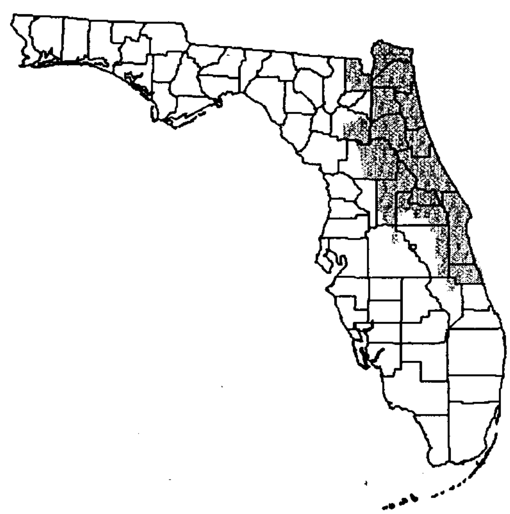
Special Publication SJ2001-SP2

DEVELOPMENT OF A METALS DATA ANALYSIS METHOD FOR DISTRICT-WIDE ASSESSMENT OF SEDIMENT CONTAMINATION

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT



FINAL REPORT

November, 2000

DEVELOPMENT OF A METALS DATA ANALYSIS METHOD FOR DISTRICT-WIDE ASSESSMENT OF SEDIMENT CONTAMINATION

Contract Number: 98B274

Prepared for

St. Johns River Water Management District
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November, 2000

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EXECUTIVE SUMMARY

One objective of the St. Johns River Water Management District (SJRWMD) sediment monitoring project is to identify general problem areas and specific potential "hot spots" that may warrant future investigation. The District-wide survey of toxic compounds in sediments includes the concentrations of trace metals from 126 stations that represent a cross-section of the District. Standard metals data interpretation – including normalizing to crustal elements such as aluminum or iron, grain size, or total organic carbon (TOC), to detect samples with anthropogenic contributions of metals – usually work well among muddy sites (containing less than 20% sand) that are in a similar environment (similar water body or geology). However, such data analysis methods are generally not appropriate to apply broadly across a large region of primarily sandy sediment sites such as the entire SJRWMD.

The objective of this study is to develop a data analysis approach/method that can be used to determine background metal concentrations (and thus anthropogenic contamination) and can be applied to a wide region.

The approach has been to investigate various statistical methods for estimating the background concentration of trace metals in sediment for the SJRWMD. The two most successful methods used are regression analysis and cluster analysis on the quantitative variables. Both methods predicted about the same background concentration range in geochemical properties. Simple linear regression against aluminum (Al) using the entire data set produced significant slopes, but poor relationships. Simple linear regression against Al using geologic subsets improved some of the correlations but not consistently for each geologic formation.

The correlations between metal concentration and environmental characteristics including land use, population density, geologic formation, and hydrologic characteristics were very poor.

The metals interpretive tool that was developed derived clusters based on 4 sediment characteristics including Al, manganese (Mn), percent mud, and percent TOC. Each of the sediment samples is a member of one of 5 clusters. For each cluster the 95% upper confidence limit (UCL) was calculated for each trace metal. Sediment samples that exceed the 95% UCL for specific trace metals were considered to be contaminated. In order to evaluate whether a "new" sediment sample is contaminated the sample must first be assigned to one of the 5 clusters based on the Al, Mn, mud and TOC content. Then the concentrations of the trace metals will be compared to the 95% UCL of that cluster.

One of the difficulties in development of a metals data analysis method is that District sediment samples are primarily sand whereas published studies have been conducted with muddy sediments containing less than 20% sand. An assumption was made that most of the 126 sediment samples are not significantly contaminated with trace metals. A few of the samples were excluded from the statistical analysis because they were obviously contaminated. However, if many of the samples that were used in this analysis are contaminated, then the 95% UCL is too high. One approach to evaluate this is to analyze sediment cores that contain sediment deposited before urban and industrial development occurred.

Estimates of the background concentrations of trace metals in coastal and estuarine muddy sediments from the southeastern U. S. have been published by several studies that used Al linear regression analysis. In comparing the 95% UCL background concentrations of trace metals in the "mud cluster" model described in this report with these published background concentrations, the mud cluster results are somewhat higher but less than a factor of two higher.

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List of Abbreviations and Acronyms

Abbreviation or Acronym	Explanation
CLP	Contract Laboratory Program
ComQAP	Comprehensive Quality Assurance Plan
CVAAS	Cold Vapor Atomic Absorption Spectroscopy
EAS	Environmental Assessment Section
EMAP	Environmental Monitoring and Assessment Program
EPA	Environmental Protection Agency
ERL	Effects Range Low
ERM	Effects Range Medium
ES	Environmental Sciences
FDEP	Florida Department of Environmental Protection
FL DOT	Florida Department of Transportation
FLUCCS	Florida Land Use, Cover and Forms Classification System
GFAAS	Graphite Furnace Atomic Absorption Spectroscopy
GIS	Geographic Information System
GS/MS	Gas Chromatography/Mass Spectrometry
LSJRB	Lower St. Johns River Basin
MDL	Method Detection Limit
MSD	Matrix Spike Duplicate
MSB	Mean Squares Between
MSE	Mean Squared Error
NEESA	Naval Energy and Environmental Support Activity
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NS&T	National Status and Trends
QA	Quality Assurance
QAP	Quality Assurance Plan
QC	Quality Control
OP	Orthophosphate
SJRWMD	St. Johns River Water Management District
STORET	Storage and Retrieval System for Water and Biological Monitoring Data
SWIM	Surface Water Improvement and Management
SWQMP	Surface Water Quality Monitoring Program
TKN	Total Kjeldahl Nitrogen
TOC	Total Organic Carbon
TP	Total Phosphorous
TS	Total Solids
TVS	Total Volatile Solids
UCL	95% Upper Confidence Limit

1.0 INTRODUCTION

1.1 General Historic Background

The St. Johns River Water Management District (SJRWMD) was created in 1972 by the Florida Legislature in response to the need for protecting and preserving the State's water resources. The SJRWMD comprises approximately 12,000 square miles in northeastern Florida, or about 21 % of the total area. The region comprises several major urban centers; numerous smaller cities, towns, and residential developments; and large tracts of rural land in agriculture and forestry. Nine percent of the SJRWMD's area is water. The SJRWMD has a population of approximately 3.2 million (1990 census), or 25 % of the State's total. The SJRWMD's population has grown rapidly in recent decades and is expected to continue growing at a comparable rate in the future. The population is projected to reach over 4.5 million by the year 2010. The most prevalent economic activities within the SJRWMD are tourism, agriculture, forestry, and paper manufacturing. The SJRWMD contains about one-third of the citrus acreage and produces 10% of Florida's fresh winter vegetables. Half of the State's pulp mills are located in the SJRWMD. Many regional economies depend on the SJRWMD's water resources.

The mission of the SJRWMD is to manage water resources to ensure their continued availability while maximizing both environmental and economic benefits. The responsibilities of the SJRWMD have expanded greatly since its inception. The SJRWMD's original focus on flood control has broadened to include water supply protection, water quality protection, and environmental enhancement. Various programs and projects have been initiated to address these responsibilities. Since 1987, the SJRWMD has been required by Florida Statute (Chap. 373.451-373.4595 F.S.) to develop and implement Surface Water Improvement and Management (SWIM) Plans. To date, four water bodies have been identified for priority restoration and protection: the Indian River Lagoon, Lake Apopka, the Upper Ocklawaha River, and the Lower St. Johns River.

Surface water quality monitoring began at SJRWMD in 1979 as a component of the Upper St. Johns River Basin Project. A district-wide monitoring program, known as the Permanent Monitoring Network Project, began in 1983 with the objectives of locating polluted surface waters and creating a long-term water quality database for analyzing temporal trends in water quality. The project was renamed Surface Water Quality Monitoring Program (SWQMP) in 1988 to more specifically reflect project activities and is managed by the Environmental Assessment Section (EAS) within the Environmental Sciences (ES) division.

Originally the SJRWMD's only surface water quality monitoring project, the SWQMP is now one of five equivalently sized monitoring programs (including Upper St. Johns Basin non-SWIM, Lower St. Johns River Basin (LSJRB) SWIM, Apopka/Upper Ocklawaha SWIM, and Indian River Lagoon SWIM Programs) in the ES division. In 1990, the SWQMP started monitoring sediments for priority pollutants. Priority pollutants include metals, hydrocarbons, pesticides and industrial chemicals known to be acutely or chronically toxic. All data collected under this program have been uploaded to the Environmental Protection Agency's (EPA) National Water Quality Data Base (STORET) and are used by the Florida Department of Environmental Protection (FDEP) for the State biennial assessment of water quality — the 305(b) report.

1.2 Sediment Investigation Background

The District-wide survey of toxic compounds in sediments was initiated in FY 89-90 following several studies which documented the prevalence of toxic organic compounds in sediments of the Lower St. Johns River (Dames and Moore, 1983; Shropp and Windom, 1987; Pierce et al., 1988; FDER, 1988). Sediment studies were continued under the SWQMP during FY 90-93. More than half of the stations surveyed to date indicate widespread contamination from polycyclic aromatic hydrocarbons (Delfino et al., 1991 and 1993).

A District-wide baseline monitoring project was performed in the winter of 1996-1997 to assess the current status of freshwater sediments at 86 selected stations with the District. In 1999 an additional 40 stations were sampled and assessed. The stations were selected to provide a representative cross-section of the District. The objectives of the 1996-1997 project were to measure trace organic and trace metal contaminants in sediments, compare them to effects-based sediment quality guideline values (e.g., Sediment Quality Guidelines), and to identify general problem areas and specific potential "hot spots" that may warrant further investigation.

A District-wide sediment assessment report was prepared based on the data gathered in this base-line monitoring project, and was published as a District Special Publication SJ 98-SP5, "*Sediment Quality in the St. Johns River Water Management District: Physical and Chemical Characteristics*" (SJRWMD, 1998). This reported indicated that the general quality of the freshwater sediments in the District were quite good. The most contaminated locations appeared to have contaminant levels that were comparable to typical U.S. urban coastal sediments. A few general locations, however, with elevated concentrations of a number of organic and metal contaminants were identified, and were recommended for further study.

It became evident in this District-wide sediment assessment study that commonly used methods for analyzing and interpreting metals contaminant data (e.g., grain size, TOC, and major metals normalization) were less useful for comparing samples from different environments, such as water bodies from across the District, than for samples from similar environments. Many of the sediments were very high in organic carbon, but much of this was undegraded plant debris that is not completely available as an organic source for "binding" contaminants. This plant debris also contributed disproportionately to the coarser fractions in the grain size determinations. As such, the grain size data did not always provide reliable information on the grain size of the mineral component of the sediment. The 126 sites that were investigated represent many different environments, with different geology and natural processes, and could therefore not be directly compared as if they were similar locations.

1.3 Metals Data Analysis/Interpretation Tool Development

Durell et al. (1997) indicated that "standard" trace metal interpretive methods are inappropriate for broad-based application, such as to a data set that covers the entire SJRWMD, and other analysis approaches may be more useful. Standard metals data interpretation — including normalizing to crustal elements such as Al or iron (Fe), grain size, or TOC, to detect samples with anthropogenic contributions of metal contaminants — usually works well among sites that are in a similar environment (similar water body, geology, and sediment type). For instance, such an approach would likely work well with the relatively large number of sampling sites that are located in the Lower St. Johns River, from Palatka to Jacksonville. However, such data analysis methods are generally not appropriate to apply broadly across a large region such as the entire SJRWMD. The samples in such a large and diverse area are from locations with very different geologies (the natural or background levels of Al, Fe, Mn, and lithium (Li), for instance, vary greatly), different grain size and TOC (some locations had much plant debris, while other were fine organic matter, and other were mostly mineral), and highly varying general sediment characteristics.

The objective of this study was to develop a data analysis method that can be used to determine background metal concentrations (and thus anthropogenic contamination) and can be applied across a wide region, such as the SJRWMD. The goal of this task appears to be unique, and there is no obvious approach to take and no predictable outcome as the "final product." Battelle will attempt to distinguish relationships and trends in the data set that may be compiled into a quantitative data analysis tool. Battelle used the data generated in 1997, along with the new baseline data generated in 1999, to perform this task.

2.0 METHODS

2.1 Sample Collection, Analysis, and Data Generation

Sediment Sample Collection and Field Procedures

The SJRWMD Environmental Assessment staff collected the samples that were used for this project. Battelle provided the SJRWMD with clean, empty jars for the sample collection, along with labels, chain-of-custody forms, and coolers for sample storage and shipment. Three sediment grabs were collected at each of the sampling sites. These three site replicates were placed in separate glass jars, chilled and shipped to the laboratory for analysis. In the laboratory, the sediments were mixed thoroughly and equal amounts from each of the three site replicates were removed and placed in a new jar, mixed, and used for the subsequent analyses.

The SJRWMD staff followed Quality Assurance/Quality Control (QA/QC) procedures in compliance with the SJRWMD's Comprehensive Quality Assurance Plan (CompQAP). The materials (e.g., clean stainless steel, glass, and Teflon materials) and procedures used to collect the samples have been demonstrated to be appropriate for collecting samples for trace chemical analysis (EPA, 1996; EPA, 1994; EPA, 1993; EPA, 1991a and 1991b; NOAA, 1998; NOAA, 1993).

Sample Collection Containers

The sample containers were 500-mL pre-cleaned glass jars with Teflon lined caps obtained from Battelle for the organic compound and metal analyses, and 120-mL glass and 250-mL plastic jars obtained from Mote Marine for TOC, nutrient and other ancillary analyses. The contract laboratories were responsible for shipping these containers, which had been cleaned in a manner that was consistent with the analysis at hand, to the SJRWMD.

Sample Collection Equipment

SJRWMD staff used pre-cleaned stainless steel petite Ponar dredges and/or Eckman dredges to collect all sediment samples. Pre-cleaned glass dishes and stainless steel spoons were utilized in mixing the individual samples and scooping them into pre-labeled containers. The procedures for the decontamination of the dredges, dishes, and spoons were developed and followed by SJRWMD laboratory staff in accordance with the CompQAP.

Sample Collection Procedures

Sediment collection procedures involved using boats, bridges, and wading apparel. Most of the lake, river, and estuarine sites were sampled using a boat. SJRWMD field personnel collected samples from smaller streams and rivers by sampling from accessible bridges or by carefully wading into the river, ensuring that the sediment to be collected was not disturbed.

Upon arrival at the site, an Eckman or Ponar dredge was chosen. SJRWMD staff employed the following protocol for dredge usage and sediment collection:

1. Unwrapped aluminum foil from the dredge.
2. Lowered the dredge into the water body until it reached the sediment. A messenger was then sent down the line to trip the spring mechanism and close the jaws of the dredge.
3. Retrieved the sample.
4. Deposited the entire sample into a glass mixing tray.
5. Used a stainless steel spoon to thoroughly mix the sample in the mixing tray.
6. Promptly partitioned the mixed sample into the appropriate sample containers in order to prevent oxidation of metal ions or volatilization of organic compounds from the sample.
7. Stored the samples immediately in a cooler with wet ice. No chemical preservative was required. FDEP and EPA sample handling, storage, and holding times were adhered to.

At each of the District-wide assessment sites, SJRWMD staff collected three separate dredge samples that were later composited at the contract laboratory. The spoon and glass dish were rinsed with de-ionized water between successive site replicate samples. The sample containers were nearly filled at each site and immediately placed into a cooler with wet ice. Sample collection and shipment was coordinated with the analytical laboratories (Battelle and Mote Marine) to ensure that sample holding times were met.

Field blanks comprised of water were collected at various intervals as required by SJRWMD's CompQAP. Deionized water was poured over the sampling equipment (spoons, dredges, and dishes) and collected into clean containers for analysis. The SJRWMD laboratory analyzed the field blank samples, as per the SJRWMD Field Plan.

Laboratory Sample Analysis Procedures

Selection of Analytical Parameters

The collected sediment samples were analyzed for a series of organic and trace metal contaminants, nutrient parameters, and various physical and chemical ancillary measurements (SJRWMD, 1998). The target analyte list was jointly derived by Battelle and SJRWMD staff and includes most of the applicable contaminants from EPA's priority pollutant list, except for some of the polar organic compounds that do not readily accumulate or do not have significant lifetimes in sediment (Table 2-1). Several organic compounds and some metals were added to the SJRWMD standard monitoring list to improve the representation, data usability, and data comparability, and to improve comparability between the SWQMP monitoring efforts and the LSJRB project.

The contaminants determined in this project include the most environmentally important and persistent organic and metal contaminants found in sediment, as documented by major monitoring programs conducted in the U.S. over the past decade (e.g., NOAA's National Status and Trends (NS&T), and EPA's Environmental Monitoring and Assessment Program [EMAP]). The compounds had to be sufficiently non-polar to accumulate in sediments and have demonstrated abilities to bioaccumulate in benthic and higher aquatic organisms to be included in the consideration when selecting the organic target compounds. Additionally, an effort was made to provide comparability to other monitoring projects being conducted by the SJRWMD. Ultimately, the target analyte list included 92 organic compounds (polycyclic aromatic hydrocarbons, chlorinated pesticides, polychlorinated biphenyls, phthalates, and other industrial compounds); 15 metals, including 3 major crustal elements (Al, Fe, and Mn); nutrients; and various sediment physico-chemical measurements (TOC, grain size, total solids

[TS], and total volatile solids [TVS]). The selection and listing of target compounds is described in more detail in the District Special Publication SJ 98-SP5 (SJRWMD, 1998).

Table 2-1. Analytical parameters, method detection limits, and analysis methods

TARGET ANALYTE	Sediment MDL (µg/kg, dry weight)	Analysis Method [a]
Organic Compounds - PAH		
1-Methylnaphthalene	0.46	8270M
1-Methylphenanthrene	0.30	8270M
2-Methylnaphthalene	0.71	8270M
1-Chloronaphthalene	0.43	8270M
2-Chloronaphthalene	0.47	8270M
2,6-Dimethylnaphthalene	0.36	8270M
2,3,5-Trimethylnaphthalene	0.32	8270M
Acenaphthene	0.40	8270M
Acenaphthylene	0.31	8270M
Anthracene	0.24	8270M
Benzo(a)anthracene	0.21	8270M
Benzo(a)pyrene	0.30	8270M
Benzo(e)pyrene	0.21	8270M
Benzo(b)fluoranthene	0.19	8270M
Benzo(g,h,i)perylene	0.83	8270M
Benzo(k)fluoranthene	0.24	8270M
Biphenyl	0.38	8270M
Chrysene	0.24	8270M
Dibenz(a,h)anthracene	0.16	8270M
Fluoranthene	0.29	8270M
Fluorene	0.34	8270M
Indeno(1,2,3-cd)pyrene	0.17	8270M
Isophorone	0.36	8270M
Naphthalene	0.60	8270M
Perylene	0.15	8270M
Phenanthrene	0.88	8270M
Pyrene	0.26	8270M
Organic Compounds - Phthalates		
Butylbenzylphthalate	1.97	8270M
Di-N-butylphthalate	6.00	8270M
Diethylphthalate	12.0	8270M
Dimethylphathalate	2.33	8270M
Bis(2-ethylhexyl)phthalate	8.97	8270M
Di-N-octylphthalate	2.03	8270M
Organic Compounds - Pesticide		
Chlordecone (Kepone)	0.10	8270M

Table 2-1 (Continued)

TARGET ANALYTE	Sediment MDL (µg/kg, dry weight)	Analysis Method [a]
Organic Compounds – Other Chlorinated		
1,2-Dichlorobenzene	1.31	8081M
1,3-Dichlorobenzene	0.80	8081M
1,4-Dichlorobenzene	1.32	8081M
1,2,4-Trichlorobenzene	0.29	8081M
1,2,4,5-Tetrachlorobenzene	0.11	8081M
Hexachlorobutadiene	0.16	8081M
Hexachloroethane	0.12	8081M
Hexachlorocyclopentadiene	0.20	8081M
Organic Compounds - PCB Congeners		
Cl_2(8)	0.08	8081M
Cl_3(18)	0.09	8081M
Cl_3(28)	0.15	8081M
Cl_4(52)	0.09	8081M
Cl_4(44)	0.07	8081M
Cl_4(66)	0.07	8081M
Cl_4(77)/Cl_5(110)	0.07	8081M
Cl_5(101)	0.10	8081M
Cl_5(118)	0.07	8081M
Cl_6(153)	0.08	8081M
Cl_5(105)	0.07	8081M
Cl_6(138)	0.07	8081M
Cl_5(126)/Cl_6(129)	0.59	8081M
Cl_7(187)	0.07	8081M
Cl_6(128)	0.07	8081M
Cl_7(180)	0.06	8081M
Cl_6(169)	0.1	8081M
Cl_7(170)	0.10	8081M
Cl_8(195)	0.08	8081M
Cl_9(206)	0.11	8081M
Cl_{10}(209)	0.12	8081M
Organic Compounds - Pesticides		
4,4'-DDD	0.05	8081M
2,4'-DDD	0.06	8081M
4,4'-DDE	0.06	8081M
2,4'-DDE	0.08	8081M
4,4'-DDT	0.08	8081M
2,4'-DDT	0.08	8081M
Aldrin	0.12	8081M
α-BHC	0.09	8081M
β-BHC	0.08	8081M
δ-BHC	0.06	8081M
γ-Chlordane	0.07	8081M
Oxychlordane	0.1	8081M

Table 2-1 (Continued)

TARGET ANALYTE	Sediment MDL (µg/kg, dry weight)	Analysis Method [a]
Organic Compounds - Pesticides (cont.)		
γ-BHC (Lindane)	0.09	8081M
Chlorpyriphos (Dursban)	0.10	8081M
α-Chlordane	0.08	8081M
trans-Nonachlor	0.07	8081M
cis-Nonachlor	0.1	8081M
Dieldrin	0.07	8081M
Endosulfan I	0.08	8081M
Endosulfan II	0.06	8081M
Endosulfan sulfate	0.06	8081M
Endrin	0.09	8081M
Endrin aldehyde	0.10	8081M
Endrin ketone	0.07	8081M
Heptachlor	0.12	8081M
Heptachlor epoxide	0.08	8081M
Hexachlorobenzene	0.11	8081M
Methoxychlor	0.10	8081M
Mirex	0.07	8081M
Metals	(mg/kg, dry weight)	
Aluminum (Al)	14.3	200.8M
Arsenic (As)	1.03	200.9M
Cadmium (Cd)	0.074	200.8M
Chromium (Cr)	1.0	200.8M
Copper (Cu)	0.657	200.8M
Iron (Fe)	400	200.8M
Lead (Pb)	0.746	200.8M
Lithium (Li)	0.928	200.8M
Manganese (Mn)	0.662	200.8M
Mercury (Hg)	0.01	245.5
Nickel (Ni)	1.14	200.8M
Selenium (Se)	0.27	200.9M
Silver (Ag)	0.022	200.9M
Tin (Sn)	0.056	200.8M
Zinc (Zn)	3.26	200.8M
Nutrients		
Total Kjeldahl Nitrogen (TKN)	5	
Total Phosphorous (TP)	5	
Orthophosphate (OP)	0.5	

Table 2-1 (Continued)

TARGET ANALYTE	Sediment MDL (µg/kg, dry weight)	Analysis Method [a]
Ancillary Measurements		
Total Organic Carbon (TOC)	0.01 % (dry weight)	
Total solids (TS)	0.5 % (wet weight)	
Total volatile solids (TVS)	0.5 % (dry weight)	
Grain Size	0.5 %	
% Moisture	0.5 %	

[a] *The instrumental analysis methods listed apply the following analytical instrumentation:*
8270M: Gas chromatography/mass spectrometry (GC/MS)
8081M: Gas chromatography/electron capture detection (GC/ECD)
200.8M: Inductively coupled plasma/mass spectrometry (ICP/MS)
200.9M: Graphite furnace atomic absorption spectroscopy (GFAAS)
245.5: Cold vapor atomic absorption spectroscopy (CVAAS)

Selection of Analytical Procedures

The analytical work for this study required the use of specialized low detection limit procedures. Two principal considerations drove the selection of analytical methods:

- In order to assess the true status of anthropogenic chemicals, analytical methods capable of measuring contaminants at ambient (background) concentrations were required. A reliable picture of the background conditions, areas of impact, and severity of chemical contamination could be resolved using these methods.

- Sensitive low-level measurements of contaminants needed to be performed in order to determine linkages between chemical presence and observed bioeffects (e.g., impact to the benthic community structure), ecological perturbations, or change. A large body of literature has been amassed demonstrating that such effects occur at very low contaminant concentrations (e.g., EPA Water Quality Criteria, EPA Proposed Sediment Quality Criteria, NOAA Effects Range Low (ERL) and Effects Range Medium (ERM) Observed Effect Concentrations), well below concentrations capable of being measured by standard EPA methods of analysis.

It has been clearly documented that standard methods of analysis such as EPA SW-846 (EPA, 1986) or Contract Laboratory Program (CLP) methods cannot obtain the detection limits needed to achieve the goals listed above (e.g., Douglas and Uhler, 1993), simply because those standard methods were designed for high level, hazardous waste site or discharge regulatory compliance monitoring. Hence, other analytical procedures were needed to achieve the performance goals required for environmental quality monitoring.

Achieving meaningful detection limits for organic and trace metal contaminants for environmental quality monitoring has been of special concern to the NOAA and the EPA. Through the NOAA NS&T Program and the EPA EMAP, a set of analytical methods have been developed specifically to meet the low-level detection limit requirements necessary for successful environmental quality monitoring. Developed over the last 10+ years, these methods are modifications and improvements upon the standard EPA methods of analysis. Generally, the very low detection limits provided by the NOAA NS&T analytical methods are achieved by using larger sample sizes, employing several additional sample cleanup steps prior to instrumental analysis, and employing instrumental analysis procedures that are highly targeted to the analytes of interest.

These methods are used by NOAA NS&T, by EPA in the National EMAP Program, and are required by the U.S. Army Corps of Engineers (USACE) in the guidance manual for *Evaluation of Proposed Discharge of Dredged Material into Ocean Water* ("Green Book"), and the USACE *Inland Testing Manual.* The methods are used in the U.S. Navy CLEAN program and the Navy Installation Restoration Programs, and are approved for use in the Naval Energy and Environmental Support Activity (NEESA) program.

These methods have been published in a NOAA Technical Memorandum in which Battelle scientists were principal authors (NOAA, 1998; NOAA, 1993), and in EPA/USACE testing and analysis documents (EPA, 1996; EPA, 1994; EPA, 1993; EPA, 1991a and 1991b). Constant refinement, strict laboratory quality control procedures, and an external quality control program administered by the National Institute of Standards and Technology (NIST) ensure that these methods are robust, accurate, and precise for low-level environmental quality monitoring programs.

Battelle employed the NOAA NS&T analytical methods for the analysis of trace metals and the nonpolar organic compounds. Battelle obtained FDEP approval for the application of these specialized methods, which have been incorporated into Battelle's FDEP CompQAP, and are also being used to provide analytical support to the SJRWMD for monitoring studies in the St. Johns River and the Cedar-Ortega River Basin. The ancillary measurements were also performed in accordance with FDEP CompQAP approved methods. The sample preparation and analysis methods, including the associated quality assurance and quality control protocols that were used, and method detection limits are described in detail in Battelle's FDEP-approved CompQAP and in the District Special Publication SJ 98-SP5 (SJRWMD, 1998).

Data Generation

The Arc/Info Regions Data Model was used to define and characterize the Surface Water Drainage Basins that drain to 189 sediment sites in the SJRWMD. For each site, the entire upstream drainage basin (Whole Basin) was defined and put into a region subclass. In addition, that portion of the drainage basin immediately surrounding each site (Local Basin) was defined as a separate region subclass.

Florida Geology, 1990 Census Tracts, 1995 Land Use, and General Physiography spatial data layers were made into region subclasses and overlaid onto the defined basins. Percentages of land use types, geological formations, general physiographic types, and population density were extracted for each whole and local basin by querying these overlays with region commands and creating new subclasses. The resulting subclass info tables were summarized in Excel, brought into ArcView, and linked to the sediment site so when a user chooses a site, all the associated layer information is highlighted.

There are 1144 detailed drainage basins in the SJRWMD's Surface Water Drainage Basins Arc/Info coverage (Adamus et al., 1997). These were delineated by the USGS from 1:24,000 scale 7.5 minute quad maps. They are aggregated into larger surface water basin groups, such as Major Basins. All basins are subdivisions of USGS Hydrologic Units and are coded hierarchically. This hierarchical scheme was used to choose the basins that drain to each sediment site.

The Surface Water Drainage Basins coverage was edited to determine which basins drained to each site. For streams, arcs were added downstream from each sediment site to terminate the basin at that site. Both local and whole basins were defined for all 189 sites, for a total of 378 drainage basins.

The drainage basins for each sediment site were unioned with the following spatial layers to create an overlapped base geometry:

- Florida Geological Formations defined by the Florida Geological Survey and used to find the percentage of geological formation types that are in each site's drainage basin.
- 1990 Population Density defined by the U.S. Census Bureau and used to find the population density within each site's drainage basin.
- Physiographic Groupings developed by the SJRWMD. These are a composite of the Physiographic Divisions of Florida (Brooks, 1981). This layer was used to find the general physiography of each site's basin.
- The 1995 Land use / Land cover based on Florida Land Use, Cover and Forms Classification System (FLUCCS) created by the Florida Department of Transportation (FL DOT, 1985). This layer was used to summarize land use for each sites basin. The FLUCCS were aggregated into seven general categories important for pollution assessment (Table 2-2).

Table 2-2. Land use aggregation

FLUCCS Land Use Code	FLUCCS Land Use Category	Aggregated Land Use Category
1199	Low Density Residential	Residential
1299	Medium Density Residential	Residential
1399	High Density Residential	Residential
1499	High Density Commercial	Commercial / Industrial
1599	Industrial	Commercial / Industrial
1699	Mining	Commercial / Industrial
1799	Low Density Commercial	Commercial / Industrial
1819	Range Open space	Range Open space
1829	Medium Density Residential	Residential
1999	Range Open space	Range Open space
2139	Range Open space	Range Open space
2199	Crops	Agricultural
2239	Citrus	Agricultural
2299	Agricultural Miscellaneous	Agricultural
2399	Animal	Agricultural
2519	Agricultural Miscellaneous	Agricultural
2539	Animal	Agricultural
2599	Agricultural Miscellaneous	Agricultural
3999	Range Open space	Range Open space
4399	Forested	Forested
4999	Silviculture	Forested
5999	Water	Water
6999	Wetlands	Wetlands
7399	Barren	Range Open space
7999	Range Open space	Range Open space
8199	Transportation	Commercial / Industrial
8319	Industrial	Commercial / Industrial
8329	Range Open space	Range Open space
8999	Range Open space	Commercial / Industrial

The unioned output coverage was queried to get the intersection of the drainage basins for each sediment site for geology, physiography, and population density and land use. The query results were summarized in Excel for each site. Percentages of geological formations, physiographic types, population density, and land use were calculated for each drainage basin. The final coverage and the Excel tables were imported to ArcView and linked to the sediment sites.

2.2 General Statistical Methods

Due to the exploratory nature of the objective of this task, the methods discussed here only provide the general statistical approach and rational to the development of the data analysis tool. The following section titled "Development of Metals Interpretive Tool" follows the specific data exploration path and analysis of trends observed. Data were provided by the SJRWMD in the form of Excel spreadsheets (Microsoft Corporation, Release Excel 2000, 1999) and an ArcView GIS compatible database (Environmental Systems Research Institute, Inc., Release 3.2, 1999). The spreadsheet data provided (Appendix A) included metal concentrations of aquatic sediment samples from within the SJRWMD and associated local and whole basin geological formations, hydrological, physiographical, and environmental characteristics including land use and population density. All metal concentrations observed as less than detected were reported and analyzed as zero. The effects of non-detects on the statistical analysis are discussed below. All exploratory analyses were conducted using the statistical software packages Statistica (StatSoft, Inc., Release 5.1, 1997) and Minitab (Minitab Inc., Release 9, 1993). It is intended, however, that the recommended Metals Interpretive Tool will be able to be conducted on a hand held calculator or using spreadsheet software.

Descriptive statistics, distribution plots, and correlations were used to evaluate metal concentrations within sediments (n = 126) collected from rivers, lakes and estuaries distributed within the SJRWMD. It was expected that potentially contaminated sediments and samples with large amounts of organic matter (e.g., small pieces of wood, twigs, grass, leaves, fibers, detritus) would confound this analysis. Metal concentrations were standardized by their mean and standard deviation to identify and remove observations that could not be considered representative of background condition. All standardized metal concentrations greater than 2 were removed from the analyses.

Sediment sample locations and their associated metal concentrations were classified using qualitative geologic and hydrologic attributes and by multivariate k-mean cluster analyses on quantitative measurements choosing observations to maximize between-cluster differences. Qualitative clusters were determined simply by sorting observations based on specific qualitative attributes. The number of qualitative clusters equaled the number of types observed. Qualitative variables used in the analyses included both local and whole basin geological formation and hydrology. To determine the appropriateness or usefulness of potential relationships between concentrations and qualitative site characteristics, the by class variability in concentration of Al and TOC was evaluated. Historically, Al concentrations and TOC have been used to separate sediment types and normalize elemental concentrations (Daskalakis and O'Connor, 1995; Windom et al., 1989; and Durell et al., 1997).

For the quantitative measurements, the number of clusters needed to represent the SJRWMD is unknown; therefore, we must balance the need for easy discrimination and enough members in each class to estimate background metal concentrations. The number of quantitative clusters classified was determined by hierarchical tree clustering using Euclidean distance as a measure of the difference between observations. The Euclidean distance is the square root of the sum of squared differences between two observations for all variables measured. Clusters were combined using a complex linkage rule measured by the Euclidean distance between the points furthest apart. In order to standardize the determination of the number of quantitative clusters, the number of clusters achieved at 50% of the maximum linkage distance was used for the number of clusters classified in the k-mean clustering analysis. The number of clusters achieved at 50% of the maximum linkage distance generally insures good discrimination between clusters and fewer classes with few members. As the number of clusters increases, the number of members in each cluster is decreased. Quantitative variables included geologically associated metal concentrations and other sediment characteristics at the site (i.e., texture and TOC).

The k-means clustering was not conducted on metal concentrations other than Al and Mn since the objective was to find physical characteristics that could be used to identify areas with potential contamination rather than to identify areas of like metal concentrations (i.e., all areas with similar mercury [Hg] concentrations). Al and Mn are associated with the geological characteristics of the soil and could potentially differentiate between sediment types and background chemical distributions. Al and Mn did not have any values less than detected (set at zero), and thus, the value substituted for non-detects did not affect the clustering results.

A forward-stepping discriminant function analysis was used on clustered data for determining the equations (scores) defining class membership (e.g., the algorithms for the Metals Interpretive Tool). This analysis assumed that class membership of the current data was correct as defined by the k-mean clustering. The discriminatory power between clusters (Wilk's lambda) and the percent correct classification were used to decide between variable combinations used for k-mean clustering. Wilk's lambda ranges between 1.0 (no discrimination power) to 0.0 (perfect discrimination). A plot of the discriminant scores for each cluster is provided to allow a visual assessment of the class membership of a new observation. New data scores can be considered from the same populations of sediment as the current sample if their scores fall within one of the clusters in the plot. If a new data score does not fall within one of the clusters, then the new observation is from a population that was not included in the current sampled data. The ability of this discriminant function analysis to classify new samples from SJRWMD is dependent on how representative the current data sample is of the sediment variability within the SJRWMD.

Finally, the 95% UCL for the background metal concentrations for each cluster was estimated. It is assumed concentrations greater than the upper confidence limit indicate contamination. Both the number of less than detected observations and the value used (i.e., zero, one-half the detection limit, or the whole detection limit) for the less than detected observations can affect the estimated upper confidence limits for background metal concentrations. If a large percentage of the data were less than detected, both the variance and the mean of the concentrations would be expected to decrease within a class, and thus, the upper confidence limit would be expected to decrease. This effect, however, would decrease as the percentage of less than detected values decreases.

Traditional regression analysis and the calculation of a 95% upper confidence limit of metal concentration against Al as described by Windom et al. (1989) was also evaluated as a definition of background concentration. This method was used both as an alternative method for defining background metal concentrations based only on Al and to evaluate the sensibility of the Metals Interpretive Tool.

3.0 DEVELOPMENT OF THE METALS INTERPRETIVE TOOL

Descriptive statistics including the mean, standard deviation, quartiles, and extreme observations are presented in Table 3-1. Only cadmium (Cd), copper (Cu), lead (Pb), Hg, silver (Ag), and zinc (Zn) had observations with potentially contaminated concentrations based on published studies by Daskalakis and O'Connor (1995a), Hanson et al. (1993), and Windom et al. (1989). These six metals are also considered to be elevated in greater than 20% of 13,000 U.S. coastal and estuarine sediments (Daskalakis and O'Connor, 1995b). Concentrations observed at or above the upper quartile of these metals could be considered elevated above background. Because the data were highly skewed towards sandy sediments, however, the upper quartile could be too low a concentration to define background levels for all sediment types. Thus, in order to remove ambiguity, metal concentrations were standardized by subtracting the mean concentration for a given metal and dividing by the standard deviation. Standardized concentrations observed greater than 2 were assumed above background (i.e., outliers) and removed from statistical analysis. The analysis of sediment cores would be a more precise means to define background metal concentrations.

A box and whisker plot of each metal and sediment characteristic (before removal of possible outliers) provides a visual characterization of the range and percentiles for each measurement greater than the detection limit (Figure 3-1). A table of correlations including possible outliers (Appendix B) shows that Al, Fe, and Li were highly correlated ($r > 0.9$). TOC was very highly correlated with total volatile solids ($r = 0.98$). Variables that were correlated greater than the absolute value of $r = 0.83$ were not used together in the cluster analysis of sediment characteristics. For example, Al and percent sand ($r = 0.83$) and Al and percent mud ($r = -0.83$) were the variables used in the cluster analysis which had the greatest absolute correlations.

Table 3-1. Descriptive statistics for each metal (n=126) concentration and sediment characteristic from samples collected within the St. John's River Water Management District (unit:mg/kg)

Metal	% Not Detected	Mean	Median	Minimum	Maximum	Lower Quartile	Upper Quartile	Quartile Range	Std.Dev.
ALUMINUM	0%	10991	5915	239	48400	1810	18000	16190	11850
ARSENIC	7%	2.43	1.03	0	15.2	0.4	3.675	3.28	2.99
CADMIUM	17%	0.241	0.136	0	2.26	0.038	0.362	0.324	0.30
CHROMIUM	0%	18.0	10.3	0.507	139	4.18	23.3	19.1	20.4
COPPER	0%	7.79	3.61	0.256	112	1.58	9.89	8.31	12.7
IRON	0%	6315	3315	63.6	30200	960	9590	8630	7141
LEAD	0%	22.34	12.0	0.61	343	5.48	26.8	21.3	40.3
LITHIUM	2%	7.82	3.80	0	50	1.83	10.5	8.67	9.73
MANGANESE	0%	76.9	50.4	1.78	425	25.6	93	67.4	81.5
MERCURY	3%	0.104	0.047	0	0.44	0.015	0.17	0.155	0.11
NICKEL	0%	5.09	2.37	0.123	29.8	0.7	7.58	6.88	5.74
SELENIUM	25%	1.39	0.531	0	28.1	0.11	2.27	2.16	2.75
SILVER	11%	0.106	0.055	0	1.55	0.016	0.109	0.093	0.19
TIN	0%	0.947	0.601	0.0669	8.35	0.326	1.18	0.854	1.11
ZINC	0%	35.2	18.4	0.901	361	8.77	42.9	34.1	49.9
SAND (%)	0%	74.6	79.4	20.5	100	62.9	92.5	29.6	21.3
SILT (%)	0%	23.0	19.0	0.1	71.7	6.3	35.1	28.8	19.6
CLAY (%)	0%	2.43	1.70	0	13.4	0.6	3.3	2.7	2.42
TOC	0%	93038	23900	230	451000	3390	180500	177110	120210
MOISTURE	0%	55.4	52.1	16.1	96.6	27.2	84.2	57.0	27.6
TOTAL_SOL	0%	44.6	48.0	3.4	83.9	15.9	72.8	57.0	27.6
TOTAL_VOL	0%	16.2	7.20	0	71.2	1	26.5	25.5	19.0

The correlation between metal concentrations and environmental characteristics including land use and population density averaged r = 0.02. The maximum correlation was between the concentration of Hg and the percent of water in the local basin (r = 0.44). The lack of any substantial correlation between metal concentrations and environmental characteristics was expected due to the chance occurrence of sampling a depositional area associated with each site. An alternative way of evaluating the relationship between the metal concentrations and the environmental characteristics is to rank each site by level of contamination and plot the characteristic (i.e., population density) by rank. Sites were ranked by the number of metal concentrations greater than the 75th percentile of the sampled distributions for the six metals containing potentially elevated concentrations.

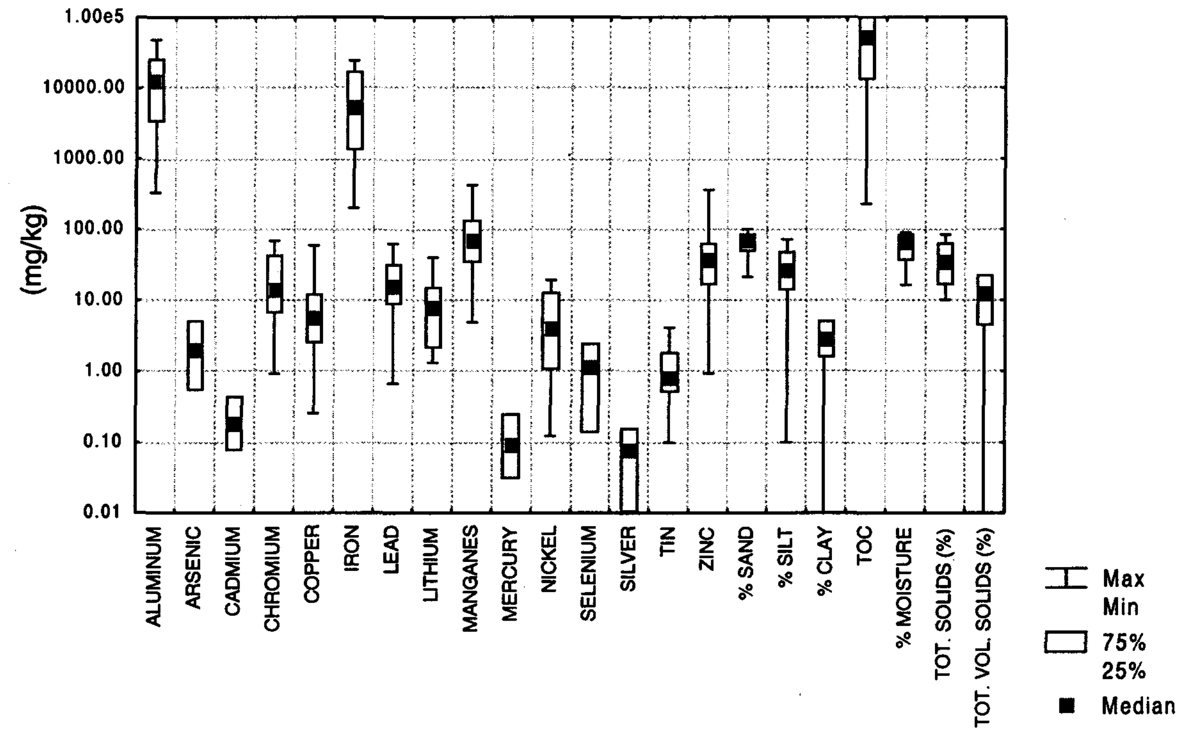

Figure 3-1. A box and whiskers plot of each detected metal and sediment characteristic from samples (n=126) collected from the St. Johns River Water Management District (unit: mg/kg)

For example, if all six metals for a given site were above the 75th percentile of the respective distributions, then the site received a rank of 6. Likewise, if only one of the metals for a given site was above its 75th percentile, then the site received a rank of 1. Thus, all sites were given a number between 0 and 6. There were no sites with all 6 metals above the 75th percentile of each distribution. There was no relationship found between the metal concentrations and environmental characteristics. For example, the contaminant class with zero metal concentrations above the 75th percentile of each distribution contained both the maximum and minimum population densities. Thus, environmental characteristics were not used in the cluster analyses described below.

3.1 Clustering Based on Geologic Characteristics

Qualitative clusters based on the local and whole basin geologic formations were defined by the greatest geologic component. For example, site LOL was designated as Tqu (Appendix A and C) since this was the greatest geologic component even though Tqu was only 30.08% of the geologic makeup of the sediment. Thus, each sample's associated maximum geologic component determined the qualitative geologic variable and cluster membership. Figures 3-2 and 3-3 depict the concentrations of Al and TOC for each of the local basin geologic formations by hydrologic type, respectively. Figures 3-4 and 3-5 depict the whole basin geologic clusters concentrations of Al and TOC, respectively. There appears to be no relationship between Al concentration, hydrologic type (e.g., whether samples came from rivers, lakes, or estuaries), and geologic cluster (local or whole basin).

Cluster membership was also determined by whether the whole basin major component was carbonate, low organic, high organic, or mixed sediment. Carbonate sediments were defined as those sediments with major components being To, Tqsu, or Qa. Low organic sediments were defined as those with major components being Thc, Thcc, Ths, Tc, Tquc, or Qbd. High organic sediments were those with major components being Tqu or Tqd. Mixed sediments were Qtr, Qu, or Qh. Again the variability in Al and TOC concentration by hydrologic characteristic and soil formation does not indicate a pattern (Figures 3-6 and 3-7, respectively).

Geologic formation clusters were also based on the map boundaries provided in the ArcView database. Again, no pattern was apparent between Al and TOC and hydrologic characteristics with sediment formation (Figures 3-8 and 3-9, respectively).

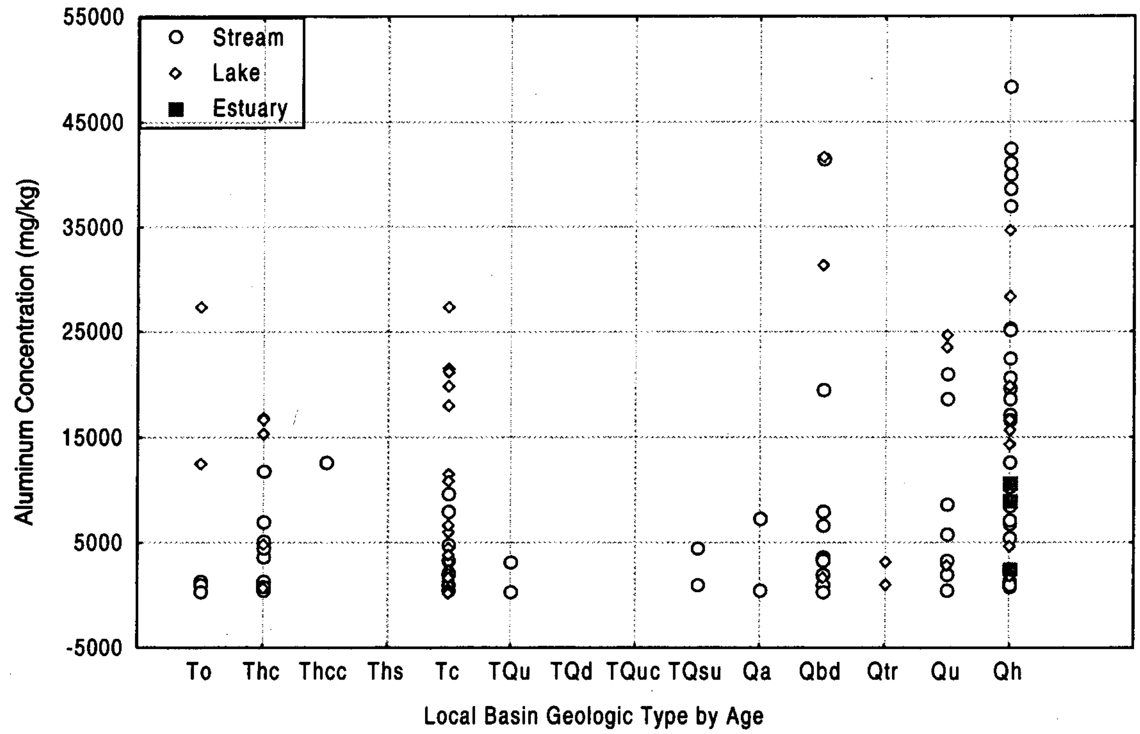

Figure 3-2. Concentration of aluminum plotted for each local basin geologic cluster

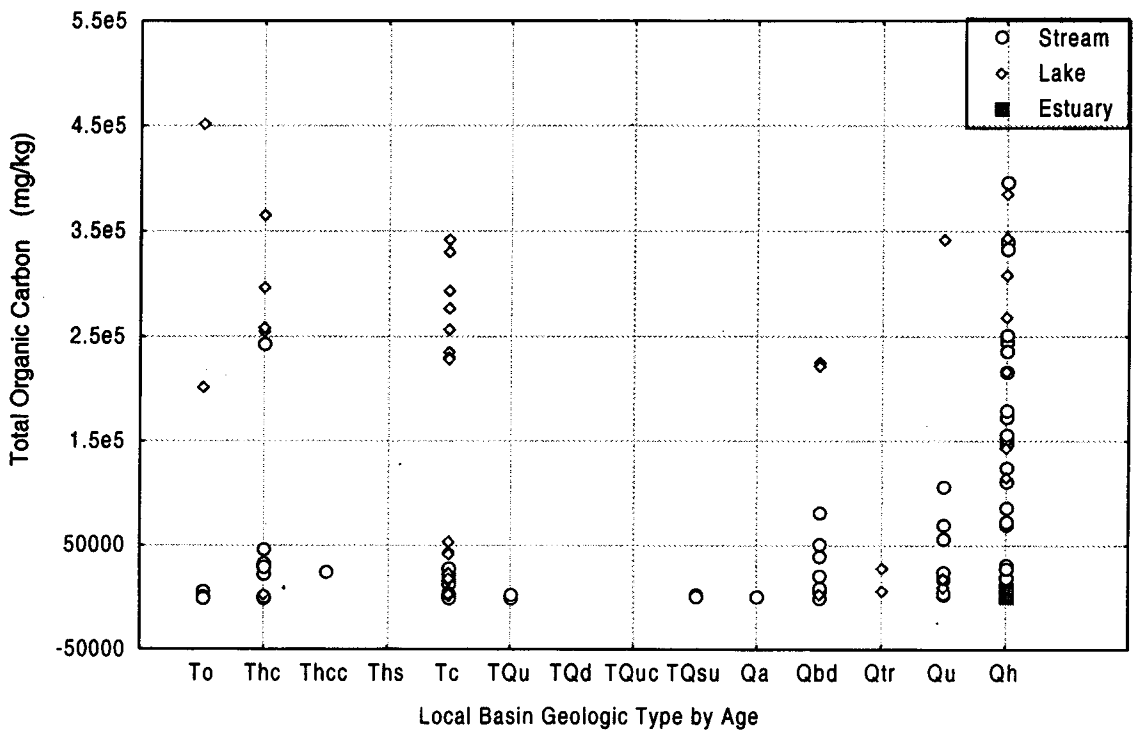

Figure 3-3. Percent total organic carbon plotted for each local basin geologic cluster

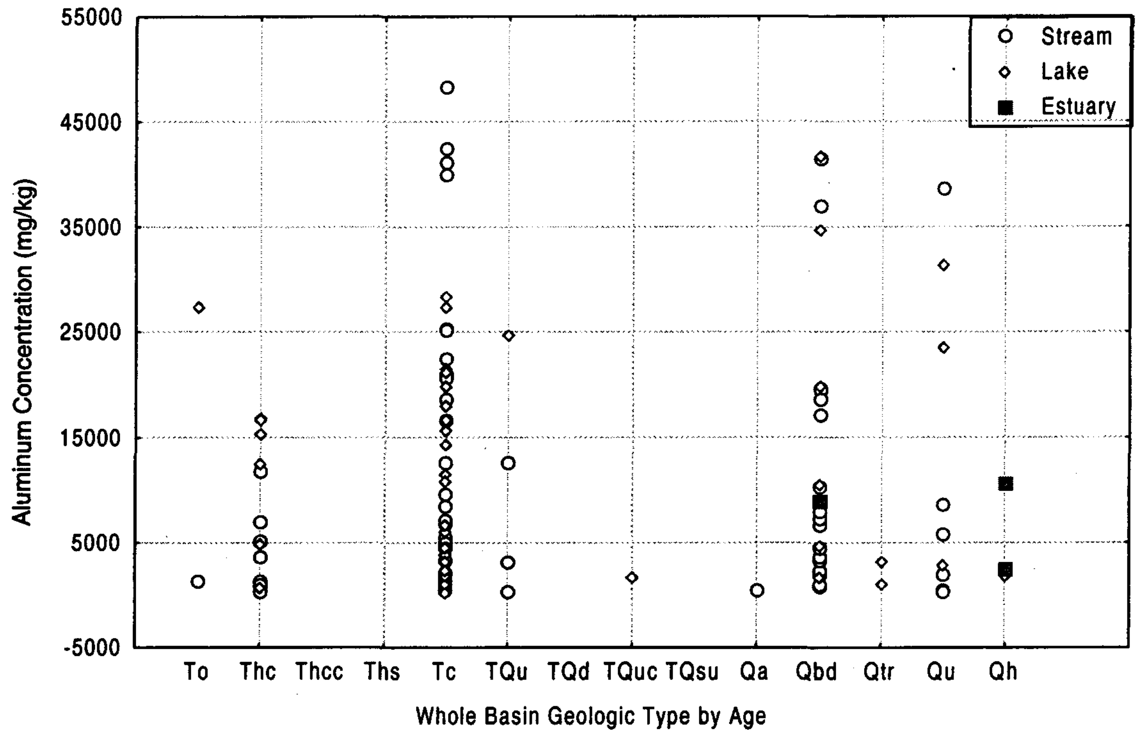

Figure 3-4. Concentration of aluminum plotted for each whole basin geologic cluster by water body type (i.e., stream, estuary, and lake)

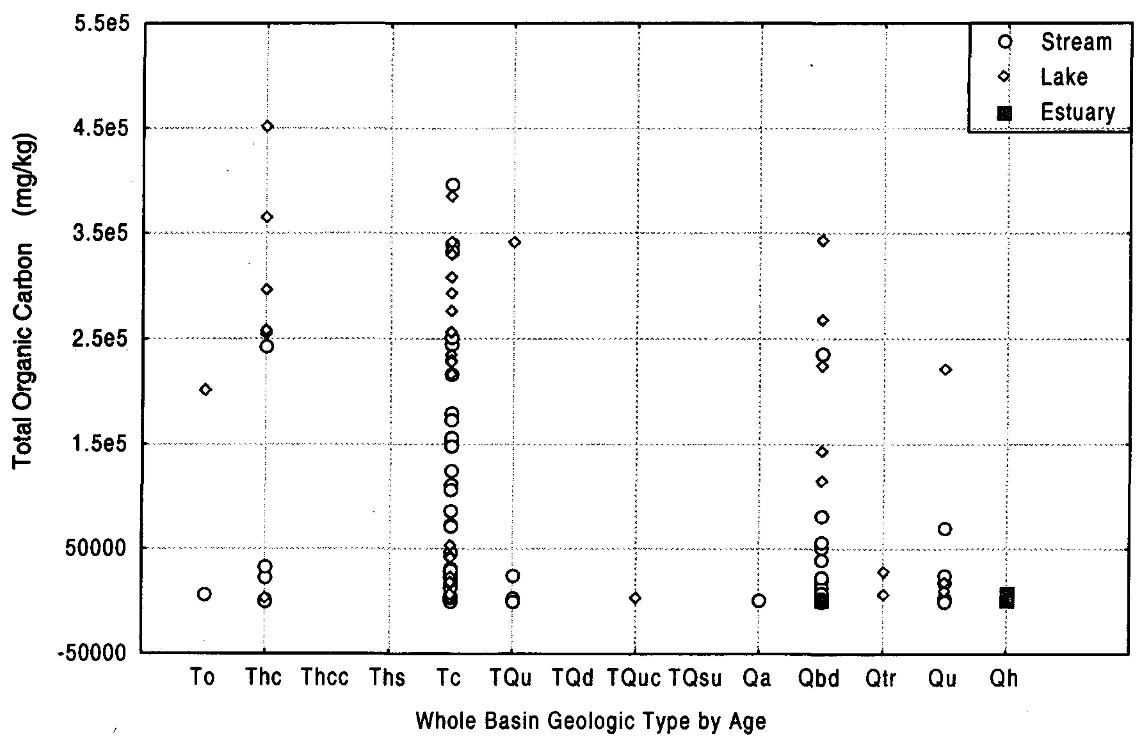

Figure 3-5. Total organic carbon plotted for each whole basin geologic cluster by water body type (i.e., stream, estuary, and lake)

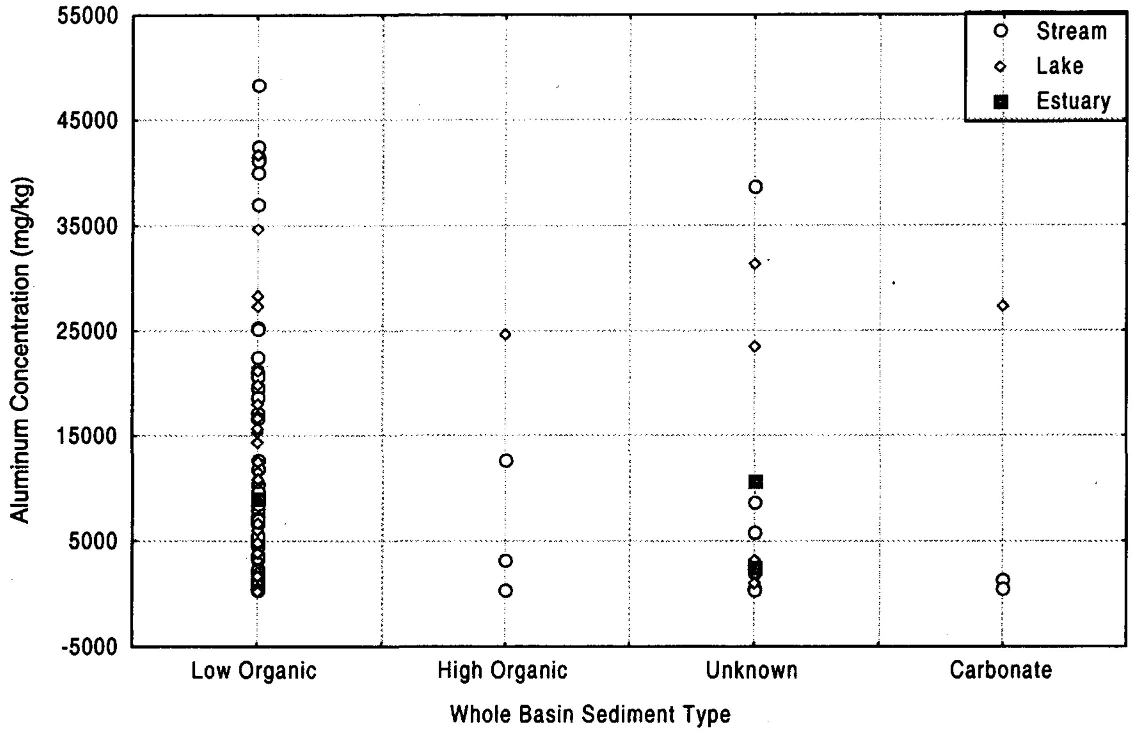

Figure 3-6. Concentration of aluminum plotted for each whole basin geologic soil type by water body type (i.e., stream, estuary, and lake)

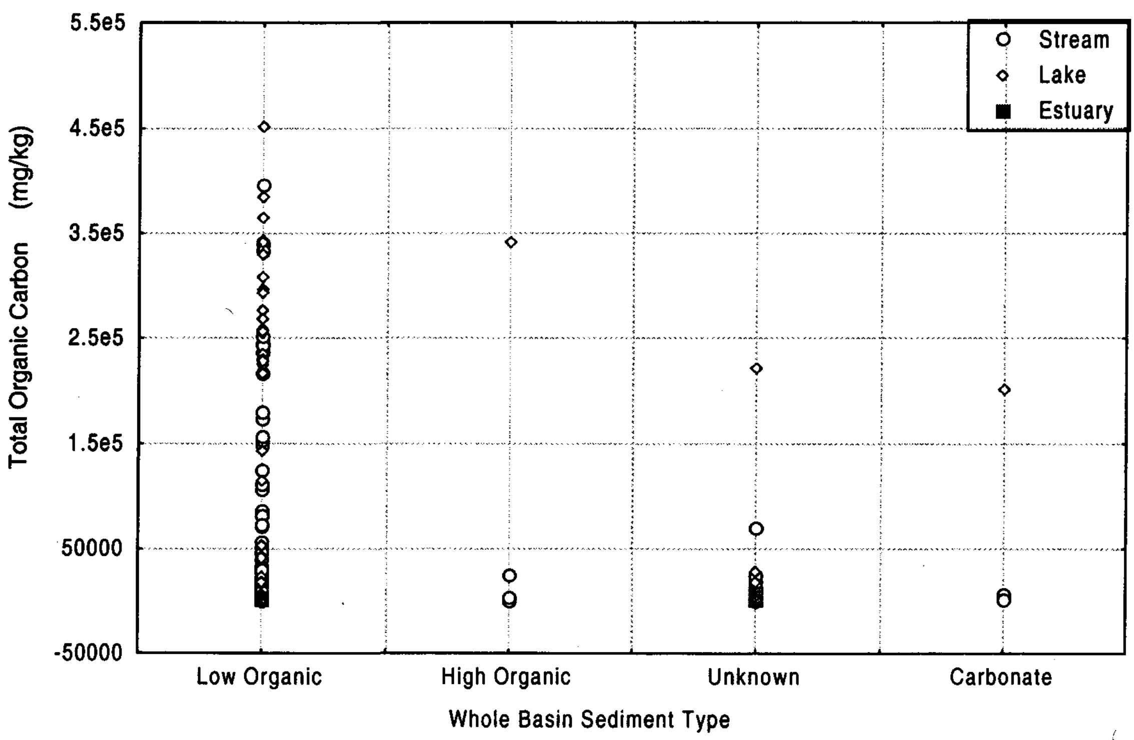

Figure 3-7. Total organic carbon plotted for each whole basin geologic soil type by water body type (i.e., stream, estuary, and lake)

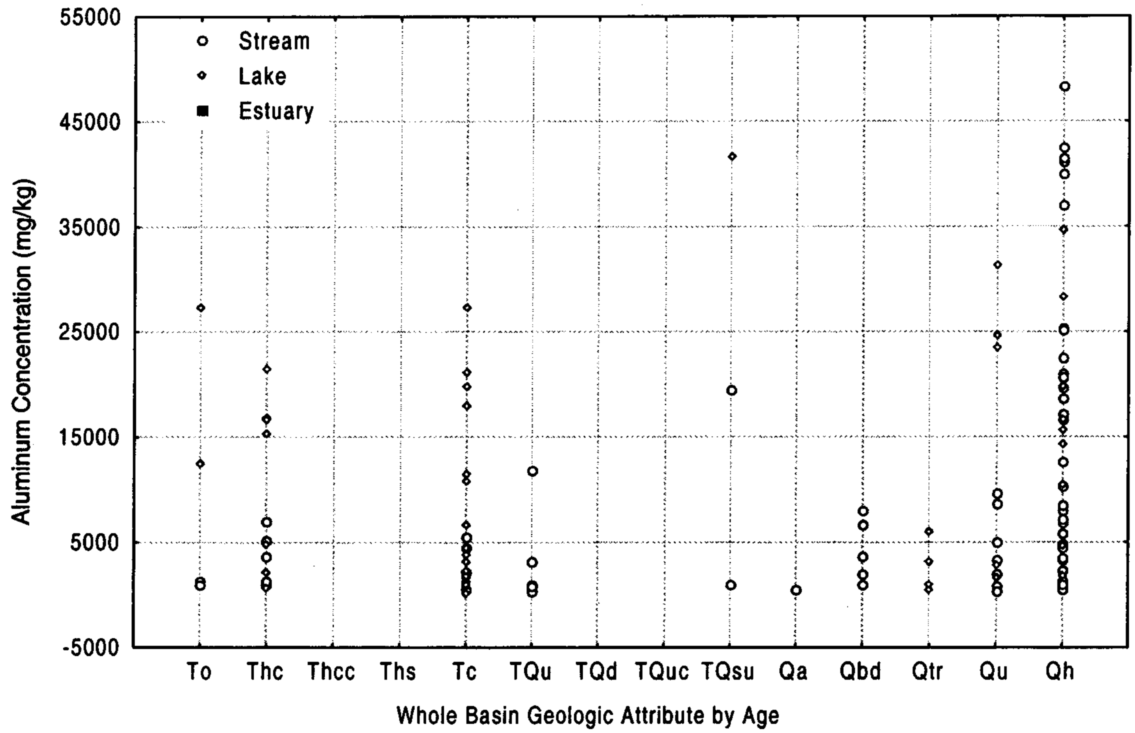

Figure 3-8. Aluminum concentration plotted for each whole basin geologic map boundary group

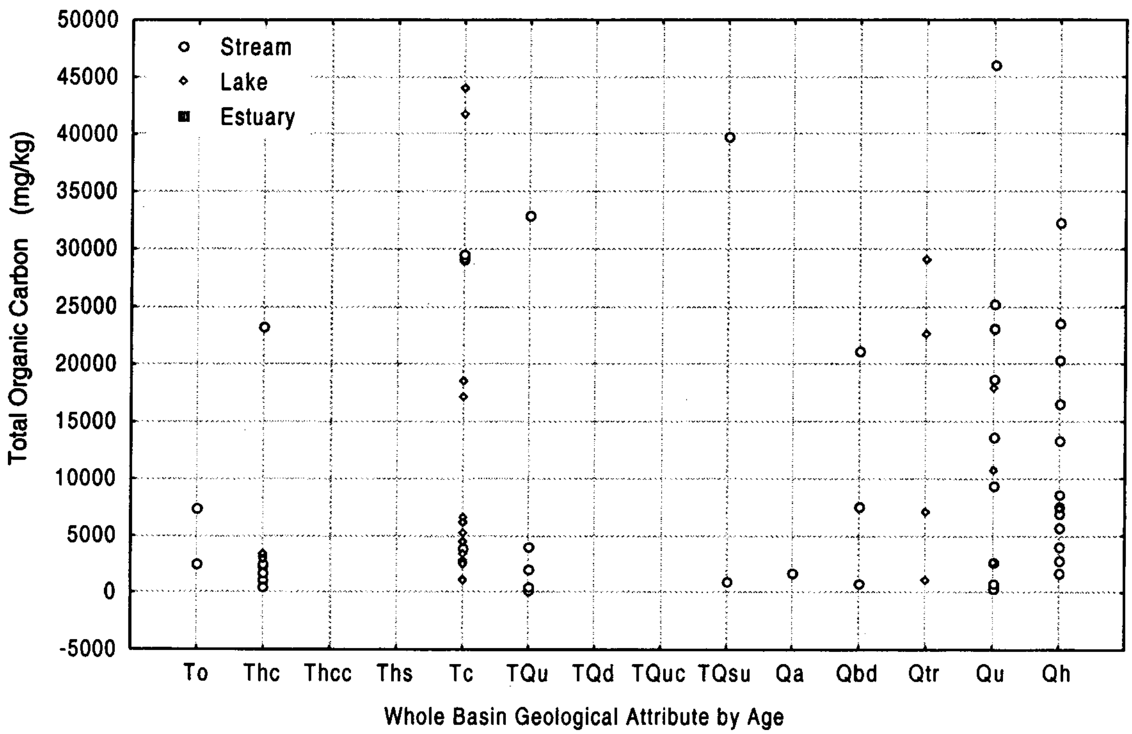

Figure 3-9. Total organic carabon plotted for each whole basin geologic map boundary group

3.2 Clustering Based on Quantitative Sediment Characteristics

Clusters based on sediment characteristics were derived by using different combinations of the variables Al, Mn, percent sand, percent clay, percent mud, and TOC. None of these variables had less than detected values. Three different combinations of these variables were tried. The first clustering attempt used only the variables Al, percent sand, and percent clay. The second clustering attempt used Al, Mn, percent sand, percent clay, and TOC. The third clustering attempt used Al, Mn, percent mud, and TOC. The discriminatory power between clusters for a given combination of variables was evaluated with Wilk's lambda and the probability of correct classification from a discriminant analysis assuming cluster identity was known. Wilk's lambda ranges from 1.0 (no discriminatory power) to 0.0 (perfect discrimination). Clustering based on each of the variable combinations was further compared by the resulting within- and between-cluster mean sums of squares (MSE and MSB, respectively). The clustering combination with the greatest probability of correct classification, the smallest Wilk's lambda, and observed significant differences between clusters for the six metals was chosen as the final clustering method. This type of clustering is highly dependent on the assumption that the variability in sediment characteristics observed at the sample sites is representative of the entire SJRWMD.

Clusters were created using all of the data standardized by subtracting the mean and dividing by the standard deviation. This standardization centers each distribution about zero with a standard deviation of 1. Thus, the clustering process will not be biased by variables that are greater in concentration or are more variable. The clustering methods were then compared using the six metals showing potential contamination and Al.

Joining tree clustering based on Al, percent sand, and percent clay (denoted as the Al Cluster Series) yielded 4 clusters at 50% of the maximum linkage distance. Discrimination between Al Clusters produced a Wilk's lambda of 0.06 with 91% correct classification. Clustering based on Al, Mn, percent sand, percent clay, and TOC (denoted as the TOC Cluster Series) yielded 5 clusters with a Wilk's lambda of 0.01 and 97% correct classification. Clustering based on Al, Mn, percent mud, and TOC (denoted as the Mud Cluster Series) yielded 5 clusters with a Wilk's lambda of 0.01 and 99% correct classification.

The Al Clustering Series (4 clusters) had the largest MSB and smaller or comparable MSE for all of the metals showing potential contamination and Al (Table 3-2). Further, the ratio of MSB to MSE, or F-statistic, was greater for more metals showing potential contamination. The Al Cluster Series yielded the greatest F-statistic for Al, but this was expected since it was the major explanatory variable for this clustering method. The Mud Cluster Series (5 clusters) produced significant differences between clusters for all metals and had comparable MSB and MSE values. The Mud Cluster Series also had the largest probability of correct classification and the smallest Wilk's lambda and, thus, used for all further analyses.

The Mud Cluster Series was characterized visually with a plot of the standardized mean concentration of each variable used to make the cluster (Figure 3-10). A table of descriptive statistics on the raw data for each cluster is presented in Table 3-3. Cluster 5 has the greatest Al and Mn concentrations and the greatest percent mud. Cluster 4 has the greatest concentration of TOC. Cluster 2 has the least Al, Mn, and TOC concentrations, and the least percent mud. TOC was the major factor separating clusters, followed by Al and Mn.

The Mud Cluster Series did not show any trends with the geologic or environmental characteristics. Mud Clusters 1-3 contained a full range of the ratio of local to whole basin acres (i.e., 0 to 100%), had an equal range in population density, and physiographic and land use characteristics. Mud Clusters 4 and 5 contained similar but generally smaller ranges of each of the environmental attributes.

Table 3-2. The mean squares between (MSB) and within (MSE) clusters for the three sets of variables clustered to characterize the sediments in the St. Johns River Water Management District

	Al Cluster			TOC Cluster			Mud Cluster		
Metal	MSB	MSE	F	MSB	MSE	F	MSB	MSE	F
Cadmium	0.924	0.020	46.7	0.790	0.017	47.4	0.785	0.017	46.7
Copper	909	15.9	57.2	783	12.6	62.3	795	12.2	65.3
Lead	3804	147	25.9	2653	155	17.1	2603	157	16.6
Mercury	0.222	0.004	59.2	0.197	0.003	71.7	0.197	0.003	71.6
Silver	0.048	0.003	16.7	0.036	0.003	12.4	0.032	0.003	10.4
Zinc	14785	307	48.1	11639	291	40.0	12144	273	44.4
Al	4.9E+09	21908888	226	3.4E+09	29815686	117	3.5E+09	26779134	133

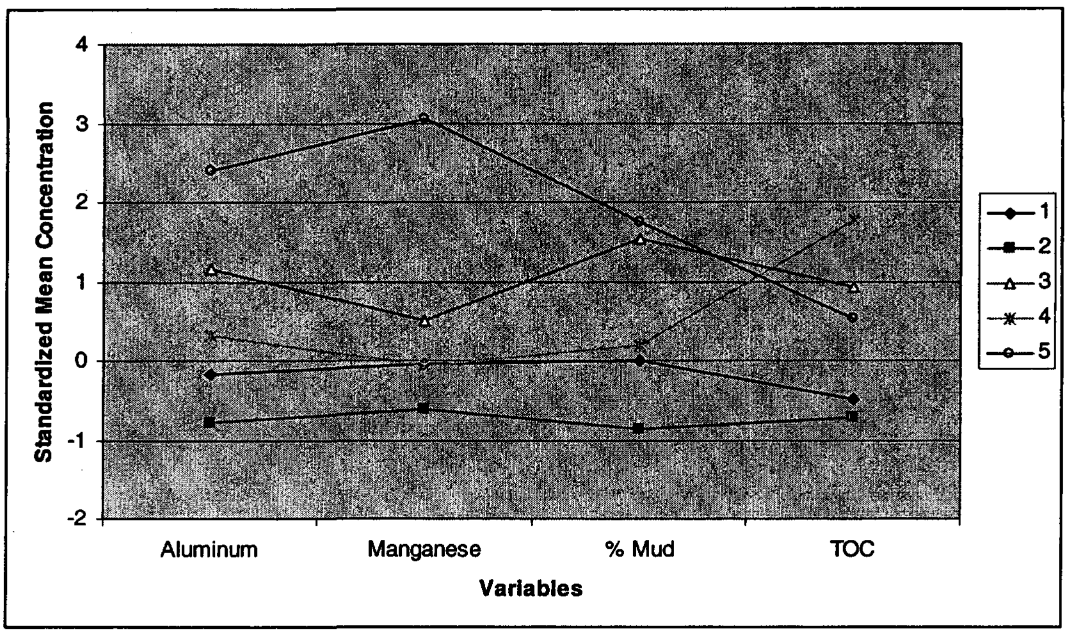

Figure 3-10. Standardized cluster means for classification based on aluminum, managanese, % mud, and total organic carbon (TOC)

Table 3-3. Descriptive statistics of the Mud Cluster variables

	Mud Cluster	N	MEAN	MEDIAN	STDEV	MIN	MAX	Q1	Q3
Al	1	33	8944	7370	5409	2150	23500	4840	11200
	2	50	1766	1315	1385	239	7070	762	2398
	3	17	24626	21500	8319	10800	41600	20200	29875
	4	18	14828	16175	6487	1420	25400	10800	18475
	5	8	39481	41175	7439	22500	48400	39012	42213
Mn	1	33	73.71	68.7	42.62	24.3	233	40.95	92.18
	2	50	26.66	19.45	23.93	1.78	121	8.68	38.3
	3	17	118.5	116	44.8	35.9	216	85.1	140.7
	4	18	72.4	55.3	42.7	17.5	162	45.9	81.5
	5	8	325.8	328	64.8	197	425	307.4	359.7
Mud (%)	1	33	25.3	24.6	9.4	9.4	55	19.6	31.55
	2	50	6.947	4.15	6.405	0.1	22.3	1.7	10.488
	3	17	58.35	56.8	9.95	44.5	79.5	50.9	65
	4	18	29.5	29.55	11.93	8.1	52.3	19.2	36.58
	5	8	62.74	63.7	12.05	43.3	78.8	52.15	73.45
TOC	1	33	34698	24300	30607	2140	124500	15450	43900
	2	50	6916	2830	11962	230	69500	1128	7145
	3	17	203771	222000	70479	53300	342000	145750	243750
	4	18	306250	302500	61190	216000	451000	252375	342125
	5	8	156912	155250	109319	51600	396000	70900	178750

New Sample Cluster Membership: Discrimination of new sediment samples is conducted in four steps. It is anticipated that these steps can be conducted on a calculator or spreadsheet.

- Data Standardization: The first step is to standardize the raw data using the descriptive statistics based on all of the data in Table 3-4. Standardization is performed by subtracting the mean and dividing by the standard deviation of each variable. For example, a new observation with an Al concentration of 990, Mn concentration of 78.5, percent mud equal to 20%, and TOC equal to 1050 would give standardized results of –0.844, 0.0196, -0.256, and –0.765, respectively.

Table 3-4. Descriptive statistics for variables used in the Mud Cluster method (n=126) and used for standardization of raw data for determining cluster membership

	MEAN	MEDIAN	STDEV	MIN	MAX	Q1	Q3
Al	10991	5915	11850	239	48400	1805	18150
Mn	76.9	50.35	81.52	1.78	425	25.35	93.85
p-mud	25.45	20.6	21.32	0.1	79.5	7.43	37.13
TOC	93038	23900	120210	230	451000	3378	185625

- Discriminant Scores: The second step in discrimination of new sediment samples is to determine the discriminant scores or roots. Two roots must be calculated using the following formulas:

$$Root1 = -1.3495*Al - 0.5455*Mn - 0.8124*Mud - 1.5639*TOC$$
$$Root2 = -0.1344*Al + 1.3897*Mn + 0.9641*Mud - 2.1777*TOC$$

where Al, Mn, Mud, and TOC are the standardized concentrations of the new sample.

- Distance from Each Cluster: The third step is to calculate the distance between the new observation's score and each cluster's centroid (center of mass for each cluster). Each distance must be calculated using the following formulas:

$$Distance1 = 0.5*[(Root1 - 1.019)^2 +(Root2 - 1.019)^2]$$
$$Distance2 = 0.5*[(Root1 - 3.212)^2 +(Root2+ 0.029)^2]$$
$$Distance3 = 0.5*[(Root1 + 4.526)^2 +(Root2 - 0.037)^2]$$
$$Distance4 = 0.5*[(Root1 + 3.335)^2 +(Root2 + 3.8)^2]$$
$$Distance5 = 0.5*[(Root1 + 7.162)^2 +(Root2 - 4.449)^2].$$

- Cluster Membership: The last step is to assign the new observation to the cluster associated with the minimum distance. The calculated scores for the new observation can also be plotted onto Figure 3-11 for visual verification of the class membership.

The distance between an observation and a cluster's centroid determines which cluster an observation belongs to. For example, an observation belongs to cluster(i) if the distance(i)= the minimum of all distances 1-5. For the example, we can calculate Root1 equal to 2.53 and Root2 equal to 1.56. Then distance 1 through 5 is calculated as 1.29, 1.49, 26.1, 31.6, and 51.2, respectively. Thus, this new observation belongs to cluster 1. Visually, if we plot the Root1 and Root2 on Figure 3-11, we can see that indeed the membership of this observation is cluster 1. New observations that did not fall near any of these clusters when plotted on Figure 3-11 would be considered outside of the area represented by the current data sampling, and should not be classified under this method. However, if the current levels of Al, Mn, percent mud, and TOC were representative of the entire SJRWMD, then data not falling into one of these clusters would be rare.

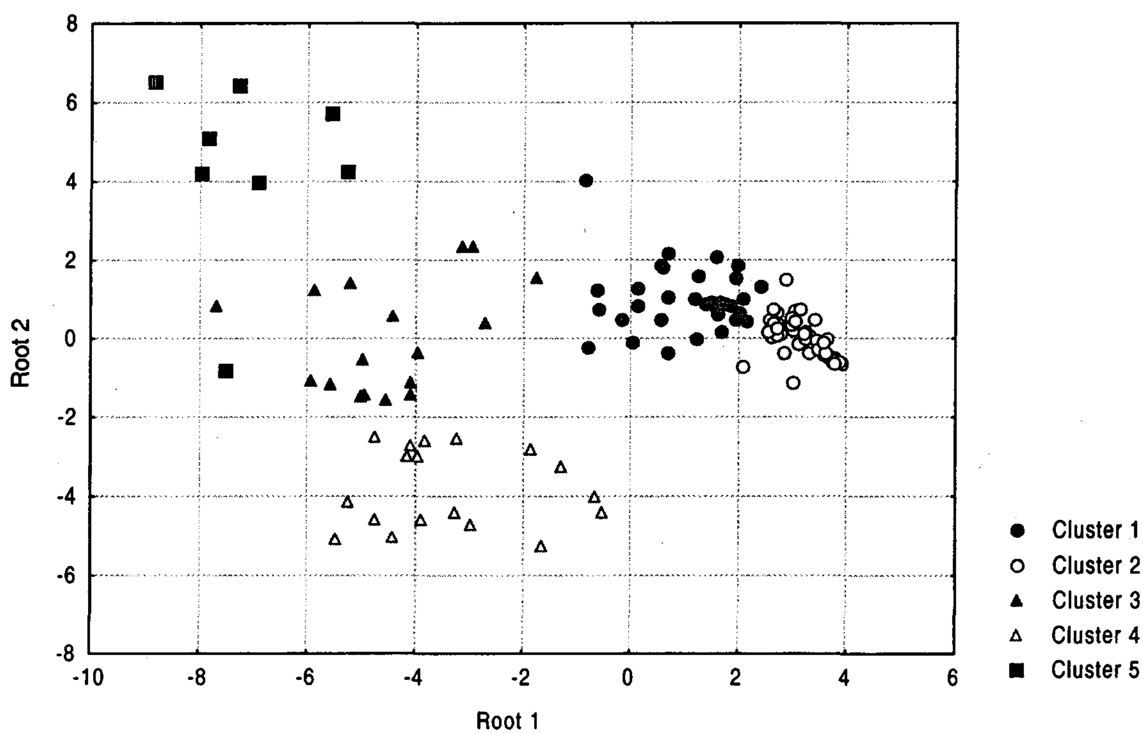

Figure 3-11. The first two roots of the discriminant function between Mud Clusters. These combined roots explain 96.5% of the total variability in the observations

Once cluster membership has been determined, we can compare the metal concentrations of the new observation with those from the same cluster. Observations for a given metal are determined to be elevated if the concentration is greater than the upper 95% confidence limit for that cluster. Upper 95% confidence limits on the raw data for each of the metals by cluster are presented in Table 3-5. Thus, in our example, if the value of As was greater than 1.90, then it would be considered elevated in comparison to other observations falling in this cluster.

Table 3-5. Upper 95% confidence limits for each metal concentration (mg/kg) by Mud Cluster

	Cluster				
	1	2	3	4	5
Arsenic	1.90	0.746	5.58	7.37	7.75
Cadmium	0.198	0.0793	0.480	0.435	0.758
Chromium	17.5	5.60	52.8	26.7	66.2
Copper	5.01	1.89	13.1	14.6	23.2
Iron	5376	1144	17832	10945	25514
Lead	19.5	11.1	32.5	30.7	47.4
Lithium	7.26	2.04	22.5	9.00	39.2
Mercury	0.0814	0.0251	0.247	0.230	0.325
Nickel	3.75	0.951	13.6	10.8	20.6
Selenium	1.15	0.296	3.31	6.61	2.49
Silver	0.0719	0.0492	0.141	0.145	0.277
Tin	1.33	0.454	2.19	1.31	3.42
Zinc	31.5	12.1	49.1	51.2	110

3.3 Regression Analysis

Traditional regression analysis against Al was conducted on the entire dataset and with selected subsets with potentially contaminated observations removed. Observations were removed if the standardized value (i.e., standardized by subtracting the mean and dividing by the standard deviation) was greater than 2. The subsets of data reflected geologic designations, neighborhoods, and basins. Each analysis provides a potential alternative to the Mud Cluster analysis above. For each metal the 95% confidence bands about the population regression line can be used to designate potentially elevated observations. The assumption is that the sediment samples used to generate the regressions are representative of background levels for metals and include the range of geochemical parameters for the area of interest, in this case the SJRWMD.

Simple linear regression against Al using the entire data set and only the metals Cd, Cu, Pb, Hg, Ag, and Zn produced significant slopes, but poor relationships (Appendix D). Cu had the greatest R^2=0.60 (n=122; Figure 3-12). The regression equations are printed at the top of each figure and include the random error term, epsilon denoted as eps. Simple linear regression against Al using whole basin geologic subsets of the data produced mostly significant slopes (Figure 3-13). Only three geologic formations had sufficient data for the regression. They were Thc (n=18), Tc (n=58), and Qbd (n=28). Many of the R^2 values were increased, but not consistently for each geologic formation (Appendix E).

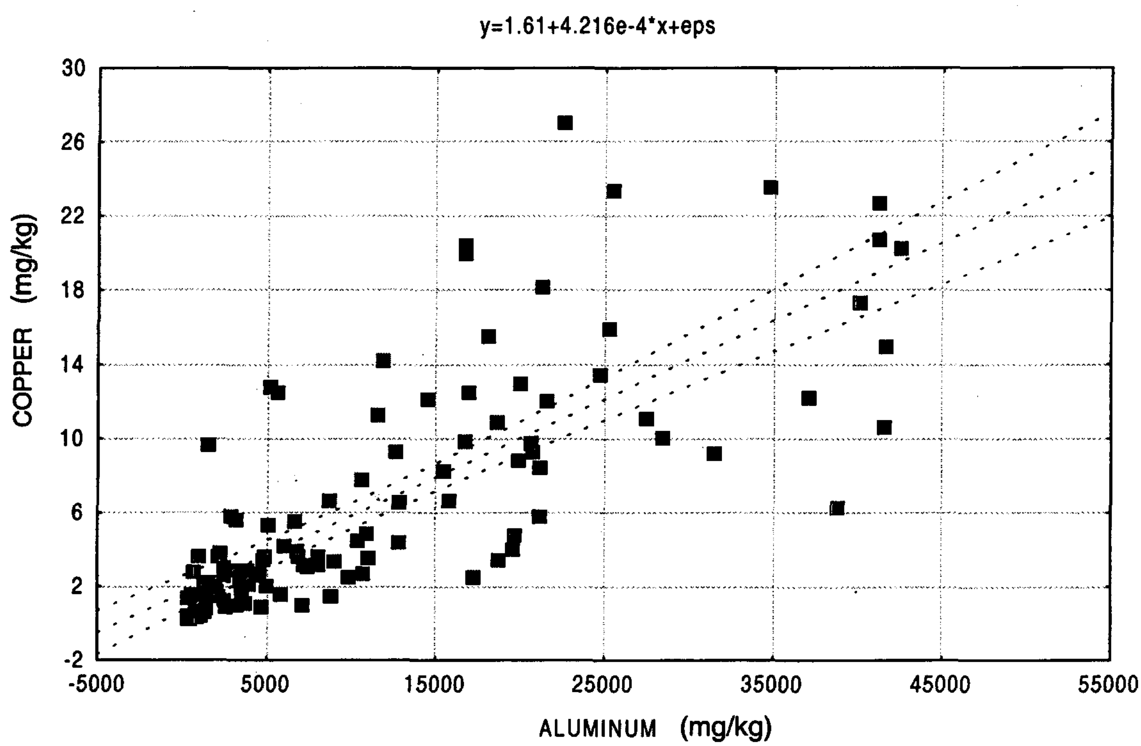

Figure 3-12. Simple linear regression of copper against aluminum from 122 sediments collected from the St. Johns River Water Management District. (Outer dashed lines represent the 95% confidence interval about the population regression line. The regression equation includes the random error term epsilon [eps])

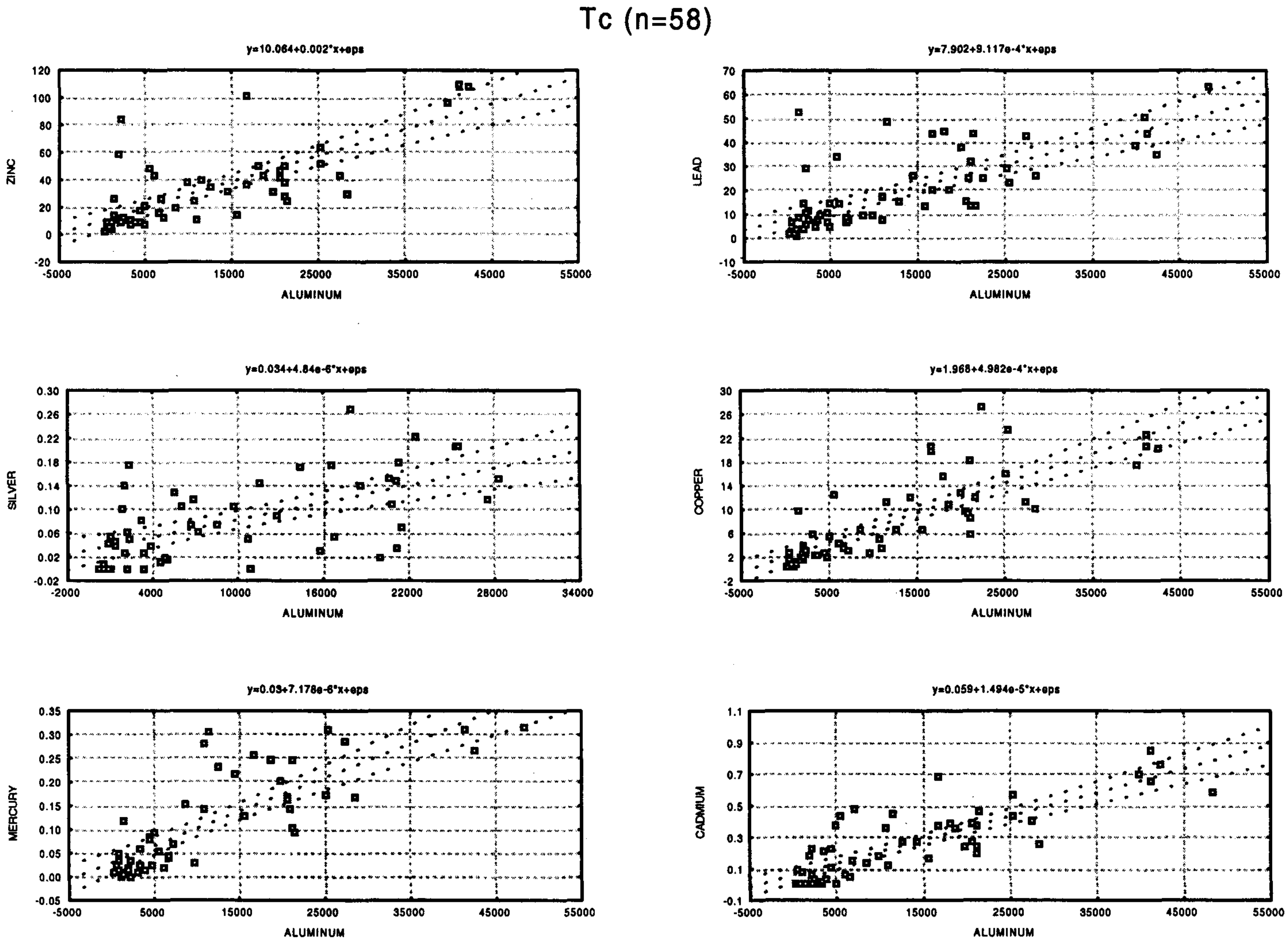

Figure 3-13. Simple linear regression of six metals against Al in the Tc whole basin geologic formation (units: mg/kg)

Simple linear regression of selected metals against Al was also conducted using subsets created by selecting observations within a 20-mile radius neighborhood (Figure 3-14). For Cd, Cu, and Hg the regressions produced higher R^2 values, but for Pb, Ag, and Zn the results were inconsistent (Appendix F). For most neighborhoods, Ag did not have a significant slope. The neighborhood about station HAW had the best increases in R^2 values over the other regression analyses (Figure 3-15).

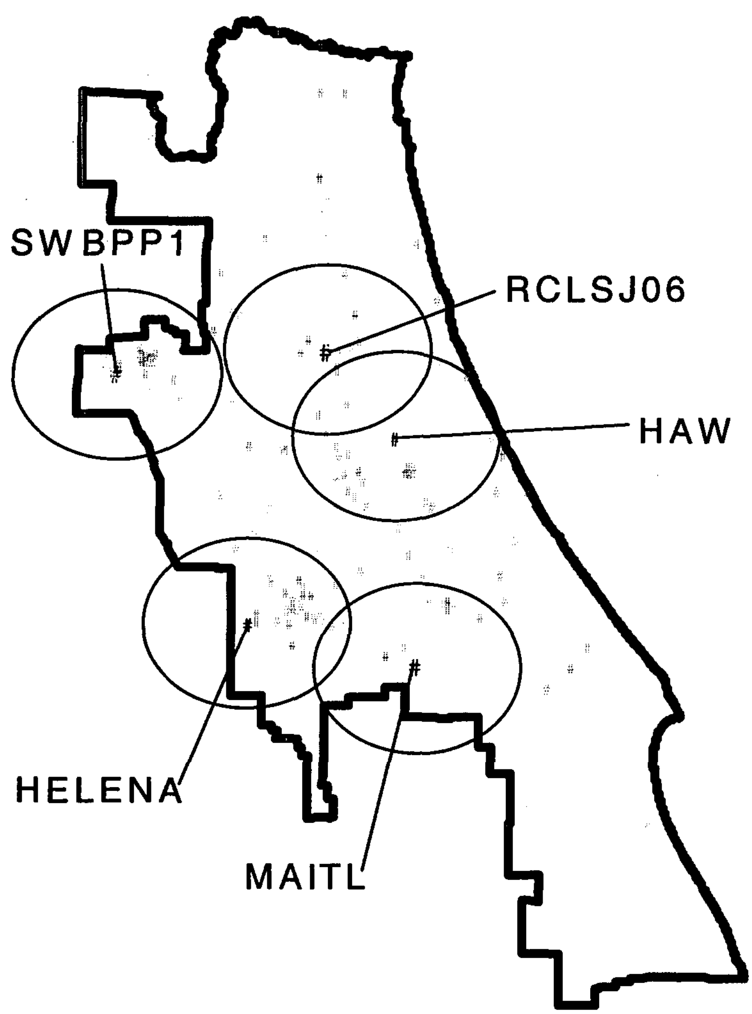

Figure 3-14. Selected neighborhood for regression analysis

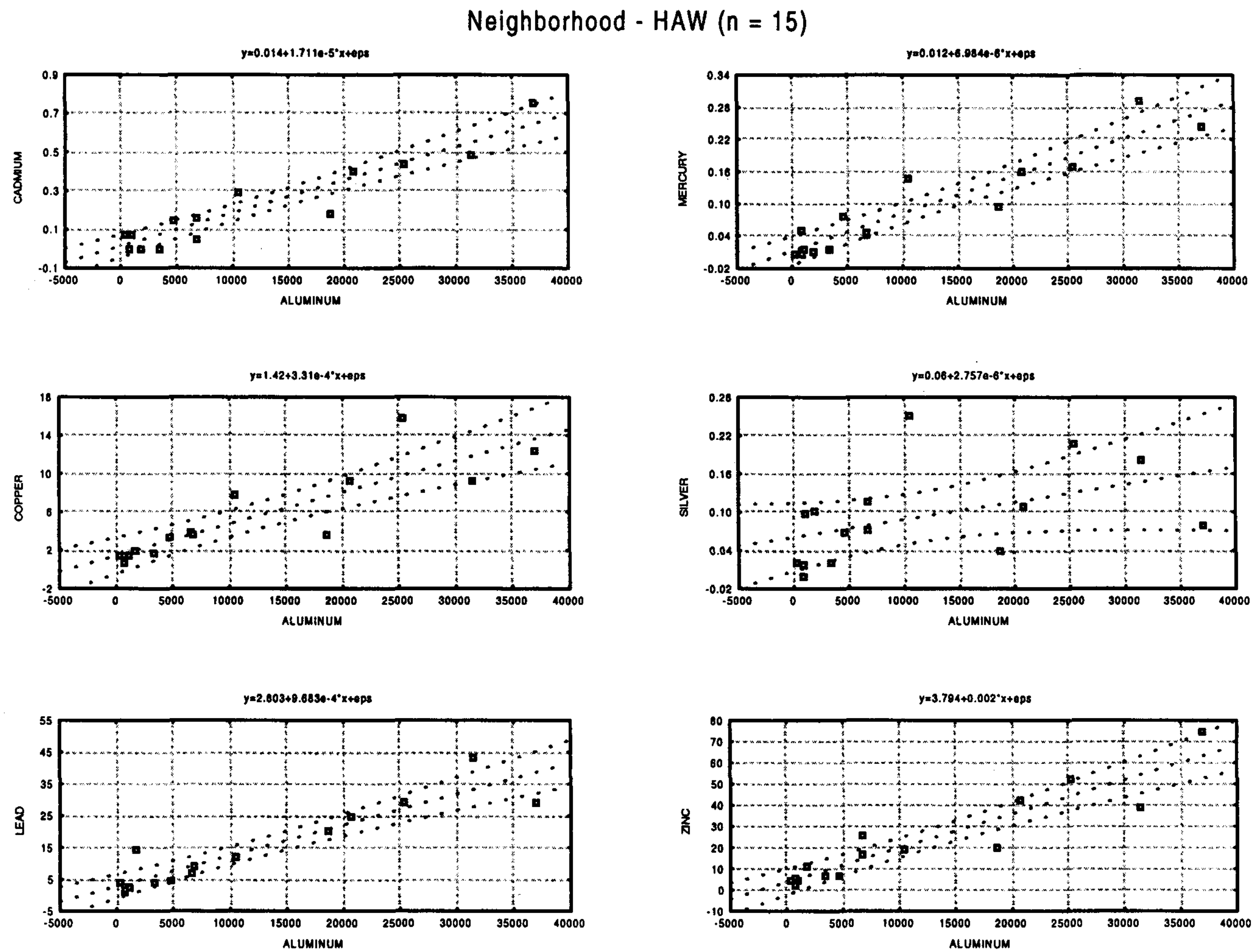

Figure 3-15. Simple linear regression of six metals against Al for the data within a 20-mile radius of the station HAW (units:mg/kg)

Finally, simple linear regression against Al was conducted on either all the data from one given basin or from combined neighboring basins for those basins with few data points (Figure 3-16). Basin subsets were data from basins 1, 2, and 3 (n=38); basin 4 (n=17); basin 5 (n=10); basins 6 and 10 (n=7); basin 7 (n=44); and basins 8 and 9 (n=10). Many of the basin subsets produced R^2 values that were less than those observed when the entire data set was used (Appendix G). The results were inconsistent. Only one basin subset (Basins 1, 2, and 3) did better or at least as well as the results observed for the entire data set combined (Figure 3-17).

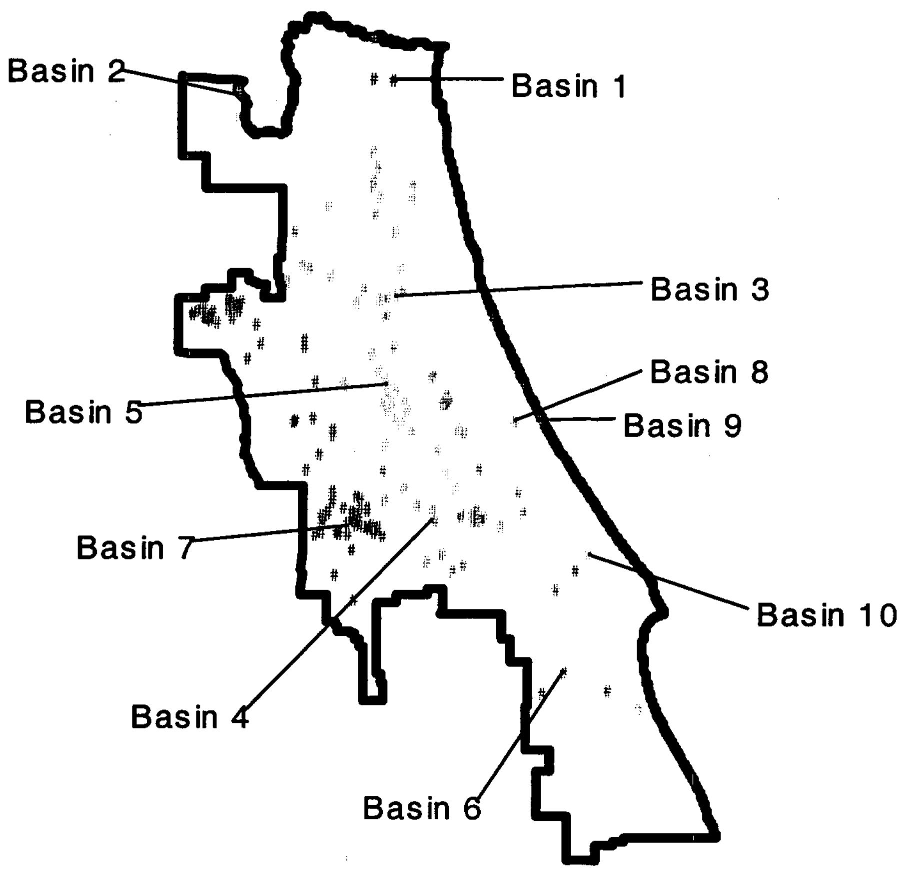

Figure 3-16. Basin subsets for regression analysis

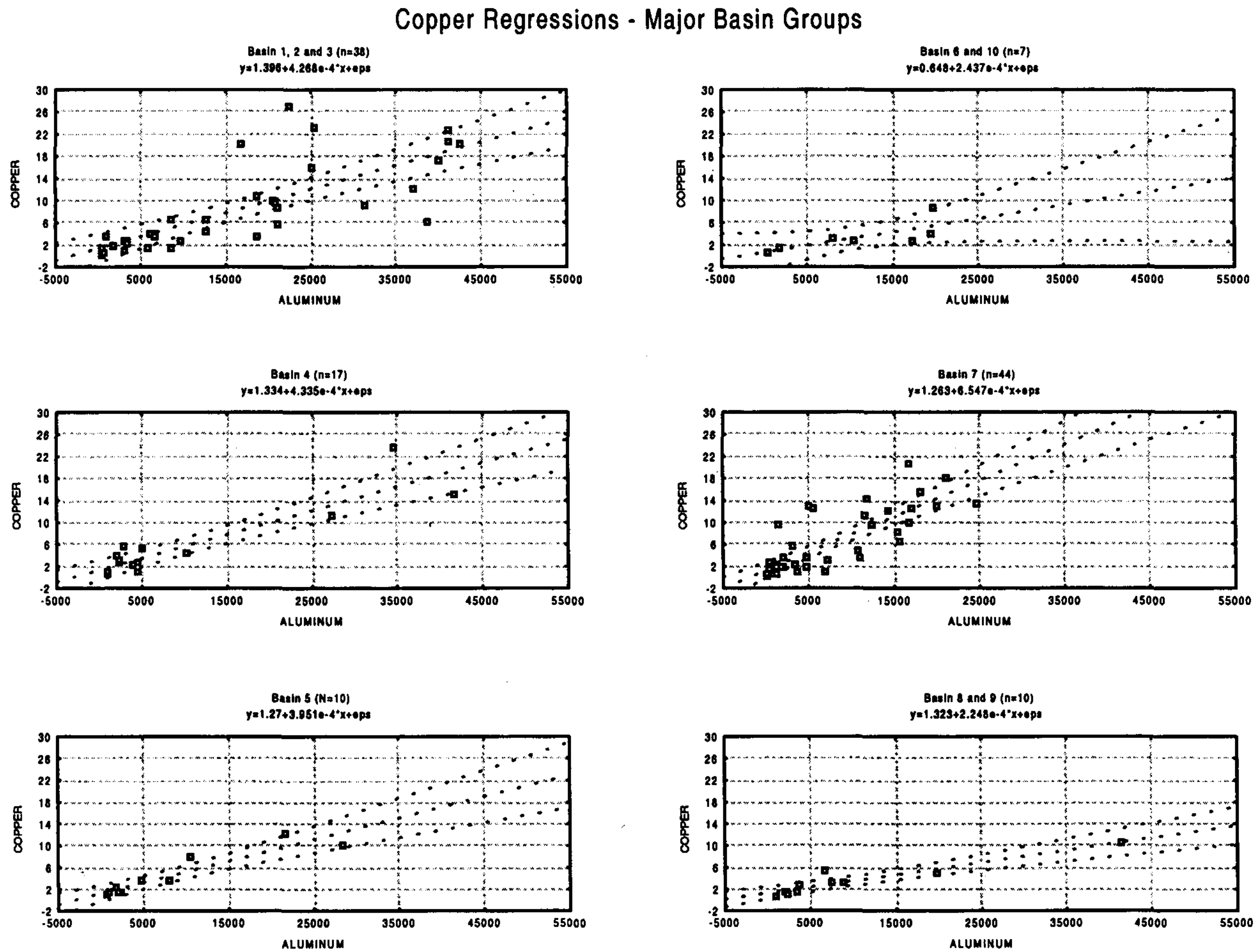

Figure 3-17. Regression of copper against aluminum for six basin subsets in the St. John's Water Management District (units:mg/kg)

4.0 DISCUSSION

Our approach has been to investigate various statistical methods for estimating the background concentration of trace metals in sediment from the SJRWMD. The section of this report titled "Development of Metals Interpretive Tool" describes several methods that were used with the goal to develop a data analysis method that can be applied across the SJRWMD. The characteristics of the sediment samples from the SJRWMD are considerably different from those of coastal and estuarine sediments in that the Al and Fe content are low, TOC content is high, and nearly all of the 126 sediment samples are sandy. The unique nature of these sediments may make comparisons of geochemical relationships with other regions of the country problematic. However, this report is focused on the procedure for determining the background range of metal concentrations within the SJRWMD.

The two most successful methods used were regression analysis and cluster analysis on the quantitative variables. Both methods predict about the same background concentration range for metals in sediment with variable geochemical properties. The linear regression model was previously applied to coastal and estuarine sediments. These areas have a narrower range in sediment properties than the sediments of the SJRWMD. Three publications determined the background trace metal concentrations in coastal and estuarine marine sediments in Florida and surrounding states (Daskalakis and O'Connor, 1995a; Hanson et al., 1993; and Windom et al., 1989). Sandy sediments were not included in these three studies in which a linear regression of metals on Al was used to predict the background trace metal concentration. The coefficient of determination (R^2) was relatively high for Cu, Pb, and Zn (>0.60) but much lower for Ag, Cd, and Hg (<0.20). In this study, Al regression summaries for these six metals (Cd, Cu, Pb, Hg, Ag, and Zn) in 120 sediment samples are shown in Appendix C with the correlation shown in Appendix B. The correlation with Al for the six metals ranged from 0.3 to 0.77 while the correlation with TOC range from 0.22 to 0.80. Regressions against Al for subsets of the sediment samples produced relationships similar to the whole data set. The subsets included geological formation (Appendix D), neighborhoods (Appendix E), and basins (Appendix F). The disadvantage of using the regressions for subsets is relatively few data are available for some subsets and the range of geochemical properties is limited compared to using the whole data set.

The cluster analysis method determines relationships between characteristics. The cluster analyses based on geological formation, soil type, neighborhoods, or basin did not produce useful relationships compared to clustering based on sediment characteristics. The cluster model that we recommend, called the " Mud Cluster" model, is based on Al, Mn, percent mud, and TOC and contains five clusters. To apply the Mud Cluster model to new sediment data the Al, Mn, % mud, and TOC results are standardized, using the procedure described in the results section and in Appendix H of this report, and the appropriate cluster is selected for each sediment sample. Then the metal concentrations in Table 3-5 can be used to determine if the metal concentrations in given sediment samples exceeds the 95% confidence limit. For example, if sediment from cluster 5 has a Cu concentration exceeding 23.2 mg/kg, it would be considered contaminated. As shown in Figure 3-10 and Table 3-2, cluster 5 sediment samples contain high concentrations of Al, Mn, percent mud, and intermediate TOC levels. For most metals, sediment samples in cluster 5 have the highest background levels of the five clusters. Cluster 5 contains a mean of 3.95% Al (Table 3-2). For comparison with the Al regression model of Hanson et al. (1993), the 95% confidence concentration for Cu in sediment containing 4% Al is about 14 mg/kg. The maximum background range of other metals that were studied by Hansen is similar to those in cluster 5 of Table 3-5. Windom et al. (1989), reported similar background maximum metal concentrations for Al-rich sediment which is to be expected because their regressions are similar to Hanson's. Also of interest is a comparison of the upper confidence limit for metals in cluster 5 (Table 3-5) with the Long et al. (1995) ERL guideline values. Long reported ERL values similar to these in cluster 5, such as Cu 34, Pb 46.7, and Zn 150 mg/kg.

5.0 CONCLUSION AND RECOMMENDATIONS

Battelle recommends the "Mud Cluster" method be used to identify "contaminated" sediment samples. The term "contaminated" is defined as having a concentration of metals greater than the 95% confidence limits listed for the appropriate cluster in Table 3-5. Each sediment sample must be assigned to one of the five clusters using the method described in Appendix H and provided as an Excel spreadsheet calculator with this document (Discrimination Version 1.0). Alternate approaches are to use the Al linear regression model or to collect sediment cores that sample sediment deposited during pre-industrial time, probably during the 1800s, and use these core samples to establish the background concentrations for a variety of sediment types. Because the "mud cluster" model used surface sediment samples that could be moderately contaminated there is the possibility that the 95% UCLs are somewhat higher than the true background concentrations for the District.

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APPENDIX A

Metal Concentration From 126 Sites and Associated Local and Whole Basin Geological Formation, Hydrological, Physiological and Environmental Characteristics

Appendix A. Metal Concentrations From 126 Sites and Associated Local and Whole Basin Geological Formation, Hydrological, Physiological and Environmental Characteristics

Site	Aluminum	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Lithium	Manganese	Mercury	Nickel
02235000	5000	2.52	0.369	13.8	5.33	6020	14.2	4.18	46.6	0.0914	4
02236000	8040	0.99	0.1	13.3	3.63	4300	7.99	5.36	101	0.036	2.13
02238000	568	0.13	0.0865	8.53	2.84	2380	3.14	1.83	121	0.0156	0.445
02240800	464	1.03	0	0.901	0.396	111	0.661	1.67	2.72	0.0143	0.18
02248000	1020	0.09	0	1.38	0.48	433	1.11	1.95	6.11	0.013	0.39
19010001	12700	1.94	0.125	17.2	4.44	8250	61.5	8.23	131	0.0386	3.26
19010006	3120	0.42	0	7.26	1.04	1070	5.74	1.31	41	0.008	0.319
19020002	38700	8	0.179	49.3	6.33	21500	21.6	37.7	343	0.0666	11.1
20010002	764	1.03	0.074	2.62	0.96	718	1.31	1.91	20.6	0.0057	0.498
20010003	10300	0.87	0.136	16.1	4.55	6570	8.62	10.2	77.7	0.0412	5.03
20010137	985	0.11	0.0818	1.61	0.756	283	1.47	1.78	8.3	0.0323	0.434
20020001	4890	0.44	0	7.1	2.02	1710	4.83	2.12	40	0.0254	1.88
20020012	3330	0.42	0	15.3	2.3	2380	4.59	2.41	90.3	0.023	1.31
20020368	18000	14.7	0.395	20.8	15.6	11000	44.4	9.76	53.5	0.334	8.24
20020371	16700	5.41	0.371	22.3	20.5	12500	43.6	11.1	58.2	0.255	7.09
20020377	10900	6.37	0.12	12.6	3.59	6460	7.96	4.89	46.2	0.144	4.26
20020381	14400	8.1	0.278	20.9	12.2	8770	25.9	7.17	79.4	0.215	6.86
20020404	279	0	0	0.507	0.264	117	0.746	1.61	3.25	0.0069	0.256
20030373	1025.5	0.27	0.074	3.9	1.53	1110	2.7	1.855	46.15	0.0152	0.645
20030400	3250	0.89	0.113	6.1	2.9	1440	8.01	1.36	40.7	0.0884	1.75
20030411	37000	2.55	0.75	54.6	12.3	24600	29.2	40.5	134	0.242	14.7
20030412	926	1.365	0.1029	3.565	3.675	775.5	8.96	1.42	24.6	0.0227	0.9755
27010024	41500	5	0.19	67.3	10.7	29400	24.1	50	197	0.103	13.4
27010037	7370	0.63	0.0945	9.83	3.13	4290	8.81	6.2	107	0.0304	2.02
27010579	1960	0.089	0	4.25	1.48	1580	3.51	3.44	49.4	0.0171	0.657
27010875	10600	0.66	0.105	11.1	2.71	4100	7.77	7.86	96.4	0.021	2.54
ASH	41600	3.38	0.525	48.2	15	15100	33.8	39.2	143	0.272	21.1
BEAR	2380	1.2	0	3.52	2.6	506	11.7	1.15	8.73	0	0.909
BLSPR	2420	0.43	0.351	7.99	1.34	1950	2.74	1.72	77	0.0275	1.63
BROWARD	1810	0.54	0	4.18	2.02	599	14	1.5	27.6	0.0097	0.575
BUL	3430	0.18	0	5.28	1.62	2210	3.71	3.51	64.6	0.0168	1.2

Appendix A - Continued

Site	Aluminum	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Lithium	Manganese	Mercury	Nickel
BWC44	2150	0.33	0.224	5.64	3.9	2360	28.9	2.4	27	0.0342	1.74
BWCCPB	4460	0.51	0.23	10.2	2.74	4010	6.2	4.71	43.4	0.083	2.52
CC03	475	0.11	0.074	0.835	0.478	310	1.02	2.13	5.5	0.0132	0.399
CHARLES	10800	5.32	0.357	12.3	4.91	8620	17.5	1.3	138	0.283	9.29
CHERRY	2040	0.632	0.0686	2.94	3.63	1020	5.85	2.13	16.9	0.0179	1
CLD	31400	2.55	0.484	43.5	9.27	17200	43.1	26.5	61.5	0.292	14.3
CLW	239	0.22	0	1.72	0.49	587	1.31	1.83	8.52	0.0114	0.319
DALHOUS	2390	0.516	0.0274	7.16	3.08	1170	7.48	1.34	55.1	0	0.676
DIAS	6680	6.39	0.0445	7.06	3.91	5580	7.06	2.21	86.5	0.0398	2.68
DMR	1030	1.03	0.0848	2.62	0.663	1240	1.37	2.71	18.9	0.01	0.391
DOR	21200	15.2	0.371	21.5	18.2	13200	43.8	11.2	77.3	0.248	7.79
DORR	1090	0.202	0	2.55	1.1	343	4.05	0.847	14	0	0.336
GEN	21100	2.72	0.246	13.4	5.85	2750	31.8	8.63	35.9	0.101	6
HALFMOON	11500	5.86	0.453	17.9	11.3	9590	48.3	5.51	173	0.304	7.58
HAR	19900	7.07	0.245	20.4	13	9500	37.6	8.13	53.1	0.204	7.13
HAT26	757	0	0.0316	1.98	0.394	175	0.791	1.83	7.06	0.0138	0.136
HAW	18700	1.06	0.185	24.1	3.52	7720	20.3	15.3	60	0.0923	4.08
HELENA	1420	2.19	2.26	11.6	9.73	1780	8.26	0	44	0.118	9.33
HOG30	985	0.12	0.0746	3.09	1.16	338	35.5	1.87	11	0.035	0.7
HOWELL	2770	0.857	0.0352	4.88	5.88	681	9.12	1.59	18.1	0.0138	1.07
INDUSPL	5130	1.51	0.274	8.49	12.8	1430	128	2.43	17.5	0.115	5.14
JOHNSON	6020	0.892	0.0653	6.71	4.2	1320	14.2	3.43	31.4	0.021	2.06
KER	21500	4.32	0.458	28.1	12.1	8450	13.5	12.9	81	0.0929	11
KERR	2120	4.8	0	3.96	1.49	862	10.3	2.66	28.5	0	0.546
LAG	4680	1.32	0.142	12.5	3.47	5860	4.37	4.08	60.8	0.0781	6.24
LEO	10500	3.71	0.297	19.7	7.85	9360	12.3	7.07	162	0.149	9.56
LHAT26	7070	0.61	0.0834	15.1	1.03	1660	6.61	3.46	13	0.0222	1.66
LHATSB	1350	0.47	0.0372	2.33	0.801	1010	1.12	2.46	6.96	0.0164	0.383
LHNBPL	3640	0.4	0.111	4.82	1.09	874	2.61	1.7	12.6	0.0159	1.12
LKWOOD	28350	3.04	0.2595	39.4	10.1	17200	25.85	20.3	104	0.17	12.6
LMAC	34700	2.19	0.714	56.9	23.6	24400	33	33.2	116	0.32	17.4
LOCCR	927	0	0	3.13	0.475	172	1.04	1.27	4.55	0.0139	0.219
LOL	24700	4.465	0.5415	47.3	13.5	12150	35.2	14.6	76.5	0.2885	11.75
LORANCRK	1980	0	0.175	7.65	1.75	2620	3.57	4.18	82.2	0.0128	0.5
LOUISA	1670	0.383	0	3.21	1.96	629	19.1	1.5	16.1	0.006	0.538
LSJ01	48400	6.265	0.5865	66.4	37.25	24400	63	34.85	364	0.3175	16.3
LSJ05	42450	7.515	0.7655	62.6	20.3	24150	35.4	29.7	347	0.2645	15.95
LSJ070	330	0.062	0.074	5.22	1.39	909	3.75	1.33	36.4	0.0051	0.314

Appendix A - Continued

Site	Aluminum	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Lithium	Manganese	Mercury	Nickel
LSJ08	39950	7.08	0.7065	55.65	17.35	18750	39.15	25.95	311.5	0.3355	14.6
LSJ087	2070	0.3	0.0897	2.99	59.7	1210	46.7	2.1	35.1	0.158	0.85
LSJ099	3370	0.24	0.111	5.13	2.54	1320	35.3	3.43	34.5	0.0146	1.06
LSJ11	41150	7.615	0.8425	68.65	22.75	23150	50.6	30.75	425	0.423	17.3
LSJ14	41200	7.9	0.6495	63.15	20.8	22900	43.3	34.8	306	0.3085	15.95
LSJ17	21050	10.425	0.1955	32.2	8.51	14250	13.4	17.2	138.5	0.1405	7.045
LSJ21	20600	10.455	0.2785	25.25	9.79	11400	14.95	12.75	174.5	0.166	7.385
LSJ28	12715	5.14	0.2695	23.3	6.63	14350	15.75	9.105	91.35	0.232	5.85
LSJ32	18600	3.675	0.355	33.9	10.95	14250	20.7	11.4	96.45	0.2445	9.555
LSJ35	25250	3.32	0.4395	41.95	15.9	17550	29.05	15.5	87.2	0.1705	13.05
LSJ40	20700	3.27	0.397	56.9	9.335	17200	24.7	14.05	131	0.161	8.78
LSJ918	8690	0.35	0.0803	10.4	1.47	3600	12.6	6.71	65.3	0.0326	1.61
LSJRC17	8585	1.445	0.144	14.5	6.66	5230	9.24	4.49	71.2	0.1545	4.27
LYC	15700	4.29	0.166	20.4	6.72	10700	13.4	11.4	57	0.13	6.33
MAITL	23500	6.34	0.347	22.6	112	3070	61.2	9.75	34.4	0.172	7.72
MAT	8980	0.53	0.098	12.2	3.36	4770	7.06	5.1	144	0.0177	1.9
MBU	5560	1.96	0.434	18.9	12.5	3330	33.7	4.07	68.7	0.0558	3.95
MILLD	1340	0.299	0	1.45	0.833	63.6	52.9	1.68	12.9	0.0047	0.553
MPS	331	0	0	0.921	0.256	201	0.673	2.05	4.86	0.0022	0.123
MR312	19600	2.37	0.136	21.9	4.78	9110	12.4	10.7	233	0.0224	4.06
MTC	6660	0.036	0.168	9.78	5.55	3120	26.8	6.65	93	0.0856	2.43
NBLACK	9750	1.51	0.187	11.4	2.53	3470	9.4	4.74	40	0.0315	2.05
NEWLKA	650	0	0.038	1.23	1.53	129	0.61	1.01	1.78	0.0117	0.273
NEWLKB	710	0	0.0313	1.39	1.04	153	0.707	1.35	3.24	0.0103	0.196
NEWLKC	4810	1.45	0.218	4.81	3.68	3950	22.1	0.997	36.3	0.105	2.5
NEWLKD	16700	6.45	0.592	22.4	9.89	8840	26.8	3.95	47	0.275	11.3
NEWLKE	16900	5.42	0.39	24.6	12.5	10500	21.3	4.67	51.3	0.233	11.2
NEWLKF	15400	6.19	0.362	23.5	8.3	9950	16.7	4.37	45	0.199	10.6
NORRIS	27400	7.91	0.403	23.4	11.1	30200	43.1	18.3	216	0.284	14.4
NRI	5810	0.3	0	7.97	1.61	3230	5.48	2.77	131	0.0049	0.864
OLA	3170	1.14	0.0246	4.65	5.66	562	6.97	1.71	21.3	0.0081	1.35
OLK	12500	4.67	0.4	27.5	9.37	11400	31.4	5.17	150	0.222	7.58
OR908	27300	3.26	1.33	139	35	9200	260	16.8	82.9	0.389	17.3
ORD	7160	2	0.486	52.7	3.16	4500	7.86	3.18	41.2	0.0701	6.13
PCR-PL	1280	0.63	0.262	6.81	2.27	420	6.5	0	15.3	0.0643	2.17
PEL	3720	0.41	0.116	6.05	2.94	3050	15.3	4.66	77.7	0.0326	1.52
RCLSJ06	22500	2.56	0.9065	35.65	27.1	10500	24.8	11.65	313	0.44	29.8
RCLSJ10	16650	4.045	0.692	30.65	20	10010	19.85	10.55	160.5	0.338	19.25

Appendix A - Continued

Site	Aluminum	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Lithium	Manganese	Mercury	Nickel
RCLSJ19	25400	3.455	0.561	43.25	23.35	16800	22.95	13.25	87.9	0.312	17.15
SELLERS	1700	0.387	0	3.9	2.28	960	5.3	1.74	32.1	0.0053	0.411
SHEEL	439	0	0	4.59	1.58	1340	6.89	1.43	62.2	0.0235	0.318
SILRV	454	1.48	0.434	30.9	1.49	690	2.21	0	11.9	0.0396	4.09
SIM	3420	0.63	0.211	7.34	2.22	1690	7.74	3.65	29.3	0.0572	1.18
SJRJESUP	4590	0.59	0.076	5.2	0.943	1520	3.62	2.35	38.9	0.013	0.79
SJRPLTKA	6790	2.05	0.158	9.98	3.64	3980	8.86	2.17	61.5	0.0442	1.87
SOUTH	1790	1.56	0.0226	4.1	1.6	5020	5.69	1.05	38.1	0.0514	2.4
SRS	17200	0.37	0.101	21.1	2.51	5310	8.95	12.8	41.6	0.0368	3.52
SUNLAND	1180	0	0.0358	2.63	0.61	307	33.6	1.94	9.19	0.0106	0.352
SWBPP1	11800	0.48	0.957	31.2	14.2	4560	343	7.44	74.3	0.114	6.89
TOL	2470	0.41	0	3.7	0.938	1370	2.19	2.35	41.7	0.0152	0.569
TUBPP1	1290	2.39	0.125	3.88	1.98	443	11.7	1.85	25.6	0.0349	1.02
USJ055	7960	0.43	0.16	8.97	3.22	3300	16.5	10.5	38.7	0.0945	2.34
USJ918	19500	0.45	0.0967	21	4.03	7000	17.8	14.7	72.1	0.139	5.04
WASH	19800	0.49	0.25	20.2	8.83	11800	22.3	8.72	102	0.19	7.41
WIN	4460	0.96	0.112	4.31	2.6	923	10.9	2.46	24.3	0.0778	1.66
WINN	3820	0.672	0.0293	3.76	2.15	571	9.75	1.3	20	0.0127	0.973
WIO	766	0.059	0	2.9	0.796	596	2.07	1.43	27.8	0.0507	0.375

Appendix A - Continued

Site	Selenium	Silver	Tin	Zinc	SAND (%)	SILT (%)	CLAY (%)	TOC	MOISTURE (%)	TOTAL SOLIDS (%)	TOTAL VOLATILE SOLIDS (%)
02235000	3.33	0.015	0.632	21.4	79.1	18.9	2	46100	64.4	35.6	16.6
02236000	0.63	0.023	0.706	19.5	64.5	32.9	2.6	23500	61.6	38.4	7.2
02238000	0	0.006	0.573	7.86	95.8	3.9	0.3	3880	33	67	1.5
02240800	0	0.009	0.0827	0.901	99.5	0.4	0.1	420	17.8	82.2	0.1
02248000	0	0.012	0.0669	3.69	98.9	0.8	0.3	830	18.8	81.2	0.3
19010001	0.28	0.033	1.85	361	81.5	15.4	3.1	24300	39	61	4.8
19010006	0	0.01	0.833	3.53	93.4	5.6	1	4020	25.7	74.3	0.9
19020002	0.56	0.037	1.21	63.7	49.9	42.7	7.4	70200	73.3	26.7	13
20010002	0.27	0.016	0.224	2.52	93.1	5.8	1.1	2710	27.1	72.9	0.6
20010003	0.55	0.051	0.635	12.6	62.7	34.5	2.7	20300	59.6	40.4	4.3
20010137	0	0	0.095	3.85	98.8	1	0.2	1050	19.7	80.3	0.4
20020001	0	0.018	0.532	6.57	91.7	7.8	0.4	16600	42.5	57.5	3.4
20020012	0.94	0.028	0.539	7.69	86.9	11.2	1.9	5660	32.8	67.2	1.6
20020368	2.84	0.27	1.81	50.2	70.2	29.4	0.4	330000	96	4	59.6
20020371	2.91	0.054	1.48	36.2	84	15.8	0.2	309000	95	5	55.6
20020377	2.53	0	0.369	10	80.7	19.1	0.2	228000	93.9	6.1	34.7
20020381	2.74	0.17	1.19	31.1	68.4	30.9	0.7	385000	96.6	3.4	61.9
20020404	0	0.006	0.169	1.18	99.9	0.1	0	540	21.2	78.8	0.1
20030373	0.23	0.0975	0.399	5.01	89.8	9.4	0.85	8630	39.95	60.05	2.05
20030400	0.71	0.015	0.319	8.36	68.7	26.3	5	29100	45.7	54.3	6.8
20030411	1.74	0.078	1.86	74.2	55.5	41.7	2.8	236000	88.5	11.5	40.3
20030412	0	0.0105	0.8125	21.45	84.05	15.45	0.5	7080	37.45	62.55	1.7
27010024	0.84	0.08	1.72	68.6	33.9	56.5	9.5	51600	74.3	25.7	11.2
27010037	0.27	0.064	0.492	16.5	89.1	7.5	3.4	2490	25.6	74.4	1.1
27010579	0	0.03	0.258	6.8	91.1	6.6	2.4	7480	27.2	72.8	1.6
27010875	0.19	0.034	0.439	9.66	80.3	14.7	5	8380	36.1	63.9	2.2

Appendix A - Continued

Site	Selenium	Silver	Tin	Zinc	SAND (%)	SILT (%)	CLAY (%)	TOC	MOISTURE (%)	TOTAL SOLIDS (%)	TOTAL VOLATILE SOLIDS (%)
ASH	4.7	0.1	1.58	50	20.5	66.1	13.4	225000	82.6	17.4	39.6
BEAR	0.259	0.0523	0.337	10.5	88.4	9.6	2	6180	31	69	1
BLSPR	0.2	0	0.286	5.92	97.4	2.1	0.5	1660	27.6	72.4	0.5
BROWARD	0.298	0.1	0.344	10.7	91.5	6.9	1.6	3340	26.3	73.7	0.9
BUL	0	0.019	0.386	6.64	91.3	6.8	2	6860	27.6	72.4	1.8
BWC44	0.34	0	0.863	84.5	74	24.3	1.7	29200	63	37	9.1
BWCCPB	2.96	0.012	0.326	9.61	78.1	19.9	2	29500	70	30	20
CC03	0.27	0.013	0.125	3.03	99	0.8	0.3	1680	16.1	83.9	0.5
CHARLES	2.69	0.052	0.382	24	23.6	66.1	10.4	342000	86.8	13.2	46.6
CHERRY	0.429	0.0284	0.206	9.47	82.5	15.4	2.1	18500	31.8	68.2	2.6
CLD	1.99	0.18	1.82	39.1	44.8	50	5.2	222000	87.5	12.5	38.7
CLW	0	0	0.0862	1.74	98.6	1.4	0.1	2560	22.6	77.4	0.5
DALHOUS	0.346	0.177	0.586	12.2	92.5	6.3	1.3	4530	27.5	72.5	0.8
DIAS	1.16	0.0729	0.317	16.6	77.3	21.2	1.5	41700	72.2	27.8	16
DMR	0.27	0.013	0.203	2.26	95.5	3	1.5	1040	19.5	80.5	0.4
DOR	2.42	0.18	1.61	50	64	35.1	0.8	277000	95.1	4.9	47.8
DORR	0.222	0.0545	0.241	5.15	96.7	2.5	0.8	2690	20.5	79.5	0.7
GEN	3.1	0.033	1.03	28.4	38.4	52.7	9	53300	62.9	37.1	14.6
HALFMOON	4.16	0.143	1.14	39.9	32.3	62.4	5.2	257000	86.3	13.7	47.9
HAR	28.1	0.02	1.05	30.6	80.1	19.7	0.1	294000	96	4	53.7
HAT26	0	0.0122	0.16	11.1	100	0.5	0.5	440	20	80	0
HAW	0.47	0.037	0.787	19.6	83.2	14.5	2.3	56400	67.3	32.7	15.1
HELENA	6.26	0.0372	0.388	26.7	81.1	18.3	0.6	340000	94.5	5.5	52.5
HOG30	0	0	2.49	3.34	96.8	2.7	0.6	2450	26.5	73.5	0.7
HOWELL	0.303	0.187	0.431	24	84.3	14.8	1	10800	40.2	59.8	1.5
INDUSPL	0.209	1.55	1.04	27.8	81.1	17.4	1.5	244000	76	24	30.9
JOHNSON	1.16	0.106	0.53	43	68.1	26.9	5	22600	37.3	62.7	4.6
KER	5.51	0.07	0.933	23.8	48.1	49.6	2.4	235000	87.1	12.9	32.4

Appendix A - Continued

Site	Selenium	Silver	Tin	Zinc	SAND (%)	SILT (%)	CLAY (%)	TOC	MOISTURE (%)	TOTAL SOLIDS (%)	TOTAL VOLATILE SOLIDS (%)
KERR	0.345	0.0628	0.239	8.45	96.6	2.6	0.8	2920	22.1	77.9	0.6
LAG	2.05	0.067	0.455	7.16	45	49.1	5.9	115000	71.5	28.5	19.9
LEO	3.3	0.25	0.797	18.5	66.2	30.4	3.5	344000	86.4	13.6	52.4
LHAT26	0	0.0666	0.461	12.6	95.1	2.3	2.5	2280	20.5	79.5	0.8
LHATSB	0	0.0302	0.326	7.39	95.9	3.6	0.5	2530	27.3	72.7	0.8
LHNBPL	0	0.0551	0.316	10	97.1	2.1	0.9	1780	20.4	79.6	0.5
LKWOOD	2.74	0.15	1.215	28.9	42.8	55.5	1.7	217000	90.4	9.6	33.95
LMAC	1.52	0.69	2.54	67.2	32.1	65.4	2.5	143000	87.9	12.1	26.5
LOCCR	0	0.0437	0.43	8.77	96.7	2.8	0.5	2060	25.4	74.6	1
LOL	3.44	0.078	1.205	69.45	62.9	36.55	0.55	341500	96.15	3.85	57.75
LORANCRK	0	0.139	0.634	58.1	99.5	0.5	0.5	280	20.2	79.8	0
LOUISA	0.258	0.0747	0.32	6.74	96.3	2.6	1.2	2830	23.6	76.4	0.6
LSJ01	1.205	0.552	2.7245	169	38.6	54.8	6.6	73000	76.75	23.25	14.25
LSJ05	2.44	0.5465	3.42	108.5	30.9	63.8	5.3	154000	84.15	15.85	23.7
LSJ070	0.27	0.022	0.388	4.15	99.1	0.7	0.2	880	18.7	81.3	0.1
LSJ08	2.48	0.687	3.14	95.85	41.7	53	5.3	156500	82.95	17.05	21.4
LSJ087	0.14	0	0.707	18.3	84.1	14.3	1.7	25300	44.6	55.4	7.8
LSJ099	0	0	0.364	29.2	84.9	11.9	3.2	9410	23.8	76.2	2.1
LSJ11	2.765	0.959	4.095	108.65	21.2	71.7	7.1	173500	83.55	16.45	22.7
LSJ14	2.795	0.5065	3.525	110	25.1	68.3	6.6	180500	85.85	14.15	26.25
LSJ17	1.47	0.1465	1.31	37.9	37.6	57.6	4.8	107300	75.35	24.65	15.8
LSJ21	1.775	0.1515	1.345	47.25	49.3	47.3	3.3	111000	80.3	19.7	18.35
LSJ28	2.605	0.0902	0.46	34.25	72.1	26.2	1.7	124500	78.9	21.1	21.55
LSJ32	2.885	0.1405	1.435	42.9	48.9	47.7	3.5	148500	82.8	17.2	25.25
LSJ35	3.18	0.207	2.08	52.35	43.2	54.5	2.3	251500	89.85	10.15	40.85
LSJ40	4.735	0.10855	1.73	41.75	51	46.3	2.8	216500	86.85	13.15	36.8
LSJ918	0.14	0.01	0.545	9.84	79.4	17.5	3.1	18700	52.3	47.7	7.8
LSJRC17	1.36	0.0725	0.8395	18.8	62.7	35.1	2.3	72200	65	35	10.45
LYC	3.01	0.03	0.656	14.6	79	20.7	0.4	216000	93.9	6.1	44.1

Appendix A - Continued

Site	Selenium	Silver	Tin	Zinc	SAND (%)	SILT (%)	CLAY (%)	TOC	MOISTURE (%)	TOTAL SOLIDS (%)	TOTAL VOLATILE SOLIDS (%)
MAITL	0.94	0.119	1.18	67.2	74.15	24.2	1.65	17900	53.7	46.3	4.8
MAT	0	0.015	0.474	12.1	90.6	6.5	2.9	2140	26.2	73.8	1.6
MBU	0.84	0.13	0.741	48.7	77.9	21.3	0.8	29100	70	30	9.8
MILLD	0.304	0.0458	0.256	14.5	96.8	2.7	0.5	44100	25.8	74.2	1.1
MPS	0	0	0.1	0.933	99.9	0.1	0	230	16.6	83.4	0
MR312	0.31	0.031	0.779	22.1	75.8	17.9	6.3	7570	38.7	61.3	2.4
MTC	0.41	0.086	0.798	35.6	75.4	22.2	2.4	81800	72.3	27.7	21.2
NBLACK	0	0.106	0.663	38.8	73.2	22.9	3.8	13700	47.7	52.3	4.6
NEWLKA	0	0.0157	0.155	5.96	98.6	1.2	0.5	3160	25.7	74.3	0.6
NEWLKB	0	0.0206	0.156	6.24	98.7	1.2	0.5	3390	24.1	75.9	1.2
NEWLKC	0.512	0.0632	0.92	29.3	92	7.6	0.5	259000	87.1	12.9	50
NEWLKD	2.13	0.0968	1.32	67.7	54.2	44.7	1	365000	94.6	5.4	56.8
NEWLKE	2.66	0.0902	0.796	47.6	47.7	51.1	1.2	296000	94.8	5.2	46.7
NEWLKF	1.98	0.0964	0.724	35.7	52.25	46.7	1.05	255000	93.65	6.35	40.45
NORRIS	1.85	0.116	1.01	44.1	40.8	51.4	7.7	230000	83.8	16.2	32.4
NRI	0	0	0.339	7.64	90.2	7.8	2	4060	33.3	66.7	1.3
OLA	0.352	0.0812	0.406	10.5	79.1	19.7	1.2	6650	43	57	2
OLK	3.11	0.046	0.748	41.7	70.7	28.5	0.8	451000	95.8	4.2	71.2
OR908	1.09	0.12	6.05	202	53.6	44.8	1.6	201000	92.1	7.9	35.7
ORD	2.29	0.062	0.6	12.1	72.6	25.5	1.9	87300	76.2	23.8	16.4
PCR-PL	0	0.0711	0.407	21.5	79.4	16.2	4.4	23300	48.1	51.9	7.9
PEL	0	0.055	0.468	13.6	82.8	15.4	1.8	21100	46.2	53.8	5
RCLSJ06	2.065	0.2225	2.245	161.5	56.7	40	3.3	396000	89.1	10.9	58.15
RCLSJ10	2.27	0.177	1.87	101.4	63.6	34.6	1.8	333500	87.65	12.35	50.45
RCLSJ19	3.36	0.205	1.98	64.55	70.8	27.6	1.5	244500	86.25	13.75	39.9
SELLERS	0.274	0.0796	0.363	16	94.4	4.85	0.8	2620	22.7	77.3	0.65
SHEEL	0.11	0	0.601	8.79	98.1	1.6	0.3	1060	24	76	0.3
SILRV	2.64	0.0869	0.261	8.68	77.7	20.7	1.6	69500	65.9	34.1	8.8
SIM	0.65	0	0.627	270	72.2	24.5	3.4	23100	45.3	54.7	7.5
SJRJESUP	0	0.0677	0.269	14	88.9	8.8	2.4	2830	31	69	0.9

Appendix A - Continued

Site	Selenium	Silver	Tin	Zinc	SAND (%)	SILT (%)	CLAY (%)	TOC	MOISTURE (%)	TOTAL SOLIDS (%)	TOTAL VOLATILE SOLIDS (%)
SJRPLTKA	0.692	0.117	1.67	25.5	80.5	18.1	1.4	32250	54.35	45.65	6
SOUTH	1.41	0.0254	0.164	15.2	80.2	19.5	0.5	7340	84.6	15.4	15.6
SRS	0.37	0.056	1.1	11.3	63	28.7	8.3	13300	45.9	54.1	3.7
SUNLAND	0	0.0232	0.307	9.13	99.3	0.5	0.5	540	19	81	0
SWBPP1	0.8	0.27	8.35	86.4	74.3	21.7	4	32900	51.8	48.2	7.2
TOL	0	0.013	0.241	4.04	96.2	2.9	0.9	1150	21.7	78.3	0.3
TUBPP1	0.13	0	0.245	10.7	91.8	7.7	0.5	7380	44	56	4.2
USJ055	0.62	0.037	0.567	22.7	76.7	21	2.2	52300	62.3	37.7	13
USJ918	1.29	0.021	1.1	15	64.6	29.5	5.9	39700	58.4	41.6	8.4
WASH	1.55	0.139	0.789	46.1	45.7	50	4.3	268000	85.6	14.4	39.5
WIN	1.12	0.012	0.378	16.9	68.2	27.7	4.1	17200	45.8	54.2	5.7
WINN	0.458	0.0388	0.199	9.67	84	13.8	2.2	5250	37.5	62.5	2.3
WIO	0	0	0.217	6.16	97.5	2	0.6	1050	30.9	69.1	0.4

Appendix A - Continued

Site	Local Hydro/Drainage Basin Major (ID)	Sub-Basin (ID)	Name	Waterbody Type	County	Drainage Basin Area Local Basin Acres	Whole Basin Acres	Ratio Local to Whole
02235000	4	4E	WEKIVA RIVER	Stream	Seminole	18567	85100	22
02236000	5	5A	ST. JOHNS RIVER	Stream	Lake	33473	1850260	2
02238000	7	7C	LAKE HARRIS AND EUSTIS	Stream	Lake	45040	405235	11
02240800	7	7G	HATCHET CREEK	Stream	Alachua	17373	41121	42
02248000	9	9A	SPRUCE CREEK	Stream	Volusia	8321	8321	100
19010001	2	2C	ST. MARYS RIVER	Stream	Nassau	7162	564759	1
19010006	2	2A	ST. MARYS RIVER	Stream	Baker	1735	29185	6
19020002	1	1A	NASSAU RIVER	Stream	Duval	7921	175923	5
20010002	5	5A	ST. JOHNS RIVER	Stream	Volusia	33841	2028552	2
20010003	4	4D	ST. JOHNS RIVER	Stream	Volusia	24998	1608082	2
20010137	4	4E	LITTLE WEKIVA RIVER	Stream	Seminole	3346	27282	12
20020001	7	7E	OCKLAWAHA RIVER	Stream	Marion	75	517282	0
20020012	7	7F	OCKLAWAHA RIVER	Stream	Marion	25276	733979	3
20020368	7	7C	LAKE HARRIS AND EUSTIS	Lake	Lake	45040	405235	11
20020371	7	7D	LK YALE OUTLET CANAL	Lake	Lake	9038	45233	20
20020377	7	7C	LAKE HARRIS AND EUSTIS	Lake	Lake	45040	236146	19
20020381	7	7D	LAKE GRIFFIN	Lake	Lake	23531	500215	5
20020404	7	7G	ORANGE CREEK	Stream	Putnam	24244	310647	8
20030373	5	5C	ST. JOHNS RIVER	Stream	Putnam	83062	2263577	4
20030400	3	3B	FALLING BRANCH	Lake	Putnam	5910	5910	100
20030411	3	3A	DUNNS CR, CRESCENT LK	Stream	Volusia	9608	232765	4
20030412	3	3C	KINGSLEY LAKE OUTLET	Lake	Clay	5207	5207	100
27010024	9	9A	TOMOKA RIVER	Stream	Volusia	10585	85651	12
27010037	9	9A	HALIFAX RIVER	Stream	Volusia	23494	199808	12
27010579	8	9A	TOMOKA RIVER	Stream	Volusia	10324	39871	26
27010875	10	10C	INDIAN RIVER LAGOON	Estuar	Brevard	78355	155264	50

Appendix A - Continued

Site	Local Hydro/Drainage Basin Major (ID)	Sub-Basin (ID)	Name	Waterbody Type	County	Drainage Basin Area Local Basin Acres	Whole Basin Acres	Ratio Local to Whole
ASH	4	4B	DEEP CR-LK ASHBY CA	Lake	Volusia	12108	19698	61
BEAR	4	4E	TROUT LAKE OUTLET	Lake	Seminole	1216	1216	100
BLSPR	5	5A	ST. JOHNS RIVER	Spring	Volusia	15659	1814869	1
BROWARD	3	3A	LAKE BROWARD OUTLET	Lake	Putnam	2172	2172	100
BUL	9	9A	BULOW CREEK	Stream	Volusia	18870	18894	100
BWC44	4	4E	BLACK WATER CREEK	Stream	Lake	16848	77283	22
BWCCPB	4	4E	BLACK WATER CREEK	Stream	Lake	8737	118670	7
CC03	10	10D	CRANE CREEK	Stream	Brevard	9506	9506	100
CHARLES	7	7F	HULLS CREEK	Lake	Marion	20549	24000	86
CHERRY	7	7A	PALATLAKAHA REACH	Lake	Lake	15660	111857	14
CLD	3	3A	LITTLE HAW CREEK	Lake	Flagler	45857	67845	68
CLW	7	7E	LAKE WEIR	Lake	Marion	13650	17982	76
DALHOUS	4	4E	LAKE DALHOUSE OUTLET	Lake	Lake	569	569	100
DIAS	3	3A	LAKE DIAS OUTLET	Lake	Volusia	2174	9015	24
DMR	4	4B	DEEP CR-LK ASHBY CA	Stream	Volusia	10416	56733	18
DOR	7	7C	DORA CANAL	Lake	Lake	11587	148737	8
DORR	4	4E	BLACK WATER CREEK	Lake	Lake	22347	22347	100
GEN	3	3B	HALFMOON LAKE OUTLET	Lake	Clay	28965	28965	100
HALFMOON	7	7F	HALFMOON LAKE	Lake	Marion	17733	17733	100
HAR	7	7C	LAKE HARRIS AND EUSTIS	Lake	Lake	45040	236146	19
HAT26	7	7G	HATCHET CREEK	Stream	Alachua	17373	41121	42
HAW	3	3A	HAW CREEK	Stream	Volusia	25141	212439	12
HELENA	7	7C	BUGG SPRING RUN	Stream	Lake	8210	1486	552
HOG30	7	7G	HOGTOWN CREEK	Stream	Alachua	1123	11474	10
HOWELL	4	4C	HOWELL CREEK	Lake	Seminole	6771	17588	38
INDUSPL	7	7G	GUMROOT SWAMP	Stream	Alachua	3428	5887	58
JOHNSON	3	3B	UNNAMED LAKE OUTLET	Lake	Clay	21051	21051	100
KER	5	5D	LITTLE LAKE KERR OUTLE	Lake	Marion	45674	45674	100

Appendix A - Continued

Site	Local Hydro/Drainage Basin Major (ID)	Sub-Basin (ID)	Name	Waterbody Type	County	Drainage Basin Area Local Basin Acres	Whole Basin Acres	Ratio Local to Whole
KERR	5	5D	LITTLE LAKE KERR OUTLE	Lake	Marion	45674	45674	100
LAG	5	5C	ST. JOHNS RIVER	Lake	Volusia	83062	2263577	4
LEO	5	5C	ST. JOHNS RIVER	Lake	Volusia	83062	2263577	4
LHAT26	7	7G	AIRPORT DRAIN	Stream	Alachua	782	11813	7
LHATSB	7	7G	AIRPORT DRAIN	Stream	Alachua	171	1476	12
LHNBPL	7	7G	GUMROOT SWAMP	Stream	Alachua	3428	5887	58
LKWOOD	5	5A	LAKE WOODRUFF OUTLET	Lake	Volusia	28585	70601	40
LMAC	4	4D	ST. JOHNS RIVER	Lake	Volusia	24998	1608082	2
LOCCR	7	7G	LOCHLOOSA CREEK	Stream	Alachua	14753	25640	58
LOL	7	7G	LOCHLOOSA LAKE	Lake	Alachua	14801	56589	26
LORANCRK	7	7G	LITTLE ORANGE CREEK	Stream	Putnam	22723	29931	76
LOUISA	7	7A	PALATLAKAHA REACH	Lake	Lake	7982	76306	10
LSJ070	3	3A	LITTLE HAW CREEK	Stream	Flagler	45857	67845	68
LSJ087	3	3H	DURBIN CREEK	Stream	St Johns	12923	27415	47
LSJ099	3	3H	BIG DAVIS CREEK	Stream	Duval	5619	9152	61
LSJ918	3	3B	RICE CREEK	Stream	Putnam	16187	29299	55
LYC	7	7D	LK YALE OUTLET CANAL	Lake	Lake	9038	45233	20
MAITL	4	4C	HOWELL CREEK	Lake	Orange	10817	10817	100
MAT	9	9B	MATANZAS RIVER	Estuar	Flagler	21495	102054	21
MBU	7	7D	LAKE GRIFFIN	Stream	Marion	23531	517207	5
MILLD	7	7F	MILL DAM LAKE	Lake	Marion	1745	19478	9
MPS	2	2A	MIDDLE PRONG ST. MARYS	Stream	Baker	47042	119303	39
MR312	9	9C	MATANZAS RIVER	Stream	St Johns	6406	70090	9
MTC	9	9C	MOULTRIE CREEK	Stream	St Johns	9212	9212	100
NBLACK	3	3C	NORTH FORK BLACK CREEK	Stream	Clay	24881	129478	19
NEWLKA	7	7G	PRAIRIE CREEK REACH	Lake	Alachua	20678	79311	26
NEWLKB	7	7G	PRAIRIE CREEK REACH	Lake	Alachua	20678	79311	26
NEWLKC	7	7G	PRAIRIE CREEK REACH	Lake	Alachua	20678	79311	26

Appendix A - Continued

Site	Local Hydro/Drainage Basin Major (ID)	Sub-Basin (ID)	Name	Waterbody Type	County	Drainage Basin Area Local Basin Acres	Whole Basin Acres	Ratio Local to Whole
NEWLKD	7	7G	SUNLAND DRAIN	Lake	Alachua	929	79311	1
NEWLKE	7	7G	PRAIRIE CREEK REACH	Lake	Alachua	20678	79311	26
NEWLKF	7	7G	PRAIRIE CREEK REACH	Lake	Alachua	20678	79311	26
NORRIS	4	4E	BLACK WATER CREEK	Lake	Lake	7133	60435	12
NRI	1	1A	ALLIGATOR CREEK	Stream	Nassau	15389	40333	38
OLA	7	7C	LAKE OLA OUTLET	Lake	Orange	2169	2169	100
OLK	7	7G	ORANGE LAKE REACH	Lake	Alachua	24899	221052	11
OR908	7	7G	BIVANS ARM	Lake	Alachua	2206	2206	100
ORD	7	7F	OCKLAWAHA RIVER	Stream	Marion	133	613345	0
PCR-PL	7	7G	GUMROOT SWAMP	Stream	Alachua	3428	5887	58
PEL	9	9B	PELLICER CREEK	Stream	St Johns	15033	41127	37
SELLERS	5	5B	NINEMILE CREEK	Lake	Lake	23811	23811	100
SHEEL	3	3B	UNNAMED LAKE OUTLET	Lake	Clay	21051	21051	100
SILRV	7	7E	SILVER RIVER	Stream	Marion	4193	13188	32
SIM	3	3B	SIMMS CREEK	Stream	Putnam	10984	31784	35
SJRJESUP	4	4B	ST. JOHNS RIVER	Stream	Volusia	38927	1466202	3
SJRPLTKA	3	3J	ST. JOHNS RIVER	Stream	Putnam	30551	4002683	1
SOUTH	6	6I	SOUTH LAKE OUTLET	Lake	Brevard	4278	4278	100
SRS	6	6I	ST. JOHNS RIVER	Stream	Orange	38943	962373	4
SUNLAND	7	7G	SUNLAND DRAIN	Stream	Alachua	4769	4769	100
SWBPP1	7	7C	SWEETWATER BRANCH	Stream	Alachua	335	2130	16
TOL	9	9D	TOLOMATO RIVER	Estuar	St Johns	16786	55436	30
TUBPP1	7	7G	BIVANS ARM	Stream	Alachua	2206	2206	100
USJ055	6	6E	CRABGRASS CREEK	Stream	Osceola	14001	19504	72
USJ918	6	6G	WOLF CREEK	Stream	Osceola	9578	17960	53
WASH	6	6F	ST. JOHNS RIVER	Lake	Brevard	63332	607033	10
WIN	4	4B	LK WINNEMISSETT OUTLET	Lake	Volusia	1383	1383	100
WINN	4	4B	LK WINNEMISSETT OUTLET	Lake	Volusia	1383	1383	100

Site	Local Hydro/Drainage Basin Major (ID)	Sub-Basin (ID)	Name	Waterbody Type	County	Drainage Basin Area Local Basin Acres	Whole Basin Acres	Ratio Local to Whole
WIO	3	3A	LAKE WINONA OUTLET	Lake	Volusia	969	969	100
LSJ01	3	3K	ST. JOHNS RIVER	Stream	Duval	8971	5070116	0
LSJ05	3	3K	ST. JOHNS RIVER	Stream	Duval	10086	4989676	0
LSJ08	3	3J	ST. JOHNS RIVER	Stream	Duval	3537	4976332	0
LSJ11	3	3J	ST. JOHNS RIVER	Stream	Duval	6409	4970975	0
LSJ14	3	3J	ST. JOHNS RIVER	Stream	St Johns	10867	4948343	0
LSJ17	3	3J	ST. JOHNS RIVER	Stream	St Johns	26423	4859307	1
LSJ21	3	3J	ST. JOHNS RIVER	Stream	St Johns	29415	4528605	1
LSJ28	3	3J	ST. JOHNS RIVER	Stream	St Johns	14336	4371407	0
LSJ32	3	3J	ST. JOHNS RIVER	Stream	Putnam	3510	4262666	0
LSJ35	3	3J	ST. JOHNS RIVER	Stream	Putnam	30551	4002683	1
LSJ40	3	3J	ST. JOHNS RIVER	Stream	Putnam	610	3546023	0
LSJRC17	3	3J	ST. JOHNS RIVER	Stream	Putnam	9535	4241389	0
RCLSJ06	3	3B	RICE CREEK	Stream	Putnam	1734	4223900	0
RCLSJ10	3	3J	ST. JOHNS RIVER	Stream	Putnam	10697	4225063	0
RCLSJ19	3	3J	ST. JOHNS RIVER	Stream	Putnam	4300	4250735	0

Physiography codes:
EF: Eastern flatlands
EML: Exposed miocene limestone
PP: Plio-pleistocene ridges

Appendix A - Continued

Site	Local Basin Population			Local Basin Physiography			Local Basin Land Use						
	Population Total	Population Density	Population Density (sqmi)	EF%	EML%	PP%	AG (%)	COM/IND (%)	FOR (%)	RES (%)	ROP (%)	WATER (%)	WET LANDS (%)
02235000	22832	1.23	787	4.77	69.89	25.33	6.19	1.13	24.50	25.28	3.92	3.21	35.76
02236000	27609	0.83	528	42.23	0.00	57.77	3.51	4.86	22.17	28.23	11.72	4.53	24.99
02238000	23555	0.52	335	0.00	90.95	9.05	6.22	4.12	3.30	14.72	8.18	53.23	10.23
02240800	1302	0.08	48	0.00	6.55	93.45	2.44	4.72	58.85	6.05	3.68	0.13	24.13
02248000	292	0.04	22	100.00	0.00	0.00	10.69	0.76	25.68	13.99	24.73	0.50	23.65
19010001	392	0.06	35	97.77	0.00	2.23	3.19	0.63	42.55	2.80	4.05	5.91	40.86
19010006	49	0.03	18	0.00	0.00	100.00	1.34	0.00	63.27	2.37	1.08	0.00	31.95
19020002	760	0.10	61	100.00	0.00	0.00	0.58	1.69	22.61	6.09	3.23	7.48	58.32
20010002	2346	0.07	44	71.54	0.00	28.46	1.74	0.26	33.64	2.89	4.46	10.57	46.43
20010003	29267	1.17	749	82.70	0.00	17.30	3.86	6.73	6.22	17.46	3.33	38.06	24.33
20010137	17897	5.35	3423	0.00	93.25	6.75	0.16	22.56	1.36	56.23	8.81	4.91	5.98
20020001	11	0.15	96	0.00	82.88	17.12	0.00	14.66	22.54	0.01	39.54	7.50	15.74
20020012	890	0.04	22	0.00	93.96	6.04	0.66	0.17	59.97	3.46	3.15	1.26	31.34
20020368	23555	0.52	335	0.00	90.95	9.05	6.22	4.12	3.30	14.72	8.18	53.23	10.23
20020371	3377	0.37	239	0.00	100.00	0.00	11.03	1.94	7.86	9.59	12.27	45.97	11.33
20020377	23555	0.52	335	0.00	90.95	9.05	6.22	4.12	3.30	14.72	8.18	53.23	10.23
20020381	13080	0.56	356	0.00	76.96	23.04	5.89	2.47	10.42	9.16	7.40	41.95	22.71
20020404	1521	0.06	40	0.00	100.00	0.00	12.92	0.29	36.49	3.83	16.00	1.02	29.46
20030373	4503	0.05	35	83.86	0.00	16.14	1.75	0.04	19.83	2.23	3.26	54.63	18.25
20030400	494	0.08	54	0.00	0.00	100.00	2.30	0.00	51.64	12.60	8.59	13.83	11.03
20030411	607	0.06	40	90.75	0.00	9.25	4.84	0.03	14.79	1.08	10.82	9.95	58.48
20030412	31	0.01	4	0.00	0.00	100.00	0.00	9.26	39.15	8.58	7.76	31.29	3.95
27010024	11954	1.13	723	100.00	0.00	0.00	0.00	8.29	30.70	20.74	8.30	4.06	27.90
27010037	26682	1.14	727	100.00	0.00	0.00	0.00	6.72	16.48	20.50	5.23	29.41	21.66
27010579	1421	0.14	88	100.00	0.00	0.00	0.74	9.42	46.99	2.65	6.92	1.69	31.59

Appendix A - Continued

	Local Basin Population			Local Basin Physiography			Local Basin Land Use						
Site	Population Total	Population Density	Population Density (sqmi)	EF%	EML%	PP%	AG (%)	COM/IND (%)	FOR (%)	RES (%)	ROP (%)	WATER (%)	WET LANDS (%)
27010875	35442	0.45	289	100.00	0.00	0.00	5.91	3.79	7.39	7.12	8.08	47.48	20.22
ASH	425	0.04	22	100.00	0.00	0.00	4.22	0.02	37.69	3.00	18.14	7.35	29.58
BEAR	3538	2.91	1862	0.00	0.00	100.00	2.58	3.39	3.22	53.51	6.65	29.50	1.16
BLSPR	3871	0.25	158	74.73	0.00	25.27	1.56	0.90	20.66	8.79	8.66	2.39	57.04
BROWARD	269	0.12	79	8.29	0.00	91.71	2.90	0.80	25.71	32.71	12.53	18.43	6.92
BUL	1748	0.09	60	100.00	0.00	0.00	0.22	3.07	38.70	9.83	18.47	2.78	26.93
BWC44	1317	0.08	50	37.27	0.00	62.73	6.37	0.20	23.56	12.29	27.02	1.39	29.17
BWCCPB	1070	0.12	78	93.39	0.00	6.61	5.62	0.09	35.60	2.86	13.74	0.84	41.26
CC03	16942	1.78	1140	100.00	0.00	0.00	2.11	26.95	16.01	34.02	14.49	2.52	3.90
CHARLES	861	0.04	27	0.00	81.83	18.17	0.89	0.63	54.46	7.02	2.43	5.99	28.57
CHERRY	4059	0.26	166	0.00	0.00	100.00	7.31	5.13	3.60	12.67	13.45	32.59	25.26
CLD	5334	0.12	74	78.88	0.00	21.12	2.85	1.50	40.10	4.69	7.29	4.96	38.62
CLW	2789	0.20	131	0.00	11.35	88.65	8.92	0.65	5.32	17.87	16.94	43.59	6.72
DALHOUS	104	0.18	117	0.00	0.00	100.00	17.90	0.00	4.70	11.25	20.17	42.99	2.99
DIAS	109	0.05	32	0.00	0.00	100.00	7.46	0.12	37.25	5.64	10.61	32.71	6.22
DMR	374	0.04	23	100.00	0.00	0.00	10.76	0.05	40.01	1.40	12.45	0.03	35.29
DOR	9122	0.79	504	0.00	95.82	4.18	5.22	6.74	1.57	21.38	12.18	39.58	13.33
DORR	2279	0.10	65	10.13	0.00	89.87	2.26	0.42	61.69	6.10	6.41	8.57	14.56
GEN	2145	0.07	47	0.00	0.00	100.00	0.70	4.54	38.04	25.70	6.64	15.64	8.74
HALFMOON	1424	0.08	51	0.00	24.13	75.87	0.17	0.05	85.14	3.02	1.73	2.54	7.36
HAR	23555	0.52	335	0.00	90.95	9.05	6.22	4.12	3.30	14.72	8.18	53.23	10.23
HAT26	1302	0.08	48	0.00	6.55	93.45	2.44	4.72	58.85	6.05	3.68	0.13	24.13
HAW	1215	0.05	31	100.00	0.00	0.00	6.08	2.01	40.72	4.70	16.96	1.10	28.43
HELENA	3223	0.39	252	0.00	0.00	100.00	18.88	3.35	7.48	8.19	11.47	3.68	46.94
HOG30	3838	3.42	2188	0.00	100.00	0.00	1.27	10.00	18.76	27.39	3.32	0.25	39.01
HOWELL	31029	4.58	2933	0.00	37.50	62.50	1.98	13.18	5.37	53.15	4.97	11.92	9.43

Appendix A - Continued

Site	Local Basin Population: Population Total	Population Density	Population Density (sqmi)	Local Basin Physiography: EF%	EML%	PP%	Local Basin Land Use: AG (%)	COM/IND (%)	FOR (%)	RES (%)	ROP (%)	WATER (%)	WET LANDS (%)
INDUSPL	1312	0.38	245	0.00	0.10	99.90	2.04	22.68	53.59	2.57	4.64	0.41	14.07
JOHNSON	2497	0.12	76	0.00	0.00	100.00	2.37	1.46	41.85	23.04	18.07	5.05	8.16
KER	1249	0.03	17	0.00	0.00	100.00	0.15	0.10	83.12	3.84	0.68	7.69	4.43
KERR	1249	0.03	17	0.00	0.00	100.00	0.15	0.10	83.12	3.84	0.68	7.69	4.43
LAG	4503	0.05	35	83.86	0.00	16.14	1.75	0.04	19.83	2.23	3.26	54.63	18.25
LEO	4503	0.05	35	83.86	0.00	16.14	1.75	0.04	19.83	2.23	3.26	54.63	18.25
LHAT26	393	0.50	322	0.00	80.64	19.36	3.30	0.24	43.03	22.86	7.93	0.50	22.15
LHATSB	87	0.51	326	0.00	51.88	48.12	1.80	20.91	38.56	16.29	14.38	0.34	7.71
LHNBPL	1312	0.38	245	0.00	0.10	99.90	2.04	22.68	53.59	2.57	4.64	0.41	14.07
LKWOOD	6772	0.24	152	61.91	0.00	38.09	10.00	1.80	15.48	16.29	6.36	11.70	38.36
LMAC	29267	1.17	749	82.70	0.00	17.30	3.86	6.73	6.22	17.46	3.33	38.06	24.33
LOCCR	786	0.05	34	0.00	88.81	11.19	8.44	0.85	64.95	3.48	3.74	0.03	18.51
LOL	778	0.05	34	0.00	100.00	0.00	1.95	0.44	26.06	1.94	1.78	37.51	30.32
LORANCRK	1677	0.07	47	0.00	53.68	46.32	6.08	1.07	39.48	10.09	12.34	7.39	23.56
LOUISA	299	0.04	24	0.00	0.00	100.00	14.61	3.92	12.22	4.84	16.77	39.90	7.74
LSJ070	5334	0.12	74	78.88	0.00	21.12	2.85	1.50	40.10	4.69	7.29	4.96	38.62
LSJ087	1748	0.14	86	100.00	0.00	0.00	3.41	0.75	43.56	1.51	4.22	0.20	46.35
LSJ099	665	0.12	76	100.00	0.00	0.00	1.15	5.16	51.51	0.97	3.12	0.96	37.13
LSJ918	1120	0.07	44	16.59	1.37	82.04	0.63	0.29	44.21	6.80	5.18	0.16	42.74
LYC	3377	0.37	239	0.00	100.00	0.00	11.03	1.94	7.86	9.59	12.27	45.97	11.33
MAITL	45184	4.18	2673	0.00	100.00	0.00	1.15	23.18	1.33	51.78	2.14	19.19	1.23
MAT	4149	0.19	124	100.00	0.00	0.00	0.02	2.61	21.40	25.06	11.16	14.33	25.41
MBU	13080	0.56	356	0.00	76.96	23.04	5.89	2.47	10.42	9.16	7.40	41.95	22.71
MILLD	71	0.04	26	0.00	70.57	29.43	0.00	0.00	73.00	6.16	1.31	10.06	9.47
MPS	1329	0.03	18	0.00	0.00	100.00	0.51	0.33	57.76	1.24	1.07	0.28	38.80
MR312	4359	0.68	436	100.00	0.00	0.00	0.00	5.58	9.21	18.03	7.66	34.88	24.64

Appendix A - Continued

Site	Local Basin Population: Population Total	Population Density	Population Density (sqmi)	Local Basin Physiography: EF%	EML%	PP%	Local Basin Land Use: AG (%)	COM/IND (%)	FOR (%)	RES (%)	ROP (%)	WATER (%)	WET LANDS (%)
MTC	1215	0.13	84	100.00	0.00	0.00	2.95	1.39	35.15	9.23	12.04	1.45	37.79
NBLACK	3614	0.15	93	0.00	0.00	100.00	0.82	1.35	57.55	11.09	4.04	0.34	24.81
NEWLKA	2710	0.13	84	0.00	100.00	0.00	3.93	0.34	38.49	6.98	2.67	28.92	18.66
NEWLKB	2710	0.13	84	0.00	100.00	0.00	3.93	0.34	38.49	6.98	2.67	28.92	18.66
NEWLKC	2710	0.13	84	0.00	100.00	0.00	3.93	0.34	38.49	6.98	2.67	28.92	18.66
NEWLKD	474	0.51	326	0.00	100.00	0.00	2.05	0.16	45.48	9.35	0.51	1.04	41.42
NEWLKE	2710	0.13	84	0.00	100.00	0.00	3.93	0.34	38.49	6.98	2.67	28.92	18.66
NEWLKF	2710	0.13	84	0.00	100.00	0.00	3.93	0.34	38.49	6.98	2.67	28.92	18.66
NORRIS	554	0.08	50	70.60	0.00	29.40	1.34	0.00	12.41	8.17	24.12	16.39	37.56
NRI	1041	0.07	44	57.07	0.00	42.93	5.10	0.82	48.01	6.06	6.80	0.98	32.22
OLA	338	0.16	100	0.00	80.60	19.40	29.94	4.70	6.20	23.92	12.03	20.48	2.73
OLK	1761	0.07	45	0.00	100.00	0.00	5.98	0.59	17.87	5.45	9.26	22.06	38.80
OR908	10357	4.70	3005	0.00	100.00	0.00	0.00	35.11	10.24	38.39	0.98	7.51	7.78
ORD	4	0.03	20	0.00	100.00	0.00	0.00	0.00	14.61	27.18	7.95	3.75	46.51
PCR-PL	1312	0.38	245	0.00	0.10	99.90	2.04	22.68	53.59	2.57	4.64	0.41	14.07
PEL	723	0.05	31	100.00	0.00	0.00	0.00	0.81	59.47	0.00	0.84	0.22	38.66
SELLERS	1090	0.05	29	0.00	0.00	100.00	0.00	0.34	87.44	0.86	2.37	5.50	3.49
SHEEL	2497	0.12	76	0.00	0.00	100.00	2.37	1.46	41.85	23.04	18.07	5.05	8.16
SILRV	1197	0.29	182	0.00	100.00	0.00	1.27	2.26	57.60	7.32	6.36	1.94	23.26
SIM	475	0.04	28	0.00	0.00	100.00	0.54	1.30	69.52	1.54	1.92	0.57	24.61
SJRJESUP	3161	0.08	52	100.00	0.00	0.00	5.51	1.46	20.12	14.30	9.12	23.41	26.08
SJRPLTKA	9107	0.30	191	96.68	0.00	3.32	2.23	1.43	19.51	17.01	7.70	16.12	35.99
SOUTH	2155	0.50	323	100.00	0.00	0.00	0.39	1.19	11.12	14.58	13.64	13.87	45.21
SRS	4602	0.12	76	99.73	0.00	0.27	2.68	0.78	4.90	1.28	5.07	13.96	71.33
SUNLAND	7047	1.48	946	0.00	100.00	0.00	10.17	14.08	24.66	22.46	14.47	0.30	13.86
SWBPP1	1024	3.06	1955	0.00	100.00	0.00	0.00	15.35	33.49	16.44	13.27	3.10	18.35

Appendix A - Continued

Site	Local Basin Population			Local Basin Physiography			Local Basin Land Use						
	Population Total	Population Density	Population Density (sqmi)	EF%	EML%	PP%	AG (%)	COM/IND (%)	FOR (%)	RES (%)	ROP (%)	WATER (%)	WET LANDS (%)
TOL	2616	0.16	100	100.00	0.00	0.00	0.05	2.06	27.68	9.38	3.88	17.79	39.15
TUBPP1	10357	4.70	3005	0.00	100.00	0.00	0.00	35.11	10.24	38.39	0.98	7.51	7.78
USJ055	71	0.01	3	0.00	0.00	100.00	0.00	0.00	0.27	0.06	74.88	0.06	24.74
USJ918	49	0.01	3	18.53	0.00	81.47	0.00	0.00	1.36	0.00	82.34	0.05	16.25
WASH	600	0.01	6	93.85	0.00	6.15	1.27	0.36	6.82	0.54	17.51	6.87	66.64
WIN	536	0.39	248	11.44	0.00	88.56	20.08	0.37	24.73	15.26	10.57	13.64	15.36
WINN	536	0.39	248	11.44	0.00	88.56	20.08	0.37	24.73	15.26	10.57	13.64	15.36
WIO	49	0.05	32	0.25	0.00	99.75	22.64	0.00	54.50	2.93	4.10	13.55	2.28
LSJ01	16535	1.84	1180	100.00	0.00	0.00	0.02	5.85	0.79	17.62	0.45	74.26	1.01
LSJ05	10222	1.01	649	100.00	0.00	0.00	0.00	12.80	3.02	17.09	0.82	65.21	1.06
LSJ08	3860	1.09	698	100.00	0.00	0.00	0.00	2.83	0.35	13.85	0.18	82.47	0.32
LSJ11	4364	0.68	436	100.00	0.00	0.00	0.00	0.91	3.00	23.20	0.53	65.21	7.15
LSJ14	2706	0.25	159	100.00	0.00	0.00	0.08	1.07	6.66	21.75	0.37	66.42	3.65
LSJ17	5623	0.21	136	91.15	0.00	8.85	3.15	5.12	24.23	8.02	6.22	41.62	11.65
LSJ21	2749	0.09	60	97.39	0.00	2.61	4.20	0.32	21.34	2.90	2.64	49.54	19.06
LSJ28	845	0.06	38	100.00	0.00	0.00	7.94	0.00	19.16	7.49	1.43	56.45	7.53
LSJ32	506	0.14	92	100.00	0.00	0.00	27.65	0.25	5.13	5.07	4.64	53.54	3.72
LSJ35	9107	0.30	191	96.68	0.00	3.32	2.23	1.43	19.51	17.01	7.70	16.12	35.99
LSJ40	33	0.05	35	100.00	0.00	0.00	0.00	0.00	6.90	15.86	1.42	42.91	32.90
LSJRC17	7822	0.82	525	96.26	0.00	3.74	3.46	7.60	12.76	16.15	3.84	42.63	13.57
RCLSJ06	739	0.43	273	99.97	0.00	0.03	0.97	21.55	16.71	1.57	7.96	10.35	40.88
RCLSJ10	7878	0.74	471	87.65	0.00	12.35	3.29	7.25	15.79	15.36	4.82	38.12	15.38
RCLSJ19	608	0.14	90	100.00	0.00	0.00	14.64	0.41	12.61	13.69	3.45	48.76	6.44

Physiography codes:

EF: Eastern flatlands

EML: Exposed miocene limestone

PP: Plio-pleistocene ridges

Appendix A - Continued

Site	Qa (%)	Qbd (%)	Qh (%)	Qtr (%)	Qu (%)	Tc (%)	Thc (%)	Thcc (%)	Ths (%)	To (%)	TQd (%)	Tqsu (%)	Tqu (%)	Tquc (%)
							Local Basin Geology							
02235000	0	0	0	0	15	26	59	0	0	0	0	0	0	0
02236000	0	0	25	0	6	60	0	0	0	0	9	0	0	0
02238000	0	0	1	0	0	99	0	0	0	0	0	0	0	0
02240800	0	0	0	0	0	0	67	0	0	0	0	0	33	0
02248000	0	100	0	0	0	0	0	0	0	0	0	0	0	0
19010001	0	0	0	0	33	6	0	61	0	0	0	0	0	0
19010006	0	0	0	0	0	0	0	0	0	0	0	0	100	0
19020002	0	0	69	0	31	0	0	0	0	0	0	0	0	0
20010002	0	0	44	0	36	20	0	0	0	0	0	0	0	0
20010003	0	0	56	0	33	12	0	0	0	0	0	0	0	0
20010137	0	0	0	0	0	73	27	0	0	0	0	0	0	0
20020001	0	0	31	0	0	69	0	0	0	0	0	0	0	0
20020012	0	0	32	0	43	25	0	0	0	0	0	0	0	0
20020368	0	0	1	0	0	99	0	0	0	0	0	0	0	0
20020371	0	0	58	0	0	42	0	0	0	0	0	0	0	0
20020377	0	0	1	0	0	99	0	0	0	0	0	0	0	0
20020381	0	0	63	0	0	37	0	0	0	0	0	0	0	0
20020404	0	0	0	0	36	0	1	0	0	62	0	0	0	0
20030373	0	3	79	0	11	7	0	0	0	0	0	0	0	0
20030400	0	0	0	100	0	0	0	0	0	0	0	0	0	0
20030411	0	0	77	0	10	14	0	0	0	0	0	0	0	0
20030412	0	0	0	100	0	0	0	0	0	0	0	0	0	0
27010024	9	81	10	0	0	0	0	0	0	0	0	0	0	0
27010037	49	19	32	0	0	0	0	0	0	0	0	0	0	0
27010579	0	100	0	0	0	0	0	0	0	0	0	0	0	0
27010875	33	17	50	0	0	0	0	0	0	0	0	0	0	0
ASH	0	72	0	0	0	0	0	0	0	0	0	28	0	0
BEAR	0	0	0	0	0	100	0	0	0	0	0	0	0	0
BLSPR	0	0	48	0	5	47	0	0	0	0	0	0	0	0

Appendix A - Continued

Site	Local Basin Geology													
	Qa (%)	Qbd (%)	Qh (%)	Qtr (%)	Qu (%)	Tc (%)	Thc (%)	Thcc (%)	Ths (%)	To (%)	TQd (%)	Tqsu (%)	Tqu (%)	Tquc (%)
BROWARD	0	0	1	0	0	99	0	0	0	0	0	0	0	0
BUL	16	72	12	0	0	0	0	0	0	0	0	0	0	0
BWC44	0	0	0	0	0	100	0	0	0	0	0	0	0	0
BWCCPB	0	0	0	0	28	27	46	0	0	0	0	0	0	0
CC03	80	0	0	0	0	0	0	0	0	0	0	20	0	0
CHARLES	0	0	0	0	0	100	0	0	0	0	0	0	0	0
CHERRY	0	0	0	0	0	100	0	0	0	0	0	0	0	0
CLD	0	43	0	0	40	16	0	0	0	0	0	0	0	0
CLW	0	0	0	0	0	92	0	0	0	0	0	0	8	0
DALHOUS	0	0	0	0	0	100	0	0	0	0	0	0	0	0
DIAS	0	0	0	0	0	100	0	0	0	0	0	0	0	0
DMR	0	0	0	0	0	0	0	0	0	0	0	100	0	0
DOR	0	0	0	0	0	100	0	0	0	0	0	0	0	0
DORR	0	32	0	0	0	68	0	0	0	0	0	0	0	0
GEN	0	0	0	20	0	74	0	0	0	0	0	0	6	0
HALFMOON	0	15	0	0	0	85	0	0	0	0	0	0	0	0
HAR	0	0	1	0	0	99	0	0	0	0	0	0	0	0
HAT26	0	0	0	0	0	0	67	0	0	0	0	0	33	0
HAW	0	32	7	0	61	0	0	0	0	0	0	0	0	0
HELENA	0	0	60	0	0	25	0	0	0	0	0	0	0	15
HOG30	0	0	0	0	0	0	0	0	0	100	0	0	0	0
HOWELL	0	0	0	0	70	30	0	0	0	0	0	0	0	0
INDUSPL	0	0	0	0	0	0	94	0	0	0	0	0	6	0
JOHNSON	0	0	0	24	0	76	0	0	0	0	0	0	0	0
KER	0	12	1	0	0	73	14	0	0	0	0	0	0	0
KERR	0	12	1	0	0	73	14	0	0	0	0	0	0	0
LAG	0	3	79	0	11	7	0	0	0	0	0	0	0	0
LEO	0	3	79	0	11	7	0	0	0	0	0	0	0	0
LHAT26	0	0	0	0	0	0	98	0	0	0	0	0	2	0
LHATSB	0	0	0	0	0	0	100	0	0	0	0	0	0	0

Appendix A - Continued

Site	Local Basin Geology													
	Qa (%)	Qbd (%)	Qh (%)	Qtr (%)	Qu (%)	Tc (%)	Thc (%)	Thcc (%)	Ths (%)	To (%)	TQd (%)	Tqsu (%)	Tqu (%)	Tquc (%)
LHNBPL	0	0	0	0	0	0	94	0	0	0	0	0	6	0
LKWOOD	0	0	53	0	6	41	0	0	0	0	0	0	0	0
LMAC	0	0	56	0	33	12	0	0	0	0	0	0	0	0
LOCCR	0	0	0	0	0	21	42	0	0	0	0	0	37	0
LOL	0	0	0	0	65	0	4	0	0	31	0	0	0	0
LORANCRK	0	0	0	0	23	70	0	0	0	0	0	0	7	0
LOUISA	0	0	0	0	0	100	0	0	0	0	0	0	0	0
LSJ070	0	43	0	0	40	16	0	0	0	0	0	0	0	0
LSJ087	0	22	0	0	78	0	0	0	0	0	0	0	0	0
LSJ099	0	88	0	0	12	0	0	0	0	0	0	0	0	0
LSJ918	0	0	0	0	100	0	0	0	0	0	0	0	0	0
LYC	0	0	58	0	0	42	0	0	0	0	0	0	0	0
MAITL	0	0	0	0	94	6	0	0	0	0	0	0	0	0
MAT	25	26	49	0	0	0	0	0	0	0	0	0	0	0
MBU	0	0	63	0	0	37	0	0	0	0	0	0	0	0
MILLD	0	0	0	0	0	100	0	0	0	0	0	0	0	0
MPS	0	0	0	0	0	0	0	0	38	0	0	0	62	0
MR312	28	17	55	0	0	0	0	0	0	0	0	0	0	0
MTC	0	100	0	0	0	0	0	0	0	0	0	0	0	0
NBLACK	0	0	0	40	8	53	0	0	0	0	0	0	0	0
NEWLKA	0	0	0	0	0	0	72	0	0	0	0	0	28	0
NEWLKB	0	0	0	0	0	0	72	0	0	0	0	0	28	0
NEWLKC	0	0	0	0	0	0	72	0	0	0	0	0	28	0
NEWLKD	0	0	0	0	0	0	100	0	0	0	0	0	0	0
NEWLKE	0	0	0	0	0	0	72	0	0	0	0	0	28	0
NEWLKF	0	0	0	0	0	0	72	0	0	0	0	0	28	0
NORRIS	0	21	0	0	0	79	0	0	0	0	0	0	0	0
NRI	0	0	3	0	59	38	0	0	0	0	0	0	0	0
OLA	0	0	3	0	0	97	0	0	0	0	0	0	0	0
OLK	0	0	0	0	0	0	22	0	0	78	0	0	0	0

Site	Local Basin Geology													
	Qa (%)	Qbd (%)	Qh (%)	Qtr (%)	Qu (%)	Tc (%)	Thc (%)	Thcc (%)	Ths (%)	To (%)	TQd (%)	Tqsu (%)	Tqu (%)	Tquc (%)
OR908	0	0	0	0	0	0	30	0	0	66	0	0	4	0
ORD	0	0	96	0	1	4	0	0	0	0	0	0	0	0
PCR-PL	0	0	0	0	0	0	94	0	0	0	0	0	6	0
PEL	0	100	0	0	0	0	0	0	0	0	0	0	0	0
SELLERS	0	77	0	0	2	1	20	0	0	0	0	0	0	0
SHEEL	0	0	0	24	0	76	0	0	0	0	0	0	0	0
SILRV	0	0	31	0	55	0	0	0	0	0	0	0	14	0
SIM	0	0	0	0	22	78	0	0	0	0	0	0	0	0
SJRJESUP	0	0	5	0	15	0	0	0	0	0	0	79	0	0
SJRPLTKA	0	0	50	0	42	8	0	0	0	0	0	0	0	0
SOUTH	1	12	65	0	0	0	0	0	0	0	0	22	0	0
SRS	1	2	67	0	0	0	0	0	0	0	0	30	0	0
SUNLAND	0	0	0	0	0	0	100	0	0	0	0	0	0	0
SWBPP1	0	0	0	0	0	0	63	0	0	30	0	0	7	0
TOL	4	9	87	0	0	0	0	0	0	0	0	0	0	0
TUBPP1	0	0	0	0	0	0	30	0	0	66	0	0	4	0
USJ055	0	100	0	0	0	0	0	0	0	0	0	0	0	0
USJ918	0	93	0	0	0	0	0	0	0	0	0	7	0	0
WASH	0	4	82	0	0	0	0	0	0	0	0	15	0	0
WIN	0	15	0	0	0	85	0	0	0	0	0	0	0	0
WINN	0	15	0	0	0	85	0	0	0	0	0	0	0	0
WIO	0	0	0	0	0	100	0	0	0	0	0	0	0	0
LSJ01	0	0	74	0	26	0	0	0	0	0	0	0	0	0
LSJ05	0	0	65	0	35	0	0	0	0	0	0	0	0	0
LSJ08	0	0	83	0	17	0	0	0	0	0	0	0	0	0
LSJ11	0	0	65	0	35	0	0	0	0	0	0	0	0	0
LSJ14	0	0	67	0	33	0	0	0	0	0	0	0	0	0
LSJ17	0	0	45	0	47	8	0	0	0	0	0	0	0	0
LSJ21	0	0	72	0	25	3	0	0	0	0	0	0	0	0
LSJ28	0	0	79	0	21	0	0	0	0	0	0	0	0	0

Appendix A - Continued

Site	Local Basin Geology													
	Qa (%)	Qbd (%)	Qh (%)	Qtr (%)	Qu (%)	Tc (%)	Thc (%)	Thcc (%)	Ths (%)	To (%)	TQd (%)	Tqsu (%)	Tqu (%)	Tquc (%)
LSJ32	0	0	100	0	0	0	0	0	0	0	0	0	0	0
LSJ35	0	0	50	0	42	8	0	0	0	0	0	0	0	0
LSJ40	0	0	87	0	13	0	0	0	0	0	0	0	0	0
LSJRC17	0	0	56	0	41	3	0	0	0	0	0	0	0	0
RCLSJ06	0	0	52	0	48	0	0	0	0	0	0	0	0	0
RCLSJ10	0	0	51	0	41	9	0	0	0	0	0	0	0	0
RCLSJ19	0	0	74	0	26	0	0	0	0	0	0	0	0	0

Physiography codes:
EF: Eastern flatlands
EML: Exposed miocene limestone
PP: Plio-pleistocene ridges

Appendix A - Continued

		Whole Hydro/Drainage Basin				Whole Basin Population		
Site	Major (ID)	Sub-Basin (ID)	Name	Water-body Type	County	Population Total	Population Density	Population Density (sqmi)
02235000	4	4E	WEKIVA RIVER	Stream	Seminole	166730	1.96	1254
02236000	5	5A	ST. JOHNS RIVER	Stream	Lake	778821	0.42	269
02238000	7	7C	LAKE HARRIS AND EUSTIS	Stream	Lake	111606	0.28	176
02240800	7	7G	HATCHET CREEK	Stream	Alachua	2743	0.07	43
02248000	9	9A	SPRUCE CREEK	Stream	Volusia	292	0.04	22
19010001	2	2C	ST. MARYS RIVER	Stream	Nassau	31475	0.06	36
19010006	2	2A	ST. MARYS RIVER	Stream	Baker	808	0.03	18
19020002	1	1A	NASSAU RIVER	Stream	Duval	14960	0.09	54
20010002	5	5A	ST. JOHNS RIVER	Stream	Volusia	793026	0.39	250
20010003	4	4D	ST. JOHNS RIVER	Stream	Volusia	584104	0.36	232
20010137	4	4E	LITTLE WEKIVA RIVER	Stream	Seminole	117594	4.31	2759
20020001	7	7E	OCKLAWAHA RIVER	Stream	Marion	146463	0.28	181
20020012	7	7F	OCKLAWAHA RIVER	Stream	Marion	180107	0.25	157
20020368	7	7C	LAKE HARRIS AND EUSTIS	Lake	Lake	111606	0.28	176
20020371	7	7D	LK YALE OUTLET CANAL	Lake	Lake	7412	0.16	105
20020377	7	7C	LAKE HARRIS AND EUSTIS	Lake	Lake	45196	0.19	122
20020381	7	7D	LAKE GRIFFIN	Lake	Lake	143750	0.29	184
20020404	7	7G	ORANGE CREEK	Stream	Putnam	38768	0.12	80
20030373	5	5C	ST. JOHNS RIVER	Stream	Putnam	804866	0.36	228
20030400	3	3B	FALLING BRANCH	Lake	Putnam	494	0.08	53
20030411	3	3A	DUNNS CR, CRESCENT LK	Stream	Volusia	16976	0.07	47
20030412	3	3C	KINGSLEY LAKE OUTLET	Lake	Clay	31	0.01	4
27010024	9	9A	TOMOKA RIVER	Stream	Volusia	35769	0.42	267
27010037	9	9A	HALIFAX RIVER	Stream	Volusia	156286	0.78	501
27010579	8	9A	TOMOKA RIVER	Stream	Volusia	10131	0.25	163
27010875	10	10C	INDIAN RIVER LAGOON	Estuar	Brevard	44122	0.28	182

Appendix A - Continued

Site	Whole Hydro/Drainage Basin Major (ID)	Sub-Basin (ID)	Name	Water-body Type	County	Whole Basin Population Population Total	Population Density	Population Density (sqmi)
ASH	4	4B	DEEP CR-LK ASHBY CA	Lake	Volusia	692	0.04	22
BEAR	4	4E	TROUT LAKE OUTLET	Lake	Seminole	3538	2.91	1861
BLSPR	5	5A	ST. JOHNS RIVER	Spring	Volusia	750105	0.41	265
BROWARD	3	3A	LAKE BROWARD OUTLET	Lake	Putnam	269	0.12	79
BUL	9	9A	BULOW CREEK	Stream	Volusia	1748	0.09	59
BWC44	4	4E	BLACK WATER CREEK	Stream	Lake	7414	0.10	61
BWCCPB	4	4E	BLACK WATER CREEK	Stream	Lake	12852	0.11	69
CC03	10	10D	CRANE CREEK	Stream	Brevard	16942	1.78	1141
CHARLES	7	7F	HULLS CREEK	Lake	Marion	1098	0.05	29
CHERRY	7	7A	PALATLAKAHA REACH	Lake	Lake	12579	0.11	72
CLD	3	3A	LITTLE HAW CREEK	Lake	Flagler	9195	0.14	87
CLW	7	7E	LAKE WEIR	Lake	Marion	3706	0.21	132
DALHOUS	4	4E	LAKE DALHOUSE OUTLET	Lake	Lake	104	0.18	117
DIAS	3	3A	LAKE DIAS OUTLET	Lake	Volusia	704	0.08	50
DMR	4	4B	DEEP CR-LK ASHBY CA	Stream	Volusia	2002	0.04	23
DOR	7	7C	DORA CANAL	Lake	Lake	60599	0.41	261
DORR	4	4E	BLACK WATER CREEK	Lake	Lake	2279	0.10	65
GEN	3	3B	HALFMOON LAKE OUTLET	Lake	Clay	2145	0.07	47
HALFMOON	7	7F	HALFMOON LAKE	Lake	Marion	1424	0.08	51
HAR	7	7C	LAKE HARRIS AND EUSTIS	Lake	Lake	45196	0.19	122
HAT26	7	7G	HATCHET CREEK	Stream	Alachua	2743	0.07	43
HAW	3	3A	HAW CREEK	Stream	Volusia	15832	0.07	48
HELENA	7	7C	BUGG SPRING RUN	Stream	Lake	175	0.12	75
HOG30	7	7G	HOGTOWN CREEK	Stream	Alachua	38090	3.32	2125
HOWELL	4	4C	HOWELL CREEK	Lake	Seminole	76212	4.33	2773
INDUSPL	7	7G	GUMROOT SWAMP	Stream	Alachua	5869	1.00	638
JOHNSON	3	3B	UNNAMED LAKE OUTLET	Lake	Clay	2497	0.12	76

Appendix A - Continued

Site	Whole Hydro/Drainage Basin Major (ID)	Sub-Basin (ID)	Name	Water-body Type	County	Whole Basin Population Population Total	Population Density	Population Density (sqmi)
KER	5	5D	LITTLE LAKE KERR OUTLE	Lake	Marion	1249	0.03	17
KERR	5	5D	LITTLE LAKE KERR OUTLE	Lake	Marion	1249	0.03	17
LAG	5	5C	ST. JOHNS RIVER	Lake	Volusia	804866	0.36	228
LEO	5	5C	ST. JOHNS RIVER	Lake	Volusia	804866	0.36	228
LHAT26	7	7G	AIRPORT DRAIN	Stream	Alachua	7351	0.62	398
LHATSB	7	7G	AIRPORT DRAIN	Stream	Alachua	865	0.59	375
LHNBPL	7	7G	GUMROOT SWAMP	Stream	Alachua	5869	1.00	638
LKWOOD	5	5A	LAKE WOODRUFF OUTLET	Lake	Volusia	9023	0.13	82
LMAC	4	4D	ST. JOHNS RIVER	Lake	Volusia	584104	0.36	232
LOCCR	7	7G	LOCHLOOSA CREEK	Stream	Alachua	1360	0.05	34
LOL	7	7G	LOCHLOOSA LAKE	Lake	Alachua	2988	0.05	34
LORANCRK	7	7G	LITTLE ORANGE CREEK	Stream	Putnam	2292	0.08	49
LOUISA	7	7A	PALATLAKAHA REACH	Lake	Lake	4726	0.06	40
LSJ070	3	3A	LITTLE HAW CREEK	Stream	Flagler	9195	0.14	87
LSJ087	3	3H	DURBIN CREEK	Stream	St Johns	3122	0.11	73
LSJ099	3	3H	BIG DAVIS CREEK	Stream	Duval	1083	0.12	76
LSJ918	3	3B	RICE CREEK	Stream	Putnam	2209	0.08	48
LYC	7	7D	LK YALE OUTLET CANAL	Lake	Lake	7412	0.16	105
MAITL	4	4C	HOWELL CREEK	Lake	Orange	45184	4.18	2673
MAT	9	9B	MATANZAS RIVER	Estuar	Flagler	10838	0.11	68
MBU	7	7D	LAKE GRIFFIN	Stream	Marion	146452	0.28	181
MILLD	7	7F	MILL DAM LAKE	Lake	Marion	1494	0.08	49
MPS	2	2A	MIDDLE PRONG ST. MARYS	Stream	Baker	2901	0.02	16
MR312	9	9C	MATANZAS RIVER	Stream	St Johns	23688	0.34	216
MTC	9	9C	MOULTRIE CREEK	Stream	St Johns	1215	0.13	84
NBLACK	3	3C	NORTH FORK BLACK CREEK	Stream	Clay	21183	0.16	105
NEWLKA	7	7G	PRAIRIE CREEK REACH	Lake	Alachua	20325	0.26	164

Appendix A - Continued

Site	Whole Hydro/Drainage Basin Major (ID)	Sub-Basin (ID)	Name	Water-body Type	County	Whole Basin Population Population Total	Population Density	Population Density (sqmi)
NEWLKB	7	7G	PRAIRIE CREEK REACH	Lake	Alachua	20325	0.26	164
NEWLKC	7	7G	PRAIRIE CREEK REACH	Lake	Alachua	20325	0.26	164
NEWLKD	7	7G	SUNLAND DRAIN	Lake	Alachua	20325	0.26	164
NEWLKE	7	7G	PRAIRIE CREEK REACH	Lake	Alachua	20325	0.26	164
NEWLKF	7	7G	PRAIRIE CREEK REACH	Lake	Alachua	20325	0.26	164
NORRIS	4	4E	BLACK WATER CREEK	Lake	Lake	6097	0.10	65
NRI	1	1A	ALLIGATOR CREEK	Stream	Nassau	2742	0.07	44
OLA	7	7C	LAKE OLA OUTLET	Lake	Orange	338	0.16	100
OLK	7	7G	ORANGE LAKE REACH	Lake	Alachua	32584	0.15	94
OR908	7	7G	BIVANS ARM	Lake	Alachua	10357	4.69	3005
ORD	7	7F	OCKLAWAHA RIVER	Stream	Marion	174163	0.28	182
PCR-PL	7	7G	GUMROOT SWAMP	Stream	Alachua	5869	1.00	638
PEL	9	9B	PELLICER CREEK	Stream	St Johns	2438	0.06	38
SELLERS	5	5B	NINEMILE CREEK	Lake	Lake	1090	0.05	29
SHEEL	3	3B	UNNAMED LAKE OUTLET	Lake	Clay	2497	0.12	76
SILRV	7	7E	SILVER RIVER	Stream	Marion	3406	0.26	165
SIM	3	3B	SIMMS CREEK	Stream	Putnam	1438	0.05	29
SJRJESUP	4	4B	ST. JOHNS RIVER	Stream	Volusia	306472	0.21	134
SJRPLTKA	3	3J	ST. JOHNS RIVER	Stream	Putnam	1175517	0.29	188
SOUTH	6	6I	SOUTH LAKE OUTLET	Lake	Brevard	2155	0.50	322
SRS	6	6I	ST. JOHNS RIVER	Stream	Orange	93418	0.10	62
SUNLAND	7	7G	SUNLAND DRAIN	Stream	Alachua	7047	1.48	946
SWBPP1	7	7C	SWEETWATER BRANCH	Stream	Alachua	6767	3.18	2033
TOL	9	9D	TOLOMATO RIVER	Estuar	St Johns	8817	0.16	102
TUBPP1	7	7G	BIVANS ARM	Stream	Alachua	10357	4.69	3005
USJ055	6	6E	CRABGRASS CREEK	Stream	Osceola	99	0.01	3
USJ918	6	6G	WOLF CREEK	Stream	Osceola	92	0.01	3

Appendix A - Continued

Site	Whole Hydro/Drainage Basin Major (ID)	Sub-Basin (ID)	Name	Water-body Type	County	Whole Basin Population Population Total	Population Density	Population Density (sqmi)
WASH	6	6F	ST. JOHNS RIVER	Lake	Brevard	12445	0.02	13
WIN	4	4B	LK WINNEMISSETT OUTLET	Lake	Volusia	536	0.39	248
WINN	4	4B	LK WINNEMISSETT OUTLET	Lake	Volusia	536	0.39	248
WIO	3	3A	LAKE WINONA OUTLET	Lake	Volusia	49	0.05	32
LSJ01	3	3K	ST. JOHNS RIVER	Stream	Duval	1577211	0.31	199
LSJ05	3	3K	ST. JOHNS RIVER	Stream	Duval	1403335	0.28	180
LSJ08	3	3J	ST. JOHNS RIVER	Stream	Duval	1381858	0.28	178
LSJ11	3	3J	ST. JOHNS RIVER	Stream	Duval	1371906	0.28	177
LSJ14	3	3J	ST. JOHNS RIVER	Stream	St Johns	1340810	0.27	173
LSJ17	3	3J	ST. JOHNS RIVER	Stream	St Johns	1289997	0.27	170
LSJ21	3	3J	ST. JOHNS RIVER	Stream	St Johns	1225582	0.27	173
LSJ28	3	3J	ST. JOHNS RIVER	Stream	St Johns	1213233	0.28	178
LSJ32	3	3J	ST. JOHNS RIVER	Stream	Putnam	1208450	0.28	181
LSJ35	3	3J	ST. JOHNS RIVER	Stream	Putnam	1175517	0.29	188
LSJ40	3	3J	ST. JOHNS RIVER	Stream	Putnam	1131833	0.32	204
LSJRC17	3	3J	ST. JOHNS RIVER	Stream	Putnam	1205815	0.28	182
RCLSJ06	3	3B	RICE CREEK	Stream	Putnam	1205458	0.29	183
RCLSJ10	3	3J	ST. JOHNS RIVER	Stream	Putnam	1205513	0.29	183
RCLSJ19	3	3J	ST. JOHNS RIVER	Stream	Putnam	1207055	0.28	182

Physiography codes:

EF: Eastern flatlands

EML: Exposed miocene limestone

PP: Plio-pleistocene ridges

Appendix A - Continued

Site	Whole Basin Physiography			Whole Basin Land Use							
	EF (%)	EML (%)	PP (%)	AG (%)	COM/ IND (%)	FOR (%)	RES (%)	ROP (%)	WATER (%)	WET LANDS (%)
02235000	2	54	43	5	8	16	33	11	4	22
02236000	52	3	44	8	2	16	10	27	5	32
02238000	0	36	64	20	3	7	10	19	23	18
02240800	0	19	81	3	3	64	6	3	0	22
02248000	100	0	0	12	1	26	14	23	1	24
19010001	10	0	90	3	1	57	3	4	0	31
19010006	0	0	100	0	0	41	0	1	0	57
19020002	68	0	32	4	1	51	6	6	1	30
20010002	51	3	46	7	2	19	9	25	5	32
20010003	56	1	43	8	2	14	9	29	5	33
20010137	0	65	35	1	22	4	49	8	9	6
20020001	0	42	58	18	3	11	10	18	22	18
20020012	0	51	49	14	2	22	10	15	17	18
20020368	0	36	64	20	3	7	10	19	23	18
20020371	0	65	35	12	2	39	8	13	15	11
20020377	0	23	77	17	3	6	9	22	19	24
20020381	0	43	57	18	3	10	10	18	22	18
20020404	0	77	23	9	2	42	8	11	7	21
20030373	50	3	47	7	2	22	9	23	7	30
20030400	0	0	100	2	0	52	13	9	14	11
20030411	84	0	16	4	1	43	4	10	3	35
20030412	0	0	100	0	9	39	9	8	31	4
27010024	100	0	0	1	6	41	9	7	2	35
27010037	100	0	0	1	7	31	18	9	7	27
27010579	100	0	0	1	8	37	3	9	1	41
27010875	100	0	0	6	4	8	8	8	46	20

Appendix A - Continued

Site	Whole Basin Physiography			Whole Basin Land Use						
	EF (%)	EML (%)	PP (%)	AG (%)	COM/ IND (%)	FOR (%)	RES (%)	ROP (%)	WATER (%)	WET LANDS (%)
ASH	100	0	0	4	0	39	5	17	5	30
BEAR	0	0	100	3	3	3	54	7	30	1
BLSPR	52	4	44	8	2	16	9	27	5	32
BROWARD	8	0	92	3	1	26	33	13	18	7
BUL	100	0	0	0	3	39	10	18	3	27
BWC44	20	0	80	4	0	32	9	23	6	25
BWCCPB	24	0	76	7	1	28	10	26	4	24
CC03	100	0	0	2	27	16	34	14	3	4
CHARLES	0	84	16	1	1	53	8	3	6	28
CHERRY	0	0	100	21	3	7	7	20	14	29
CLD	58	0	42	6	2	38	6	10	6	33
CLW	0	10	90	17	1	5	21	18	33	5
DALHOUS	0	0	100	18	0	5	11	20	43	3
DIAS	0	0	100	15	0	36	9	11	14	15
DMR	100	0	0	6	0	38	3	12	2	39
DOR	0	57	43	25	4	7	12	13	29	9
DORR	10	0	90	2	0	62	6	6	9	15
GEN	0	0	100	1	4	38	26	7	16	9
HALFMOON	0	24	76	0	0	85	3	2	3	7
HAR	0	23	77	17	3	6	9	22	19	24
HAT26	0	19	81	3	3	64	6	3	0	22
HAW	87	0	13	4	1	45	4	10	2	34
HELENA	0	0	100	14	4	19	22	31	1	10
HOG30	0	99	1	3	14	10	61	2	0	10
HOWELL	0	76	24	1	19	3	53	3	16	4
INDUSPL	0	26	74	2	21	47	11	5	1	13
JOHNSON	0	0	100	2	1	42	23	18	5	8

Appendix A - Continued

Site	Whole Basin Physiography EF (%)	EML (%)	PP (%)	Whole Basin Land Use AG (%)	COM/ IND (%)	FOR (%)	RES (%)	ROP (%)	WATER (%)	WET LANDS (%)
KER	0	0	100	0	0	83	4	1	8	4
KERR	0	0	100	0	0	83	4	1	8	4
LAG	50	3	47	7	2	22	9	23	7	30
LEO	50	3	47	7	2	22	9	23	7	30
LHAT26	0	35	65	1	15	49	8	7	0	19
LHATSB	0	64	36	0	36	24	2	29	0	8
LHNBPL	0	26	74	2	21	47	11	5	1	13
LKWOOD	66	0	34	9	1	30	9	8	6	37
LMAC	56	1	43	8	2	14	9	29	5	33
LOCCR	0	73	27	11	1	58	5	7	0	18
LOL	0	88	12	7	1	51	5	5	10	22
LORANCRK	0	55	45	5	1	39	15	11	9	20
LOUISA	0	0	100	23	2	7	4	20	10	33
LSJ070	58	0	42	6	2	38	6	10	6	33
LSJ087	100	0	0	2	1	49	1	3	0	43
LSJ099	100	0	0	1	3	47	1	2	1	45
LSJ918	9	1	90	1	0	55	7	6	0	31
LYC	0	65	35	12	2	39	8	13	15	11
MAITL	0	100	0	1	23	1	52	2	19	1
MAT	100	0	0	0	2	40	17	6	4	31
MBU	0	42	58	18	3	11	10	18	22	18
MILLD	0	28	72	0	0	84	3	2	3	8
MPS	0	0	100	1	0	54	1	1	0	43
MR312	100	0	0	1	4	36	17	8	8	26
MTC	100	0	0	3	1	35	9	12	1	38
NBLACK	0	1	99	1	4	59	9	6	2	19
NEWLKA	0	48	52	3	5	52	8	4	8	20

Appendix A - Continued

Site	Whole Basin Physiography EF (%)	EML (%)	PP (%)	Whole Basin Land Use AG (%)	COM/ IND (%)	FOR (%)	RES (%)	ROP (%)	WATER (%)	WET LANDS (%)
NEWLKB	0	48	52	3	5	52	8	4	8	20
NEWLKC	0	48	52	3	5	52	8	4	8	20
NEWLKD	0	48	52	3	5	52	8	4	8	20
NEWLKE	0	48	52	3	5	52	8	4	8	20
NEWLKF	0	48	52	3	5	52	8	4	8	20
NORRIS	15	0	85	4	1	34	8	22	7	24
NRI	55	0	45	7	1	47	8	10	1	27
OLA	0	81	19	30	5	6	24	12	20	3
OLK	0	78	22	10	3	43	7	9	8	20
OR908	0	100	0	0	35	10	38	1	8	8
ORD	0	47	53	17	3	14	11	17	19	18
PCR-PL	0	26	74	2	21	47	11	5	1	13
PEL	100	0	0	0	2	55	5	4	1	34
SELLERS	0	0	100	0	0	87	1	2	6	3
SHEEL	0	0	100	2	1	42	23	18	5	8
SILRV	0	100	0	4	1	67	8	7	1	12
SIM	0	0	100	2	3	65	2	3	0	24
SJRJESUP	59	0	41	8	1	15	5	31	4	35
SJRPLTKA	39	21	40	8	2	27	9	18	9	27
SOUTH	100	0	0	0	1	11	15	14	14	45
SRS	56	0	44	10	1	10	3	39	4	33
SUNLAND	0	100	0	10	14	25	23	14	0	14
SWBPP1	0	100	0	0	31	11	47	4	1	6
TOL	100	0	0	0	2	37	10	4	11	37
TUBPP1	0	100	0	0	35	10	38	1	8	8
USJ055	0	0	100	0	0	1	0	77	0	23
USJ918	28	0	72	0	0	6	0	78	0	15

Appendix A - Continued

Site	Whole Basin Physiography EF (%)	EML (%)	PP (%)	Whole Basin Land Use AG (%)	COM/ IND (%)	FOR (%)	RES (%)	ROP (%)	WATER (%)	WET LANDS (%)
WASH	44	0	56	14	0	8	1	40	4	33
WIN	11	0	89	20	0	25	15	11	14	15
WINN	11	0	89	20	0	25	15	11	14	15
WIO	0	0	100	23	0	55	3	4	14	2
LSJ01	41	16	43	8	2	30	10	16	9	26
LSJ05	41	17	43	8	2	30	9	16	9	26
LSJ08	41	17	43	8	2	30	9	16	9	26
LSJ11	41	17	43	8	2	30	9	16	8	26
LSJ14	40	17	43	8	2	30	9	16	8	26
LSJ17	39	17	44	8	2	30	9	16	8	26
LSJ21	41	18	41	8	2	28	9	17	9	27
LSJ28	39	19	42	8	2	28	9	17	9	27
LSJ32	38	20	42	8	2	28	9	17	9	27
LSJ35	39	21	40	8	2	27	9	18	9	27
LSJ40	33	24	43	8	2	25	10	19	9	27
LSJRC17	38	20	43	8	2	28	9	18	9	27
RCLSJ06	38	20	43	8	2	28	9	18	9	27
RCLSJ10	38	20	43	8	2	28	9	18	9	27
RCLSJ19	38	20	43	8	2	28	9	17	9	27

Physiography codes:
EF: Eastern flatlands
EML: Exposed miocene limestone
PP: Plio-pleistocene ridges

Appendix A - Continued

Site	Qa (%)	Qbd (%)	Qh (%)	Qtr (%)	Qu (%)	Tc (%)	Thc (%)	Thcc (%)	Ths (%)	To (%)	TQd (%)	Tqsu (%)	Tqu (%)	Tquc (%)
	Whole Basin Geology													
02235000	0	0	0	0	19	51	29	0	0	0	0	0	0	0
02236000	2	25	20	0	17	12	2	0	0	0	0	22	0	0
02238000	0	0	15	0	0	72	0	0	0	0	0	0	0	13
02240800	0	0	0	0	0	12	61	0	0	0	0	0	27	0
02248000	0	100	0	0	0	0	0	0	0	0	0	0	0	0
19010001	0	0	0	2	7	30	0	3	4	0	0	0	53	0
19010006	0	0	0	0	0	0	0	0	0	0	0	0	100	0
19020002	0	0	4	0	65	31	0	0	0	0	0	0	0	0
20010002	2	25	20	0	17	14	2	0	0	0	0	20	0	0
20010003	2	29	22	0	17	3	0	0	0	0	0	25	0	0
20010137	0	0	0	0	39	57	4	0	0	0	0	0	0	0
20020001	0	1	19	0	0	70	0	0	0	0	0	0	0	10
20020012	0	1	18	0	6	65	0	0	0	0	0	0	2	7
20020368	0	0	15	0	0	72	0	0	0	0	0	0	0	13
20020371	0	8	17	0	0	75	0	0	0	0	0	0	0	0
20020377	0	0	3	0	0	76	0	0	0	0	0	0	0	22
20020381	0	1	19	0	0	70	0	0	0	0	0	0	0	10
20020404	0	0	0	0	14	16	39	0	0	18	0	0	13	0
20030373	2	24	22	0	17	16	2	0	0	0	0	18	0	0
20030400	0	0	0	100	0	0	0	0	0	0	0	0	0	0
20030411	0	45	5	0	37	12	0	0	0	0	1	0	0	0
20030412	0	0	0	100	0	0	0	0	0	0	0	0	0	0
27010024	6	93	1	0	0	0	0	0	0	0	0	0	0	0
27010037	26	69	6	0	0	0	0	0	0	0	0	0	0	0
27010579	0	100	0	0	0	0	0	0	0	0	0	0	0	0
27010875	37	17	46	0	0	0	0	0	0	0	0	0	0	0
ASH	0	78	0	0	0	0	0	0	0	0	0	22	0	0
BEAR	0	0	0	0	0	100	0	0	0	0	0	0	0	0

Appendix A - Continued

	Whole Basin Geology													
Site	Qa (%)	Qbd (%)	Qh (%)	Qtr (%)	Qu (%)	Tc (%)	Thc (%)	Thcc (%)	Ths (%)	To (%)	TQd (%)	Tqsu (%)	Tqu (%)	Tquc (%)
BLSPR	2	26	20	0	17	11	2	0	0	0	0	22	0	0
BROWARD	0	0	1	0	0	99	0	0	0	0	0	0	0	0
BUL	16	72	12	0	0	0	0	0	0	0	0	0	0	0
BWC44	0	11	0	0	0	89	0	0	0	0	0	0	0	0
BWCCPB	0	7	0	0	2	86	5	0	0	0	0	0	0	0
CC03	80	0	0	0	0	0	0	0	0	0	0	20	0	0
CHARLES	0	0	0	0	0	100	0	0	0	0	0	0	0	0
CHERRY	0	0	0	0	0	63	0	0	0	0	0	0	0	37
CLD	0	29	0	0	35	34	0	0	0	0	2	0	0	0
CLW	0	0	0	0	0	94	0	0	0	0	0	0	6	0
DALHOUS	0	0	0	0	0	100	0	0	0	0	0	0	0	0
DIAS	0	0	0	0	0	100	0	0	0	0	0	0	0	0
DMR	0	52	0	0	0	0	0	0	0	0	0	48	0	0
DOR	0	1	36	0	0	63	0	0	0	0	0	0	0	0
DORR	0	32	0	0	0	68	0	0	0	0	0	0	0	0
GEN	0	0	0	20	0	74	0	0	0	0	0	0	6	0
HALFMOON	0	15	0	0	0	85	0	0	0	0	0	0	0	0
HAR	0	0	3	0	0	76	0	0	0	0	0	0	0	22
HAT26	0	0	0	0	0	12	61	0	0	0	0	0	27	0
HAW	0	49	2	0	37	11	0	0	0	0	1	0	0	0
HELENA	0	0	21	0	0	70	0	0	0	0	0	0	0	9
HOG30	0	0	0	0	0	0	84	0	0	16	0	0	0	0
HOWELL	0	0	0	0	85	15	0	0	0	0	0	0	0	0
INDUSPL	0	0	0	0	0	0	96	0	0	0	0	0	4	0
JOHNSON	0	0	0	24	0	76	0	0	0	0	0	0	0	0
KER	0	12	1	0	0	73	14	0	0	0	0	0	0	0
KERR	0	12	1	0	0	73	14	0	0	0	0	0	0	0
LAG	2	24	22	0	17	16	2	0	0	0	0	18	0	0
LEO	2	24	22	0	17	16	2	0	0	0	0	18	0	0

Appendix A - Continued

Site							Whole Basin Geology							
	Qa (%)	Qbd (%)	Qh (%)	Qtr (%)	Qu (%)	Tc (%)	Thc (%)	Thcc (%)	Ths (%)	To (%)	TQd (%)	Tqsu (%)	Tqu (%)	Tquc (%)
LHAT26	0	0	0	0	0	0	72	0	0	0	0	0	28	0
LHATSB	0	0	0	0	0	0	100	0	0	0	0	0	0	0
LHNBPL	0	0	0	0	0	0	96	0	0	0	0	0	4	0
LKWOOD	0	0	30	0	25	41	0	0	0	0	3	0	0	0
LMAC	2	29	22	0	17	3	0	0	0	0	0	25	0	0
LOCCR	0	0	0	0	0	41	25	0	0	0	0	0	34	0
LOL	0	0	0	0	22	18	21	0	0	9	0	0	30	0
LORANCRK	0	0	0	0	22	72	0	0	0	0	0	0	6	0
LOUISA	0	0	0	0	0	47	0	0	0	0	0	0	0	53
LSJ070	0	29	0	0	35	34	0	0	0	0	2	0	0	0
LSJ087	0	19	0	0	81	0	0	0	0	0	0	0	0	0
LSJ099	0	64	0	0	36	0	0	0	0	0	0	0	0	0
LSJ918	0	0	0	11	69	20	0	0	0	0	0	0	0	0
LYC	0	8	17	0	0	75	0	0	0	0	0	0	0	0
MAITL	0	0	0	0	94	6	0	0	0	0	0	0	0	0
MAT	6	77	17	0	0	0	0	0	0	0	0	0	0	0
MBU	0	1	19	0	0	70	0	0	0	0	0	0	0	10
MILLD	0	14	0	0	0	86	0	0	0	0	0	0	0	0
MPS	0	0	0	0	0	0	0	0	19	0	0	0	81	0
MR312	25	64	11	0	0	0	0	0	0	0	0	0	0	0
MTC	0	100	0	0	0	0	0	0	0	0	0	0	0	0
NBLACK	0	0	1	34	3	62	0	0	0	0	0	0	0	0
NEWLKA	0	0	0	0	0	6	68	0	0	0	0	0	26	0
NEWLKB	0	0	0	0	0	6	68	0	0	0	0	0	26	0
NEWLKC	0	0	0	0	0	6	68	0	0	0	0	0	26	0
NEWLKD	0	0	0	0	0	6	68	0	0	0	0	0	26	0
NEWLKE	0	0	0	0	0	6	68	0	0	0	0	0	26	0
NEWLKF	0	0	0	0	0	6	68	0	0	0	0	0	26	0
NORRIS	0	14	0	0	0	86	0	0	0	0	0	0	0	0

Appendix A - Continued

Site	Qa (%)	Qbd (%)	Qh (%)	Qtr (%)	Qu (%)	Tc (%)	Thc (%)	Thcc (%)	Ths (%)	To (%)	TQd (%)	Tqsu (%)	Tqu (%)	Tquc (%)
	Whole Basin Geology													
NRI	0	0	1	0	57	42	0	0	0	0	0	0	0	0
OLA	0	0	3	0	0	97	0	0	0	0	0	0	0	0
OLK	0	0	0	0	5	7	54	0	0	17	0	0	17	0
OR908	0	0	0	0	0	0	30	0	0	66	0	0	4	0
ORD	0	1	20	0	2	66	0	0	0	0	0	0	3	8
PCR-PL	0	0	0	0	0	0	96	0	0	0	0	0	4	0
PEL	0	100	0	0	0	0	0	0	0	0	0	0	0	0
SELLERS	0	77	0	0	2	1	20	0	0	0	0	0	0	0
SHEEL	0	0	0	24	0	76	0	0	0	0	0	0	0	0
SILRV	0	0	10	0	83	0	0	0	0	2	0	0	4	0
SIM	0	0	0	0	17	83	0	0	0	0	0	0	0	0
SJRJESUP	2	33	22	0	14	1	0	0	0	0	0	28	0	0
SJRPLTKA	1	17	18	0	19	24	5	0	0	3	0	10	2	1
SOUTH	1	12	65	0	0	0	0	0	0	0	0	22	0	0
SRS	3	32	28	0	13	0	0	0	0	0	0	23	0	0
SUNLAND	0	0	0	0	0	0	100	0	0	0	0	0	0	0
SWBPP1	0	0	0	0	0	0	94	0	0	5	0	0	1	0
TOL	4	41	55	0	0	0	0	0	0	0	0	0	0	0
TUBPP1	0	0	0	0	0	0	30	0	0	66	0	0	4	0
USJ055	0	100	0	0	0	0	0	0	0	0	0	0	0	0
USJ918	0	96	0	0	0	0	0	0	0	0	0	4	0	0
WASH	1	32	30	0	21	0	0	0	0	0	0	16	0	0
WIN	0	15	0	0	0	85	0	0	0	0	0	0	0	0
WINN	0	15	0	0	0	85	0	0	0	0	0	0	0	0
WIO	0	0	0	0	0	100	0	0	0	0	0	0	0	0
LSJ01	1	15	16	3	22	27	4	0	0	2	0	8	1	1
LSJ05	1	15	16	3	21	26	4	0	0	2	0	8	1	1
LSJ08	1	15	16	3	21	27	4	0	0	2	0	8	1	1
LSJ11	1	15	16	3	21	27	4	0	0	2	0	8	1	1

Appendix A - Continued

Site	Whole Basin Geology													
	Qa (%)	Qbd (%)	Qh (%)	Qtr (%)	Qu (%)	Tc (%)	Thc (%)	Thcc (%)	Ths (%)	To (%)	TQd (%)	Tqsu (%)	Tqu (%)	Tquc (%)
LSJ14	1	15	16	3	21	27	4	0	0	2	0	8	1	1
LSJ17	1	15	16	3	20	27	4	0	0	2	0	8	2	1
LSJ21	1	17	17	1	21	25	5	0	0	2	0	9	2	1
LSJ28	1	17	17	1	20	25	5	0	0	2	0	9	2	1
LSJ32	1	16	17	1	19	26	5	0	0	3	0	9	2	1
LSJ35	1	17	18	0	19	24	5	0	0	3	0	10	2	1
LSJ40	1	16	18	0	15	26	6	0	0	3	0	11	2	1
LSJRC17	1	16	17	1	19	26	5	0	0	3	0	10	2	1
RCLSJ06	1	16	17	1	19	26	5	0	0	3	0	10	2	1
RCLSJ10	1	16	17	1	19	26	5	0	0	3	0	10	2	1
RCLSJ19	1	16	17	1	19	26	5	0	0	3	0	10	2	1

Physiography codes:
EF: Eastern flatlands
EML: Exposed miocene limestone
PP: Plio-pleistocene ridges

APPENDIX B

Correlation Matrix

Appendix B. Correlation matrix of each metal and sediment characteristic from samples collected in the St. John's River Management District

CHARACTERISTIC	ALUMINUM	ARSENIC	CADMIUM	CHROMIUM	COPPER	IRON	LEAD	LITHIUM	MANGANES	MERCURY	NICKEL
ALUMINUM	1.00	0.63	0.52	0.84	0.48	0.92	0.30	[illegible]	0.77	0.77	0.86
ARSENIC	0.63	1.00	0.38	0.48	0.39	0.65	0.17	0.48	0.51	0.67	0.57
CADMIUM	0.52	0.38	1.00	0.65	0.40	0.49	0.47	0.42	0.43	0.68	0.72
CHROMIUM	0.84	0.48	0.65	1.00	0.44	0.77	0.50	0.78	0.64	0.73	0.80
COPPER	0.48	0.39	0.40	0.44	1.00	0.35	0.37	0.36	0.31	0.54	0.49
IRON	[illegible]	0.65	0.49	0.77	0.35	1.00	0.21	0.88	0.77	0.76	0.82
LEAD	0.30	0.17	0.47	0.50	0.37	0.21	1.00	0.23	0.17	0.37	0.33
LITHIUM	[illegible]	0.48	0.42	0.78	0.36	0.88	0.23	1.00	0.72	0.60	0.75
MANGANES	0.77	0.51	0.43	0.64	0.31	0.77	0.17	0.72	1.00	0.61	0.69
MERCURY	0.77	0.67	0.68	0.73	0.54	0.76	0.37	0.60	0.61	1.00	0.89
NICKEL	0.86	0.57	0.72	0.80	0.49	0.82	0.33	0.75	0.69	0.89	1.00
SELENIUM	0.31	0.39	0.32	0.25	0.16	0.30	0.08	0.19	0.15	0.39	0.35
SILVER	0.46	0.32	0.36	0.41	0.30	0.42	0.36	0.40	0.47	0.47	0.46
TIN	0.61	0.35	0.61	0.73	0.41	0.53	0.83	0.54	0.51	0.60	0.61
ZINC	0.48	0.29	0.44	0.53	0.35	0.43	0.42	0.41	0.47	0.48	0.51
SAND__%_	-0.83	-0.60	-0.52	-0.71	-0.36	-0.80	-0.25	-0.73	-0.67	-0.76	-0.80
SILT__%_	0.83	0.62	0.54	0.72	0.38	0.81	0.25	0.72	0.65	0.78	0.81
CLAY__%_	0.60	0.24	0.21	0.41	0.13	0.52	0.14	0.61	0.57	0.35	0.47
TOC	0.52	0.62	0.61	0.47	0.30	0.57	0.22	0.34	0.36	0.80	0.73
MOISTURE	0.68	0.69	0.63	0.63	0.38	0.71	0.27	0.52	0.47	0.81	0.77
TOTAL_SO	-0.68	-0.69	-0.63	-0.63	-0.38	-0.71	-0.27	-0.52	-0.47	-0.81	-0.77
TOTAL_VO	0.52	0.63	0.60	0.47	0.30	0.57	0.22	0.34	0.33	0.80	0.71

Appendix B. Continued

CHARACTERISTIC	SELENIUM	SILVER	TIN	ZINC	SAND %	SILT %	CLAY %	TOC	MOISTURE	TOTAL_SO	TOTAL_VO
ALUMINUM	0.31	0.46	0.61	0.48	-0.83	0.83	0.60	0.52	0.68	-0.68	0.52
ARSENIC	0.39	0.32	0.35	0.29	-0.60	0.62	0.24	0.62	0.69	-0.69	0.63
CADMIUM	0.32	0.36	0.61	0.44	-0.52	0.54	0.21	0.61	0.63	-0.63	0.60
CHROMIUM	0.25	0.41	0.73	0.53	-0.71	0.72	0.41	0.47	0.63	-0.63	0.47
COPPER	0.16	0.30	0.41	0.35	-0.36	0.38	0.13	0.30	0.38	-0.38	0.30
IRON	0.30	0.42	0.53	0.43	-0.80	0.81	0.52	0.57	0.71	-0.71	0.57
LEAD	0.08	0.36	0.83	0.42	-0.25	0.25	0.14	0.22	0.27	-0.27	0.22
LITHIUM	0.19	0.40	0.54	0.41	-0.73	0.72	0.61	0.34	0.52	-0.52	0.34
MANGANES	0.15	0.47	0.51	0.47	-0.67	0.65	0.57	0.36	0.47	-0.47	0.33
MERCURY	0.39	0.47	0.60	0.48	-0.76	0.78	0.35	0.80	0.81	-0.81	0.80
NICKEL	0.35	0.46	0.61	0.51	-0.80	0.81	0.47	0.73	0.77	-0.77	0.71
SELENIUM	1.00	0.06	0.15	0.09	-0.30	0.32	0.07	0.50	0.50	-0.50	0.53
SILVER	0.06	1.00	0.47	0.28	-0.42	0.43	0.22	0.31	0.35	-0.35	0.26
TIN	0.15	0.47	1.00	0.55	-0.51	0.51	0.30	0.32	0.43	-0.43	0.32
ZINC	0.09	0.28	0.55	1.00	-0.41	0.42	0.26	0.28	0.34	-0.34	0.27
SAND__%_	-0.30	-0.42	-0.51	-0.41	1.00	-1.00	-0.73	-0.58	-0.76	0.76	-0.57
SILT__%_	0.32	0.43	0.51	0.42	-1.00	1.00	0.67	0.61	0.79	-0.79	0.60
CLAY__%_	0.07	0.22	0.30	0.26	-0.73	0.67	1.00	0.13	0.29	-0.29	0.12
TOC	0.50	0.31	0.32	0.28	-0.58	0.61	0.13	1.00	0.85	-0.85	[illegible]
MOISTURE	0.50	0.35	0.43	0.34	-0.76	0.79	0.29	0.85	1.00	-1.00	0.89
TOTAL_SO	-0.50	-0.35	-0.43	-0.34	0.76	-0.79	-0.29	-0.85	-1.00	1.00	-0.89
TOTAL_VO	0.53	0.26	0.32	0.27	-0.57	0.60	0.12	[illegible]	0.89	-0.89	1.00

APPENDIX C

Sediment Formation Codes and Description

Appendix C: Sediment Formation Codes and Description

Geologic Formation Code	Geologic Formation	Description	Formation Type
Qa	Anastasia Formation	interbedded sands and coquinoid limestones	Carbonate sediments
Qbd	Undifferentiated Quaternary Sediments	siliciclastics, organics and freshwater carbonates	Mixed Sediment
Qh	Holocene Sediments	quartz sands, carbonate sands and muds, and organics	Mixed Sediment
Qtr	Undifferentiated Quaternary Sediments	siliciclastics, organics and freshwater carbonates	Mixed Sediment
Qu	Undifferentiated Quaternary Sediments	siliciclastics, organics and freshwater carbonates	Mixed Sediment
Tc	Cypresshead Formation	Siliciclastic formation	Low organic sediments
Thc			Low organic sediments
Thcc	Coosawhatchie Formation, Charlton Member	Light gray to greenish gray, poorly to moderately consolidated, dolomitic to calcareous, silty, sandy often fossiliferous clays. Few carbonate beds occur.	Low organic sediments
Ths			Low organic sediments
To	Ocala Limestone	Pure limestones and occasional dolostones	Carbonate sediments
TQd	Tertiary-Quaternary Dunes	fine to medium quartz sand with varying amounts of disseminated organic matter	High organic sediments
Tqsu	Tertiary-Quaternary Fossiliferous Sediments	fossiliferous sands and carbonates	Carbonate sediments
Tqu	Undifferentiated Tertiary-Quaternary Sediments	siliciclastics which occur above 100 feet (30 meters) above present sea level	High organic sediments
Tquc	Undifferentiated reworked Cypresshead Formation	fine to coarse quartz sands with scattered quartz gravel and varying percentages of clay matrix	Low organic sediments

APPENDIX D

Regression Summary Using All Data

Appendix D: Regression Summary Using All Data

Regression Summary for Dependent Variable: CADMIUM
R= .76742952 R^2= .58894807 Adjusted R^2= .58552263
F(1,120)=171.93 p<.00000 Std.Error of estimate: .13229

Cadmium	B	St. Err. of B	t(120)	p-level
Intercept	.060381	.016244	3.71699	.000308
ALUMINUM	.000013	.000001	13.11236	.000000

Regression Summary for Dependent Variable: COPPER
R= .77669783 R^2= .60325952 Adjusted R^2= .59995335
F(1,120)=182.46 p<.00000 Std.Error of estimate: 3.9016

Copper	B	St. Err. of B	t(120)	p-level
Intercept	1.610334	.482317	3.33874	.001121
ALUMINUM	.000422	.000031	13.50795	.000000

Regression Summary for Dependent Variable: LEAD
R= .64553564 R^2= .41671626 Adjusted R^2= .41189574
F(1,121)=86.446 p<.00000 Std.Error of estimate: 11.809

Lead	B	St. Err. of B	t(121)	p-level
Intercept	7.832097	1.447121	5.412194	.000000
ALUMINUM	.000836	.000090	9.297645	.000000

Regression Summary for Dependent Variable: MERCURY
R= .76252563 R^2= .58144534 Adjusted R^2= .57789827
F(1,118)=163.92 p<.00000 Std.Error of estimate: .06254

Mercury	B	St. Err. of B	t(118)	p-level
Intercept	.024664	.007687	3.20844	.001719
ALUMINUM	.000006	.000001	12.80322	.000000

Regression Summary for Dependent Variable: SILVER
R= .47090030 R^2= .22174709 Adjusted R^2= .21509536
F(1,117)=33.337 p<.00000 Std.Error of estimate: .05636

Silver	B	St. Err. of B	t(117)	p-level
Intercept	.037877	.007167	5.284661	.000001
ALUMINUM	.000003	.000001	5.773797	.000000

Regression Summary for Dependent Variable: ZINC
R= .77242000 R^2= .59663266 Adjusted R^2= .59324302
F(1,119)=176.02 p<.00000 Std.Error of estimate: 16.498

Zinc	B	St. Err. of B	t(119)	p-level
Intercept	8.629432	2.040861	4.22833	.000046
ALUMINUM	.001749	.000132	13.26712	.000000

APPENDIX E

Regression Summary Using Whole Basin Geologic Subsets

Appendix E: Regression Summary Using Whole Basin Geologic Subsets

Thc (n=18) (based on maximum formation percentage)

Regression Summary for Dependent Variable: CADMIUM
R= .88795400 R^2= .78846231 Adjusted R^2= .77435980
F(1,15)=55.909 p<.00000 Std.Error of estimate: .08456

Cadmium	B	St. Err. of B	t(15)	p-level
Intercept	.037067	.027406	1.352513	.196250
ALUMINUM	.000026	.000003	7.477256	.000002

Regression Summary for Dependent Variable: COPPER
R= .81655785 R^2= .66676673 Adjusted R^2= .64593965
F(1,16)=32.014 p<.00004 Std.Error of estimate: 3.0131

Copper	B	St. Err. of B	t(16)	p-level
Intercept	.725697	.976526	.743141	.468168
ALUMINUM	.000672	.000119	5.658128	.000036

Regression Summary for Dependent Variable: LEAD
R= .47403042 R^2= .22470484 Adjusted R^2= .16932662
F(1,14)=4.0576 p<.06360 Std.Error of estimate: 12.258

Lead	B	St. Err. of B	t(14)	p-level
Intercept	7.666693	4.044852	1.895420	.078873
ALUMINUM	.001005	.000499	2.014358	.063599

Regression Summary for Dependent Variable: MERCURY
R= .92745818 R^2= .86017868 Adjusted R^2= .85143985
F(1,16)=98.432 p<.00000 Std.Error of estimate: .03508

Mercury	B	St. Err. of B	t(16)	p-level
Intercept	.005051	.011369	.444323	.662760
ALUMINUM	.000014	.000001	9.921278	.000000

Regression Summary for Dependent Variable: SILVER
R= .62454914 R^2= .39006162 Adjusted R^2= .34939906
F(1,15)=9.5926 p<.00736 Std.Error of estimate: .05146

Silver	B	St. Err. of B	t(15)	p-level
Intercept	.021545	.016977	1.269067	.223756
ALUMINUM	.000006	.000002	3.097200	.007359

Regression Summary for Dependent Variable: ZINC
R= .82949177 R^2= .68805660 Adjusted R^2= .66856014
F(1,16)=35.291 p<.00002 Std.Error of estimate: 13.941

Zinc	B	St. Err. of B	t(16)	p-level
Intercept	5.218532	4.518195	1.155004	.265048
ALUMINUM	.003264	.000549	5.940653	.000021

Appendix E. Continued

TC (n=58) (based on maximum formation percentage)

Regression Summary for Dependent Variable: CADMIUM
R= .82757627 R^2= .68488249 Adjusted R^2= .67904698
F(1,54)=117.36 p<.00000 Std.Error of estimate: .12812

Cadmium	B	St. Err. of B	t(54)	p-level
Intercept	.059308	.024577	2.41313	.019240
ALUMINUM	.000015	.000001	10.83350	.000000

Regression Summary for Dependent Variable: COPPER
R= .81779982 R^2= .66879655 Adjusted R^2= .66277467
F(1,55)=111.06 p<.00000 Std.Error of estimate: 4.1099

Copper	B	St. Err. of B	t(55)	p-level
Intercept	1.967588	.790690	2.48844	.015888
ALUMINUM	.000498	.000047	10.53855	.000000

Regression Summary for Dependent Variable: LEAD
R= .71850546 R^2= .51625010 Adjusted R^2= .50761171
F(1,56)=59.762 p<.00000 Std.Error of estimate: 11.094

Lead	B	St. Err. of B	t(56)	p-level
Intercept	7.901547	2.093990	3.773440	.000391
ALUMINUM	.000912	.000118	7.730608	.000000

Regression Summary for Dependent Variable: MERCURY
R= .80520377 R^2= .64835311 Adjusted R^2= .64145808
F(1,51)=94.032 p<.00000 Std.Error of estimate: .06220

Mercury	B	St. Err. of B	t(51)	p-level
Intercept	.029628	.011983	2.472552	.016790
ALUMINUM	.000007	.000001	9.697002	.000000

Regression Summary for Dependent Variable: SILVER
R= .60715526 R^2= .36863752 Adjusted R^2= .35625786
F(1,51)=29.778 p<.00000 Std.Error of estimate: .05554

Silver	B	St. Err. of B	t(51)	p-level
Intercept	.034076	.011656	2.923391	.005152
ALUMINUM	.000005	.000001	5.456893	.000001

Regression Summary for Dependent Variable: ZINC
R= .76507621 R^2= .58534161 Adjusted R^2= .57751787
F(1,53)=74.816 p<.00000 Std.Error of estimate: 18.900

Zinc	B	St. Err. of B	t(53)	p-level
Intercept	10.06378	3.686077	2.730215	.008573
ALUMINUM	.00190	.000220	8.649627	.000000

Appendix E. Continued

Qbd (n=28) (based on maximum formation percentage)

Regression Summary for Dependent Variable: CADMIUM
R= .73271773 R^2= .53687527 Adjusted R^2= .51906278
F(1,26)=30.140 p<.00001 Std.Error of estimate: .13328

Cadmium	B	St. Err. of B	t(26)	p-level
Intercept	.045127	.035140	1.284216	.210392
ALUMINUM	.000011	.000002	5.490026	.000009

Regression Summary for Dependent Variable: COPPER
R= .83616163 R^2= .69916628 Adjusted R^2= .68759575
F(1,26)=60.426 p<.00000 Std.Error of estimate: 2.8795

Copper	B	St. Err. of B	t(26)	p-level
Intercept	.771147	.759156	1.015796	.319087
ALUMINUM	.000340	.000044	7.773447	.000000

Regression Summary for Dependent Variable: LEAD
R= .71857606 R^2= .51635155 Adjusted R^2= .49774969
F(1,26)=27.758 p<.00002 Std.Error of estimate: 7.7419

Lead	B	St. Err. of B	t(26)	p-level
Intercept	5.725607	2.041114	2.805138	.009394
ALUMINUM	.000619	.000118	5.268591	.000017

Regression Summary for Dependent Variable: MERCURY
R= .80956429 R^2= .65539434 Adjusted R^2= .64214027
F(1,26)=49.449 p<.00000 Std.Error of estimate: .05185

Mercury	B	St. Err. of B	t(26)	p-level
Intercept	.008715	.013670	.637548	.529343
ALUMINUM	.000006	.000001	7.031967	.000000

Regression Summary for Dependent Variable: SILVER
R= .28349775 R^2= .08037097 Adjusted R^2= .04358581
F(1,25)=2.1849 p<.15186 Std.Error of estimate: .05078

Silver	B	St. Err. of B	t(25)	p-level
Intercept	.042767	.013471	3.174734	.003953
ALUMINUM	.000001	.000001	1.478132	.151862

Regression Summary for Dependent Variable: ZINC
R= .86623313 R^2= .75035983 Adjusted R^2= .74075828
F(1,26)=78.150 p<.00000 Std.Error of estimate: 10.486

Zinc	B	St. Err. of B	t(26)	p-level
Intercept	5.258366	2.764680	1.901980	.068308
ALUMINUM	.001407	.000159	8.840243	.000000

APPENDIX F

Regression Summary Using Neighborhood Subsets

Appendix F: Regression Summary Using Neighborhood Subsets

For Transects Within 20m of RCLSJ06 –

Regression Summary for Dependent Variable: CADMIUM
R= .79956274 R^2= .63930058 Adjusted R^2= .60924230
F(1,12)=21.269 p<.00060 Std.Error of estimate: .12529

CADMIUM	B	St. Err. of B	t(12)	p-level
Intercept	.023615	.062843	.375772	.713645
ALUMINUM	.000019	.000004	4.611800	.000599

Regression Summary for Dependent Variable: COPPER
R= .82708671 R^2= .68407242 Adjusted R^2= .65977030
F(1,13)=28.149 p<.00014 Std.Error of estimate: 4.8045

COPPER	B	St. Err. of B	t(13)	p-level
Intercept	-1.10540	2.391825	-.462158	.651608
ALUMINUM	.00081	.000153	5.305532	.000143

Regression Summary for Dependent Variable: LEAD
R= .87839047 R^2= .77156981 Adjusted R^2= .75399826
F(1,13)=43.910 p<.00002 Std.Error of estimate: 3.3892

LEAD	B	St. Err. of B	t(13)	p-level
Intercept	6.934089	1.687253	4.109690	.001231
ALUMINUM	.000713	.000108	6.626475	.000016

Regression Summary for Dependent Variable: MERCURY
R= .79880940 R^2= .63809646 Adjusted R^2= .60519614
F(1,11)=19.395 p<.00106 Std.Error of estimate: .06053

MERCURY	B	St. Err. of B	t(11)	p-level
Intercept	.018776	.030379	.618082	.549105
ALUMINUM	.000009	.000002	4.403957	.001056

Regression Summary for Dependent Variable: SILVER
R= .81137923 R^2= .65833625 Adjusted R^2= .63205443
F(1,13)=25.049 p<.00024 Std.Error of estimate: .04319

SILVER	B	St. Err. of B	t(13)	p-level
Intercept	.022847	.021500	1.062615	.307298
ALUMINUM	.000007	.000001	5.004908	.000241

Regression Summary for Dependent Variable: ZINC
R= .66886251 R^2= .44737706 Adjusted R^2= .39713861
F(1,11)=8.9051 p<.01243 Std.Error of estimate: 20.087

ZINC	B	St. Err. of B	t(11)	p-level
Intercept	10.12249	11.02454	.918179	.378218
ALUMINUM	.00211	.00071	2.984137	.012427

Appendix F. Continued

For Transects Within 20m of HAW –

Regression Summary for Dependent Variable: CADMIUM
R= .94447628 R^2= .89203545 Adjusted R^2= .88373048
F(1,13)=107.41 p<.00000 Std.Error of estimate: .07542

CADMIUM	B	St. Err. of B	t(13)	p-level
Intercept	.014272	.026989	.52882	.605844
ALUMINUM	.000017	.000002	10.36387	.000000

Regression Summary for Dependent Variable: COPPER
R= .86789142 R^2= .75323552 Adjusted R^2= .73425363
F(1,13)=39.682 p<.00003 Std.Error of estimate: 2.4013

COPPER	B	St. Err. of B	t(13)	p-level
Intercept	1.419752	.859270	1.652278	.122413
ALUMINUM	.000331	.000053	6.299350	.000027

Regression Summary for Dependent Variable: LEAD
R= .92873581 R^2= .86255021 Adjusted R^2= .85197715
F(1,13)=81.580 p<.00000 Std.Error of estimate: 4.8990

LEAD	B	St. Err. of B	t(13)	p-level
Intercept	2.802613	1.753045	1.598711	.133896
ALUMINUM	.000968	.000107	9.032164	.000001

Regression Summary for Dependent Variable: MERCURY
R= .93339883 R^2= .87123337 Adjusted R^2= .86132824
F(1,13)=87.958 p<.00000 Std.Error of estimate: .03403

MERCURY	B	St. Err. of B	t(13)	p-level
Intercept	.012405	.012177	1.018774	.326896
ALUMINUM	.000007	.000001	9.378584	.000000

Regression Summary for Dependent Variable: SILVER
R= .45813922 R^2= .20989155 Adjusted R^2= .14911397
F(1,13)=3.4534 p<.08591 Std.Error of estimate: .06779

SILVER	B	St. Err. of B	t(13)	p-level
Intercept	.060254	.024256	2.484052	.027400
ALUMINUM	.000003	.000001	1.858343	.085906

Regression Summary for Dependent Variable: ZINC
R= .93235203 R^2= .86928031 Adjusted R^2= .85922495
F(1,13)=86.449 p<.00000 Std.Error of estimate: 7.9017

ZINC	B	St. Err. of B	t(13)	p-level
Intercept	3.793765	2.827549	1.341715	.202656
ALUMINUM	.001608	.000173	9.297819	.000000

Appendix F. Continued

For Transects Within 20m of HELENA –

Regression Summary for Dependent Variable: CADMIUM
R= .89496676 R^2= .80096550 Adjusted R^2= .78106205
F(1,10)=40.243 p<.00008 Std.Error of estimate: .06880

CADMIUM	B	St. Err. of B	t(10)	p-level
Intercept	.011451	.033099	.345967	.736536
ALUMINUM	.000016	.000003	6.343701	.000084

Regression Summary for Dependent Variable: COPPER
R= .80186657 R^2= .64299000 Adjusted R^2= .61053454
F(1,11)=19.811 p<.00098 Std.Error of estimate: 4.0559

COPPER	B	St. Err. of B	t(11)	p-level
Intercept	2.685724	1.786758	1.503127	.160961
ALUMINUM	.000634	.000143	4.451007	.000977

Regression Summary for Dependent Variable: LEAD
R= .89039542 R^2= .79280401 Adjusted R^2= .77396801
F(1,11)=42.090 p<.00005 Std.Error of estimate: 8.1678

LEAD	B	St. Err. of B	t(11)	p-level
Intercept	1.068560	3.598207	.296970	.772022
ALUMINUM	.001862	.000287	6.487668	.000045

Regression Summary for Dependent Variable: MERCURY
R= .90174395 R^2= .81314215 Adjusted R^2= .79445637
F(1,10)=43.517 p<.00006 Std.Error of estimate: .04554

MERCURY	B	St. Err. of B	t(10)	p-level
Intercept	.013687	.020091	.681278	.511164
ALUMINUM	.000011	.000002	6.596713	.000061

Regression Summary for Dependent Variable: SILVER
R= .39431944 R^2= .15548782 Adjusted R^2= .07871399
F(1,11)=2.0253 p<.18244 Std.Error of estimate: .08456

SILVER	B	St. Err. of B	t(11)	p-level
Intercept	.039872	.037253	1.070305	.307405
ALUMINUM	.000004	.000003	1.423120	.182439

Regression Summary for Dependent Variable: ZINC
R= .78329692 R^2= .61355407 Adjusted R^2= .57842262
F(1,11)=17.465 p<.00154 Std.Error of estimate: 10.523

ZINC	B	St. Err. of B	t(11)	p-level
Intercept	7.345644	4.635864	1.584525	.141381
ALUMINUM	.001545	.000370	4.179058	.001539

Appendix F. Continued

For Transects Within 20m of MAITL –

Regression Summary for Dependent Variable: CADMIUM
R= .84379160 R^2= .71198427 Adjusted R^2= .67998252
F(1,9)=22.248 p<.00109 Std.Error of estimate: .11961

CADMIUM	B	St. Err. of B	t(9)	p-level
Intercept	.061486	.046969	1.309060	.222949
ALUMINUM	.000017	.000004	4.716810	.001094

Regression Summary for Dependent Variable: COPPER
R= .94716574 R^2= .89712294 Adjusted R^2= .88426331
F(1,8)=69.763 p<.00003 Std.Error of estimate: 2.2409

COPPER	B	St. Err. of B	t(8)	p-level
Intercept	1.216686	.881497	1.380249	.204849
ALUMINUM	.000621	.000074	8.352408	.000032

Regression Summary for Dependent Variable: LEAD
R= .70478450 R^2= .49672119 Adjusted R^2= .44080132
F(1,9)=8.8827 p<.01544 Std.Error of estimate: 13.286

LEAD	B	St. Err. of B	t(9)	p-level
Intercept	6.856831	5.217070	1.314307	.221251
ALUMINUM	.001166	.000391	2.980391	.015440

Regression Summary for Dependent Variable: MERCURY
R= .94231306 R^2= .88795391 Adjusted R^2= .87550434
F(1,9)=71.324 p<.00001 Std.Error of estimate: .03385

MERCURY	B	St. Err. of B	t(9)	p-level
Intercept	.001618	.013294	.121720	.905795
ALUMINUM	.000008	.000001	8.445359	.000014

Regression Summary for Dependent Variable: SILVER
R= .33329664 R^2= .11108665 Adjusted R^2= -----
F(1,8)=.99975 p<.34665 Std.Error of estimate: .05941

SILVER	B	St. Err. of B	t(8)	p-level
Intercept	.040940	.025731	1.591044	.150264
ALUMINUM	.000003	.000003	.999876	.346650

Regression Summary for Dependent Variable: ZINC
R= .57787876 R^2= .33394386 Adjusted R^2= .25993762
F(1,9)=4.5124 p<.06261 Std.Error of estimate: 24.731

ZINC	B	St. Err. of B	t(9)	p-level
Intercept	16.36202	9.711461	1.684815	.126308
ALUMINUM	.00155	.000728	2.124235	.062605

Appendix F. Continued

For Transects Within 20m of SWBPP1 –

Regression Summary for Dependent Variable: CADMIUM
R= .89995466 R^2= .80991839 Adjusted R^2= .79873712
F(1,17)=72.435 p<.00000 Std.Error of estimate: .08457

CADMIUM	B	St. Err. of B	t(17)	p-level
Intercept	.048739	.025523	1.909639	.073203
ALUMINUM	.000023	.000003	8.510891	.000000

Regression Summary for Dependent Variable: COPPER
R= .83786810 R^2= .70202295 Adjusted R^2= .68546867
F(1,18)=42.407 p<.00000 Std.Error of estimate: 2.9313

COPPER	B	St. Err. of B	t(18)	p-level
Intercept	.994891	.883307	1.126325	.274821
ALUMINUM	.000601	.000092	6.512092	.000004

Regression Summary for Dependent Variable: LEAD
R= .57638356 R^2= .33221801 Adjusted R^2= .29048163
F(1,16)=7.9599 p<.01229 Std.Error of estimate: 11.514

LEAD	B	St. Err. of B	t(16)	p-level
Intercept	7.733908	3.543849	2.182347	.044337
ALUMINUM	.001040	.000369	2.821332	.012288

Regression Summary for Dependent Variable: MERCURY
R= .93895025 R^2= .88162758 Adjusted R^2= .87505133
F(1,18)=134.06 p<.00000 Std.Error of estimate: .03470

MERCURY	B	St. Err. of B	t(18)	p-level
Intercept	.009574	.010457	.91550	.372030
ALUMINUM	.000013	.000001	11.57853	.000000

Regression Summary for Dependent Variable: SILVER
R= .57344199 R^2= .32883572 Adjusted R^2= .29154881
F(1,18)=8.8191 p<.00821 Std.Error of estimate: .05113

SILVER	B	St. Err. of B	t(18)	p-level
Intercept	.030071	.015331	1.961511	.065475
ALUMINUM	.000004	.000001	2.969691	.008208

Regression Summary for Dependent Variable: ZINC
R= .84380789 R^2= .71201175 Adjusted R^2= .69601240
F(1,18)=44.503 p<.00000 Std.Error of estimate: 25.743

ZINC	B	St. Err. of B	t(18)	p-level
Intercept	.804761	7.577621	.106202	.916596
ALUMINUM	.004596	.000689	6.671023	.000003

APPENDIX G

Regression Summary Using Subsets Created from Basins

Appendix G. Regression Summary Using Subsets Created from Basins

Regressions for BASINS 1, 2 and 3 (n=38)

Regression Summary for Dependent Variable: **CADMIUM**
R= .85896958 R^2= .73782874 Adjusted R^2= .73033813
F(1,35)=98.501 p<.00000 Std.Error of estimate: .13395

CADMIUM	B	St. Err. of B	t(35)	p-level
Intercept	.026809	.033144	.808867	.424056
ALUMINUM	.000015	.000002	9.924743	.000000

Regression Summary for Dependent Variable: **COPPER**
R= .76740294 R^2= .58890727 Adjusted R^2= .57681631
F(1,34)=48.706 p<.00000 Std.Error of estimate: 4.9848

COPPER	B	St. Err. of B	t(34)	p-level
Intercept	1.396121	1.286083	1.085560	.285311
ALUMINUM	.000427	.000061	6.978997	.000000

Regression Summary for Dependent Variable: **LEAD**
R= .68000154 R^2= .46240209 Adjusted R^2= .44746882
F(1,36)=30.965 p<.00000 Std.Error of estimate: 12.253

LEAD	B	St. Err. of B	t(36)	p-level
Intercept	9.184620	3.027123	3.034108	.004459
ALUMINUM	.000768	.000138	5.564580	.000003

Regression Summary for Dependent Variable: **MERCURY**
R= .79016299 R^2= .62435755 Adjusted R^2= .61261872
F(1,32)=53.187 p<.00000 Std.Error of estimate: .06556

MERCURY	B	St. Err. of B	t(32)	p-level
Intercept	.027290	.016488	1.655182	.107664
ALUMINUM	.000006	.000001	7.292968	.000000

Regression Summary for Dependent Variable: **SILVER**
R= .59367986 R^2= .35245578 Adjusted R^2= .33156725
F(1,31)=16.873 p<.00027 Std.Error of estimate: .05840

SILVER	B	St. Err. of B	t(31)	p-level
Intercept	.027157	.015536	1.748025	.090359
ALUMINUM	.000004	.000001	4.107697	.000271

Regression Summary for Dependent Variable: **ZINC**
R= .86281790 R^2= .74445473 Adjusted R^2= .73646894
F(1,32)=93.222 p<.00000 Std.Error of estimate: 17.085

ZINC	B	St. Err. of B	t(32)	p-level
Intercept	7.208873	4.444312	1.622045	.114607
ALUMINUM	.002026	.000210	9.655176	.000000

Appendix G. Continued

Regressions for BASIN 4 (n=17)

Regression Summary for Dependent Variable: **CADMIUM**
R= .86758021 R^2= .75269542 Adjusted R^2= .73620845
F(1,15)=45.654 p<.00001 Std.Error of estimate: .10613

CADMIUM	B	St. Err. of B	t(15)	p-level
Intercept	.060006	.033014	1.817598	.089153
ALUMINUM	.000014	.000002	6.756771	.000006

Regression Summary for Dependent Variable: **COPPER**
R= .90509407 R^2= .81919528 Adjusted R^2= .80628066
F(1,14)=63.432 p<.00000 Std.Error of estimate: 2.7372

COPPER	B	St. Err. of B	t(14)	p-level
Intercept	1.334101	.851843	1.566135	.139635
ALUMINUM	.000434	.000054	7.964396	.000001

Regression Summary for Dependent Variable: **LEAD**
R= .75444496 R^2= .56918720 Adjusted R^2= .54046635
F(1,15)=19.818 p<.00047 Std.Error of estimate: 11.509

LEAD	B	St. Err. of B	t(15)	p-level
Intercept	6.990196	3.580097	1.952516	.069798
ALUMINUM	.000983	.000221	4.451731	.000466

Regression Summary for Dependent Variable: **MERCURY**
R= .94366578 R^2= .89050510 Adjusted R^2= .88320544
F(1,15)=121.99 p<.00000 Std.Error of estimate: .03700

MERCURY	B	St. Err. of B	t(15)	p-level
Intercept	.006142	.011508	.53370	.601367
ALUMINUM	.000008	.000001	11.04503	.000000

Regression Summary for Dependent Variable: **SILVER**
R= .34627591 R^2= .11990700 Adjusted R^2= .05704322
F(1,14)=1.9074 p<.18890 Std.Error of estimate: .05857

SILVER	B	St. Err. of B	t(14)	p-level
Intercept	.048160	.018359	2.623276	.020048
ALUMINUM	.000002	.000001	1.381090	.188899

Regression Summary for Dependent Variable: **ZINC**
R= .62380360 R^2= .38913093 Adjusted R^2= .34840632
F(1,15)=9.5552 p<.00745 Std.Error of estimate: 20.774

ZINC	B	St. Err. of B	t(15)	p-level
Intercept	14.26586	6.461950	2.207672	.043257
ALUMINUM	.00123	.000398	3.091145	.007451

Appendix G. Continued

Regressions for BASIN 5 (n=10)

Regression Summary for Dependent Variable: **CADMIUM**
R= .63344855 R^2= .40125706 Adjusted R^2= .32641419
F(1,8)=5.3613 p<.04927 Std.Error of estimate: .12874

CADMIUM	B	St. Err. of B	t(8)	p-level
Intercept	.091123	.054653	1.667311	.134010
ALUMINUM	.000010	.000004	2.315454	.049268

Regression Summary for Dependent Variable: **COPPER**
R= .93171249 R^2= .86808816 Adjusted R^2= .85159918
F(1,8)=52.647 p<.00009 Std.Error of estimate: 1.5594

COPPER	B	St. Err. of B	t(8)	p-level
Intercept	1.270360	.662004	1.918960	.091262
ALUMINUM	.000395	.000054	7.255795	.000088

Regression Summary for Dependent Variable: **LEAD**
R= .91197130 R^2= .83169166 Adjusted R^2= .81065311
F(1,8)=39.532 p<.00024 Std.Error of estimate: 3.2094

LEAD	B	St. Err. of B	t(8)	p-level
Intercept	2.920865	1.362447	2.143837	.064390
ALUMINUM	.000705	.000112	6.287433	.000236

Regression Summary for Dependent Variable: **MERCURY**
R= .83217189 R^2= .69251006 Adjusted R^2= .65407382
F(1,8)=18.017 p<.00282 Std.Error of estimate: .03645

MERCURY	B	St. Err. of B	t(8)	p-level
Intercept	.014148	.015474	.914293	.387289
ALUMINUM	.000005	.000001	4.244657	.002820

Regression Summary for Dependent Variable: **SILVER**
R= .41986742 R^2= .17628865 Adjusted R^2= .07332473
F(1,8)=1.7121 p<.22705 Std.Error of estimate: .07059

SILVER	B	St. Err. of B	t(8)	p-level
Intercept	.055431	.029965	1.849823	.101504
ALUMINUM	.000003	.000002	1.308488	.227047

Regression Summary for Dependent Variable: **ZINC**
R= .88257513 R^2= .77893886 Adjusted R^2= .75130622
F(1,8)=28.189 p<.00072 Std.Error of estimate: 4.4797

ZINC	B	St. Err. of B	t(8)	p-level
Intercept	6.839710	1.901721	3.596589	.007017
ALUMINUM	.000831	.000156	5.309339	.000720

Appendix G. Continued

Regressions for BASINS 6 and 10 (n=7)

Regression Summary for Dependent Variable: **CADMIUM**
R= .59924085 R^2= .35908959 Adjusted R^2= .23090751
F(1,5)=2.8014 p<.15504 Std.Error of estimate: .06314

CADMIUM	B	St. Err. of B	t(5)	p-level
Intercept	.056740	.042506	1.334896	.239463
ALUMINUM	.000005	.000003	1.673739	.155038

Regression Summary for Dependent Variable: **COPPER**
R= .73736109 R^2= .54370138 Adjusted R^2= .45244166
F(1,5)=5.9577 p<.05859 Std.Error of estimate: 1.9795

COPPER	B	St. Err. of B	t(5)	p-level
Intercept	.647885	1.332657	.486160	.647411
ALUMINUM	.000244	.000100	2.440847	.058593

Regression Summary for Dependent Variable: **LEAD**
R= .76786176 R^2= .58961169 Adjusted R^2= .50753403
F(1,5)=7.1836 p<.04381 Std.Error of estimate: 5.3237

LEAD	B	St. Err. of B	t(5)	p-level
Intercept	3.483300	3.584130	.971868	.375752
ALUMINUM	.000720	.000269	2.680221	.043809

Regression Summary for Dependent Variable: **MERCURY**
R= .66698262 R^2= .44486582 Adjusted R^2= .33383899
F(1,5)=4.0068 p<.10172 Std.Error of estimate: .05413

MERCURY	B	St. Err. of B	t(5)	p-level
Intercept	.017619	.036443	.483472	.649190
ALUMINUM	.000005	.000003	2,001707	.101717

Regression Summary for Dependent Variable: **SILVER**
R= .59186394 R^2= .35030292 Adjusted R^2= .22036351
F(1,5)=2.6959 p<.16153 Std.Error of estimate: .03800

SILVER	B	St. Err. of B	t(5)	p-level
Intercept	.011728	.025581	.458460	.665860
ALUMINUM	.000003	.000002	1.641918	.161530

Regression Summary for Dependent Variable: **ZINC**
R= .52110680 R^2= .27155229 Adjusted R^2= .12586275
F(1,5)=1.8639 p<.23039 Std.Error of estimate: 13.032

ZINC	B	St. Err. of B	t(5)	p-level
Intercept	7.657146	8.773997	.872709	.422745
ALUMINUM	.000897	.000657	1.365251	.230392

Appendix G. Continued

Regressions for BASIN 7 (n=44)

Regression Summary for Dependent Variable: **CADMIUM**
R= .71431349 R^2= .51024376 Adjusted R^2= .49768591
F(1,39)=40.631 p<.00000 Std.Error of estimate: .12948

CADMIUM	B	St. Err. of B	t(39)	p-level
Intercept	.069515	.028428	2.445332	.019090
ALUMINUM	.000018	.000003	6.374280	.000000

Regression Summary for Dependent Variable: **COPPER**
R= .81526807 R^2= .66466202 Adjusted R^2= .65648304
F(1,41)=81.265 p<.00000 Std.Error of estimate: 3.3511

COPPER	B	St. Err. of B	t(41)	p-level
Intercept	1.263205	.721348	1.751172	.087395
ALUMINUM	.000655	.000073	9.014694	.000000

Regression Summary for Dependent Variable: **LEAD**
R= .60767793 R^2= .36927246 Adjusted R^2= .35309996
F(1,39)=22.833 p<.00003 Std.Error of estimate: 12.991

LEAD	B	St. Err. of B	t(39)	p-level
Intercept	7.494184	2.825229	2.652593	.011492
ALUMINUM	.001354	.000283	4.778426	.000025

Regression Summary for Dependent Variable: **MERCURY**
R= .88291546 R^2= .77953971 Adjusted R^2= .77402821
F(1,40)=141.44 p<.00000 Std.Error of estimate: .04780

MERCURY	B	St. Err. of B	t(40)	p-level
Intercept	.009881	.010310	.95836	.343640
ALUMINUM	.000013	.000001	11.89280	.000000

Regression Summary for Dependent Variable: **SILVER**
R= .49588852 R^2= .24590542 Adjusted R^2= .22751287
F(1,41)=13.370 p<.00072 Std.Error of estimate: .05727

SILVER	B	St. Err. of B	t(41)	p-level
Intercept	.035392	.012240	2.891465	.006109
ALUMINUM	.000004	.000001	3.656479	.000721

Regression Summary for Dependent Variable: **ZINC**
R= .69912092 R^2= .48877007 Adjusted R^2= .47630104
F(1,41)=39.199 p<.00000 Std.Error of estimate: 15.330

ZINC	B	St. Err. of B	t(41)	p-level
Intercept	9.148598	3.300011	2.772293	.008335
ALUMINUM	.002080	.000332	6.260890	.000000

Appendix G. Continued

Regressions for BASINS 8 and 9 (n=10)

Regression Summary for Dependent Variable: **CADMIUM**
R= .70756729 R^2= .50065146 Adjusted R^2= .43823290
F(1,8)=8.0209 p<.02208 Std.Error of estimate: .05609

CADMIUM	B	St. Err. of B	t(8)	p-level
Intercept	.038997	.022953	1.699034	.127739
ALUMINUM	.000004	.000002	2.832115	.022078

Regression Summary for Dependent Variable: **COPPER**
R= .92786781 R^2= .86093867 Adjusted R^2= .84355600
F(1,8)=49.529 p<.00011 Std.Error of estimate: 1.1899

COPPER	B	St. Err. of B	t(8)	p-level
Intercept	1.323294	.486879	2.717910	.026334
ALUMINUM	.000225	.000032	7.037654	.000108

Regression Summary for Dependent Variable: **LEAD**
R= .60799925 R^2= .36966309 Adjusted R^2= .29087098
F(1,8)=4.6916 p<.06220 Std.Error of estimate: 7.6574

LEAD	B	St. Err. of B	t(8)	p-level
Intercept	6.192032	3.133276	1.976217	.083536
ALUMINUM	.000445	.000206	2.166016	.062204

Regression Summary for Dependent Variable: **MERCURY**
R= .70232525 R^2= .49326076 Adjusted R^2= .42991836
F(1,8)=7.7872 p<.02354 Std.Error of estimate: .02413

MERCURY	B	St. Err. of B	t(8)	p-level
Intercept	.017891	.009875	1.811709	.107609
ALUMINUM	.000002	.000001	2.790558	.023538

Regression Summary for Dependent Variable: **SILVER**
R= .49202662 R^2= .24209019 Adjusted R^2= .14735147
F(1,8)=2.5553 p<.14859 Std.Error of estimate: .02625

SILVER	B	St. Err. of B	t(8)	p-level
Intercept	.029603	.010742	2.755804	.024835
ALUMINUM	.000001	.000001	1.598545	.148589

Regression Summary for Dependent Variable: **ZINC**
R= .90258208 R^2= .81465441 Adjusted R^2= .79148621
F(1,8)=35.163 p<.00035 Std.Error of estimate: 9.1176

ZINC	B	St. Err. of B	t(8)	p-level
Intercept	4.927529	3.730773	1.320780	.223104
ALUMINUM	.001452	.000245	5.929807	.000350

APPENDIX H

Stepwise Method of Identifying Contaminated Sediment Sample

Appendix H - Stepwise Method of Identifying Contaminated Sediment Samples.

Step 1 – Standardize Al, Mn, % mud, and TOC.

Subtract the mean and divide by the standard deviation of each of the four variables in Table 3-4. The following example is from page 3-10.

Table 3-4. Descriptive statistics for variables used in the Mud Cluster method (n=126) and used for standardization of raw data for determining cluster membership.

	MEAN	MEDIAN	STDEV	MIN	MAX	Q1	Q3
Al	10991	5915	11850	239	48400	1805	18150
Mn	76.9	50.35	81.52	1.78	425	25.35	93.85
p-mud	25.45	20.6	21.32	0.1	79.5	7.43	37.13
TOC	93038	23900	120210	230	451000	3378	185625

For example, an Al concentration of 990 mg/kg, the standardized value is

$$990 - 10991 \div 11850 = -0.844.$$

Step 2 – Determine cluster membership

Root1 and Root2 are calculated using the following formulas:

$$Root1 = -1.3495*Al - 0.5455*Mn - 0.8124*Mud - 1.5639*TOC$$
$$Root2 = -0.1344*Al + 1.3897*Mn + 0.9641*Mud - 2.1777*TOC$$

From the example on page 3-11

$$Root1 = 1.139 - 0.0107 + 0.208 + 1.196 = 2.53$$

Next, the distance from each cluster's center is calculated using the five distance formulas:

$$Distance1 = 0.5*[(Root1 - 1.019)^2 + (Root2 - 1.019)^2]$$
$$Distance2 = 0.5*[(Root1 - 3.212)^2 + (Root2 + 0.029)^2]$$
$$Distance3 = 0.5*[(Root1 + 4.526)^2 + (Root2 - 0.037)^2]$$
$$Distance4 = 0.5*[(Root1 + 3.335)^2 + (Root2 + 3.8)^2]$$
$$Distance5 = 0.5*[(Root1 + 7.162)^2 + (Root2 - 4.449)^2].$$

For this example, Distance 1 is calculated as follows:

$$\begin{aligned} Distance\ 1 &= 0.5*[(Root1 - 1.019)^2 + (Root2 - 1.019)^2] \\ &= 0.5*[(2.53 - 1.019)^2 + (1.56 - 1.019)^2] \\ &= 0.5*[2.28 + 0.293] = 1.29 \end{aligned}$$

The values for the others for distances 2 through 5 in this example are 1.49, 26.1, 31.6, and 51.2, respectively.

Appendix H – Continued

The sediment sample belongs to the cluster with the minimum distance. Therefore, in this example, Distance 1 was the smallest so the example sediment sample belongs to Cluster 1.

Step 3 – Determine if sample is contaminated

To determine whether a sediment sample is contaminated, that it contains concentrations of metals that are elevated compared to the observations in its cluster, compare the raw data in the new sediment sample to other upper 95% confidence limits in Table 3.5. In the example, an As concentration above 1.90 mg/kg would be considered contaminated since it exceeded the upper 95% confidence limit for the sample belonging to Cluster 1.

Table 3.5. Upper 95% confidence limits for each metal concentration (mg/kg) by Mud Cluster

	Cluster				
	1	2	3	4	5
Arsenic	1.90	0.746	5.58	7.37	7.75
Cadmium	0.198	0.0793	0.480	0.435	0.758
Chromium	17.5	5.60	52.8	26.7	66.2
Copper	5.01	1.89	13.1	14.6	23.2
Iron	5376	1144	17832	10945	25514
Lead	19.5	11.1	32.5	30.7	47.4
Lithium	7.26	2.04	22.5	9.00	39.2
Mercury	0.0814	0.0251	0.247	0.230	0.325
Nickel	3.75	0.951	13.6	10.8	20.6
Selenium	1.15	0.296	3.31	6.61	2.49
Silver	0.0719	0.0492	0.141	0.145	0.277
Tin	1.33	0.454	2.19	1.31	3.42
Zinc	31.5	12.1	49.1	51.2	110