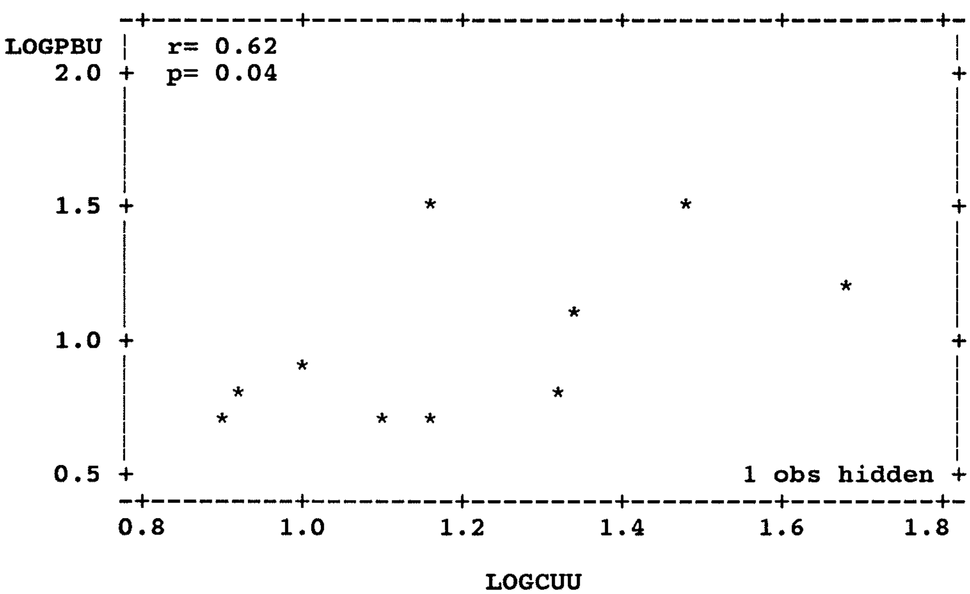
LOG MEAN TOTAL CHROMIUM VS. MEAN PH



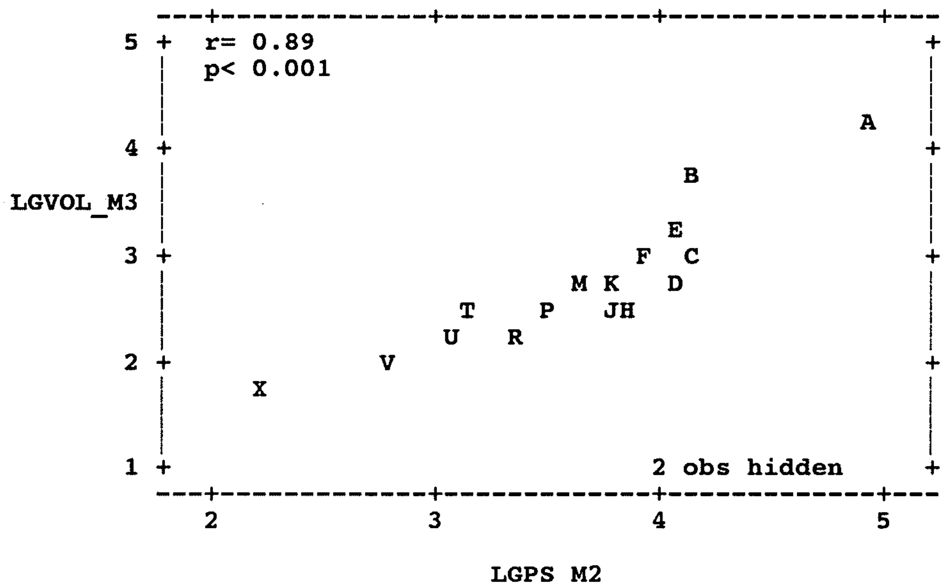
LOG MEAN TOTAL LEAD (UG/L) VS. MEAN PH



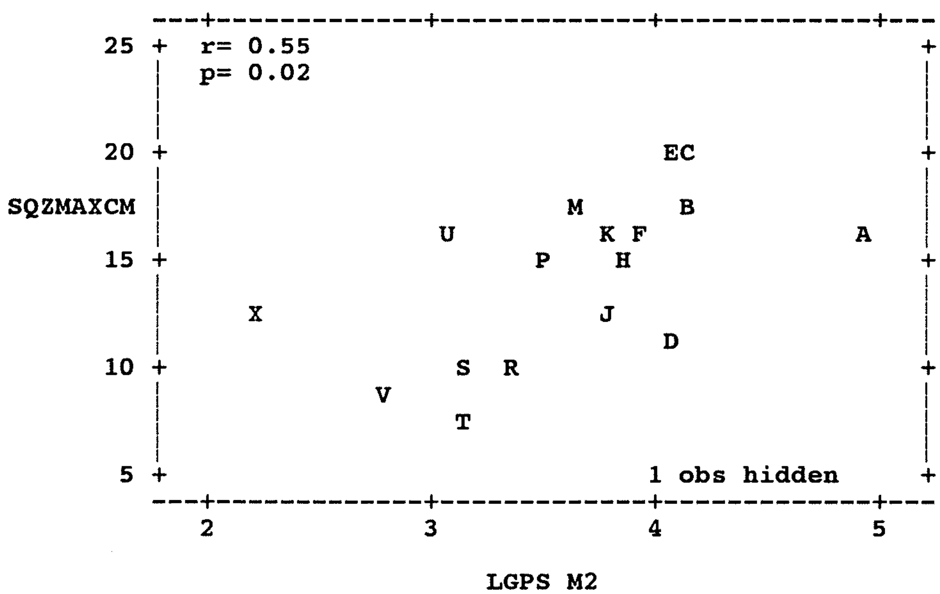
LOG MEAN TOTAL LEAD (UG/L) VS. LOG MEAN TOTAL COPPER (UG/L)



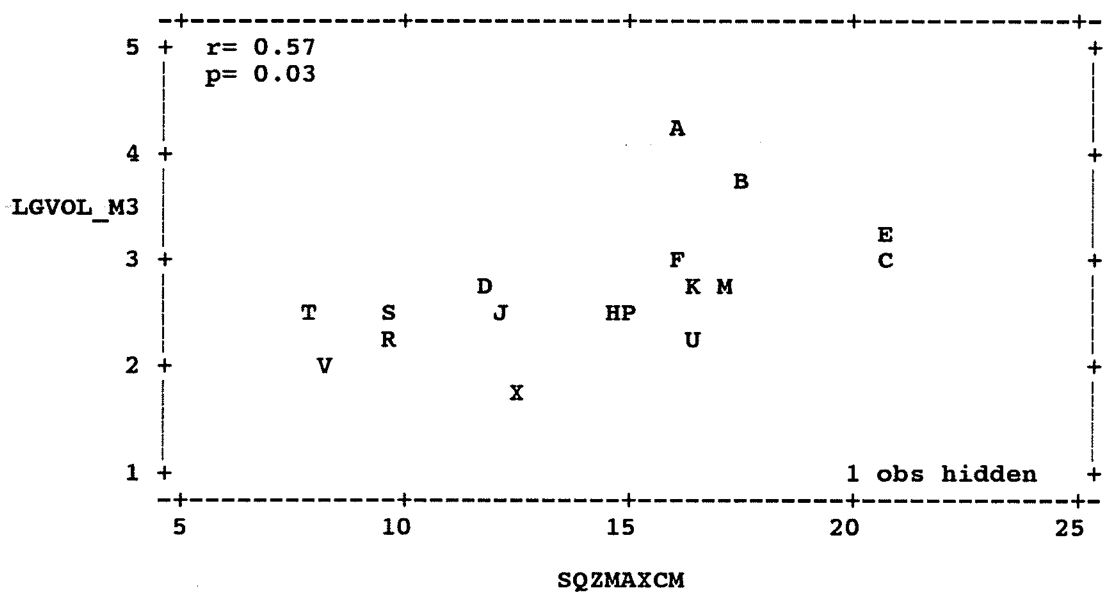
LOG TREATMENT VOLUME (M^3) VS. LOG POND AREA (M^2)



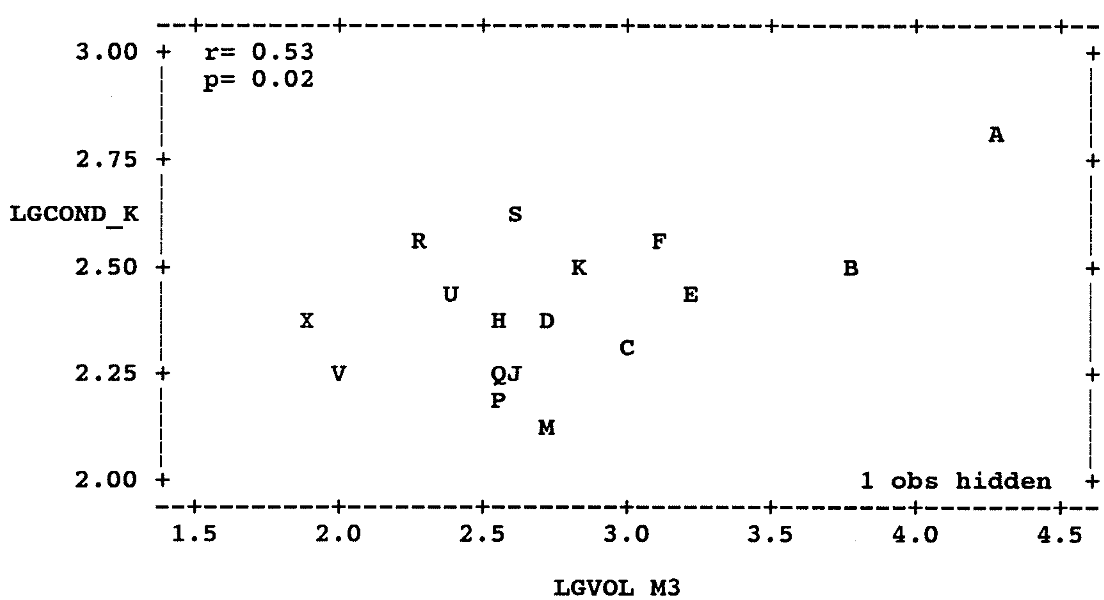
SQUARE ROOT Z_{MAX} (CM) VS. LOG POND AREA (M^2)



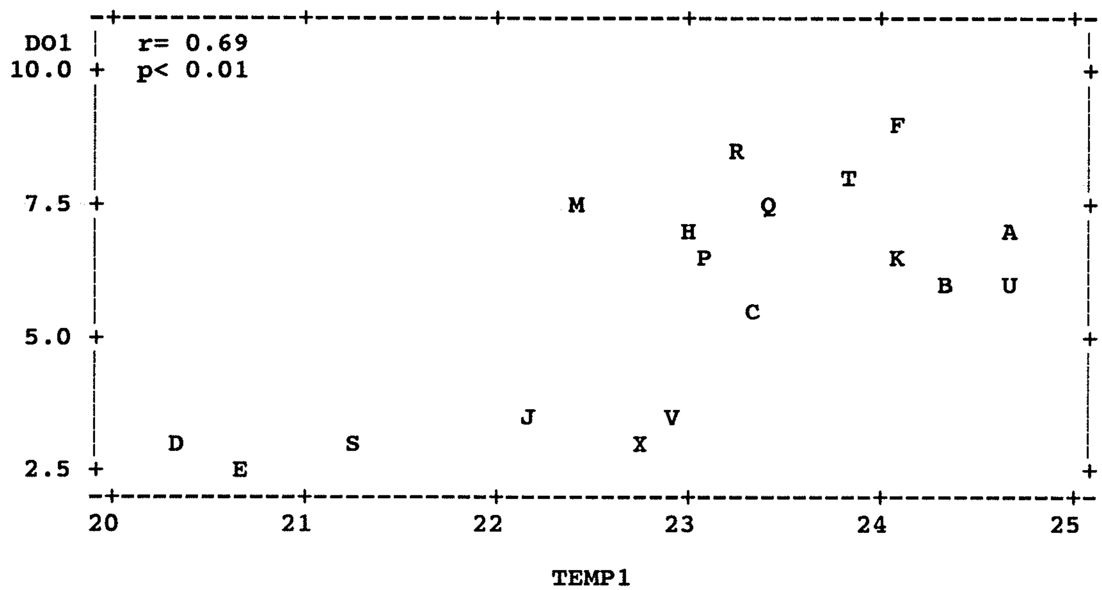
LOG TREATMENT VOLUME (M^3) VS. SQUARE ROOT Z_{MAX} (M^3)



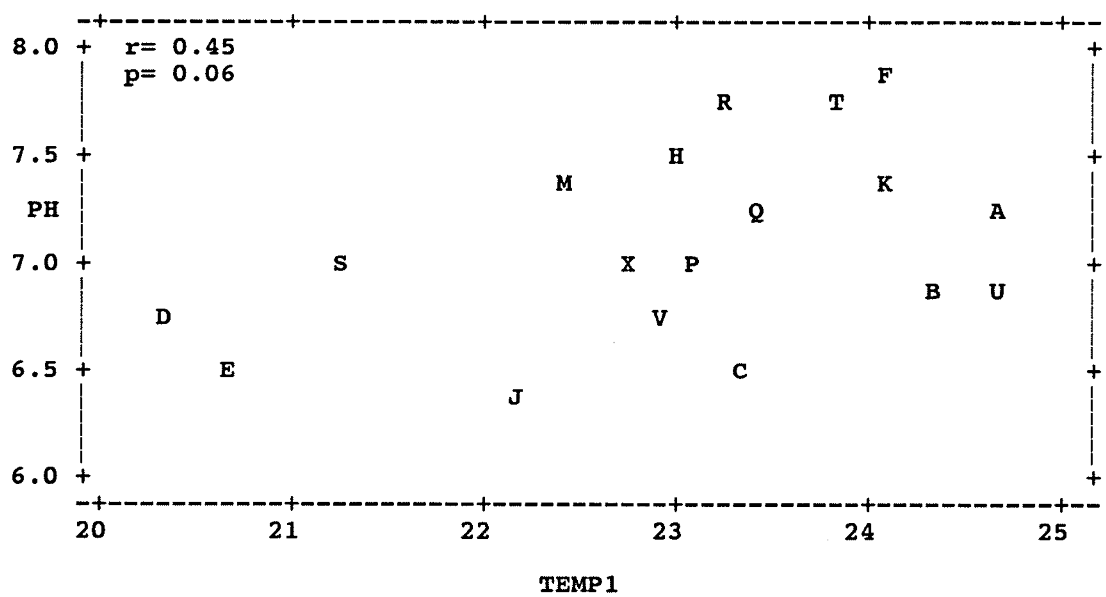
LOG MEAN CONDUCTIVITY (UMHOS/CM) VS. LOG TREATMENT VOLUME (M^3)



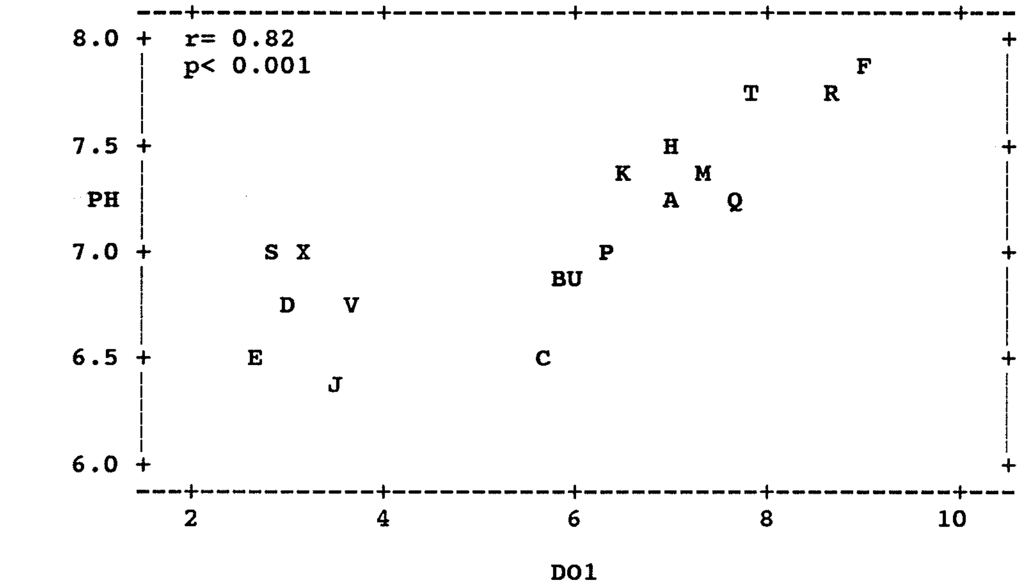
MEAN DISSOLVED OXYGEN (MG/1) VS. MEAN TEMPERATURE (CELSIUS)



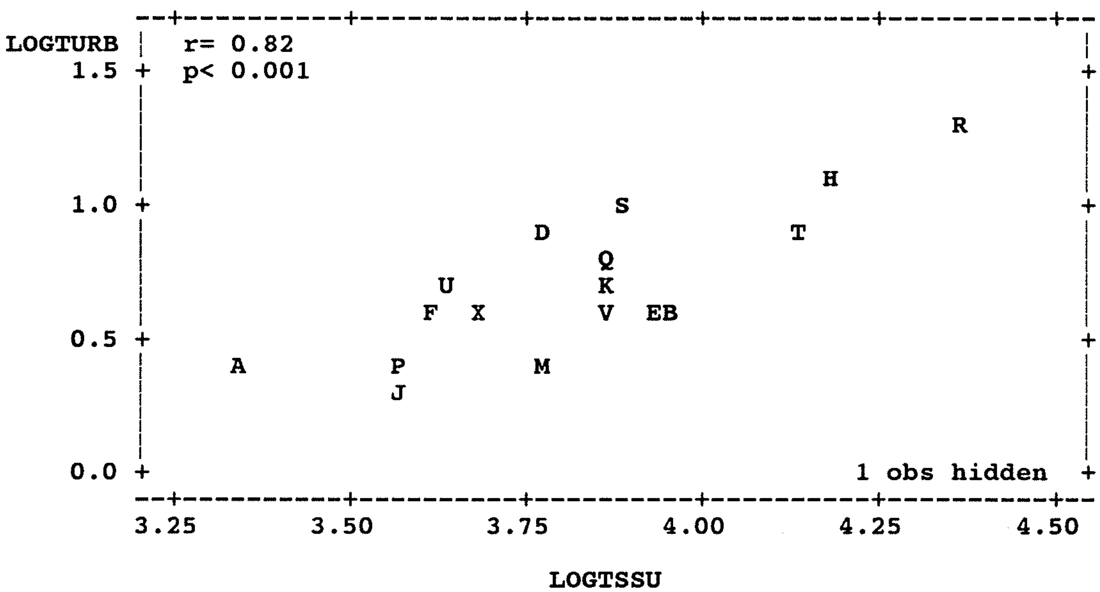
MEAN PH VS. MEAN TEMPERATURE (CELSIUS)



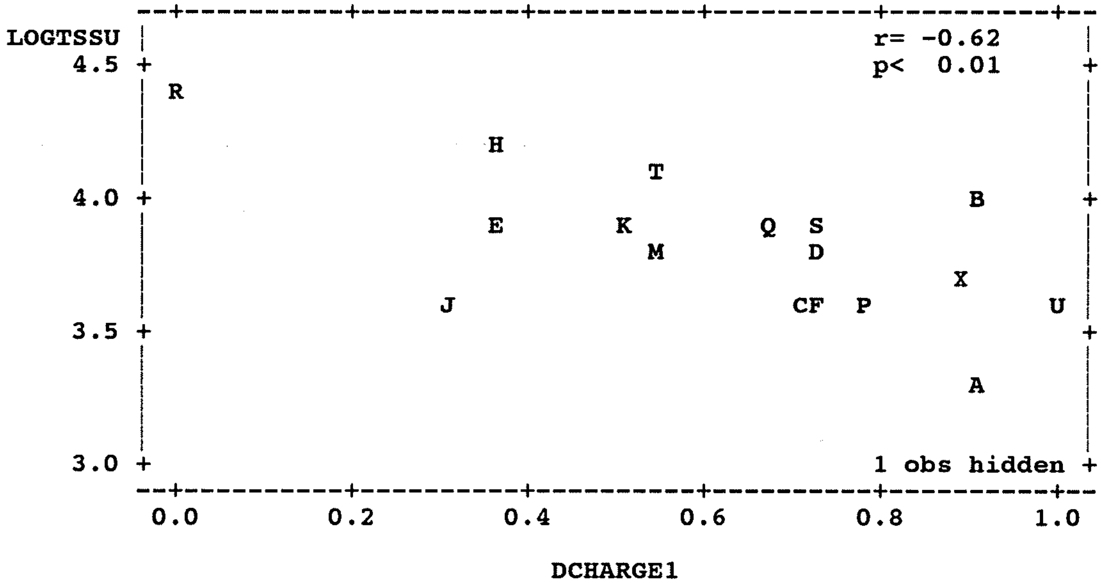
MEAN PH VS. MEAN DISSOLVED OXYGEN (MG/L)



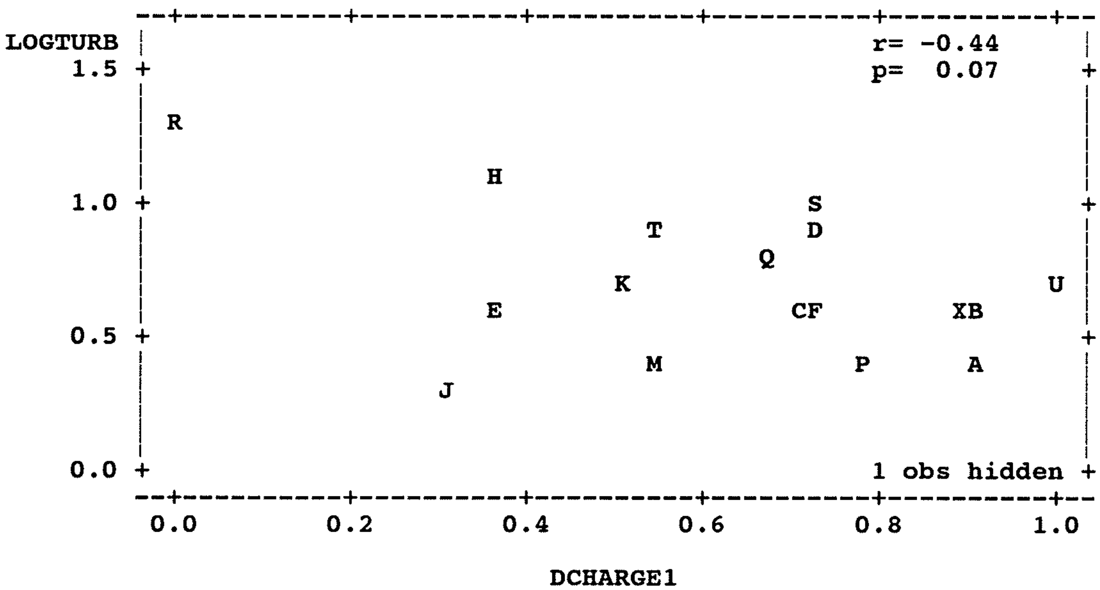
LOG MEAN TURBIDITY (N.T.U.) VS. LOG MEAN TOTAL SUSPENDED SOLIDS (UG/L)



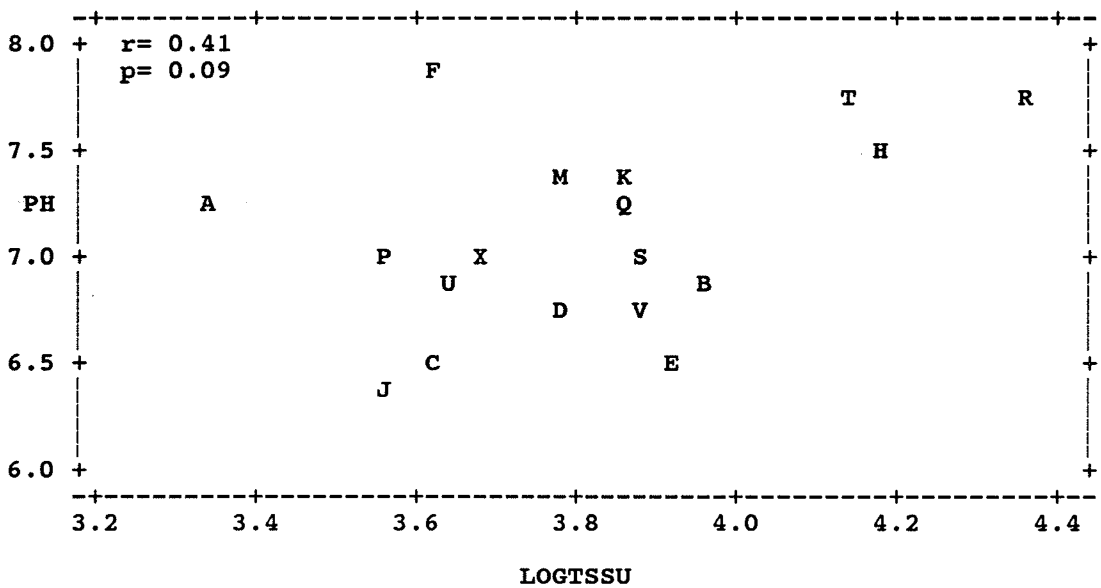
LOG MEAN TOTAL SUSPENDED SOLIDS (UG/L) VS. DISCHARGE FREQUENCY



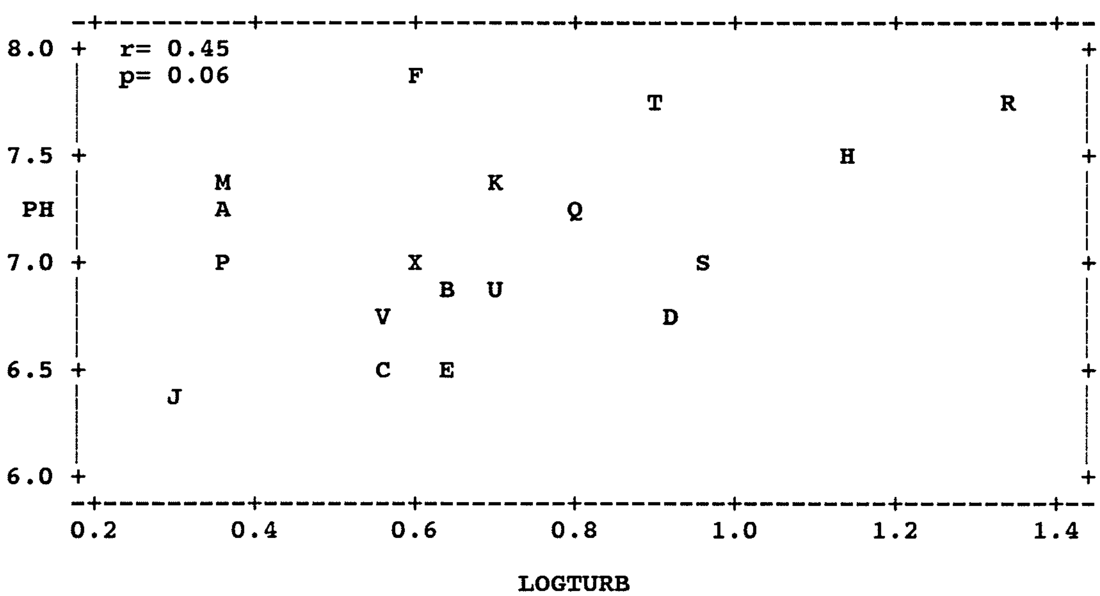
LOG MEAN TURBIDITY (N.T.U.) VS. DISCHARGE FREQUENCY



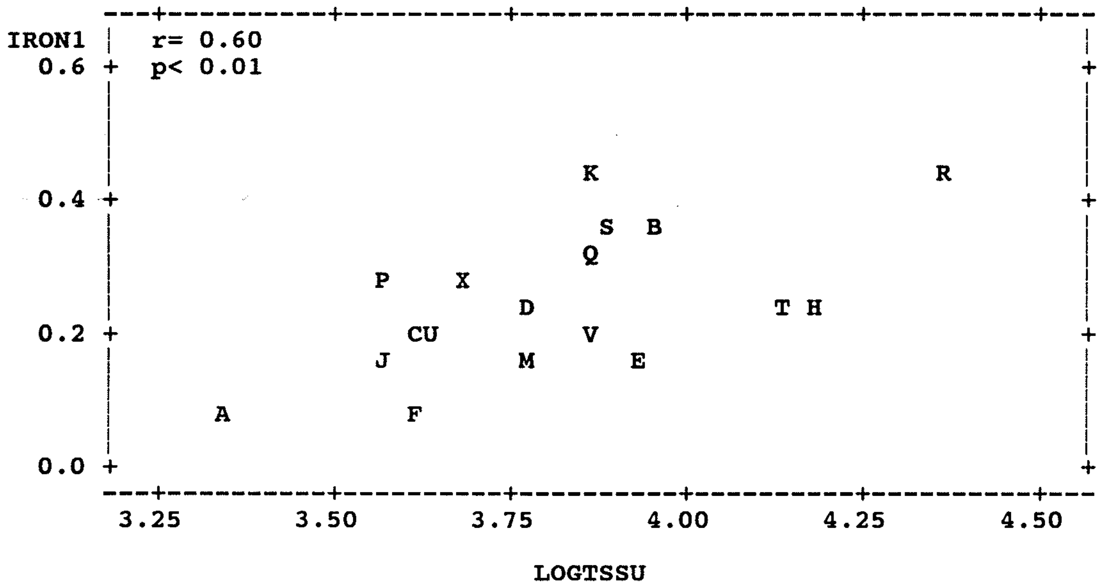
MEAN PH VS. LOG MEAN TOTAL SUSPENDED SOLIDS (UG/L)



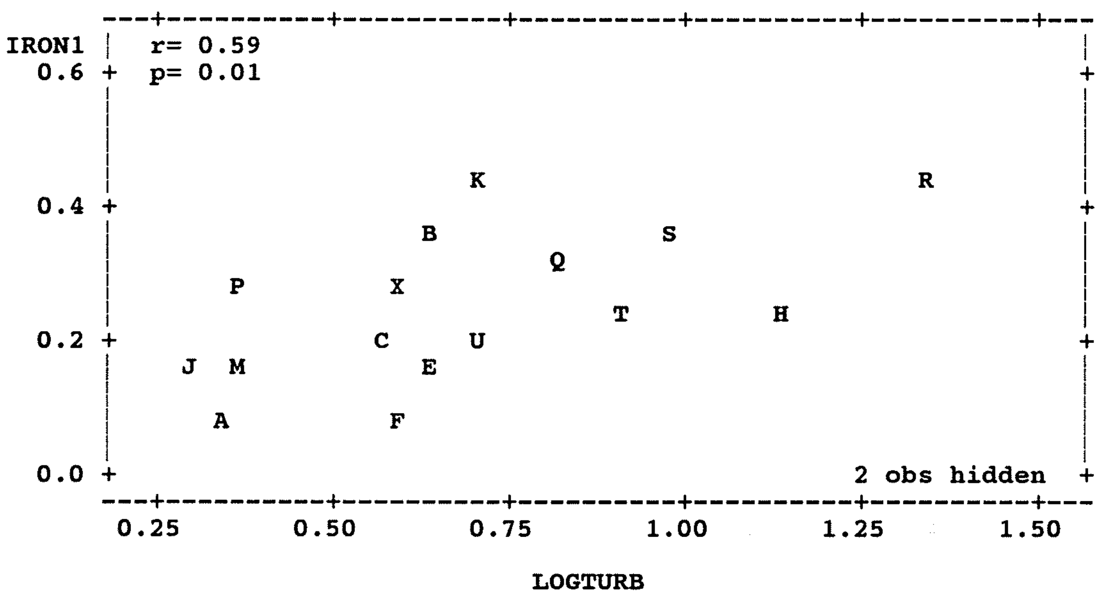
MEAN PH VS. LOG MEAN TURBIDITY (N.T.U.)



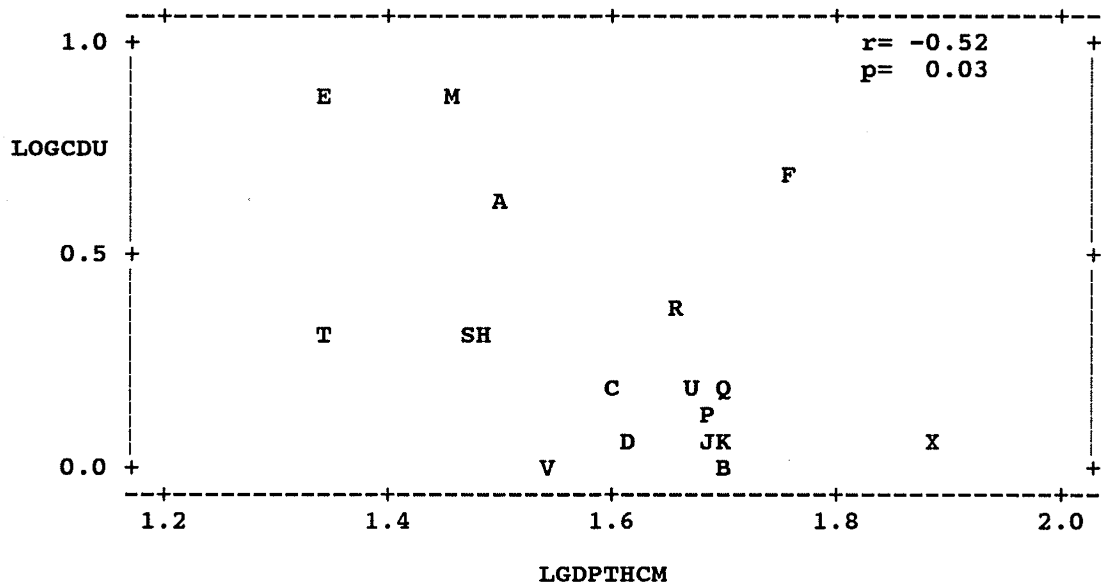
MEAN TOTAL IRON (MG/L) VS. LOG MEAN TOTAL SUSPENDED SOLIDS (UG/L)



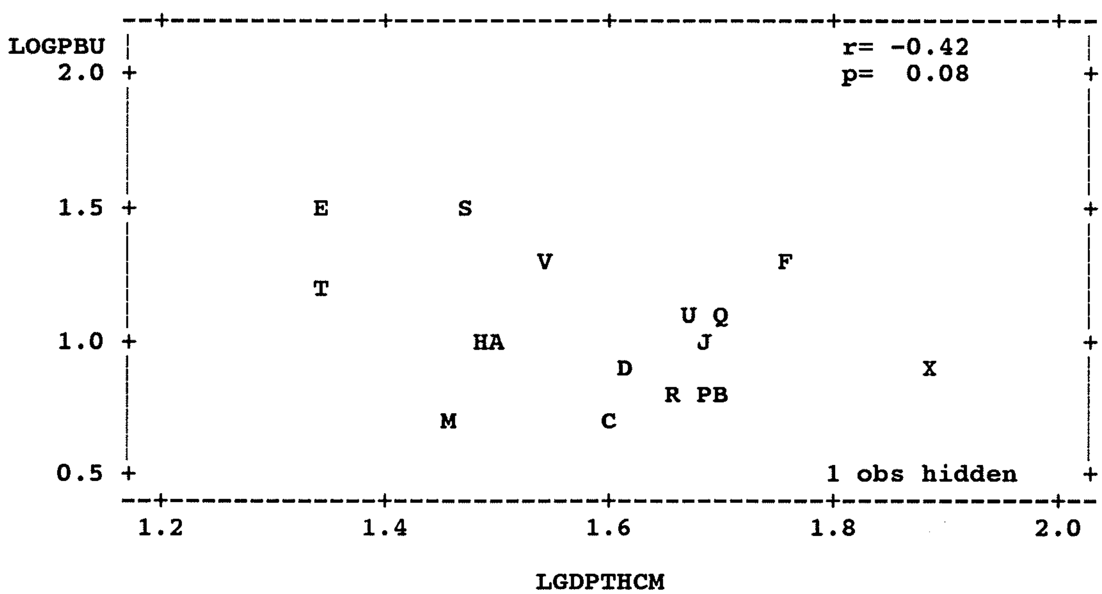
MEAN TOTAL IRON (MG/L) VS. LOG MEAN TURBIDITY (N.T.U.)



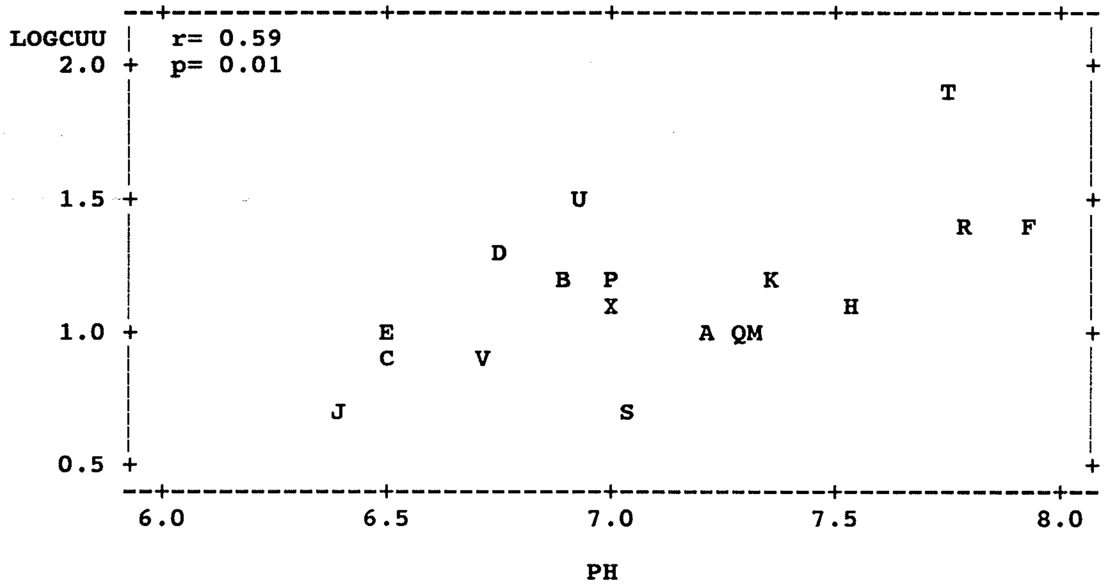
LOG MEAN TOTAL CADMIUM (UG/L) VS. LOG MEAN BOTTOM DEPTH (CM)



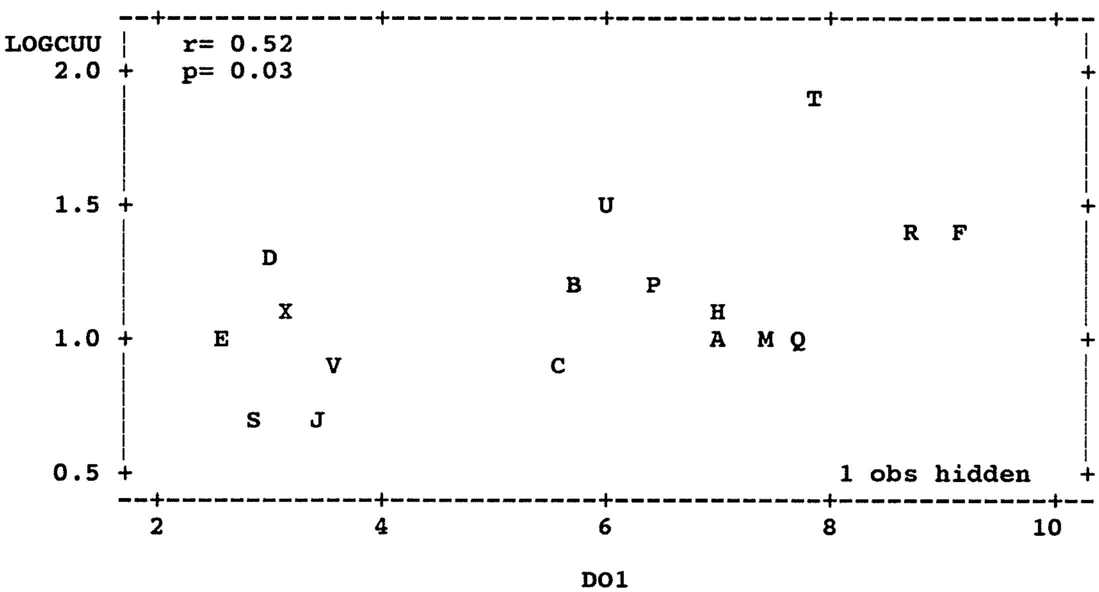
LOG MEAN TOTAL LEAD (UG/L) VS. LOG MEAN DEPTH (CM)



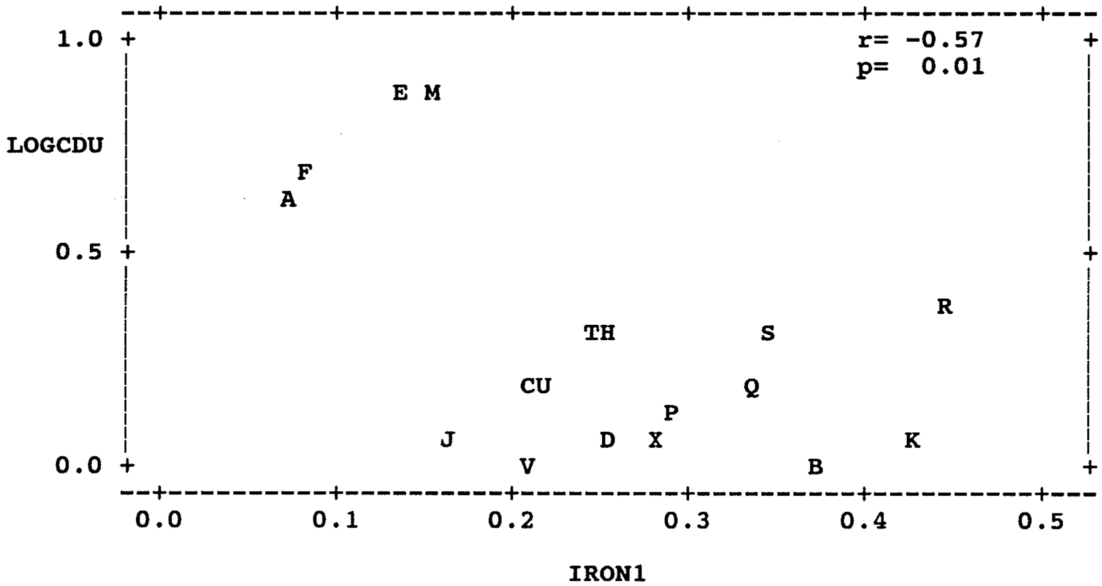
LOG MEAN TOTAL COPPER (UG/L) VS. MEAN PH



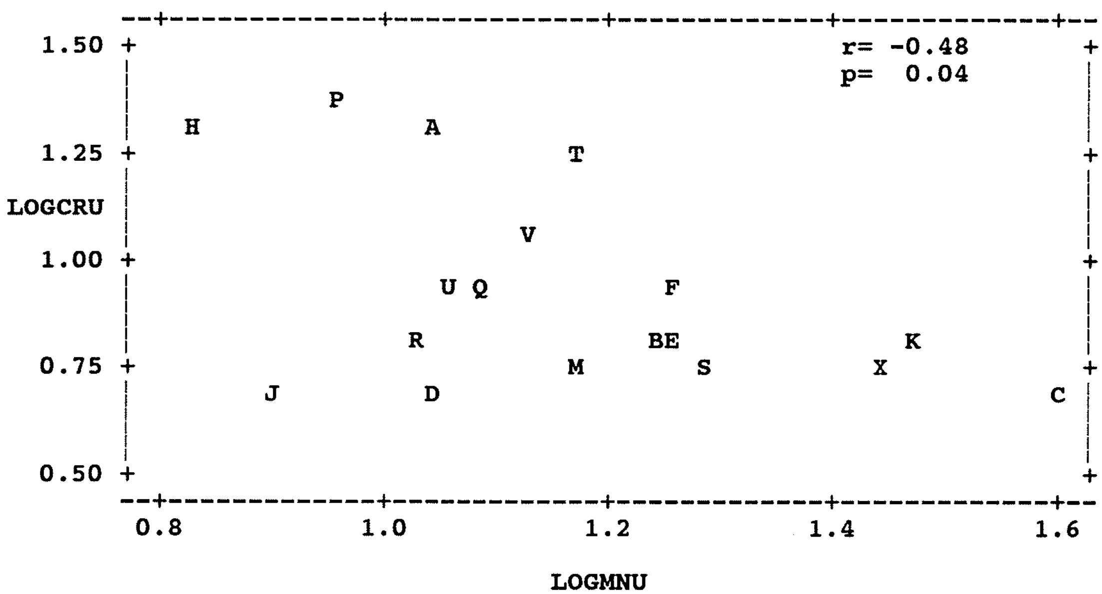
LOG MEAN TOTAL COPPER VS. MEAN DISSOLVED OXYGEN (MG/L)



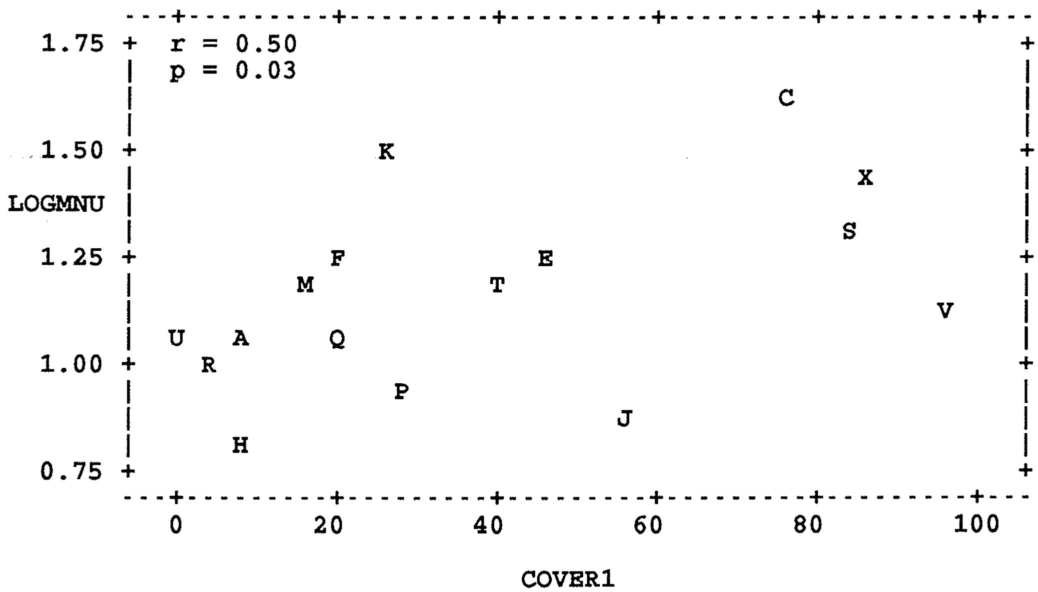
LOG MEAN TOTAL CADMIUM (UG/L) VS. MEAN TOTAL IRON (MG/L)



LOG MEAN TOTAL CHROMIUM (UG/L) VS. LOG MEAN TOTAL MANGANESE (UG/L)

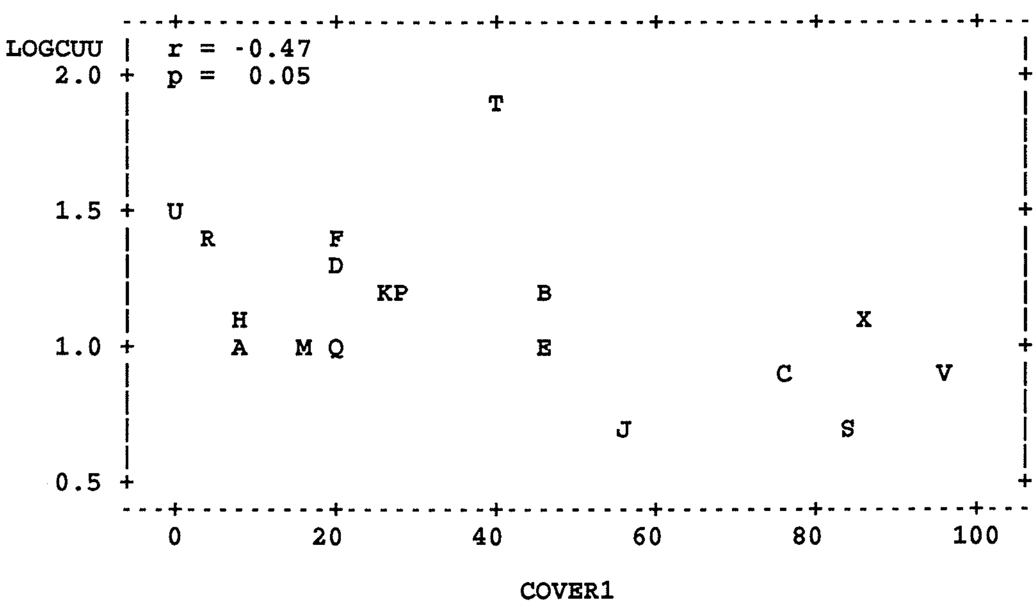


LOG MEAN TOTAL MANGANESE VS. PERCENT COVER ESTIMATE

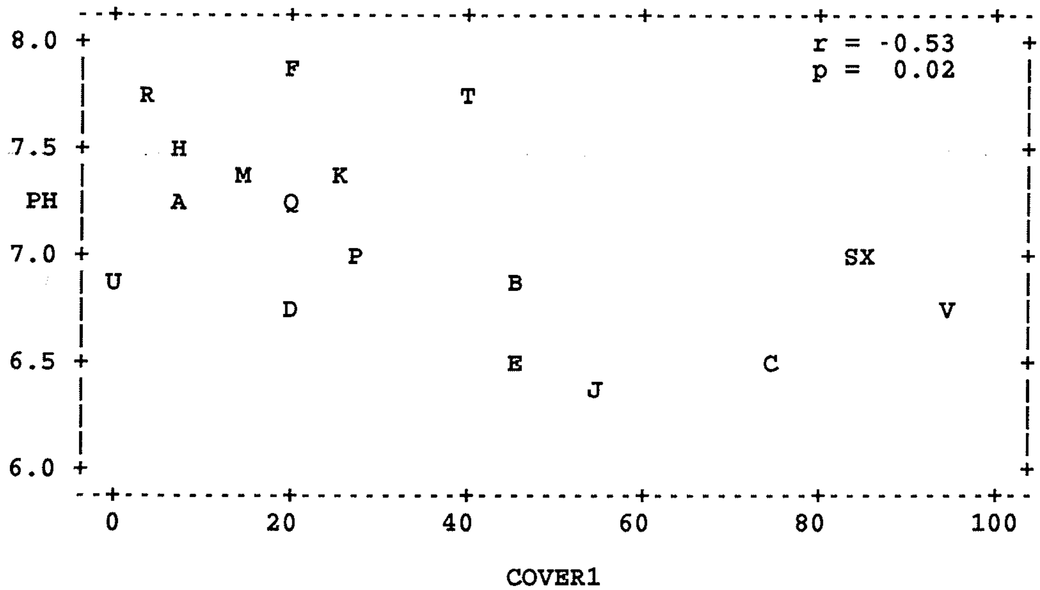


NOTE: 2 obs hidden.

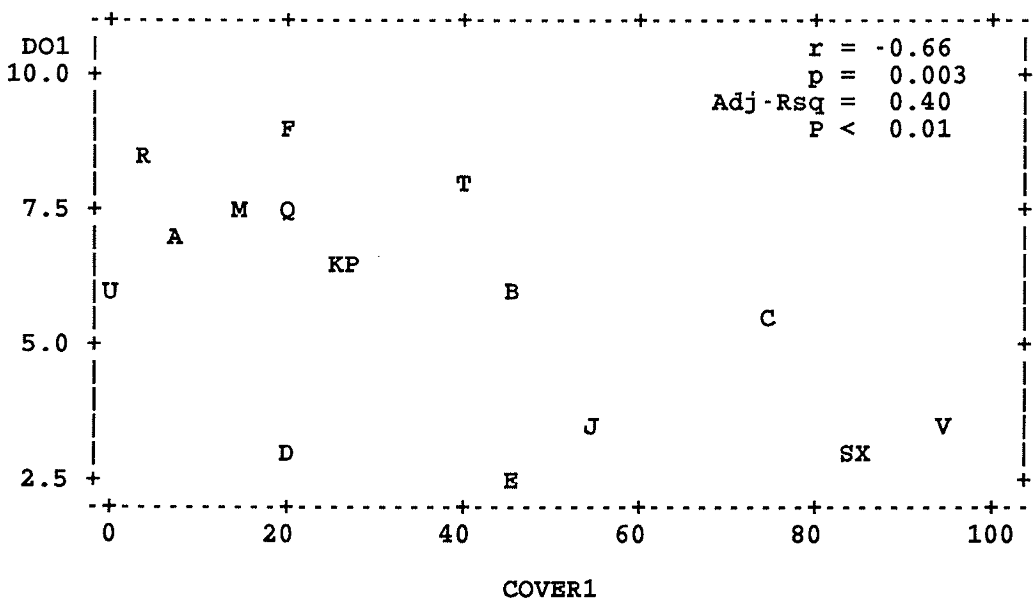
LOG MEAN TOTAL COPPER VS. PERCENT COVER ESTIMATE



MEAN PH VS. PERCENT COVER ESTIMATE

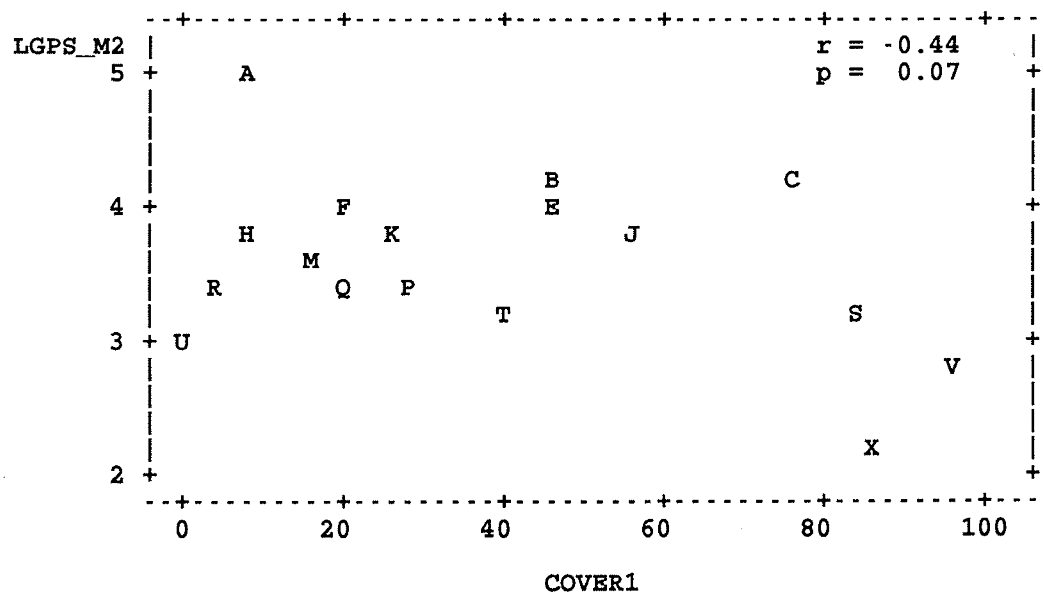


MEAN DISSOLVED OXYGEN VS. PERCENT COVER ESTIMATE



NOTE: 1 obs hidden.

LOG MEAN POND SIZE (M2) VS. PERCENT COVER ESTIMATE



NOTE: 1 obs hidden.