Contaminant Survey of Sarasota Bay Priority Watersheds - Cedar Hammock Creek, Bowlees Creek, Whitaker Bayou, Hudson Bayou, and Phillippi Creek

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EXECUTIVE SUMMARY

A variety of existing information on the density of historical (1972) and present day industries, specific categories of stormwater generators (multi-sector permittees), and land use was compiled to identify the subbasins within the Sarasota Bay priority watersheds which were the likely sources of the noteworthy sediment contamination documented in Lowery, et al. (1993). Contamination potential was estimated under the assumption of poor housekeeping practices. Surficial sediments from the identified groups of subbasins were sampled for selected metals, pesticides, and polynuclear aromatic hydrocarbons (PAH) and data were combined with existing sediment quality data to determine the locus of contamination and to allow prioritization of subbasins for treatment activities.

The drainageways sampled during the project typically do not accumulate sediment fines. As a result, exceedances of probable and threshold biological impacts due to bulk contaminant concentrations (using criteria developed for coastal waters) are less frequent in the watershed stations than in earlier data from the tidal portions of the tributaries. Normalization techniques (metal enrichment ratios and PAH per weight of organic matter) were used which would account for the differing depositional environments. No chlorinated pesticides above the method detection limits were found in the 1998-9 watershed samples.

Metal enrichment was more prevalent in the Cedar Hammock Creek, Whitaker Bayou and Hudson Bayou watersheds, and lead or zinc were the most commonly enriched metals among all of the stations. In particular, the lead enrichment from the lower central subbasins of Hudson Bayou watershed dwarfed all other contaminated areas and was inconsistent with predictions of regional stormwater loadings based on land use.

As may be expected when examining a variety of contaminants and contaminant classes, spatial and temporal patterns of contamination vary by individual parameter. For PAH, sediments are even more non-homogenous at a given station than are metals, implying a more variable input. Compounds present are typical of stormwater, indicative of both petroleum and combustion products contamination. PAH concentrations appear to be a more serious problem for biota as the bulk concentrations of many more stations exceeded probable effects levels. Some watersheds had pervasive concentrations of PAH; Cedar Hammock Creek, lower Bowlees Creek, and Hudson Bayou. Other watersheds, such as Phillippi Creek, were comparatively free of PAH with a few notable exceptions.

For metals, controlling discharges and source identification within the lower central subbasins of Hudson Bayou is a clear priority to reduce lead contamination. Regionalized treatment systems or activities may be an effective approach for addressing watersheds with pervasive contamination, but are less justifiable if contamination is limited to a few areas. Placement of systems for removal of contaminants clearly should follow an thorough assessment of watershed contamination as unlikely sources of significant contamination can override expected contaminant loads.

I. PROJECT BACKGROUND

Sarasota Bay was incorporated into the National Estuary Program in 1989. At the time, the estuary was unique for the predominance of urban and residential influences on the Bay, and a general lack of heavy industrial sources (Estevez, 1988). Early and brief calculations of pollution susceptibility using toxic inputs and approximate flushing characteristics estimated low to moderate loadings of toxic and petroleum compounds and moderate particle retention efficiency (Klein *et al.*, 1988) for Sarasota Bay.

Early characterization efforts (Lowrey *et al.*, 1993), however, detected substantial levels of contaminants in the tributary sediments, including toxic metals, pesticides, and petroleum or combustion compounds (polynuclear aromatic hydrocarbons or PAH). Tributaries most contaminated included Cedar Hammock Creek, Bowlees Creek, Whitaker Bayou, Hudson Bayou, and Phillippi Creek (**Figure 1**). In particular, the shellfish near Hudson Bayou were noted for lead concentrations which exceeded any site measured during the National Status and Trends Program from 1986-1989. Toxic organics in sediments exceeded the levels at which biological effects could be expected in numerous locations. The regions that were highly contaminated evidenced a variety of toxic compounds. Sediments in the Bay proper were generally uncontaminated. While the tributary sediments form a relatively small areal extent of the benthic habitat available in Sarasota Bay, they also represent almost all of the low salinity habitat on which many juvenile life forms depend (Edwards, 1992).

Since the characterization efforts, the Sarasota Bay National Estuary Program (SBNEP) in both the Framework for Action (1992) and the Comprehensive Conservation and Management Plan (1995) have identified toxic sediment contamination as an issue of concern and a priority research need. Existing sediment data and workshops were used to identify priority tributaries and to consider potential sources of toxics. A generalized approach to address the issue of toxic contamination was developed by Mote Marine Laboratory. Due to the level of sediment contamination and to the interest of other agencies in stormwater planning, the Hudson Bayou watershed was selected for a demonstration of the evaluation technique. Subsequently, the remaining four basins (Cedar Hammock Creek, Bowlees Creek, Whitaker Bayou, and Phillippi Creek were similarly addressed.

II. PROJECT OBJECTIVES AND SUMMARY

The objective of the project can be summarized ***to identify the historic and present-day regions within the watershed which contribute toxic compounds to receiving waters.*** The evaluation technique initially developed for the Hudson Bayou watershed consisted of five activities which would together identify potential toxin sources (both historical and present-day) and stormwater loading estimates by watershed subbasin.

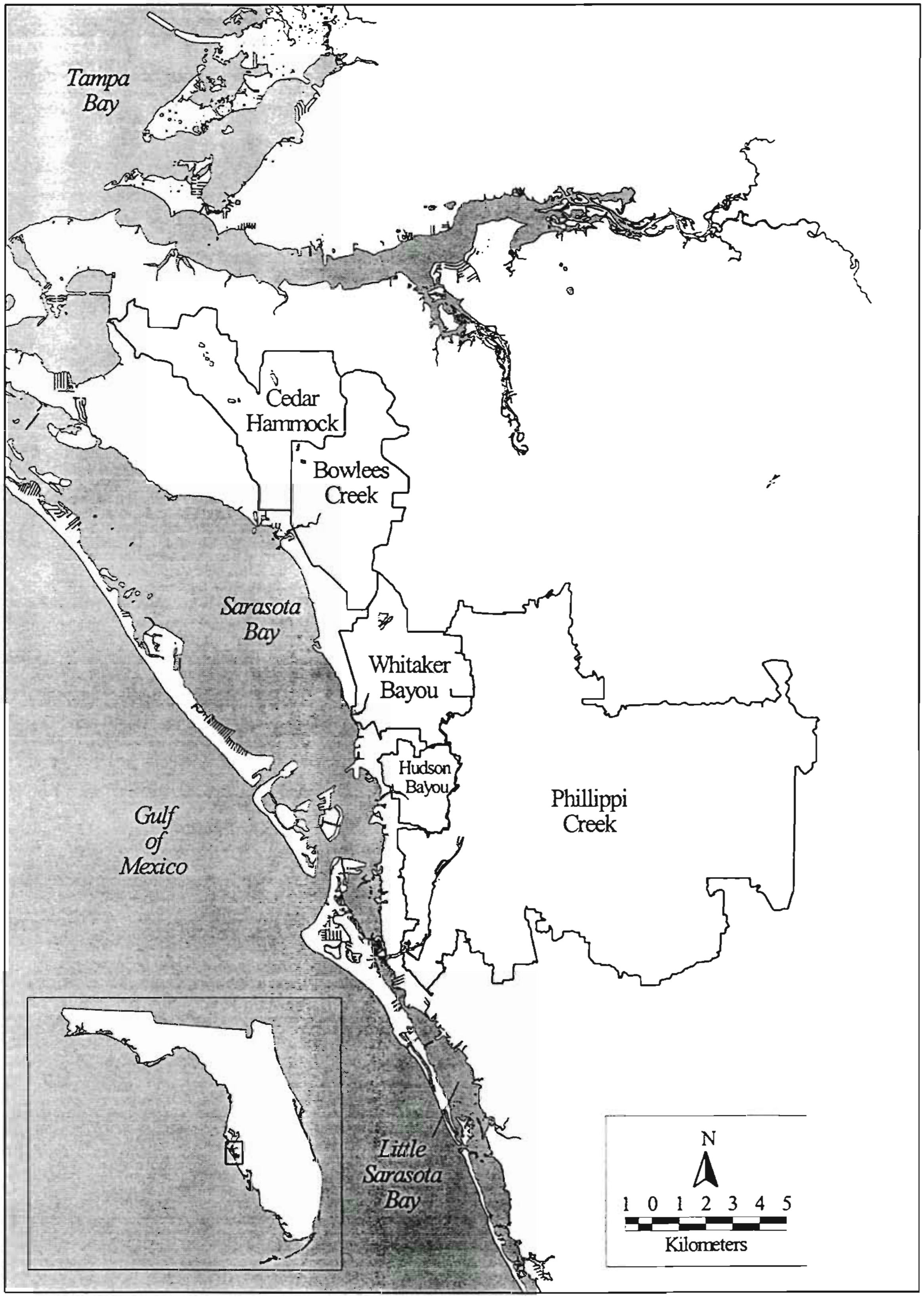

Figure 1. Sarasota Bay National Estuary Program priority watersheds.

Historical Sources - The number of businesses and industries present at a selected prior time period were obtained from City Directories. Based on the type of commercial activity, businesses were categorized as ***potential*** contamination sources for metals, pesticides, and PAH. The density of potential sources (units per acre) was used to qualitatively rank subbasins within the watershed for historical contamination potential.

Present Day Sources - Present-day contamination potential was similarly evaluated using County databases and inspection reports of small and large quantity generators (of hazardous wastes), augmented with occupational licensing. Again, industries were categorized as ***potential*** sources of metals, pesticides, and PAH, and density of industries used to qualitatively rank subbasins.

Multi-sector Sources - The U.S. Environmental Protection Agency (EPA) has also identified certain categories of industries which, because of size or activity, are likely pollution generators. These industries, identified by SIC codes (Standard Industrial Code), are required to participate in multi-sector stormwater discharge permits. Based on EPA-issued descriptions of activities and stormwater quality, multi-sector businesses in present day County databases were categorized as potential sources of metals, pesticides, and PAH. Density of industries per acre was again used to qualitatively rank subbasins.

Stormwater Loadings - Present-day loadings and relative subbasin contamination potentials were calculated from non-point source modeling, using a current database of stormwater concentrations from specific land-uses and land uses within the Hudson Bayou watershed. Loadings were used to quantitatively rank subbasins.

New Analyses - Sediments within or downstream of the highest-ranked basins (most loading potential) were sampled for confirmation and relative contamination status. Sediment results were not used to provide quantitative loading information in themselves.
The information on relative subbasin rankings in the above qualitative categories, the potential number of toxin sources, estimated stormwater loadings, and analytical results can then be used to identify and prioritize subbasins. Remediation efforts or stormwater treatment can be applied to provide the most effective controls of new loadings to receiving waters.

After the initial application of the technique in Hudson Bayou, the delineation of potential historical sources was eliminated from the project approach. Historical and present-day patterns of land use appeared relatively similar, and so efforts were redirected into a greater density of new samples and analyses to identify or confirm contaminated basins. Subsequent text describing the ranking process continues to refer to historical patterns but it should be kept in mind that historical (1972) commercial activities were only ranked for the Hudson Bayou watershed.

III. METHODS

Parameters of Interest

Based on technical and economic constraints, the contaminant survey was limited to those parameters already identified as existing at excessive concentrations in the priority tributary sediments (Lowery *et al.*, 1993). Qualitative rankings for subbasins based on historical, present day, and multi-sector industries were performed by three parameter categories, 1) metals, 2) pesticides, and 3) hydrocarbons (polynuclear aromatic hydrocarbons, or PAH). For non-point source modeling, quantitative loadings were calculated individually for copper, lead, and zinc, the metals which were most often enriched in Sarasota Bay sediments (Lowrey *et al.*, 1993). For pesticides and PAH, many recent stormwater concentrations of individual compounds are less than the analytical limits of detection. As a result, the calculation of basin loadings is problematic. New analyses of sediments collected under this project included the metals aluminum, copper, lead, and zinc, chlorinated pesticides, and PAH.

Subbasin Boundaries, Drainage, and Land Use

Basin and subbasin boundaries for Hudson Bayou were obtained from Sarasota County. in GIS format. The subbasin boundaries used were a composite of two prior efforts. Delineations by Post Buckley Schuh & Jernigan for stormwater master planning appeared to follow topographical contours, while contributing areas defined by Camp Dresser & McKee followed artificial drainage, generally along transportation right of ways. Where boundaries in a region did not agree between the two studies, the larger of the two areas was used as a conservative estimate to define the study boundaries for this project. Hard copy of subbasin boundaries did not always agree with the magnetic versions, with magnetic versions often combining two or more subbasins that had been identified for previous hydrological modeling. Since none of the subbasin compilations crossed major subbasin boundaries, the magnetic delineation was used, maintaining the subbasin numbering system contained in the magnetic version. Unnumbered basins were assigned identifications (020701, and 020801) using nomenclature similar to existing. A total of 51 basins resulted (**Figure 2**), all of which were maintained for analysis in the demonstration effort. Areas of basins were computed on 1 foot grids in the ArcView environment.

Drainage between subbasins was not well defined by existing information. Flood plain delineations performed in 1997 by PBS&J illustrate the major open channel conveyances within the Hudson Bayou watershed, but only detail a small fraction of the network of closed pipe stormwater drainage. Much of the region's drainage is subsurface, particularly in the urbanized sections. Subbasins are grouped according to estimated drainage, but several are connected at more than one point and routes to the receiving waters can obviously vary with localized conditions. From the major subbasins, however, and from windshield surveys of the watershed *surface* topography and drainage directions at the time of the survey, probable drainage areas and contributing subbasins were identified.

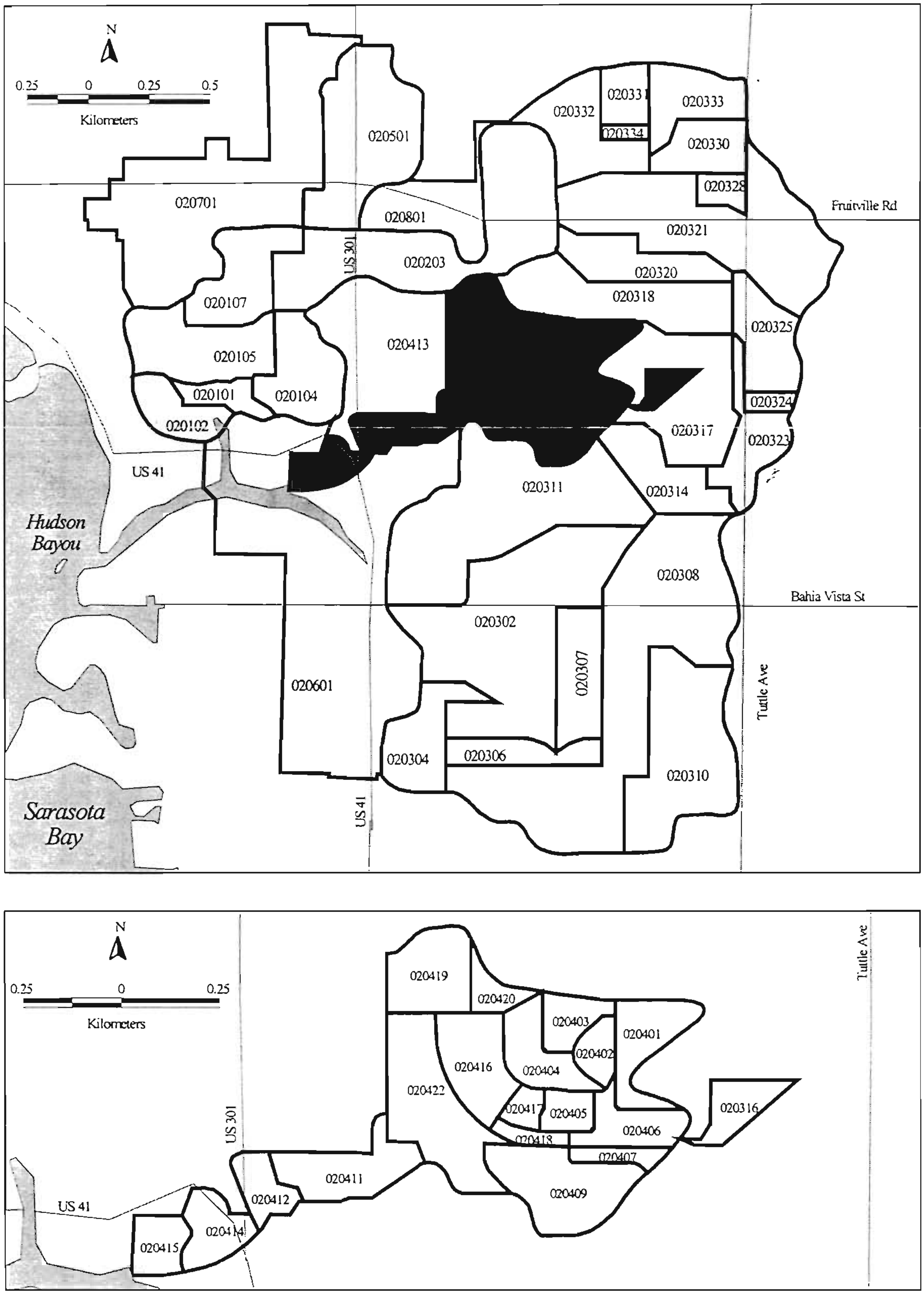

Figure 2. Subbasin identifications, Hudson Bayou watershed.

Subsequently basin delineations were also obtained for Cedar Hammock Creek, Bowlees Creek, Whitaker Bayou, and Phillippi Creek (**Figures 3-6**). Manatee County Public Works Division supplied magnetic files of Cedar Hammock and Bowlees Creek basins in GIS format. There were relatively few basins illustrated in Cedar Hammock and so 5' contours from 1:24,000 quadrangles were used to estimate additional subbasins. Drainage was determined through reference to stream layers, mapping products (Florida Atlas & Gazetteer), and windshield surveys of surface topography. Basins for Whitaker Bayou were obtained from Sarasota County in paper format, the interim product of a recent U.S. Army Corp of Engineers basin delineation effort. As the magnetic version was not yet available, the basins depicted on the aerial photography were hand digitized to allow further analysis. Subbasins within Phillippi Creek were supplied as a magnetic GIS file by the Sarasota County Transportation Department - Stormwater Environmental Utility.

The remaining watersheds were each subdivided into fewer subbasins than the 51 of Hudson Bayou. For Cedar Hammock, Bowlees Creek, Whitaker Bayou, and Phillippi Creek, respectively, subbasins numbered 8, 11, 27, and 14. Areas of basins were computed on 1 foot grids in the ArcView environment. The watersheds also vary by a factor of 20 in relative size between smallest and largest. Hudson Bayou is the smallest (1,754 acres), followed by Whitaker Bayou (4,648 acres), Bowlees Creek (5,975 acres), Cedar Hammock Creek (6,468 acres), and the largest, Phillippi Creek (35,802 acres).

Cedar Hammock Creek was somewhat unusual in that the basins identified had a total of three outlets, one to Sarasota Bay, one to Palma Sola Bay, and a third to the Manatee River (Wares Creek). As the focus of the investigation was to determine the sources of contaminated sediments in Sarasota Bay, fieldwork on this basin included a determination of the portion of the drainage basin which typically drains to Sarasota Bay. This location may vary, of course, depending on relative water levels. Under the conditions in late fall 1999, the area contributing to Sarasota Bay was roughly a third of the total watershed delineated and is indicated on Figure 3, above.

Land use classifications for the Sarasota County portion of the study area were obtained from Sarasota County Planning Department, who had refined and updated SWFWMD 1991 FLUCCS (Florida Land Use Code and Classification System) coverages based on 1995 data. These classifications were used for Hudson Bayou, and the Sarasota County portions of Whitaker Bayou and Phillippi Creek. Coverages from SWFWMD for 1995 were used for the Manatee County portion of the study area; Cedar Hammock, Bowlees Creek, and small portions of Whitaker Bayou and Phillippi Creek watersheds.

Historical Non-Point Sources

Investigation of older commercial interests was only performed for Hudson Bayou. A list of potential, historical, non-point sources to the Hudson Bayou watershed was developed from a 1972 City Directory (Polk, 1972).

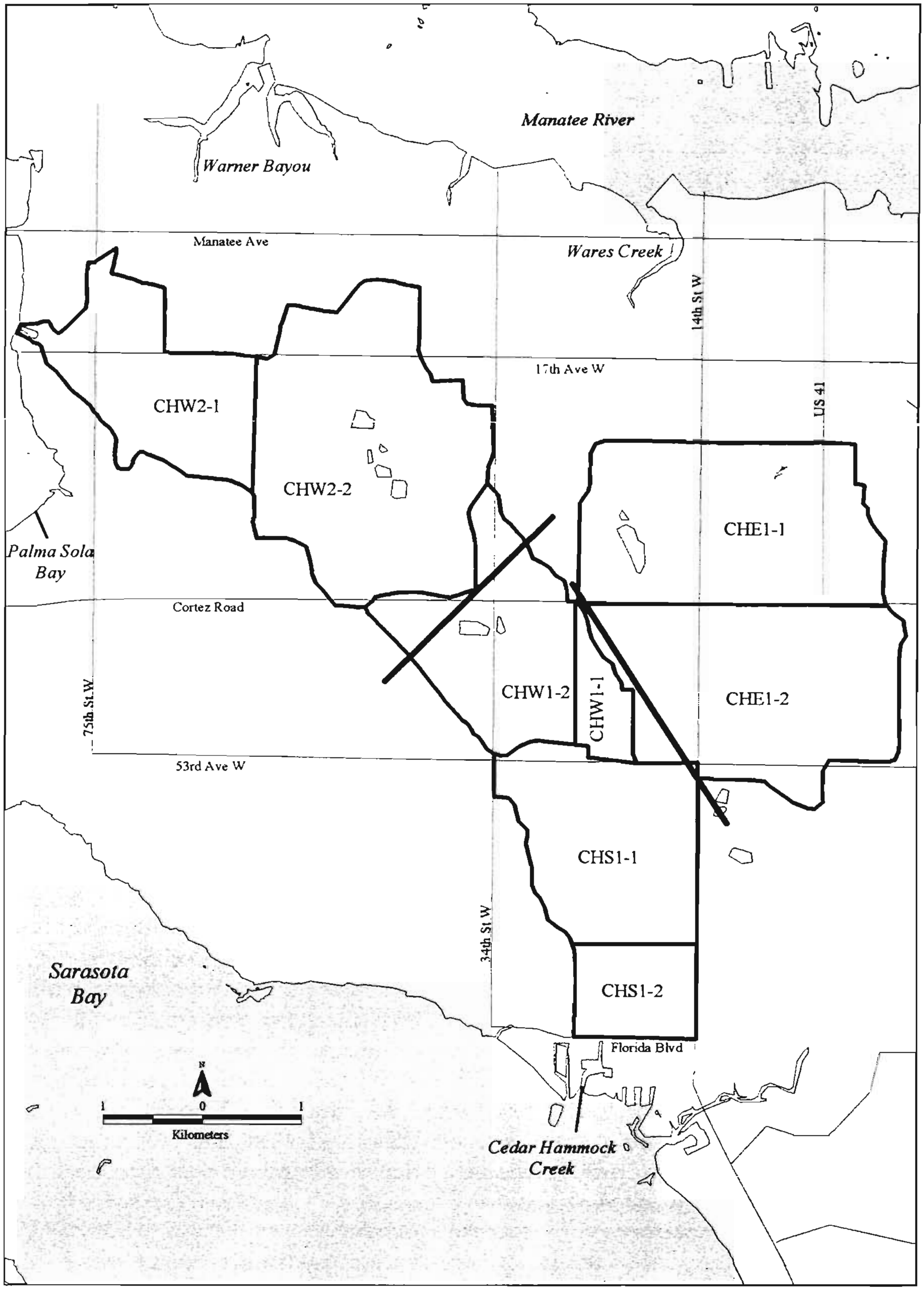

Figure 3. Subbasin identifications, Cedar Hammock Creek watershed.

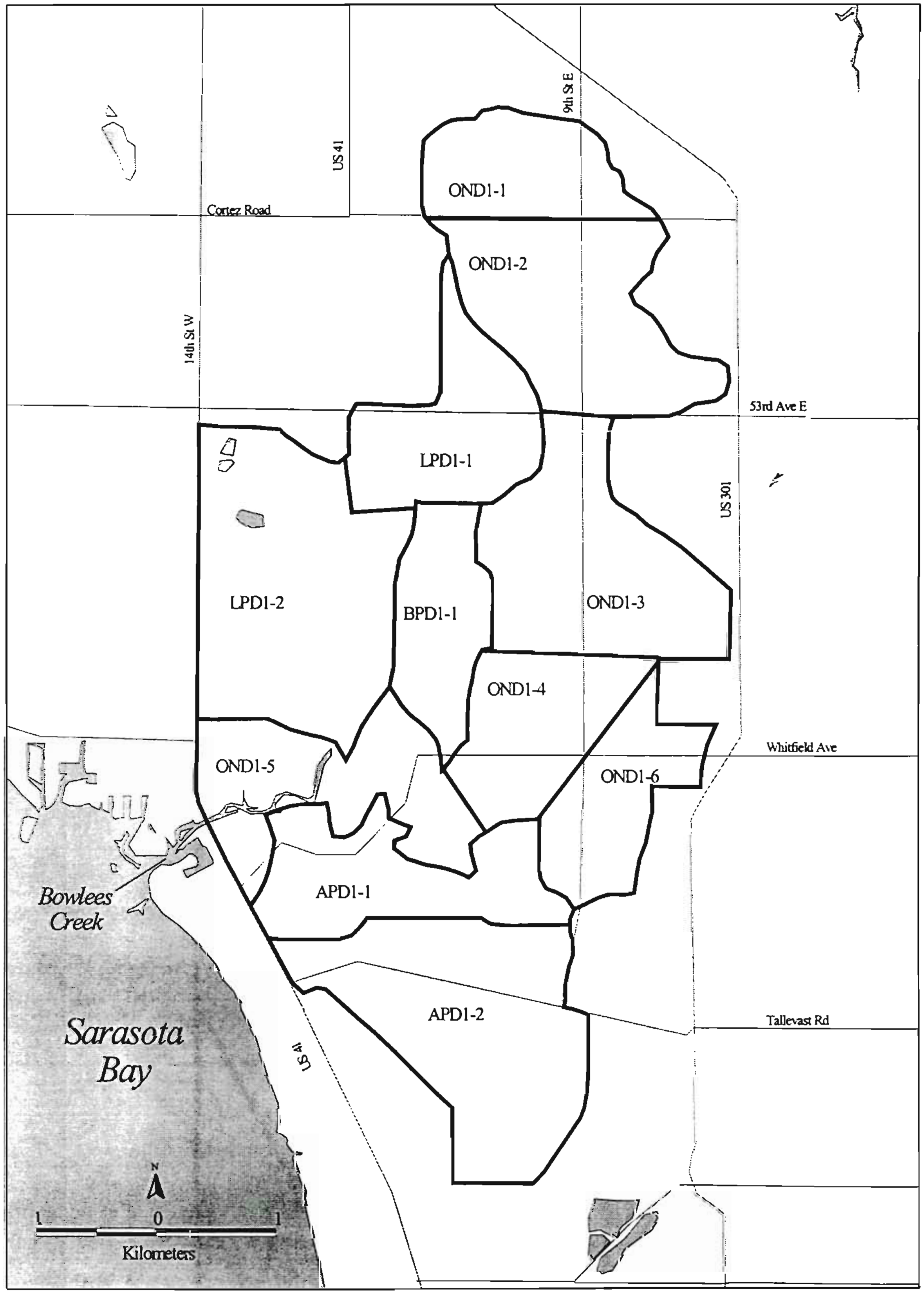

Figure 4. Subbasin identifications, Bowlees Creek watershed.

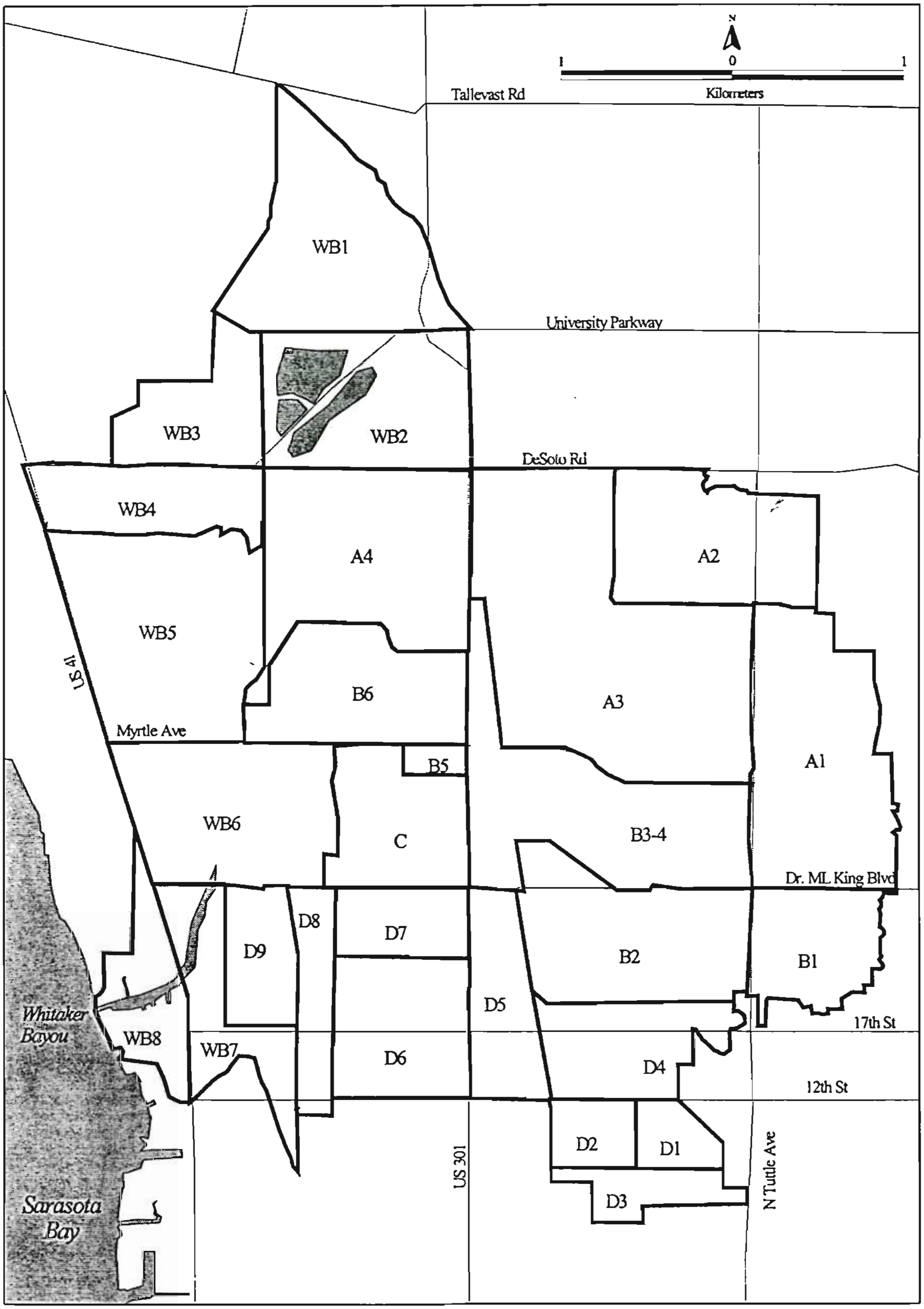

Figure 5. Subbasin identifications, Whitaker Bayou watershed.

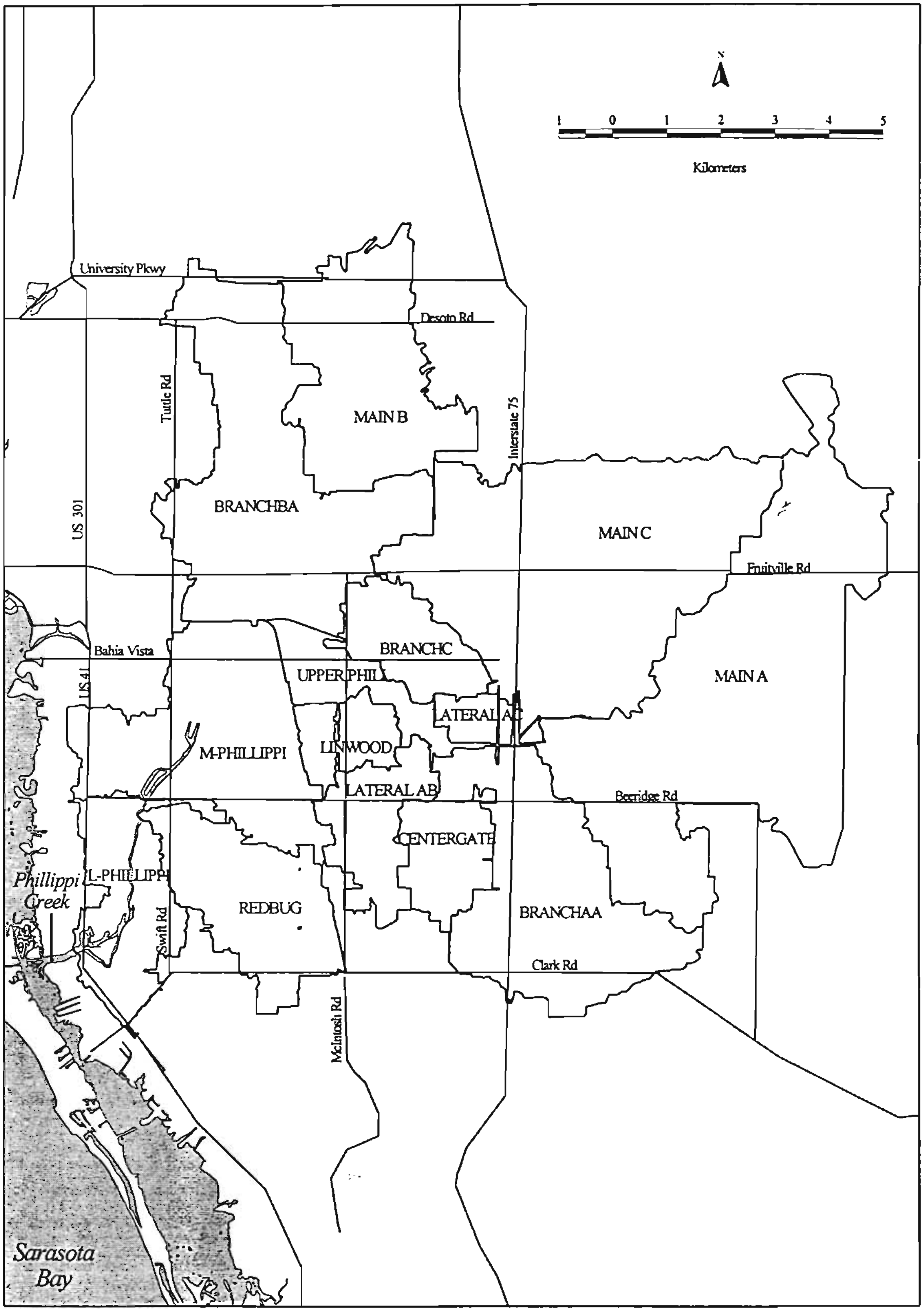

Figure 6. Subbasin identifications, Phillippi Creek watershed.

The time period was selected to coincide with the year of the enactment of the Federal Water Pollution Control Act (October 18, 1972), commonly known as the Clean Water Act. The legislation was the first nationwide regulatory program to address the control of discharge of contaminants into navigable waters. The Act marked an increasing awareness of the impacts of pollutants on receiving waters and was followed by an upsurge in the activities of local and state regulatory agencies. City Directories, in addition to the alphabetical listing of county residents and street listings, provide tabulations of commercial entities by general groups, such as suppliers of "Power Tools", "Plywood", or "Printer's Supplies".

Commercial groupings in the Directory were categorized as to the types of contaminants possible; metals, pesticides, hydrocarbons (PAH). To categorize a business for potential contaminants, the raw materials used, products manufactured, and probable manufacturing processes were all considered. Retailers (of pre-packaged items) were generally not considered to be potential contaminant sources. Large retailers, such as shopping centers or department stores were considered to have large parking areas, high vehicular traffic, and were categorized as potential PAH and metals sources. Transportation industries (moving companies), delivery services, and other businesses likely employing a fleet of trucks was also considered a potential PAH and metals source. Pesticides were assumed in use not only at nursery-related industries, but also for large food preparation industries and public attractions with elaborate or extensive landscaping. **Poor "housekeeping" practices (outside and uncovered storage of raw materials, discarded manufactured items, and inappropriate discard and/or poor control of wastes) were assumed in all cases and so undoubtedly represent an overestimate of the contamination sources.**

The general commercial groupings (from the Directory headings) considered as possible contamination sources, together with the assigned contamination categories, appear in Appendix A-1. All businesses listed under these headings in the Directory were then compiled, with duplicate entries (under more than one category) and multiple entries at a single street address eliminated where appropriate. A total of 1107 entries resulted for Sarasota County as a whole. Listings were geolocated using U.S. Census Bureau Tiger95 maps of street addresses (TIGER/Line, 1995) and mapped on the watershed subbasin boundaries. Unmatched businesses were individually reviewed to optimize the database size. For all businesses falling within the subbasins of the Hudson Bayou watershed, each subbasin assignment was individually reviewed for reasonableness. A total of 147 businesses were identified as potential contaminant sources within the Hudson Bayou watershed in 1972.

Within each subbasin, the number of potential sources of metals, pesticides, and PAH was computed and normalized for the subbasin area. The number of businesses per acre was used to assign ranks to the subbasins for each of the contaminant categories with 1 as the least and 51 as the highest. The three contaminant rankings (metals, pesticides, and PAH) for each subbasin were then averaged to obtain combined historical rankings of all Hudson Bayou subbasins (Appendix A-2). The ranking of historical sources did not include any estimation of residential non-point sources or any permitted point sources. As described above, the ranking of potential historical sources was not performed for the remaining basins.

Present-day Non-point Sources

A list of potential, present day non-point sources (again excluding residential loadings) was identified from a variety of references, including federal, state, and local agency databases. Listings of small and large quantity generators of hazardous wastes were obtained from Sarasota County Fire Department Hazardous Waste Management and covered Sarasota County and City, as well as Venice and other communities. Manatee County's Environmental Management Department supplied a similar listing. The list structure and content originated with the Florida Department of Environmental Protection (FDEP) but has been updated by both Counties through inspections, telephone interviews, occupational licensing (where applicable), additions to yellow pages, commercial solid waste accounts, and FDEP identification numbers for the removal of hazardous wastes. The list includes SIC codes which are assigned by the County Tax Assessors Office in conjunction with occupational licensing.

The list was augmented as necessary to include large quantity generators of hazardous wastes, on-line facility listings obtained from the Facility Index System (FINDS) maintained by EPA Office of Information Resources Management (OIRM), inventories of EPA regulated facilities, and other facilities listed by a number of EPA program offices, including:

- National Pollutant Discharge Elimination System (NPDES) permit holders and the Permit Compliance System data base,
- Closed landfills identified in the NPDES Municipal Separate Storm Sewer System (MS4) applications
- Toxics Chemical Release Inventory System (TRIS),
- Biennial Reporting System submitted by generators of hazardous wastes and facilities that treat store or dispose of hazardous wastes, required by RCRA (Resource Conservation and Recovery Act),
- Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS),
- Hazardous Substance Release/Health Effects Data Base (HazDat) maintained by the Agency for Toxic Substances and Disease Registry for releases from superfund sites or emergency events.

The present day listings for Manatee County and Sarasota County, combined, included 3238 businesses. Potential contaminant categories were assigned to each unique SIC code based on raw materials, manufacturing processes, probable commercial activity, and under the assumption of poor housekeeping practices. Contaminant categories were matched with SIC codes of the individual businesses. Present day listings were geolocated, with review procedures as described above for historical sources. Of the present day industries with contamination potential, 1938 were within the watersheds of the priority subbasins.

Within the Hudson Bayou watershed, 122 entities were judged to be potential contaminant sources. Within the remaining four basins, 244, 415, 305, and 852 potential sources of contamination were found within Cedar Hammock (entire watershed), Bowlees Creek, Whitaker Bayou, and Phillippi Creek, respectively. The SIC codes of present day industries that are considered to have contamination potential and that are located within the various watersheds appear in Appendix B-1. Density of sources per acre was used to rank the subbasins by each contaminant category, and to compute an average ranking for potential present day sources (Appendix B-2 through B-5) Again, residential non-point sources and permitted point sources were not included in the development of the present day rankings.

Multi-sector Industries

Under the EPA's Multi-Sector Industrial stormwater NPDES permitting program, a number of SIC codes are treated as a single category for runoff permitting purposes (Appendix C-1). The industries are those which, because of materials used or manufacturing activity, must take particular care to prevent pollutants from entering stormwater. For each of these 29 facility groups, EPA has published an *Industry Profile* (Appendix C-2 through C-5) which lists toxic products and by-products which are associated with the industry, a select list of pollutants (and concentrations) found in runoff from these facilities, and options for controlling stormwater loads. The *Industry Profiles* were used to assign the potential contaminant categories of metals, pesticides, and PAH to each of the multi-sector facility types. Based on SIC codes contained in the compiled Sarasota and Manatee County database, multi-sector industries were identified, assigned potential contaminant categories, and geolocated as described for historical and present day potential sources. Of the 231 multi-sector industries within Sarasota County, 22 were within the Hudson Bayou watershed. A total of 30, 135, 82, and 121 multisector industries were within the boundaries of Cedar Hammock, Bowlees Creek, Whitaker Bayou, and Phillippi Creek, respectively. Within Hudson Bayou, the most numerous category (9 of 22) was printing and publishing facilities. The most numerous facilities type within the Cedar Hammock watershed was Sector R, 'Ship and Boat Building or Repairing and within the Bowlees Creek watershed was 'Fabricated Metal Products' (Sector AA). The Whitaker Bayou watershed had a concentration of Sector W, 'Furniture and Fixtures', as did Phillippi Creek. Facility types within each watershed are listed in Appendix C-6. Density per acre was used to define rankings for each of the contaminant categories. The average ranking for multi-sector industries was then computed as the mean of the three contaminant rankings (Appendix C-7 through C-10) .

Quantitative Present-day Non-Point Source Loadings

Estimates of subbasin loading were developed using a Windows-based version of the Watershed Management Model (WMM), a public-domain software prepared for Florida Department of Environmental Protection (FDEP) by CDM. The model has been accepted by EPA for use in watershed management as noted in the Compendium of Watershed-Scale Models for TMDL Development (EPA 841-R-92-002) and was the most commonly used model by municipalities to meet their annual loading estimate requirements under the MS4 NPDES program. The majority of the development work was completed as part of a EPA stormwater demonstration project (Rouge River Watershed Demonstration Project, http://www.epa.gov/OWOW/watershed/rouge_mi.html).

The core calculations of WMM were derived from a simple equation:

Watershed Runoff X Event Mean Concentration = Watershed Load

Recently (1991-present), a sizeable and current database of runoff quality was developed by municipalities around the country as a Federal requirement for obtaining an NPDES permit to discharge stormwater. Known as MS4 permits, each applicant is required to sample three representative storms from up to five different land use types in order to characterize the type and concentration of pollutants in runoff. While the value of such expensive sampling remains subject to debate, the program produced a database rivaling EPA's landmark efforts in the 1980's known as the Nationwide Urban Runoff Program (NURP). The NURP data were the source of Event Mean Concentrations (EMC - average concentration in stormwater runoff) data for many non-point source modeling efforts over that past decade. However, newer data is believed to reflect both the advances in sampling/analytical techniques as well as the changes brought about by years of improved environmental regulations (*e.g.* reduction of leaded gasoline additives beginning in the early 1970's [Trefry *et al.*, 1985]). Consequently, a conscientious effort was made to acquire and convert the newer data into EMC data for the present project.

Runoff quality data submitted to EPA as part of NPDES MS4 permit applications were obtained for 192 sites, representing 603 storm events. Relatively few of the sites represented a single land use, and it was necessary to combine similar land use types. The land uses sampled by each site, along with the location of each site, is given in Appendix D-1. The MS4 application process did not specify land use categories, and as a result, there is a great deal of variation in describing the land use. For example the terms ' forest', 'open', 'park', 'urban open' and ' recreational' might all be used to described a wooded parcel within an urbanized or rural setting. Similar problems of definition occur when attempting to describe "industrial " (light, medium , heavy or intensive) and other land uses. Land use types for which stormwater data were available and which were combined for the present evaluation are given in **Table 1**. The selection criteria applied to development of an EMC for a defined land use type was that the combinations of the land uses must exceed 70% of the total land use. For example, if combination of forest and urban open exceeded 70% at a given monitor site, then the data were included for development of an 'open' land use EMC.

For pesticides and polynuclear aromatic hydrocarbons, the same pattern as seen in the NURP data was repeated in the newer data. In essence, the overwhelming majority of these analytical results indicated that the compounds were undetectable under the required analytical methodology regardless of the land use. **Table 2** gives the compounds evaluated and typical detection limits, while **Table 3** illustrates the percentage of non-detectable values by land use. Generally, the number of detectable results represented less than 3% of the observations. For purposes of ranking stormwater pollution potential of sub basins, the large number of results below the detection limit would result in the conclusion that loading was independent of land use (and thus independent of differences in subbasins).

Table 1. NPDES MS4 land uses, number of sites with the predominant land use, and land uses combined for non-point source stormwater modeling.

NPDES MS4 Land Use	Commercial	Heavy Industry	Highway	Industrial	Light Industry	Multi-Family Res.	Office	Mixed Land Use	Open	Other Urban	Public	Residential	Single Family Res.	Water	Forest
Number of sites with > 70 % specified use	40	1	0	37	1	5	1	4	5	0	0	54	14	0	0
PARK / URBAN OPEN / FOREST / WATER / WETLAND									X						
SF MEDIUM DENSITY RESIDENTIAL												X	X		
HIGH DENSITY / MULTI FAMILY RESIDENTIAL						X									
RETAIL / COMMERCIAL / OFFICES / INSTITUTIONAL / ROADS	X						X								
INDUSTRIAL				X	X										

Table 2. Polynuclear aromatic hydrocarbons (PAH) and chlorinated pesticide detection limits measured for NPDES MS4 applications.

PAH	Detection Limit-typical (ug/l)
3,4-BENZOFLUORANTHENE	7
ACENAPHTHENE	7
ACENAPHTHYLENE	7
ANTHRACENE	6
BENZO(A)ANTHRACINE	8
BENZO(A)PYRENE	7
BENZO(GHI)PERYLENE	7
BENZO(K)FLUORANTHENE	7
CHRYSENE	7
DIBENZO(A,H)ANTHRACENE	8
FLOURENE	6
FLURORANTHENE	7
INDENO(1,2,3-CD)PYRENE	7
NAPTHALENE	6
PHENANTHRENE	6
PYRENE	6

Chlorinated Pesticides	Detection Limit-typical (ug/l)
4,4'-DDT	4
ALDRIN	2
ALPHA-BHC	4
DELTA-BHC	2
ENDRIN	4
GAMMA-BHC (LINDANE)	4
HEPTACHLOR	4

Table 3. Percentages of nondetectable results in NPDES MS4 applications; polynuclear aromatic hydrocarbons (PAH) and chlorinated pesticides.

PAH	% Nondetecable	# Obs.	Chlorinated Pesticides	% Nondetectable	# Obs.
Single Family / Medium Density	97.6%	2,591	Single Family / Medium Density	96.1%	1,556
Multi-Family / High Density Residential	100.0%	196	Multi-Family / High Density Residential	100.0%	112
Retail, Commerical, Offices, Institutional, Roads	97.1%	1,696	Retail, Commerical, Offices, Institutional, Roads	99.2%	1,009
Industrial	97.3%	1,507	Industrial	96.9%	894
Park, Urban Open, Forest, Water, Wetland	100.0%	180	Park, Urban Open, Forest, Water, Wetland	99.0%	96

In lieu of the fact that all land uses would have the same EMC and no differences in loading or ranking could be developed, runoff modeling for PAH and chlorinated pesticides was not undertaken.

The metals of interest, however, were generally detectable in runoff, and a database was developed along the combined land uses previously described. The data were normalized to a common concentration unit and inspected for outliers or suspect values. In some cases the reported value was less than the reported detection limit. In other cases, the reporting units appeared to be incorrect (converted values were orders of magnitude different from the remainder of the data for either detection limits or reported values, or both.) Suspect data were discarded. Stormwater concentrations generally follow a log-normal distribution and a protocol for estimating the arithmetic mean from a log-normal distribution was reported in the NURP Final Report (USEPA, 1983) as follows (report nomenclature retained):

$$M = T * SQRT\ (1 + CV^2)$$

Where

M	=	(Mean, Arithmetic) Estimated Arithmetic Mean of EMC based on log-normal distribution
T	=	(Median) - Geometric mean of transformed data, = exp(U)
U	=	(Mean, logarithmic) Mean of natural logarithm transformed data
CV	=	(Coefficient of variation, arithmetic), Estimated Arithmetic CV based on log-normal distribution, = SQRT $(\exp(W^2)-1)$
W	=	(standard deviation, logarithmic). Standard deviation of transformed data

The resultant EMCs are given in **Table 4**, along with the number of observations contributing to the derived EMC. Also shown are the EMC data used in prior modeling work for Sarasota Bay (CDM, 1991). In general, the recent lead and zinc EMCs are lower than those previously used, although it is unknown if these differences are statistically significant. This apparent decrease could be the result of improved environmental awareness and controls (eg. The phase-out of leaded gasoline) or differences in sampling. For example, the recent MS4 NPDES program imposed a 72-hour antecedent dry period prior to sampling, and storm volume and duration were specified for the MS4 program. The wide-spread use of automatic samplers in the MS4 program probably contributed to more uniform sampling coverage across the storm hydrograph than occurred during the NURP study.

Annual loadings were desired for the present evaluation. Consequently, an annual average rainfall of 54.7 inches (CDM, 1992) was specified and used for all stormwater modeling. Pervious area was assigned a runoff coefficient of 0.15 and a value of 0.95 was assigned as the runoff factor for impervious area. Baseflow loadings were not simulated in the current study as the primary focus was on stormwater loadings.

Table 4. Event mean concentrations used for non-point source modeling.

Present Study For Toxics Evaluation				SBNEP - Phase I, II and III Point / Non-Point Source	
	Lead, ug/l (n=)	Copper, ug/l (n=)	Zinc, ug/l (n=)	Lead, ug/l	Zinc, ug/l
Single Family / Medium Density	0.027 (n =183)	0.023 (n =181)	0.102 (n =187)	0.049	0.054
Multi-Family / High Density Residential	0.018 (n =14)	0.013 (n =14)	0.113 (n =14)	0.076	0.060
Retail, Commerical, Offices, Institutional, Roads	0.024 (n =109)	0.024 (n =108)	0.175 (n =95)	0.235	0.120
Industrial	0.031 (n =114)	0.039 (n =114)	0.276 (n =101)	0.235	0.120
Park, Urban Open, Forest, Water, Wetland	0.020 (n =14)	0.007 (n =13)	0.033 (n =13)	0.000-0.006	0.000-0.120

The directly connected impervious areas (DCIA) assigned to each land use were as follows:

Land Use	DCIA (%)
Single Family / Medium Density Residential	30
Multi-Family / High Density Residential	45
Industrial	70
Park, Urban Open, Forest, Water, Wetland	1
Retail, Commercial, Offices, Institutional, and Roads	70

The combined land use file from all five basins consisted of 100 standardized (FLUCCS) land uses (Appendix E-1). Duplicate code numbers with differing descriptions were retained for completeness. Due to limitations of land use descriptors used to characterize runoff quality and the limited number of land use types for which runoff quality data are available, the land use within each basin was assigned and consolidated into five major categories (Appendix E-1) with resulting acreages per subbasin and combined land use types listed by watershed and subbasin in Appendix E-2 through E-4. The combined land uses are illustrated for the Hudson Bayou watershed in **Figure 7** and indicate that the single family-medium density designation forms the bulk of the land use (750 acres), with a relatively small proportion of industrial (12 acres). **Figures 8** through **11** illustrate land use for the remaining four basins. Cedar Hammock is dominated by multi family and high density residential (54% of approximately 6,500 acres) with only 0.5% classified as industrial. Nearly 38% of Bowlees Creek 5,975 acres was also multi-family and high density residential with nearly 12% industrial land use. Whitaker Bayou land use was relatively evenly divided between open and single family medium density categories(29% and 24% of 4,648 acres), but with the largest industrial category (15.7%) of any of the watersheds examined. Phillippi Creek, however, contained 54% of its 35,800 acres as open land, with another 30% as single family medium density residential.

Quantitative Present-Day Point Source Loadings

Point sources within the priority watersheds were represented in the loadings calculations described above. A list of permitted domestic and industrial point source discharges within Florida was obtained from FDEP's website. This information was obtained twice during the project in order to obtain the most current information. The first retrieval was on November 2, 1997 for the Hudson Bayou evaluation, and a second download was conducted on July 13,1999 for the remainder of the basins. Included with the facility name and permit number is the discharge location, design treatment capacity, status, method of disposal and type of treatment. In addition, the address of the facility and the name of the individual responsible for the facility is included.

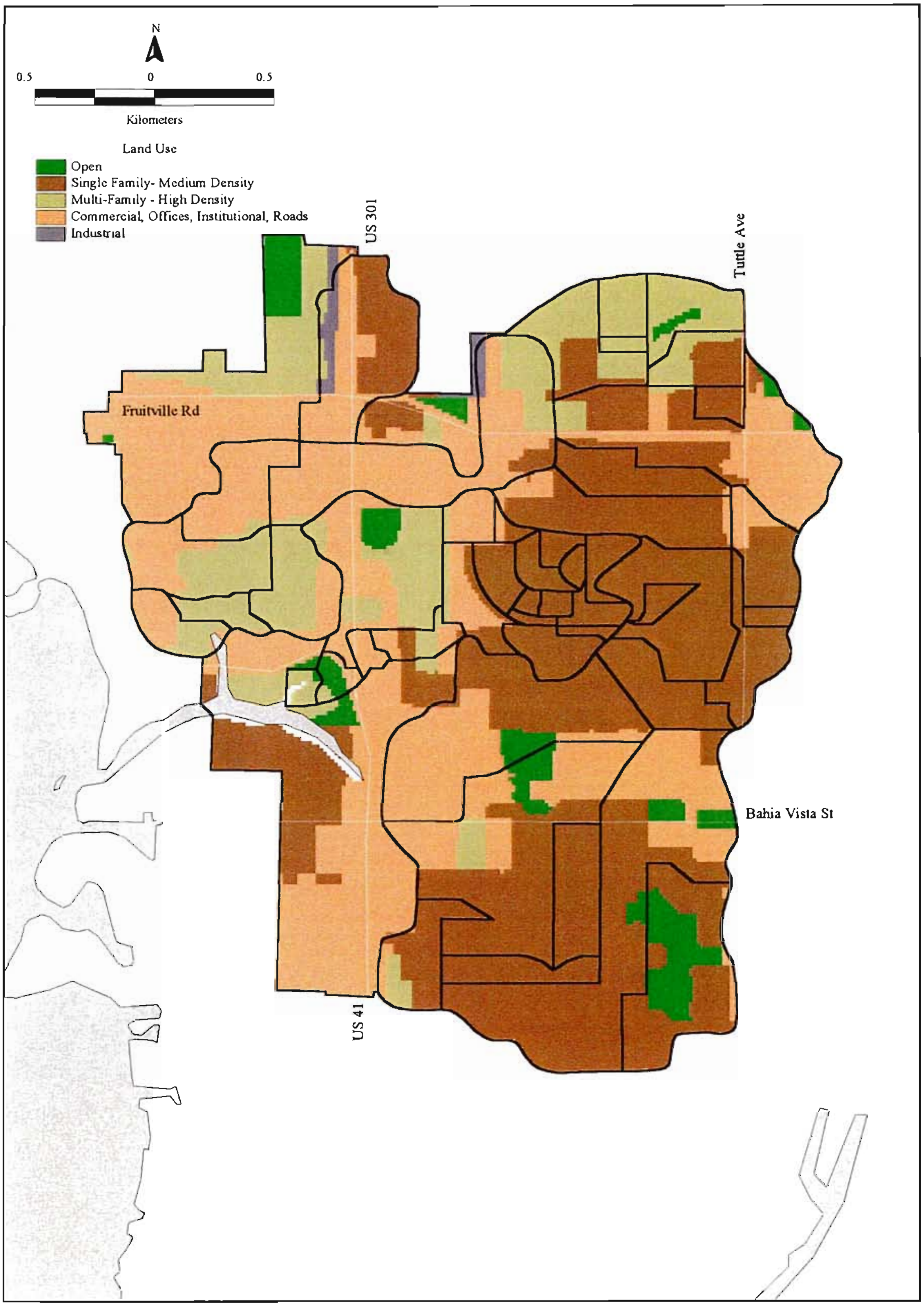

Figure 7. Combined land use distribution used for modeling stormwater loadings of metals to Hudson Bayou.

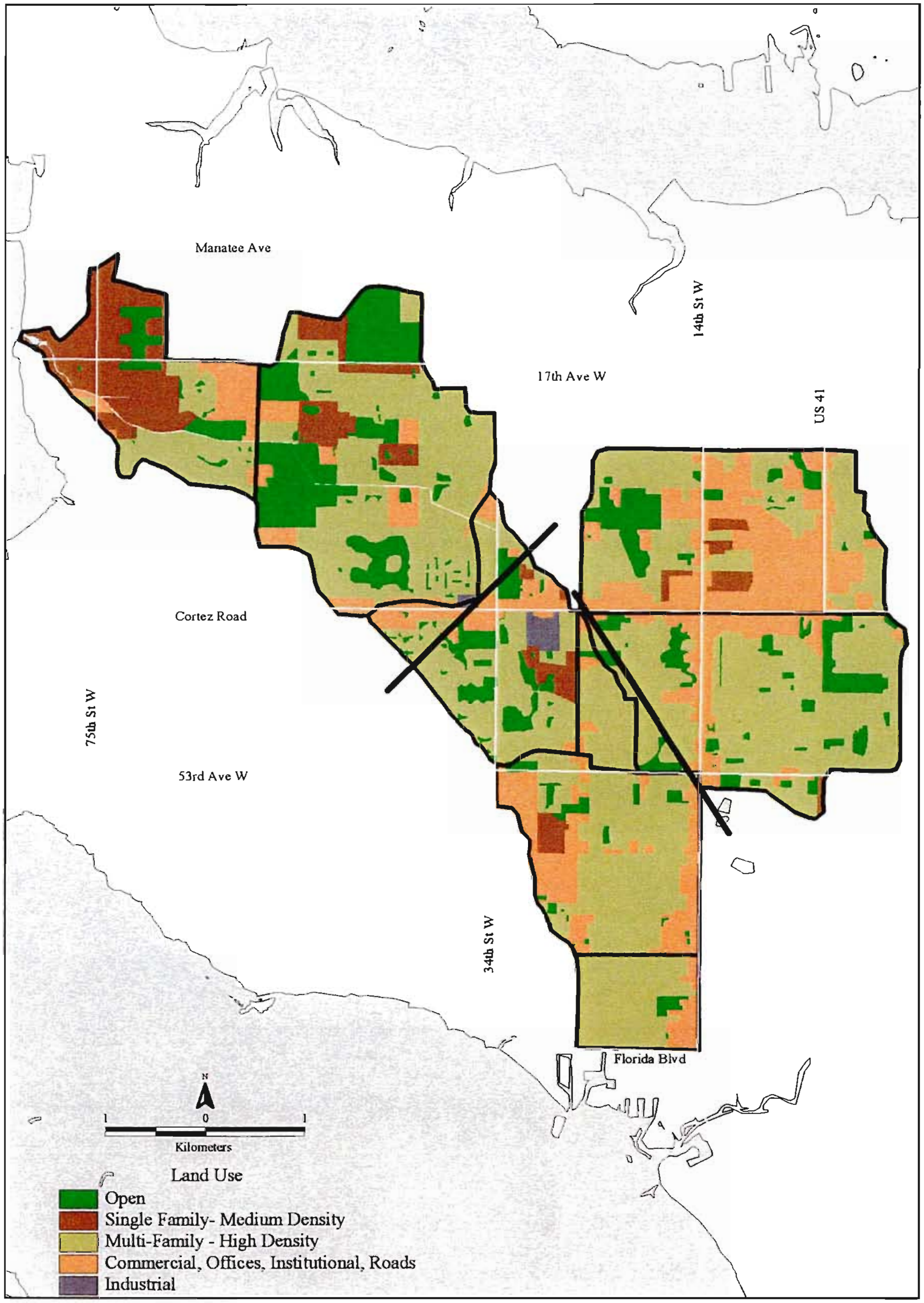

Figure 8. Combined land use distribution used for modeling stormwater loadings of metals to Cedar Hammock Creek..

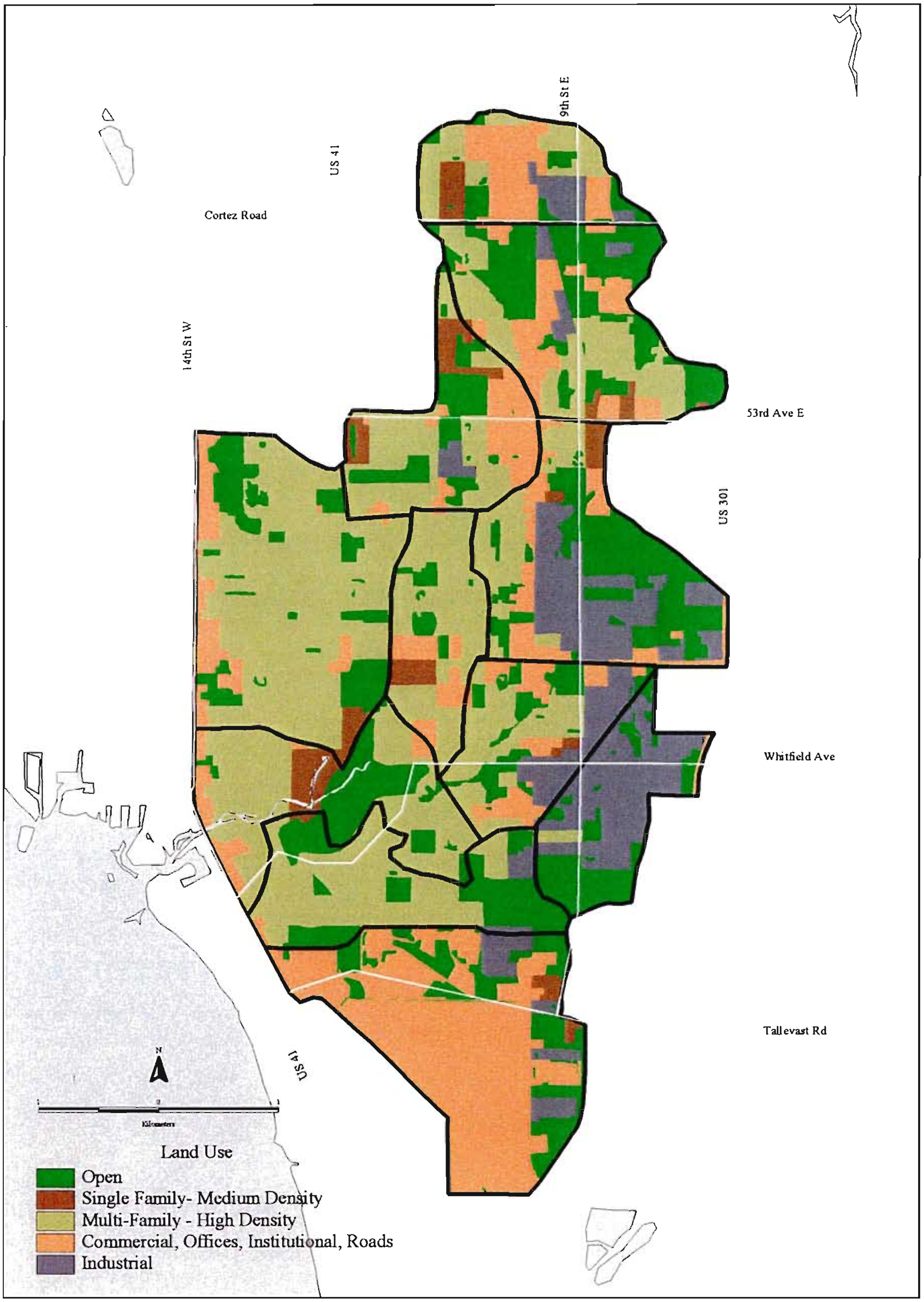

Figure 9. Combined land use distribution used for modeling stormwater loadings of metals to Bowlees Creek.

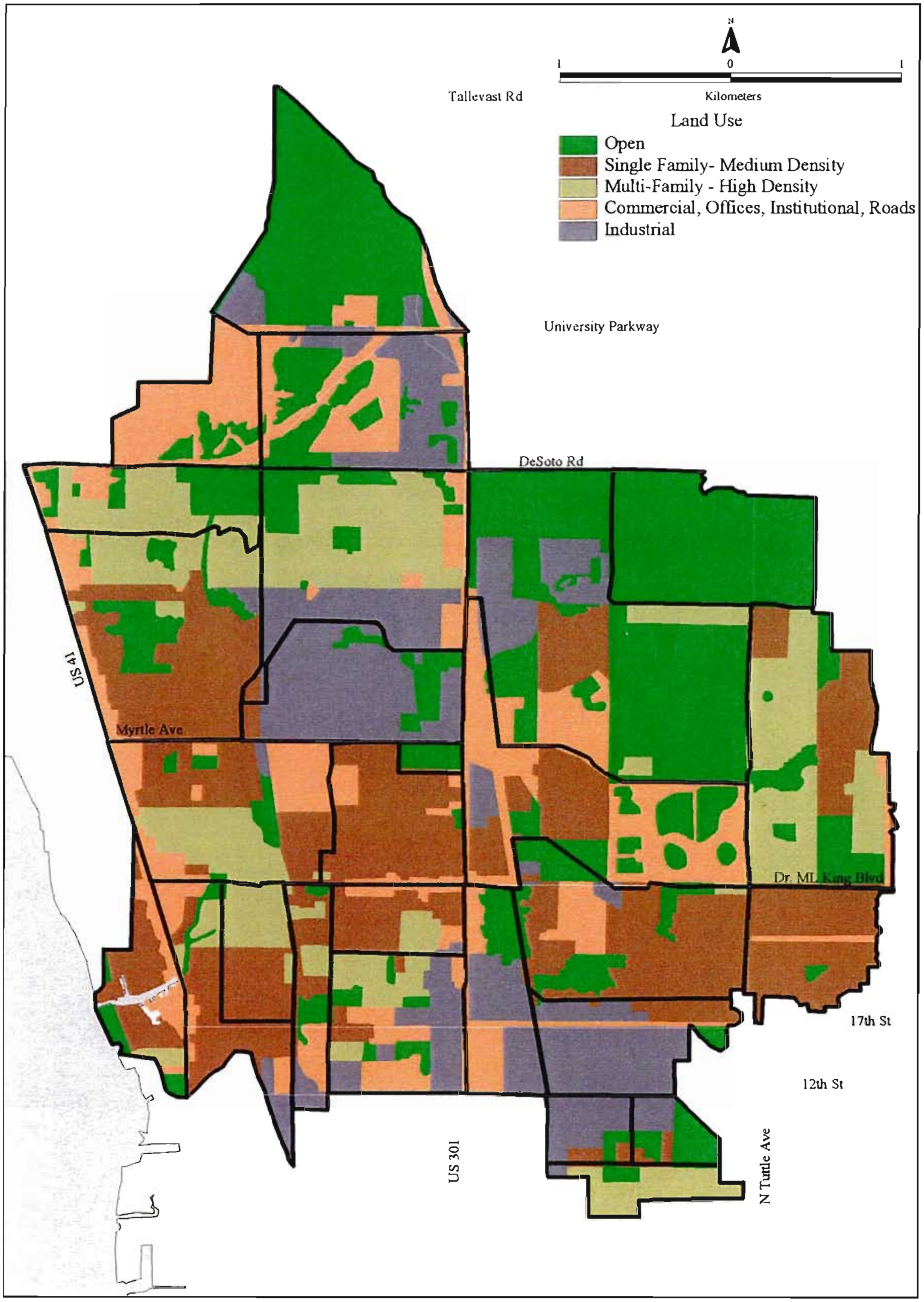

Figure 10. Combined land use distribution used for modeling stormwater loadings of metals to Whitaker Bayou.

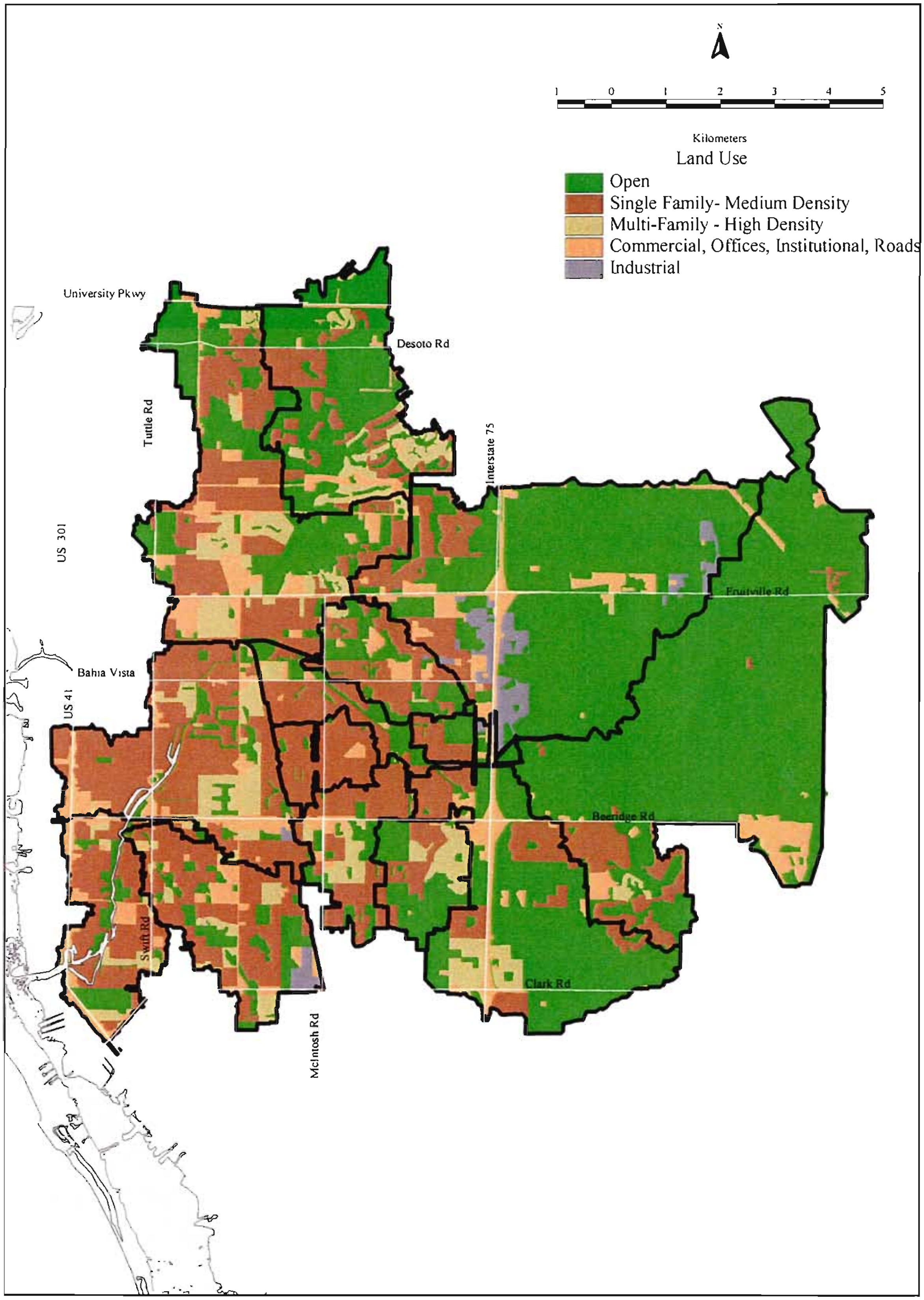

Figure 11. Combined land use distribution used for modeling stormwater loadings of metals to Phillippi Creek.

The industrial and domestic waste discharge databases were combined and facilities in Sarasota or Manatee County were abstracted. Facilities which were inactive, or under construction were deleted and the remaining entries were plotted according to the reported latitude and longitude on a base map of the NEP study area in ArcView. Basin and sub-basin boundaries for Hudson, Bowless Creek, Cedar Hammock, Phillippi Creek, and Whitaker Bayou were added. Facilities, which plotted in close proximity, but not within the study boundaries, were individually, evaluated to ensure that errors in location were minimized. One such station (City of Sarasota discharge into Whitaker Bayou at US 41) was retained although the City's discharge location is technically within the coastal drainage basin, which discharges directly to Sarasota Bay.

There were no discharges located within the Bowlees Creek, or Cedar Hammock watersheds. There was one facility, which plotted within the Hudson Bayou watershed, but the mailing address for this facility (South Bay Utilities) is listed as South Tamiami Trail. The facility is known to be located outside of the Hudson Bayou watershed, and was deleted from further evaluation. There were 27 potential dischargers in Phillippi Creek and 4 in Whitaker Bayou. Included in this list were several permitted stormwater discharges (e.g. Sarasota County Area Transit Facility) and other discontinuous discharges for which no loading can be assigned. Stormwater loadings are implicitly included in the land-use specific EMC and the intermittent discharge facilities were removed from the database.

The method of disposal was investigated next. Deep well injection facilities were removed from the database. For sites which practice reuse, ten percent of the total flow was assumed to reach the receiving waterbody. This value is consistent with earlier SBNEP estimates (CDM, 1991) and Tampa Bay NEP (Coastal Environmental, 1994) which applied load reduction rates of 90-95 %.

In order to eliminate sites that were insignificant contributors, sub-basin stormwater loadings were modeled independent of point source loadings and compared to the estimated point source loadings. Design capacity, adjusted for reuse if necessary, was used for this screening and typical secondary treatment concentrations were assumed as described later in this section. Discharge facilities were retained for further evaluation if the annual point source loading was five percent or greater than the sub-basin stormwater loading. Facilities which were retained were contacted (Appendix F-1) in an effort to get current average flows and site-specific effluent metal concentrations. If provided, the current information was substituted for the design capacities and assumed concentrations. Appendix F-2 gives a listing of rejected and retained facility names and locations.

Very few Florida domestic discharge permits require monitoring for heavy metals. In the absence of effluent-specific data, default concentration values were determined by taking the median metal concentration from several published secondary treatment effluents illustrated in **Table 5**. This resulted in copper, lead, and zinc effluent concentrations of 0.06, 0.03, and 0.23 mg/L respectively.

Table 5. Metal concentrations reported in secondary effluent.

Location	Copper (mg/L)	Lead (mg/L)	Zinc (mg/L)	Source
New York Region	0.105	0.190	0.185	1
Various	0.040	0.008	0.040	2
Hollister, CA	0.034	0.054	0.048	3
Anderson, Indiana	0.396	0.040	0.375	4
Buffalo, NY	0.053	0.025	0.704	4
Dayton, OH	0.325			4
Grand Rapids, MI			0.684	4
Muddy Creek, OH	0.083			4
Muncie, IN		0.167	0.345	4
Pittsburgh, Penn.	0.056	0.023	0.227	4
Wahiawa, Hawaii	0.020	0.015	0.073	4
Winnipeg, Man	0.048	0.060	0.066	4
Burlington, Ontario	0.084	0.016	0.552	4
Median	0.056	0.033	0.227	

1) 'Technical Guidance Manual for Developing Total Maximum Daily Loads, Book 2, Part 1, Table A-7. USEPA. EPA-823-B-97-002. 1997.

2) Irrigation with Reclaimed Municipal Wastewater, Table 13-1 Pettygrove, G. and T. Asano. Lewis Publishers. 1985.

3) 'Irrigation with Reclaimed Municipal Wastewater, Table 3-12. Pettygrove, G. and T. Asano. Lewis Publishers. 1985.

4) Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants in Surface and Ground- Table III-35. USEPA.

Because Sarasota County requires AWT, these typical secondary treatment values probably overestimate the loadings for several of the facilities. A list of the retained facilities, and their modeled inputs is given in **Table 6**.

Reported toxic releases are considered to be minimal based on the results of the TRIS inventory and were not included as they do not represent a continuing load to the priority watershed. Atmospheric deposition to the water surface of the conveyances within the basin was not quantified due to the comparatively small ratio of water to land surface. Atmospheric deposition to land surface was assumed to be captured in land use-specific EMC values. Groundwater contributions of toxic contaminants were also assumed to be minimal (McConnell and Brink, 1997). No adjustments for in-stream removals or removals by stormwater treatment systems were applied.

The summations of annual point and non-point source loading estimates for copper, lead, and zinc are given in Appendix G-1 through G-3. Results were normalized for area and ranked from highest generation rate (highest rank) to the lowest for each metal. The average of the individual metal rankings was computed as an overall indicator of potential heavy metal generation attributable to point and non-point source runoff.

Final Basin Ranking

Rankings of subbasins based on the categories of potential historical, present day, multi-sector, and modeled point and non-point sources of contaminants (Appendices A-2, B-2 through B-5, C-7 through 10, and G-1 through G-3) were computed based on density of industries per subbasin. Overall combined ranks were computed as the mean of the category rankings, again with the highest rank indicating the most likely contamination potential. For simplicity, subbasins were assigned a 'Final Basin Rank', an integer value indicating the likelihood of contamination. The final basin ranks were used to identify sampled sites,
are presented in Appendix H-1 through H-3.

Existing Information on Sediment Contaminants

In addition to the analyses performed on sediments from the estuarine portions of the priority watersheds in 1991 (Lowery *et al.*, 1993; Dixon, 1992), more recent analyses were also available from Hudson Bayou and Phillippi Creek. Hudson Bayou sediment data were available from a number of stations, both in the Bayou and within the watershed, while additional data for Phillippi Creek were limited to two stations. For Hudson Bayou, sediment analyses were required in advance of a permit for dredging the upper portion of the navigable Bayou, between the Osprey Avenue bridge and U.S. 41. Sediment toxicity characteristic leaching procedure (TCLP) analyses were performed on a composite of three shallow cores by the Center for Applied Engineering (Atlanta Testing and Engineering, 1996), to mimic the quality of decant water that might be expected from upland disposal.

Table 6. Site specific effluent characteristics modeled.

Basin	Site	Flow (mgd)	Copper (mg/L)	Lead (mg/L)	Zinc (mg/L)
Phillippi Creek	Bee Ridge WRF	0.59	0.0010	0.0005	0.0329
Whitaker Bayou	City of Sarasota WWTF (1)	4.00	0.0040	0.0025	0.0300
Phillippi Creek	South Gate WWTF	1.20	0.0015	0.0028	0.0074
Phillippi Creek	Dolomite Utilities Tri Par WWTP (2)	0.25	0.0050	0.0005	0.0750
Phillippi Creek	Kensington Park - TOTAL (3)	0.39			

1) Only discharged portion shown.
2) Copper and Lead concentrations are 0.5 MDL.
3) Sum of 'Kensington Park - 27th St Plant (0.085 mgd) and Monica Pkwy (0.304 mgd)

While no parameter exceeded upper regulatory limits for dredging purposes, lead was one of the few parameters detected in the analyses, indicating that sediments would still have measurable concentrations. More recent water column samples (May 1998) collected Ardaman and Associates, Inc. and analyzed by Environmental Quality Laboratory (EQL, June 17, 1998) from Hudson Bayou, Phillippi Creek, and the Myakahatchee Creek reveal that waters of Hudson Bayou, despite being heavily tidally influenced, have the highest lead concentrations of any of the three systems examined.

Other sampling in Hudson Bayou and Phillippi Creek has been conducted as part of an EPA NPDES MS4 permit held by Sarasota County permitees (EPA, 1997). With an effective date of December 31, 1996, the monitoring plan contained three activities pertinent to this project. Sediment sampling for selected trace metals is conducted annually at two stations in Hudson Bayou, the Orange Avenue and Osprey Avenue bridges, and two stations in Phillippi Creek, the Bahia Vista Bridge, and Coburn Road, east of I-75. Results are available for December 1997 and are included in tables of results from this project. Additionally, a one-time sampling was conducted in Hudson Bayou in May 1998, analyzing 12 cores collected from the mouth of the Bayou to the headwaters of the basin. Several of the 12 stations were located within the recently dredged portion of the Bayou, and many were collected from tidally influenced waters. As a result of the contaminated areas defined by this project, more recent sediment sampling efforts have been conducted by Sarasota County in the Hudson Bayou watershed, but these results are not yet available for inclusion here.

Sediment analyses for the NPDES monitoring and the one-time sampling of Hudson Bayou sediments were performed by Environmental Quality Laboratory (EQL, June 15, 1998) by SW-846 3050 and 6020 methods (EPA, 1996). This method, while a strong acid digestion, is not considered a total digestion. Metal:aluminum ratios used to determine sediment enrichment were developed using total digestion procedures. Comparing less than total digestion analyses to pristine values developed with total digestion procedures may underestimate the degree of contamination present.

Additional Fieldwork and Analyses

Ranking of subbasins by a combination of the approaches detailed above was used to design a sampling program to confirm the relative contributions of contaminants and to answer specific questions regarding the various subbasins. Since there were generally more subbasins than analyses planned, samples were preferentially collected from the downstream end of the highest ranked subbasins. By budgetary constraints, sampling within Hudson Bayou was limited to five stations within the watershed. The subsequent four basins eliminated the development of historical rankings in order to sample 7 sites per basin, on average. (Cedar Hammock, with the contributing portion being relatively small, was limited to 4 subbasins sampled, while 10 subbasins were sampled within the Phillippi Creek watershed.)

Sediments were analyzed since the toxic organic compounds of interest are hydrophobic and both organics and metals preferentially accumulate in the solid phase. Sediments were analyzed for the selected metals (copper, lead, and zinc), for pesticides, and for PAH (**Table 7**). Methodologies for metals included a total acid digestion (FDER, 1986), duplicating those described in Lowrey *et al.* (1993) to allow comparison with previous data and to allow an evaluation of metallic enrichment against aluminum concentration (Schropp and Windom, 1988). Existing metals data that may have been generated by less rigorous digestion methods may represent an underestimate of total metals present. Existing sediment data were reviewed prior to sampling site selection (Lowrey *et al.*, 1993, and more recent information from Phillippi Creek and Hudson Bayou). Sampling and analysis was conducted under Mote Marine Laboratory's FDEP- approved Comprehensive Quality Assurance Plan (FDEP #870216G), with subcontracted analyses for pesticides and PAH performed under similar plans (Savannah Laboratories, FDEP #890142G).

The anthropogenic enrichment of sediment metals has also been computed as the ratio of sample concentration to the concentration of the upper 95 percentile confidence interval that could be expected from 'clean' areas unaffected by anthropogenic activities. The confidence intervals have been developed from the linear relationship of sediment metal to aluminum content in sediments considered pristine (Schropp and Windom, 1988). Enrichment ratios of 1.00 represent the maximum that can reasonably be expected in uncontaminated sediments, while sediments with values greater than 1.00 can be considered significantly impacted.

Where possible, sediments were preferentially collected from within the subbasins above typical tidal influences, rather than from the receiving waters. Station selection within subbasins would allow identification of subbasins, or groups of subbasins, contributing contaminants, and could also eliminate large areas from consideration. If contaminant sources or residual contaminants from historical practices were still present in the watershed, then sediments within subbasins were expected to be either enriched (for metals) or to exceed levels for predicted biological effects. Identifying contamination in the main stem of the tidally influenced tributary would be difficult to assign to specific subbasins, and due to reversing tidal flows, could not definitively eliminate areas from consideration. In addition, any dredging to navigable waters that may have occurred as well as continuing boat traffic, may have disturbed the more recent layers of sediments, leading to a potential comparison between widely varying time periods if dredged areas are compared with undredged regions.

The role of analytical values in the project was to confirm the existence or absence of contamination in subbasins. Since sediment concentrations and degree of anthropogenic enrichment is a function of distance from source, as well as of contaminant load, sediment concentrations cannot be used quantitatively to compare the total loadings between subbasins or groups of subbasins.

Table 7. Methodologies and average detection limits for sediment analyses, Pesticides and PAH in ug/kg dry weight, metals in ug/g dry weight.

Parameter	Method	Detection Limit	
Metals			
Digest	FDER, 1986	-	
Copper	220.2	0.5	
Lead	239.2	0.1	
Zinc	289.1	2	
Aluminum	202.1	5	
Chlorinated Pesticides	SW-846, 8081	Various, dependent on sample % moisture	
Aldrin	1.7	o,p' DDD	3.3
alpha-BHC	1.7	o,p' DDE	3.3
beta-BHC	1.7	o,p' DDT	3.3
delta-BHC	1.7	p,p' DDD	3.3
gamma-BHC	1.7	p,p' DDE	3.3
Chlordane	17	p,p' DDT	3.3
Dieldrin	3.3	Toxaphene	170
Endosulfan I	1.7	Aroclors 1016	33
Endosulfan II	1.7	Aroclors 1260	67
Endosulfan sulfate	3.3	Aroclors 1221	33
Endrin	3.3	Aroclors 1232	33
Endrin Aldehyde	3.3	Aroclors 1242	33
Heptachlor	1.7	Aroclors 1248	33
Heptachlor Epoxide	1.7	Aroclors 1254	33
Methoxychlor	17		
Polynuclear Aromatic Hydrocarbons	SW846, 8310	Various, dependent on sample % moisture	
Acenaphthene	50	Dibenzo(a,h)anthracene	10
Acenaphthylene	20	Fluoranthene	10
Anthracene	4	Fluorene	10
Benzo(a)anthracene	4	Indeno(1,2,3-cd)pyrene	10
Benzo(a)pyrene	4	Naphthalene	20
Benzo(b)fluoranthene	4	Phenanthrene	4
Benzo(g,h,i)perylene	10	Pyrene	10
Benzo(k)fluoranthene	4	1-Methylnaphthalene	20
Chrysene	4	2-Methylnaphthalene	20

Station locations were further constrained by the character of the drainage system. In some regions, most of the stormwater system was below ground, typically in concrete pipe of varying diameters. Sediment accumulation in these conveyances is, by design, minimal. Any sediment accumulation within the storm sewers generally reflects only the most recent loads to a system, rather than an integration of loads over some longer time period. The small accumulations of sediments are not always accessible to sampling. Stations were selected, therefore, to reflect an integrated time period and to be traceable to specific subbasins or groups of subbasins. Where conveyances in basins were typically more exposed, the choice of sampling locations less constrained.

IV. RESULTS AND DISCUSSION

Chlorinated Pesticides

For samples collected in 1998 and 1999, no chlorinated pesticides were found above instrumental detection limits. This in contrast to the work in 1991, in which the pesticides beta BHC, lindane, heptachlor, heptachlor epoxide, aldrin, chlorpyrifos (Dursban), o,p'-DDE, p,p'-DDE, o,p'-DDD, p,p'-DDD, o,p'-DDT, dieldrin, and endrin were detected variously in Cedar Creek, Cedar Hammock Creek, Bowlees Creek, Whitaker Bayou, Marina Jacks, Island Park, Hudson Bayou, Matheny Creek, and Elligraw Bayou. In particular, p,p'-DDE, p,p'-DDD, Dieldrin, and possibly lindane were detected at levels exceeding the probable effects levels (PEL) in 1991. (Supporting data to determine PEL and TEL values are less numerous for pesticides and not all detected compounds have sediment quality guidelines assigned.) In the earlier data, Hudson Bayou and Cedar Hammock Creek had the most stations at which PEL values were exceeded, but one or more stations in all of the priority watersheds, with the exception of Phillippi Creek, recorded pesticide levels in excess of PEL values. It appears that, of the pesticides examined, there are no longer substantial sources in the watershed subbasins sampled.

Hudson Bayou

The overall ranking of Hudson Bayou subbasins for potential contamination is illustrated in **Figure 12** and since there were many more subbasins than analyses planned, higher ranked basins (Appendix H-1) were preferentially sampled where drainage conveyances allowed. The subbasins upstream of each sampling site were consolidated for data interpretation (**Figure 13**).

The eastern portion of the watershed consisted of a northeastern and a southeastern region, the drainage from which converges on the campus of Sarasota High School. The station designated as HB-3 is above a weir control structure and represents the northeastern region, an area of generally low rankings for potential contaminants.

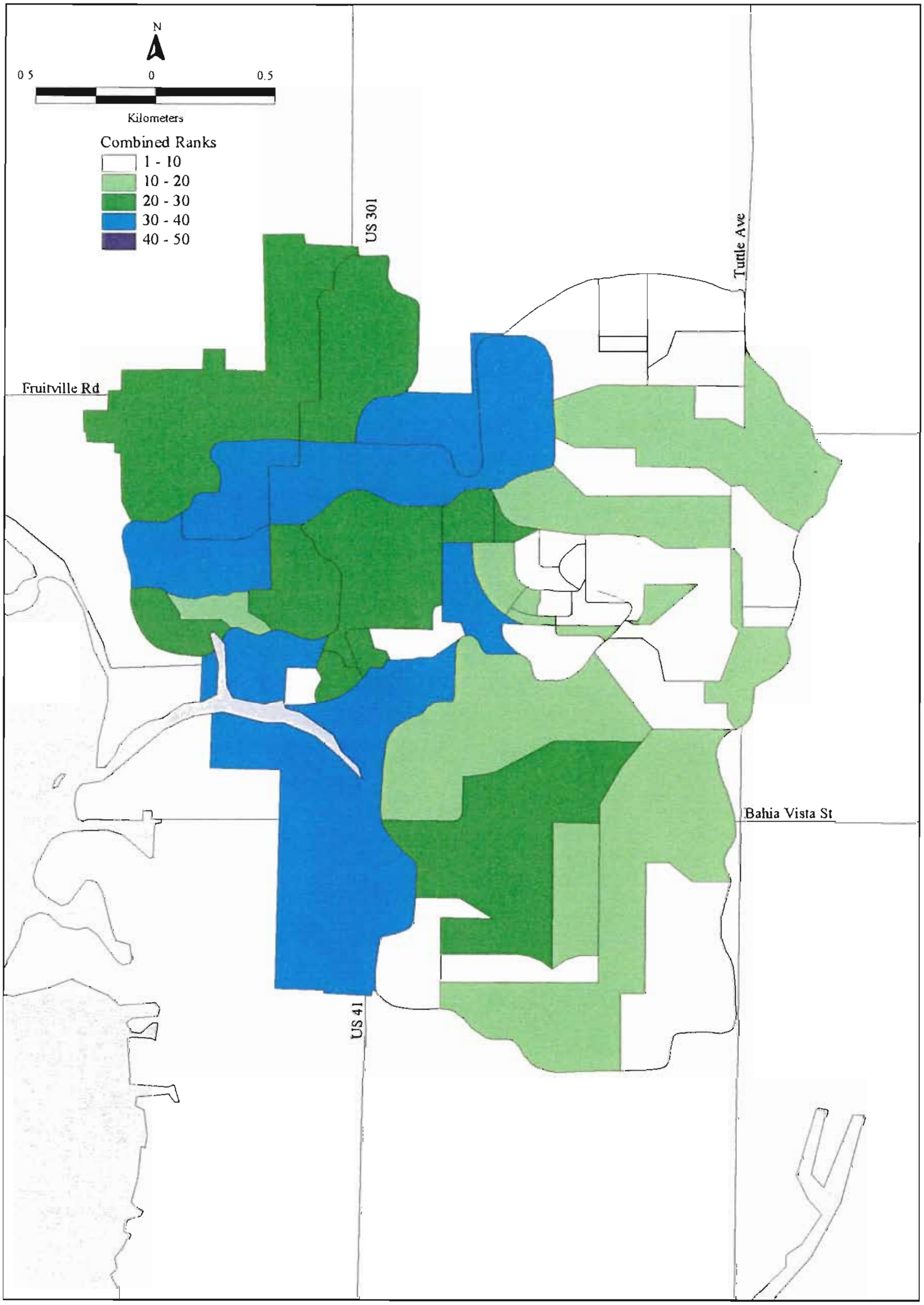

Figure 12. Combined ranks of the density of potential contaminant sources based on historical and present day industry presence, multi-sector industries and estimated metals loadings in stormwater, Hudson Bayou.

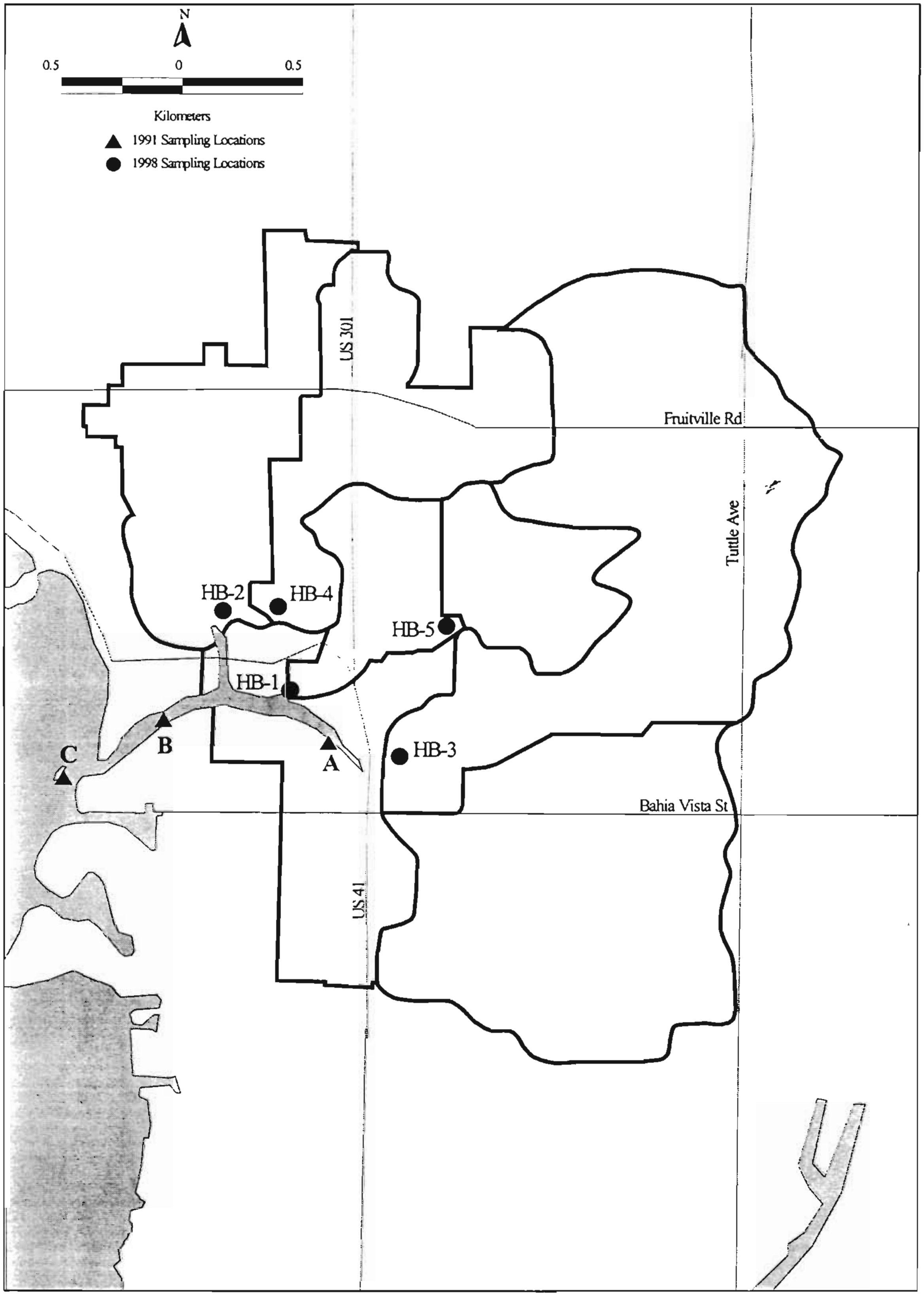

Figure 13. Consolidated subbasins and location of sediment samplings conducted in 1991 and 1998, Hudson Bayou watershed.

The southwestern portion consists of a single subbasin (020601) on both the north and south banks of the Bayou, and contains the southern portion of U.S. 41 corridor, as well. The drainage is entirely in closed pipes, with multiple discharges directly into the tidal waters of the Bayou. This subbasin was not sampled.

The downtown region is the most hydrologically complex, and is entirely in closed pipes. Apparent drainage is from North Washington Boulevard (U.S. 301, subbasin 020501), west along Fruitville Road, to collectors on Osprey Avenue. Lime Avenue runoff (subbasin 020203) is routed west along Ringling Boulevard, also joining with Osprey Avenue. Osprey and Orange Avenue drainage both discharge to a small north-south tributary to Hudson Bayou, located between the two Avenues. Discharges from subbasin 020104, with possible contributions from the central portion of the watershed (subbasin 020413) were represented in sediments sampled at HB-4. Discharges from the western side of the basin (primarily along Orange Avenue) were sampled by sediments from HB-2. The remaining central section of the watershed drains to a small embayment located above a salinity control structure immediately to the east of Osprey Avenue and on the north bank of the Bayou. Sediment samples were collected at this location (HB-1) to represent activities in the entire group of central subbasins. An additional sample was collected farther upstream in the central group of subbasins (HB-5). Sediments from HB-1 include the subbasins represented by HB-5, as well as the additional influences of subbasins 020411, 010412, 020414, and 020413.

Results of sediment analyses for metals within Hudson Bayou appear in **Table 8** together with older data (Lowery *et al.*, 1993) on sediments within the Bayou and calculated enrichment ratios. More recent sediment data analyzed by differing methods are also listed (EQL, February 2, 1998; EQL, June 15, 1998). **Figure 14** summarizes enrichment ratios for stations sampled under this project and in 1991.

For metals, all of the six new sediment samples collected under this project were enriched in lead and in zinc, while three of five stations were enriched in copper. Most notably, concentrations of lead at the outfall from the central region (HB-1) were 30-40 times greater than would be expected from uncontaminated sediments. (The highest lead enrichment values previously observed in the Bayou sediments were approximately 20 times higher than expected.) Zinc concentrations were 10 times expected levels at this location, and copper 2-3 times higher than would be found in uncontaminated sediments. Farther upstream in the same portion of the central watershed (HB-5), however, lead and zinc enrichments were only on the order of 4 times higher than expected, implying a substantial source between the two sampling locations. Other stations with substantially metal-enriched sediments were HB-2 and HB-5 for lead and for zinc.

Since lead enrichment was higher than previously (1991) observed in sediments within the tidal portion of the Bayou, the lower central basin appears to be a dominant source of lead to Hudson Bayou. As sediment samples were from the top 2-5 cm of sediment and were selected to avoid dredged or disturbed areas, sediment data should be representative of recent accumulations. Contamination with lead is either ongoing, or of such a magnitude historically that even recent sediments are still substantially contaminated.

Table 8. Sediment metal concentrations from samples collected in 1998, 1997 and 1991, Hudson Bayou. Enrichment ratios computed as the ratio of sediment concentration to the upper 95th percentile of the values of pristine sediments. Shaded values are from analyses using less rigorous digestion methods. 'T' indicates tidally influenced station.

				Aluminum	Copper	Lead	Zinc	Enrichment Ratio			
Station	Date	Tidal	Description	ug/g dry wt	ug/g dry wt	ug/g dry wt	ug/g dry wt	Copper	Lead	Zinc	Mean
HB-3	1998	-	Near Sarasota High Schl	1,161	1.1	3.5	8	0.2	1.2	1.1	0.8
HB-1	1998	-	Pond E of Osprey Ave	7,480	40.7	528.1	260	2.3	46.6	9.0	19.3
HB-1R	1998	-	Pond E of Osprey Ave	21,343	84.8	811.7	654	2.9	33.3	10.7	15.7
HB-2	1998	-	Nr Alderman and Orange	1,120	9.4	21.7	54	1.3	7.5	7.3	5.4
HB-5	1998	-	School St near Novis St	6,688	15.2	42.6	125	0.9	4.1	4.7	3.2
HB-4	1998	-	Nr Alderman and Osprey	1,020	1.7	9.0	13	0.3	3.3	1.9	1.8
H-1	1998	T	Bayou mouth	2,160	6.9	15.3	15	0.7	3.3	1.3	1.8
H-2	1998	T	Downtown	3,320	6.2	14.6	37	0.5	2.3	2.3	1.7
H-3	1998	T	Osprey Ave	3,680	20.5	76.8	59	1.7	11.3	3.4	5.5
H-4	1998	T	Orange Ave	2,410	17.1	37.1	32	1.7	7.4	2.5	3.9
H-4R	1998	T	Orange Ave	1,730	10.8	27.6	21	1.3	7.0	2.0	3.4
H-5	1998	T	Bayou btwn Osprey/Orange	3,350	29.6	181.0	150	2.5	28.6	9.2	13.4
H-6	1998	-	Central basins	950	9.4	115.0	441	1.5	44.9	66.1	37.5
H-7	1998	T	US 41	1,680	7.4	13.6	28	0.9	3.5	2.8	2.4
H-8	1998	-	NE basins (Sar. HS)	1,110	1.7	6.4	15	0.2	2.2	2.1	1.5
H-9	1998	-	SE basins	875	5.8	10.1	36	0.9	4.2	5.6	3.6
H-10	1998	-	Upper SE basins	1,190	3.9	57.5	33	0.5	19.1	4.2	8.0
H-11	1998	-	Upper NE basins	2,690	0.6	3.7	6	0.1	0.7	0.5	0.4
H-12	1998	-	Upper NE basins	6,480	3.5	37.5	36	0.2	3.7	1.4	1.8
H-3	1997	T	Osprey Ave	8,460	12.2	35.7	46	0.7	2.9	1.5	1.7
H-4	1997	T	Orange Ave	4,720	20.3	62.8	54	1.5	7.7	2.6	3.9
24-A	1991	T	Near US 41	3,150	24.3	117.6	109	2.1	19.4	7.0	9.5
24-A	1991	T	Near US 41	7,390	43.6	121.0	76	2.5	10.8	2.7	5.3
24-A	1991	T	Near US 41	15,190	115.8	307.8	589	4.7	16.2	12.3	11.1
24-A	1991	T	Near US 41	7,840	76.2	257.1	410	4.3	21.9	13.8	13.3
24-B	1991	T	Orange Ave	19,130	73.1	199.2	82	2.7	8.9	1.5	4.3
24-B	1991	T	Orange Ave	27,290	92.5	195.1	214	2.8	6.7	2.9	4.2
24-B	1991	T	Orange Ave	21,990	77.5	196.2	193	2.6	7.9	3.1	4.5
24-B	1991	T	Orange Ave	19,700	76.4	195.5	203	2.7	8.5	3.5	4.9
24-C	1991	T	Bayou mouth	2,150	3.7	6.7	6	0.4	1.5	0.5	0.8
24-C	1991	T	Bayou mouth	1,080	1.9	3.0	6	0.3	1.1	0.8	0.7
			TEL		18.7	30.2	124				
			PEL		108.0	112.0	271				

[dashed box] = Above TEL [solid box] = Above PEL

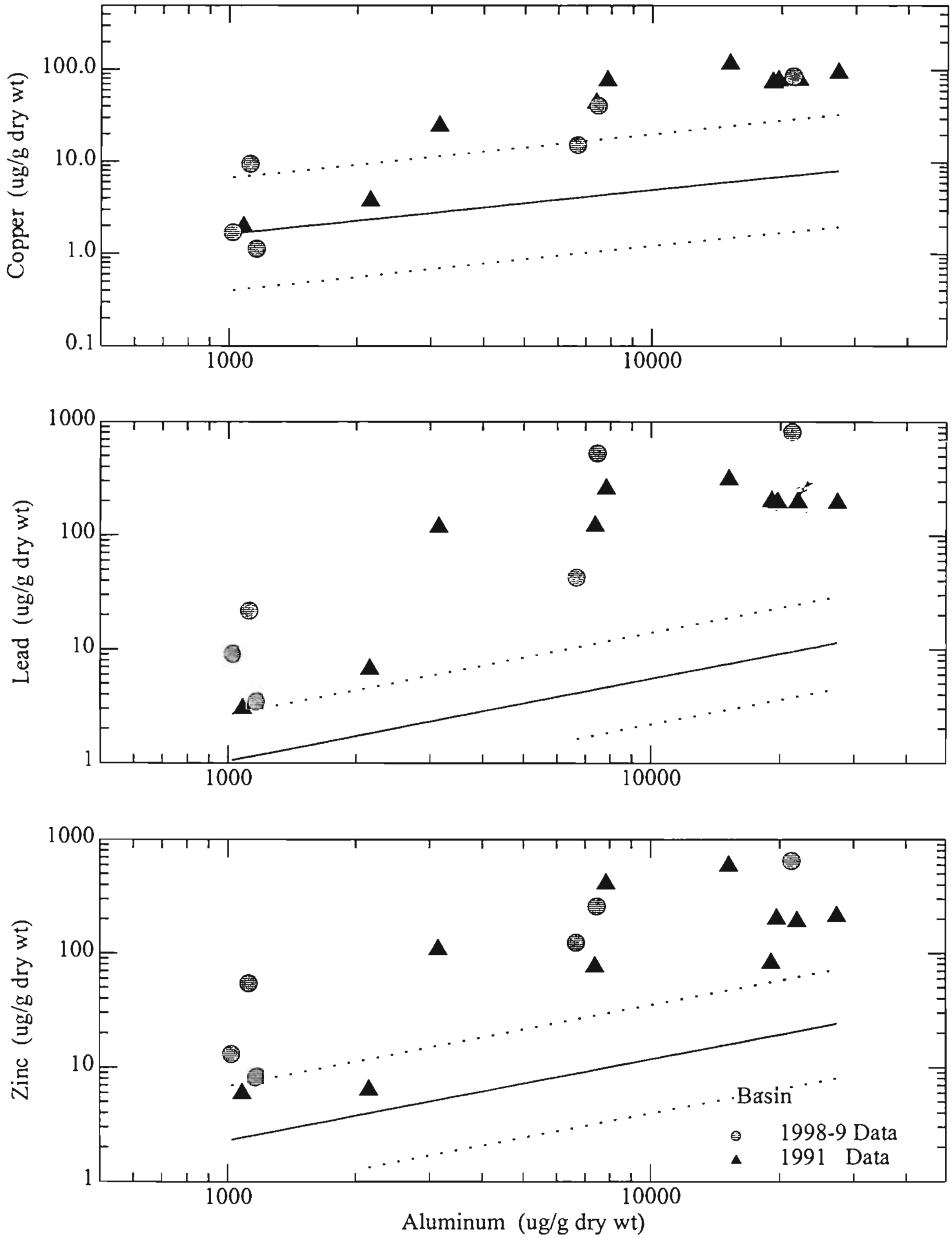

Figure 14. Sediment metal concentrations from the Hudson Bayou watershed illustrated with the linear relationship (and 95% confidence intervals) of metal to aluminum in pristine sediments.

The quantitative loadings from stormwater (Appendix G-1) were tabulated by region, with the central section divided into an upper and a lower portion (**Table 9**). In comparison with other stations and regional loadings, sediments at the outfall from the central region (HB-1) appear much more contaminated with lead and zinc than can be accounted for by either total pounds of metal contributed or as an average pounds per acre average loading rate. A point or non-point source that is atypical of the generalized land uses within the basin is implied.

As Hudson Bayou sediments in 1991 displayed enrichment factors for copper and zinc slightly higher than observed in the 1998 sampling under this project, the central region may not be the largest source of either copper or zinc to the Bayou. Of the stations sampled in this project, however, the lower central region of the watershed does appear to be the dominant source of copper, lead, and zinc to Hudson Bayou, despite the fact that predicted loading rates for the three metals (in lbs/ac/yr) are highest for the southwestern and downtown regions (Table 9, above).

Comparison of lead enrichment values from co-located stations (HB-1 and H-6) reveal similar orders of magnitude of contamination for sediments collected in 1998, despite differing digestion procedures. From this, one can assume that there is little clay in the sediments at this station and that both digestion techniques produce representative lead values. Accordingly, enrichment values from all sediment data and time periods were examined to identify contaminated areas more precisely than was possible using data from this project alone.

For copper, sediments entering Hudson Bayou from the lower central basin (HB-1, H-6) appear to be the most contaminated (1998 data, enrichment factors of 2-3). Sediments at the upper Bayou stations were comparably contaminated in 1991, but after dredging (H-7 and H-3), concentration levels in sediments appear reduced. Undredged sediments in the Bayou between the Orange and Osprey Avenue bridges (H-5) remain enriched by a factor of 2 or more. None of the remaining tributaries or upper watershed stations appears to have large levels of contamination for copper. This result is consistent with the predicted loading rates for copper (Table 9, above) in which regional values are quite comparable, ranging from 0.12 to 0.17 lb/ac/yr.

Lead distributions support the discussion above, with the lower central basin apparently contributing the bulk of the lead in Hudson Bayou sediments. The range in enrichment values between replicate samples (33.3 and 46.6) at this station indicates that the sediments are non-homogeneous. The lead source could be intermittent, rather than a continuous discharge, or sediments contaminated upstream could be deposited only during storm events sufficient to transport large quantities of material. The sediment newly exposed at dredged stations (H-7 and H-3) is lower in concentration from that observed in 1991 (24A), but undredged areas of the Bayou (downstream of the Osprey Avenue bridge) retain substantially enriched levels, with factors of nearly 30 times pristine levels. All sampled tributaries are contributing enriched sediments at some level, however, with an upper watershed station (H-10) also quite contaminated. Other than the mouth of the Bayou in 1991, and the upper northeastern portion of the watershed, no station could be considered pristine. Loading rates for lead (Table 9, above) are generally comparable between basins (0.14-0.18 lb/ac/yr) and do not account for the range in sediment contamination. An unpermitted point source or unusual activity for the given land use is indicated.

Table 9. Predicted stormwater loadings for the major regions of the Hudson Bayou watershed.

Region	Copper		Lead		Zinc		Region Area	Percent of Watershed Loads			
	(lb/yr)	(lb/ac/yr	(lb/yr)	(lb/ac/yr	(lb/yr)	(lb/ac/yr	(acres)	Copper	Lead	Zinc	Area
Northeastern	65.43	0.13	73.68	0.14	335.50	0.66	510.7	27%	28%	24%	29%
Southeastern	49.14	0.12	54.60	0.14	267.70	0.66	403.3	20%	20%	19%	23%
Southwestern	33.95	0.17	35.46	0.18	221.67	1.10	200.9	14%	13%	16%	11%
Downtown	71.97	0.16	75.75	0.17	438.21	0.99	443.5	29%	28%	31%	25%
Upper Central	13.48	0.13	15.10	0.15	71.57	0.70	102.8	5%	6%	5%	6%
Lower Central	11.93	0.13	13.24	0.14	62.21	0.67	92.4	5%	5%	4%	5%
SUM	245.89		267.82		1396.87		1753.6				

In comparing results from H-6 and HB-1, zinc contamination is also non-homogeneous at a single station. Of the non-tidal tributaries sampled, the lower central basin again has elevated enrichment ratios and appears to contribute much of the zinc contamination to the Bayou. Dredged regions are similarly lower in concentration than 1991 values, with undredged sediments downstream of the Osprey Avenue bridge remaining nearly 10 times higher in zinc than for pristine sediments. Sediments in the southeastern region (H-10 and H-9) were contaminated to a greater extent than those in the northeastern area (H-11, H-12, HB-3). Other than the lower central region, sediments downstream of the downtown region (HB-2) were the next most enriched. The downtown region was also one of the regions with the higher zinc loading rates (Table 9, above 0.99 lb/ac/yr, compared to a range of 0.66 to 1.10 lb/ac/yr for the remaining basins).

Sediment metal concentrations also exceeded levels at which biological effects could be expected for many stations. Using a weight-of-evidence approach and a modification of the National Status and Trends Program, MacDonald (1994) prepared sediment quality assessment guidelines for Florida coastal sediments. Threshold effects level (TEL), and a probable effects levels (PEL) were identified for a number of compounds, including metals, pesticides, and PAH. Sediment metal concentrations exceeding either one or both of these thresholds are noted in Table 8, above. During the most recent sampling under this project, lead concentrations were three to five times higher than the probable effects level for the station draining the central subbasins (HB-1). Probable effects could also be expected due to the zinc concentrations for some sediments from this station. Fewer stations are contaminated with copper, but HB-1 again has levels that are above the TEL concentrations. Several other basins exceeded the TEL values for copper, lead, and zinc. Sediments collected in the tidal waters of the Bayou in the past have also been contaminated enough with lead and zinc to expect biological effects.

Data for PAH compounds in sediments collected in 1998 appear in **Table 10**. As PAH compounds preferentially adsorb to organic matter in sediments, data are also presented as normalized to the organic content of the samples for comparison between stations (μg PAH/kg organic matter). Similar to metals distributions, sediments at HB-1 exhibited a wide range in concentration of PAH, clearly reflecting intermittent rather than continuous discharges. Sediments from the upper central basins (HB-5) also have substantial quantities of PAH and so the lower central basins do not appear to be the only or even the dominant source of PAH to Hudson Bayou. In 1998, the sediments downstream of the downtown region (HB-2) were the most elevated in PAH for the organic matter present. The northeastern region (HB-3) appears to have the lowest PAH contamination. PAH data from 1991 similarly indicate a series of intermittent contamination events as replicate samples are highly variable in this data set as well. In addition, in 1991 the highest total PAH per organic matter exceeded 510,000 ug/kg in sediments within the tidal Bayou (24-A) which would further indicate a substantial, but intermittent source, that is relatively close to the tidal waters.

Table 10. Polynuclear aromatic hydrocarbons (PAH) in the sediments of the Hudson Bayou watershed. Averages and sums computed only if analytical values were greater than the method detection limit.

Compound (ug/kg dry wt)	HB-1	HB-1R	HB-2	HB-3	HB-4	HB-5	Average	TEL	PEL
Acenaphthene	<190	<1600	<270	<63	<110	<290	0	6.71	88.9
Acenaphthylene	<77	<640	<110	<25	<42	<110	0	5.87	128
Anthracene	<15	<130	<21	<5.1	<8.4	42	8	46.9	245
Benzo(a)anthracene	93	1,600	290	<5.1	82	260	296	74.8	693
Benzo(a)pyrene	140	2,600	380	8.4	110	410	456	88.8	763
Benzo(b)fluoranthene	250	4,500	580	14	160	430	712	-	-
Benzo(g,h,i)perylene	160 X	3,400 X	540 X	<13	170	330 X	564	-	-
Benzo(k)fluoranthene	98 X	1,800 X	250	5.7	69	190 X	293	-	-
Chrysene	180	2,600	490	9.6	140	400	486	108	846
Dibenzo(a,h)anthracene	96	2,100	290	<13	62	150	320	6.22	135
Fluoranthene	460	7,100	1,100	21 X	290	930	1,224	600**	3600**
Fluorene	<38	<320	<53	<13	<21	<57	0	21.2	144
Indeno(1,2,3-cd)pyrene	120	2,500	340	<13	100	230	396	-	-
Naphthalene	<77	<640	<110	<25	<42	<110	0	34.6	391
Phenanthrene	83	700	330	<5.1	97	400	244	86.7	544
Pyrene	330	4,700	700	<13	200	600	803	153	1398
1-Methylnaphthalene	<77	<640	<110	<25	<42	<110	0	-	-
2-Methylnaphthalene	120 X	2,300 X	380 X	<25	83	290 X	393	20.1	201
Sum of detectable PAH	2,130	35,900	5,670	59	1,563	4,662	8,331	1,684	16,770

[dotted box] = Above TEL   [solid box] = Above PEL
F42 - Diluted for analysis   X - Minimal precision btwn columns

Compound	HB-1	HB-1R	HB-2	HB-3	HB-4	HB-5	Average
Percent Organics	11.5	24.5	1.3	0.3	0.9	5.1	
(ug/kg dry wt of organics)							
Acenaphthene							0
Acenaphthylene							0
Anthracene						824	165
Benzo(a)anthracene	809	6,531	22,308		9,111	5,098	8,037
Benzo(a)pyrene	1,217	10,612	29,231	2,800	12,222	8,039	11,641
Benzo(b)fluoranthene	2,174	18,367	44,615	4,667	17,778	8,431	17,152
Benzo(g,h,i)perylene	1,391	13,878	41,538		18,889	6,471	14,906
Benzo(k)fluoranthene	852	7,347	19,231	1,900	7,667	3,725	7,324
Chrysene	1,565	10,612	37,692	3,200	15,556	7,843	14,076
Dibenzo(a,h)anthracene	835	8,571	22,308		6,889	2,941	7,368
Fluoranthene	4,000	28,980	84,615	7,000	32,222	18,235	31,713
Fluorene							0
Indeno(1,2,3-cd)pyrene	1,043	10,204	26,154		11,111	4,510	9,480
Naphthalene							0
Phenanthrene	722	2,857	25,385		10,778	7,843	9,159
Pyrene	2,870	19,184	53,846		22,222	11,765	19,772
1-Methylnaphthalene							0
2-Methylnaphthalene	1,043	9,388	29,231		9,222	5,686	9,871
Sum of detectable PAH	18,522	146,531	436,154	19,567	173,667	91,412	160,665

During both time periods, fluoranthene and pyrene were the compounds present in the highest concentration (normalized for organics). The presence of methylated compounds (1- and 2-methylnaphthalene) and ratios of methylated to non-methylated species in the 1998 data indicate contamination with high molecular weight petroleum products in addition to the typical suite of heavier compounds indicative of urban stormwater runoff. Similar to the metals, the bulk sediment concentrations of selected and total PAH also exceeded probable biological effects concentrations for a number of compounds. The sediments at HB-1 were particularly contaminated, exceeding PEL concentrations for nine of the 19 compounds. Station HB-2 exceeded PEL values for two compounds, while Station HB-5 exceeded PEL values for one compound. No other station exceed any PEL value. All stations exceeded the TEL values for at least seven compounds or categories.

Cedar Hammock Creek

The Cedar Hammock Creek watershed was one of the smaller watersheds, and subbasins were not as numerous as for the other priority watersheds. The entire watershed was delineated into eight individual basins, of which only three and a portion of a fourth typically drain to Sarasota Bay. Much of the land use is residential (54% MFR/HDR, 9% SFMD), with corridors of commercial activity (21% OTHER) along Cortez Road and U.S. Highway 41. For the portion draining to Sarasota Bay, drainage is typically in swales and smaller subsurface conveyances through residential and commercial areas which contribute to flows in large trapezoidal or rectangular drainage ditches. Banks are armored with rip-rap and/or cement in many locations and the most downstream portion has recently been refurbished with sheet pile walls and rip-rap. Recreational boating is evident in the seawalled potion and small boat basin near Sarasota Bay. A series of lakes within Basin CHW1-2 form the high point from which flows distribute to both to Sarasota Bay and to Palma Sola Bay. The main drainageway to Palma Sola Bay is a large trapezoidal, and mostly armored ditch. The lower portion is seawalled and discharges to a community marina off of Palma Sola Bay. From just north of 53rd Avenue, however, drainage in the eastern portion (CHE1-2 and CHE1-1) is northward and is routed below U.S. 41 and commercial interests, emerging north of Desoto Mall for eventual discharge to Wares Creek and the Manatee River.

The results of rankings based on densities of present-day potential sources, multisector industries, and modeled stormwater and point-source loadings appear in Appendix H-2 with overall basin rankings illustrated in **Figure 15**. Both the lowest (CHW2-2, CHW2-1) and highest (CHE1-1) ranked basins do not drain to Sarasota Bay. The four areas sampled were at the downstream ends of the remaining four basins (**Figure 16**, CHW1-1, CHS1-2, CHS1-1, and CHW1-2) with stations numbered in order of increasing contamination potential Station CH-1 was located to the southeast of the intersection of 53rd Ave West and 20th St. West. CH-2 was at Florida Blvd, CH-3 was at Bayshore Gardens Parkway, and CH-4 was on 26th St. West, north of 53rd Ave. West.

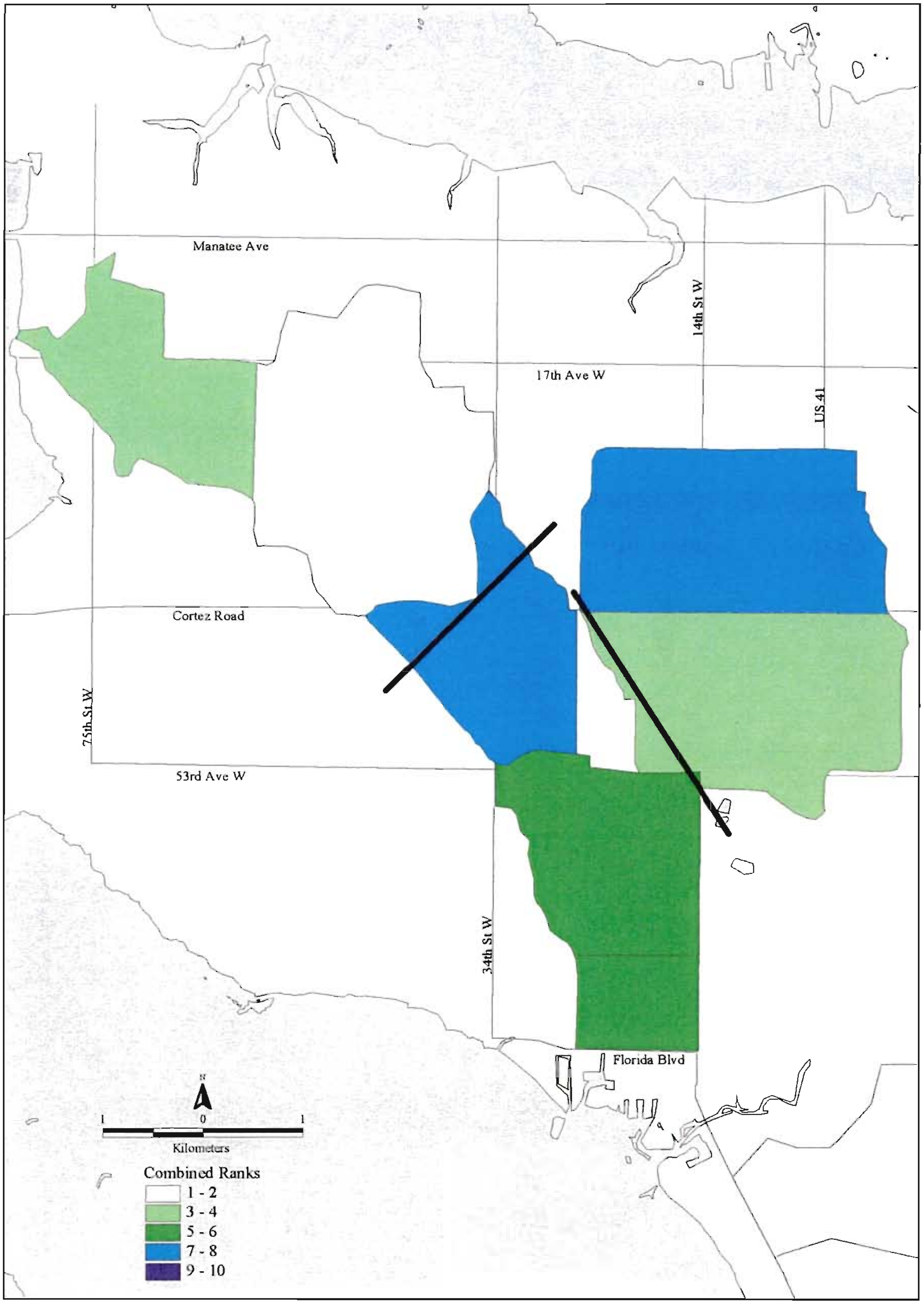

Figure 15. Combined ranks of the density of potential contaminant sources based on present day industry presence, multi-sector industries and estimated metals loadings in stormwater, Cedar Hammock Creek.

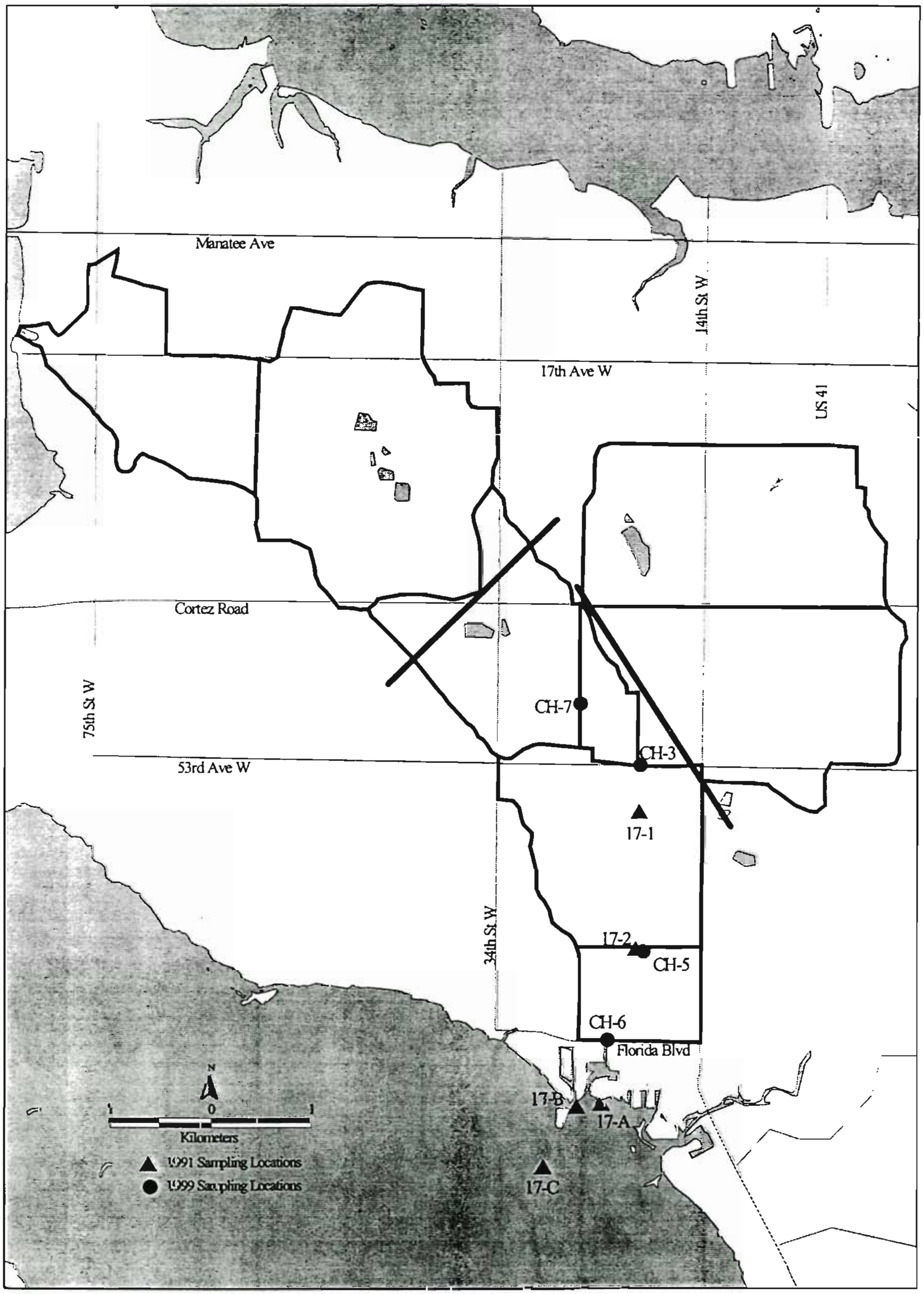

Figure 16. Consolidated subbasins and location of sediment samplings conducted in 1991 and 1999, Cedar Hammock Creek watershed.

Results for the Cedar Hammock Creek watershed metals analyses appear in **Table 11** and **Figure 17**. Both lead and zinc were enriched, all except the most downstream (CH-2). In particular, CH-4 lead levels were 13 times higher than would be expected. The lead enrichment at this station is inconsistent with the modeled lead loadings (Appendix G-2) as subbasin CHW1-2 is the lowest (0.11 lb/ac/yr) of the four basins (0.11 - 0.14 lb/ac/yr range). In general, there appears no correspondence between degree of sediment metal enrichment and modeled loadings for lead and zinc at these stations. Indeed, the only station not enriched for zinc was the site (Florida Blvd, CH-2) with the highest predicted zinc loading (CHS1-2, 0.82 lb/ac/yr). Copper was only enriched at CH-1, and then only slightly. No metals were enriched at station CH-2, where Florida Blvd crosses the drainageway, which may be the result of the recent drainage improvements at the site and the exposure of uncontaminated sediments.

Combining the 1999 and 1991 samples, stations 17-2 and CH-3 were co-located at Bayshore Gardens Parkway. Levels of enrichment were comparable, with ratios between 3 to 9 for lead and zinc during both time periods and only slightly more copper in 1991 than in 1999. As a general pattern, zinc appeared more enriched in the upper watershed (at and above Bayshore Gardens Parkway), as did lead (at and above the boat basin, Station 17-A, and particularly above 26th St West). Enriched copper sediments, on the other hand, were concentrated near the boat basin (Station 17-A).

In contrast to the 1991 data, relatively few biological impacts can be expected when the criteria for Florida coastal sediments are applied (MacDonald, 1994). Lead at both stations CH-1 and CH-4 exceeded the TEL criteria of 21 ug/g, above which biological effects are possible. No samples from 1999 exceeded probable effect levels (PEL) for lead of 160 ug/g. Many samples exceeded TEL levels in 1991, and the site downstream of the boat basin (Site A) exceeded the PEL for both lead and copper.

The lack of sediment concentrations which exceed biologically based criteria is due, in part, to the hydrological character of the sampled drainageways in comparison to the wider and deeper portions of the Creek downstream. Aluminum values can be compared to illustrate that the sediments downstream (sampled in 1991) have much more clay (higher aluminum) Since the biological criteria are based on bulk concentrations rather than any normalized value, exceedances will be more likely wherever finer particles tend to settle out, even if all enrichment values are comparable. Enrichment values, however, account for differing grain size to a large extent and are more useful for depicting watershed processes.

For sediment PAH concentrations (**Table 12**), stations in Cedar Hammock were among the highest overall, with the total PAH of all stations averaging over 400,000 ug/kg of organic matter. Station CH-3 (CHS1-1) was especially contaminated, with total PAH exceeding 500,000 ug/kg of organic matter. The least concentration was observed at the most downstream station (CH-2, Florida Blvd.), but even here, chrysene and dibenzo(a,h) anthracene exceeded TEL levels for possible biological impacts. Of the remaining three stations, six to nine compounds exceeded the level at which biological impacts would likely occur (PEL), with additional compounds exceeding

Table 11. Sediment metal concentrations from samples collected in 1998, 1997, and 1991, Cedar Hammock Creek. Enrichment ratios computed as the ratio of sediment concentration to the upper 95th percentile of the values of pristine sediments. Shaded values are from analyses using less rigorous digestion methods. 'T' indicates tidally influenced station.

				Aluminum	Copper	Lead	Zinc	Enrichment Ratio			
Station	Date	Tidal	Description	ug/g dry wt	ug/g dry wt	ug/g dry wt	ug/g dry wt	Copper	Lead	Zinc	Mean
CH-1	1999	-	53rd Ave and 20th St W	2,970	14.5	36.0	86	1.3	6.2	5.8	4.4
CH-2	1999	T	Florida Blvd	1,450	1.6	3.1	10	0.2	0.9	1.1	0.7
CH-3	1999	-	Bayshore Gardens Pkway	1,100	6.4	18.1	41	0.9	6.4	5.6	4.3
CH-4	1999	-	26th St W	880	4.2	31.5	37	0.7	13.0	5.9	6.5
17-1	1991	T	55th Ave W	828	10.3	11.4	42	1.7	4.9	6.9	4.5
17-1	1991	T	55th Ave W	779	9.4	9.2	27	1.6	4.1	4.7	3.5
17-2	1991	T	Bayshore Gardens Pkway	2,580	16.8	45.5	62	1.6	8.7	4.6	5.0
17-2	1991	T	Bayshore Gardens Pkway	2,440	26.2	32.0	47	2.6	6.3	3.6	4.2
17-A	1991	T	Dnstrm of boat basin	21,500	141.0	131.0	95	4.9	5.3	1.5	3.9
17-A	1991	T	Dnstrm of boat basin	23,600	160.0	131.0	250	5.3	5.0	3.8	4.7
17-A	1991	T	Dnstrm of boat basin	30,200	160.0	127.0	136	4.7	4.0	1.7	3.5
17-A	1991	T	Dnstrm of boat basin	31,900	166.0	131.0	206	4.7	4.0	2.5	3.7
17-B	1991	T	Mouth of Cedar Hammock	13,900	43.8	44.7	75	1.9	2.5	1.7	2.0
17-B	1991	T	Mouth of Cedar Hammock	16,600	57.7	77.0	104	2.3	3.8	2.0	2.7
17-C	1991	T	Near Marker #1	23,900	24.6	25.8	60	0.8	1.0	0.9	0.9
17-C	1991	T	Near Marker #1	18,200	29.4	30.6	62	1.1	1.4	1.1	1.2

[dashed box] = Above TEL   [solid box] = Above PEL

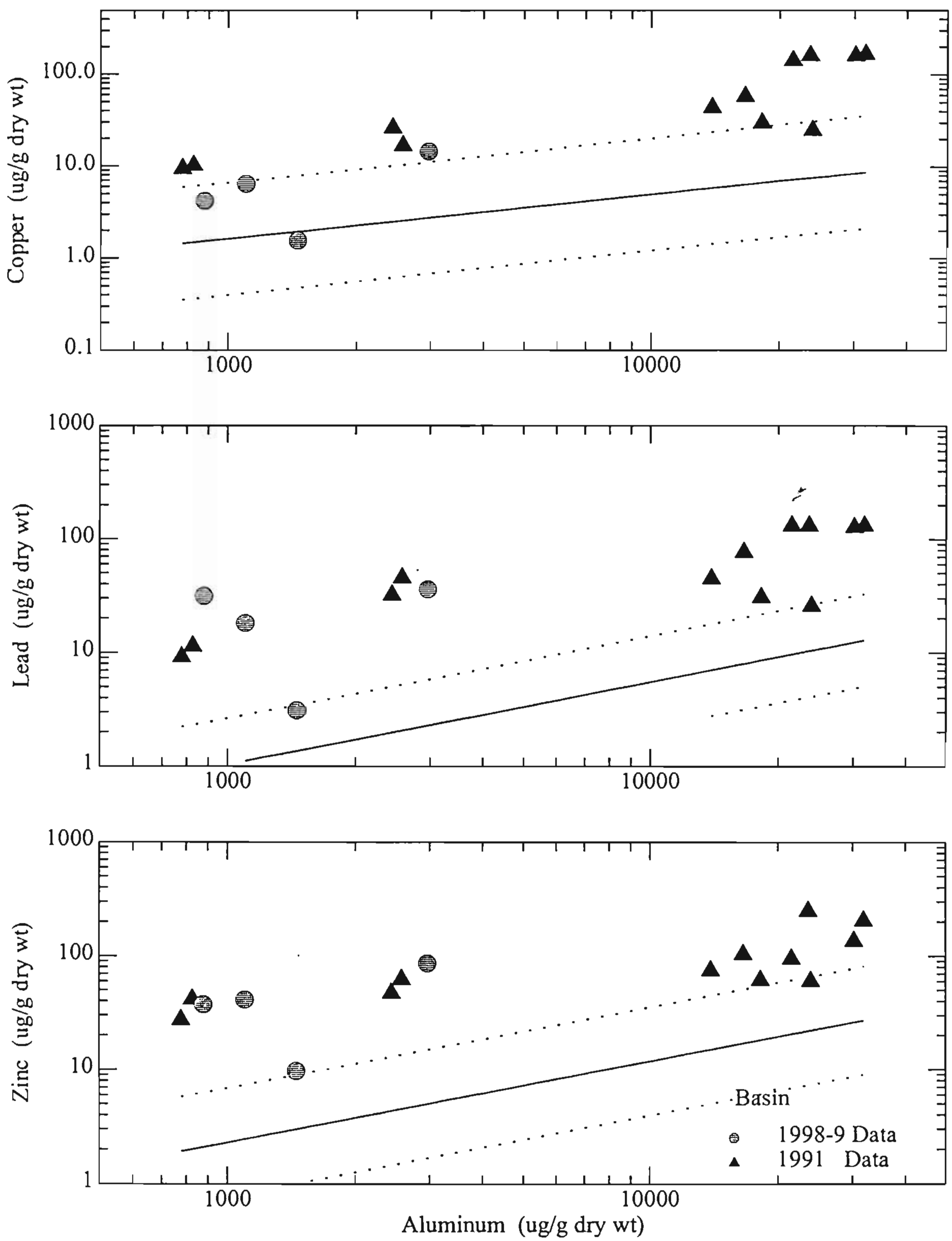

Figure 17. Sediment metal concentrations from the Cedar Hammock Creek watershed illustrated with the linear relationship (and 95% confidence intervals) of metal to aluminum in pristine sediments.

Table 12. Polynuclear aromatic hydrocarbons (PAH) in the sediments of the Cedar Hammock Creek watershed. Averages and sums computed only if analytical values were greater than the method detection limit.

Compound	CH-1		CH-2		CH-3		CH-4		Average
Percent Organics	4.2		0.8		2.8		2.7		
(ug/kg dry wt)									
Acenaphthene	<68		<61		<79		<660		0
Acenaphthylene	<27		<24		<32		<260		0
Anthracene	33	X	<4.9		43		83	X	40
Benzo(a)anthracene	670	*F42	40		710	*F42	980		600
Benzo(a)pyrene	920	*F42	87		970	*F42	1000		744
Benzo(b)fluoranthene	1500	*F42	140		1500	*F42	1800		1,235
Benzo(g,h,i)perylene	1500	*F42	200	X	1600	*F42	1400	X	1,175
Benzo(k)fluoranthene	600	*F42	59		660	*F42	740		515
Chrysene	1000	*F42	110		1400	*F42	1500		1,003
Dibenzo(a,h)anthracene	1200	*F42	48	X	880	*F42	600	X	682
Fluoranthene	2500	*F42	230	X	2700	*F42	3800		2,308
Fluorene	<14		<12		<16		<130		0
Indeno(1,2,3-cd)pyrene	900	*F42	99		960	*F42	1000		740
Naphthalene	<27		<24		<32		<260		0
Phenanthrene	530	*F42	49		690	*F42	890		540
Pyrene	1500	*F42	140		1600	*F42	2300		1,385
1-Methylnaphthalene	170		<24		320		<260		123
2-Methylnaphthalene	490	X	<24		510	X	760	X	440
									0
Sum of detectable PAH	13,513		1,202		14,543		16,853		11,528

[dashed box] = Above TEL [double box] = Above PEL

F42 - Diluted for analysis X - Minimal precision btwn columns

Compound	CH-1	CH-2	CH-3	CH-4	Average
Percent Organics	4.2	0.8	2.8	2.7	
(ug/kg dry wt of organics)					
Acenaphthene					0
Acenaphthylene					0
Anthracene	786		1,536	3,074	1,349
Benzo(a)anthracene	15,952	5,000	25,357	36,296	20,651
Benzo(a)pyrene	21,905	10,875	34,643	37,037	26,115
Benzo(b)fluoranthene	35,714	17,500	53,571	66,667	43,363
Benzo(g,h,i)perylene	35,714	25,000	57,143	51,852	42,427
Benzo(k)fluoranthene	14,286	7,375	23,571	27,407	18,160
Chrysene	23,810	13,750	50,000	55,556	35,779
Dibenzo(a,h)anthracene	28,571	6,000	31,429	22,222	22,056
Fluoranthene	59,524	28,750	96,429	140,741	81,361
Fluorene					0
Indeno(1,2,3-cd)pyrene	21,429	12,375	34,286	37,037	26,282
Naphthalene					0
Phenanthrene	12,619	6,125	24,643	32,963	19,087
Pyrene	35,714	17,500	57,143	85,185	48,886
1-Methylnaphthalene	4,048		11,429		3,869
2-Methylnaphthalene	11,667		18,214	28,148	14,507
Sum of detectable PAH	321,738	150,250	519,393	624,185	403,892

the TEL values. Fluoranthene, followed by pyrene, benzo(b)fluoranthene, and benzo(g,h,i)perylene were the compounds in highest abundance. Similar to Hudson Bayou, the presence of methylated and heavier molecular weight compounds indicates a mixed source of both petroleum and combustion products. PAH data from 1991 and from sediments in the tidal portions of the Creek ranged from 3,200 to 156,000 ug/kg of organic matter. As these data were lower than the 1999 values, implied is that sources originate within the watershed rather than from activities at the mouth of the Creek.

Bowlees Creek

The Bowlees Creek watershed was divided into 11 subbasins, with the downstream end terminating at U.S. 41. Drainage occurs from residential areas, a large portion of the Sarasota Bradenton Airport, and from multiple commercial interests bordering U.S. 41 and Highway 301. Commercial interests total about 23% of the watershed with another 12% in industrial classification. High density residential (MFR/HDR) is the largest category (38%) followed by open lands (24%). Most of the major drainageways are in surface ditches of varying sizes, both with and without armoring. The tidal portions of the Creek are generally seawalled, with recreational boating evident in the lower portions. Several marinas operate near and downstream of U.S. 41.

The results of rankings based on densities of present-day potential sources, multisector industries, and modeled stormwater loadings appear in Appendix H-2 with overall basin rankings illustrated in **Figure 18**. The areas sampled were at the downstream ends of subbasins OND1-5, LPD1-1, APD1-1, LPD1-2, APD1-2, OND1-2, and OND1-4, with stations numbered in order of increasing contamination potential. Since again there were more basins than scheduled analyses, some sample sites represent a combination of basins. **Figure 19** illustrates the basins that were effectively consolidated and the station locations.

The results of metals analyses from samples collected both in 1991 and 1999 appear in **Table 13** and **Figure 20**. Again, only one of the recent samples was enriched for copper, at BC-2. Previous copper enrichment was minimal as well and was limited to an area upstream of U.S. 41, Station 18-A. More stations were enriched with respect to lead and zinc (4 of 7 and 6 of 7 station, respectively, for 1999 data) with lead 3 and 4 times pristine levels at Stations BC-4 and BC-2. In 1999, maximum zinc enrichment was limited to about twice that expected in pristine sediments.

Stations 18-2 (1991) and BC-7 were in the same general vicinity and enrichment ratios were very similar for all metals, indicating that enrichment values can be relatively stable over time periods. The variation in enrichment observed at Station 18-A for all three metals also indicates that metals loadings are very episodic at this location. Comparisons of sediment enrichment to predicted loadings are again unusual. Although APD1-2 had the highest predicted loadings (Appendix G-2) of any basin for copper, lead, and zinc, this station (BC-5) was one of two stations with no enriched sediments for copper and lead, and zinc enrichment ratio of only 1.6. Station BC-2, draining subbasin LPD1-1 was enriched for copper (1.6), lead (4.1), and zinc (2.3), but had predicted loading rates of only 60-70% of the maximum loadings.

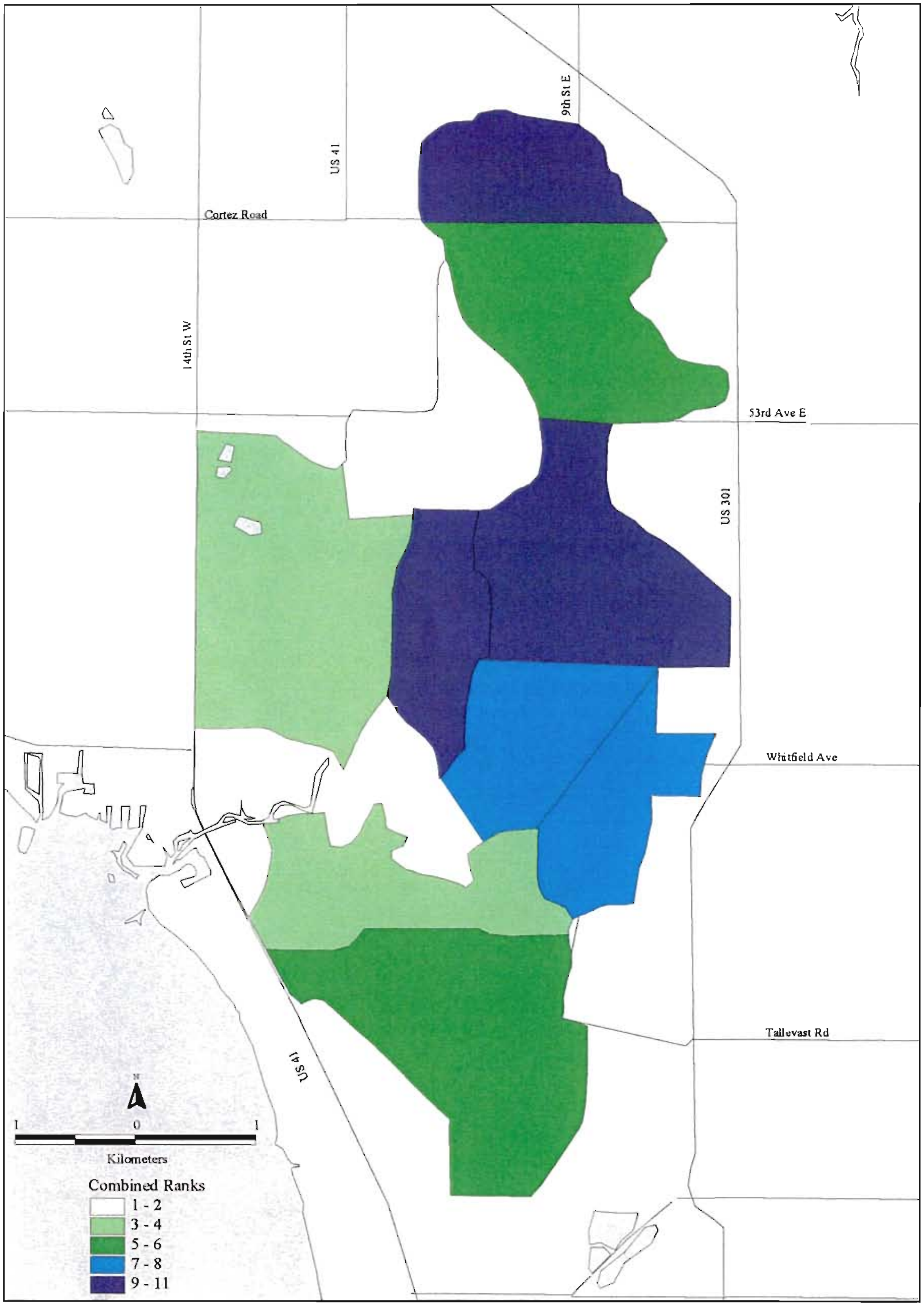

Figure 18. Combined ranks of the density of potential contaminant sources based on present day industry presence, multi-sector industries and estimated metals loadings in stormwater, Bowlees Creek.

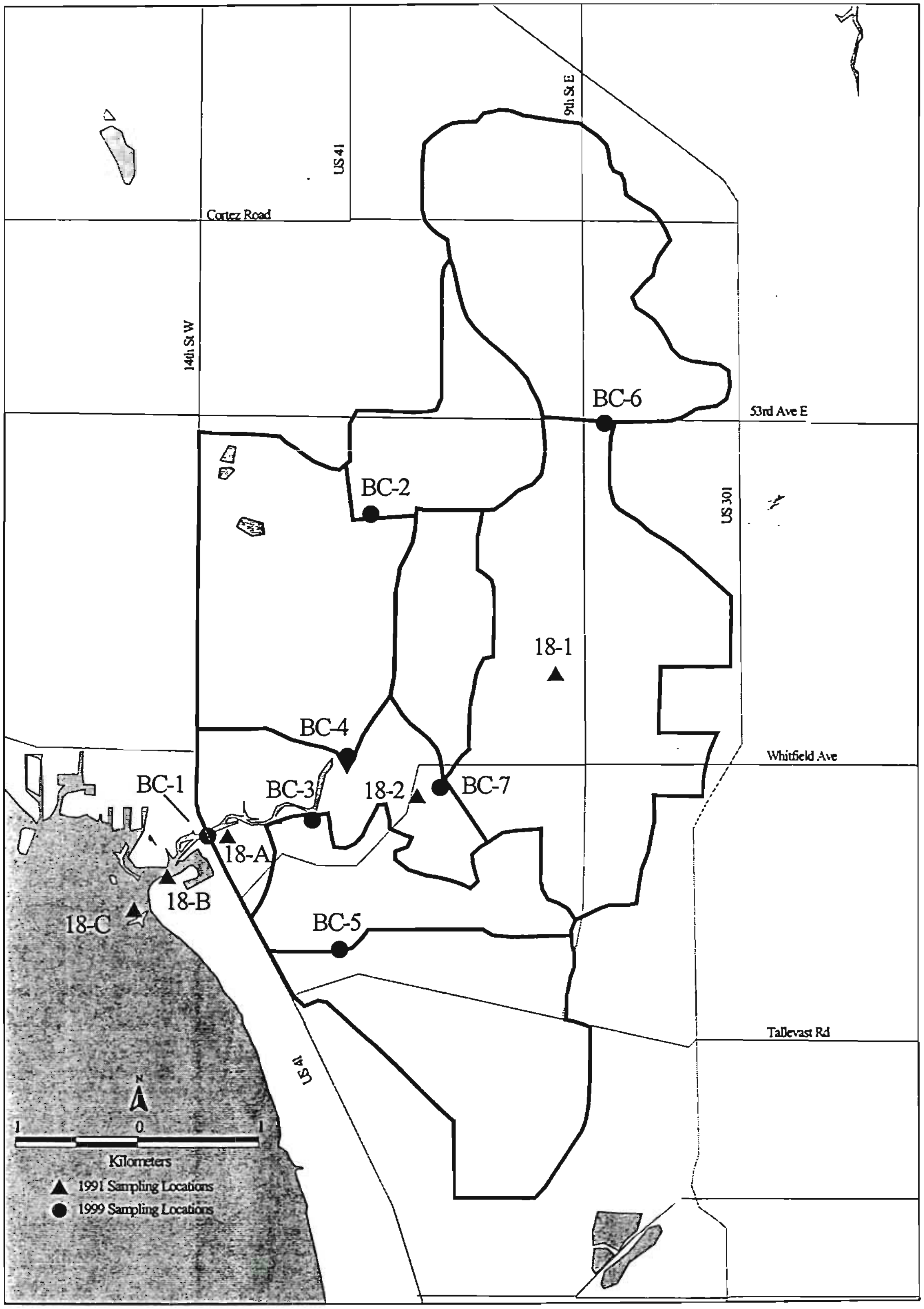

Figure 19. Consolidated subbasins and location of sediment samplings conducted in 1991 and 1999, Bowlees Creek watershed.

Table 13. Sediment metal concentrations from samples collected in 1998, 1997, and 1991, Bowlees Creek. Enrichment ratios computed as the ratio of sediment concentration to the upper 95th percentile of the values of pristine sediments. Shaded values are from analyses using less rigorous digestion methods. 'T' indicates tidally influenced station.

				Aluminum	Copper	Lead	Zinc	Enrichment Ratio			
Station	Date	Tidal	Description	ug/g dry wt	ug/g dry wt	ug/g dry wt	ug/g dry wt	Copper	Lead	Zinc	Mean
BC-1	1999	T	US 41	2,640	9.3	8.5	25	0.9	1.6	1.8	1.4
BC-2	1999	-	57th Ave near 3rd St E	5,340	24.2	36.1	52	1.6	4.1	2.3	2.7
BC-3	1999	T	Magellan Dr near Golf Club	1,980	3.0	3.1	16	0.3	0.7	1.5	0.8
BC-4	1999	-	Magellan near 67th Ave	970	1.4	9.1	12	0.2	3.5	1.8	1.8
BC-5	1999	-	Tallevast Rd	2,340	5.9	4.0	21	0.6	0.8	1.6	1.0
BC-6	1999	-	53rd Ave near 18StCt E	1,280	0.6	1.9	6	0.1	0.6	0.8	0.5
BC-7	1999	-	9th St E near Whitfield Ave	3,660	8.7	9.3	38	0.7	1.4	2.2	1.4
BC-7R	1999	-	9th St E near Whitfield Ave	4,360	10.6	10.2	40	0.8	1.3	2.0	1.4
18-1	1991	T	Saunders Rd nr 17th St E	810	2.1	2.2	6	0.3	1.0	1.1	0.8
18-1	1991	T	Saunders Rd nr 17th St E	794	2.3	3.4	6	0.4	1.5	1.1	1.0
18-2	1991	T	Whitfield Ave nr 9th St E	1,260	1.7	9.4	17	0.2	3.0	2.1	1.8
18-2	1991	T	Whitfield Ave nr 9th St E	1,180	2.8	4.4	12	0.4	1.5	1.5	1.1
18-A	1991	T	Upstrm of US41	15,200	112.0	53.8	178	4.6	2.8	3.7	3.7
18-A	1991	T	Upstrm of US41	7,900	169.0	40.5	162	9.5	3.4	5.4	6.1
18-A	1991	T	Upstrm of US41	3,750	21.0	17.6	42	1.7	2.6	2.4	2.2
18-A	1991	T	Upstrm of US41	7,910	30.0	108.0	69	1.7	9.2	2.3	4.4
18-B	1991	T	At boat basin	19,200	48.4	46.9	101	1.8	2.1	1.8	1.9
18-B	1991	T	At boat basin	26,600	55.5	57.3	158	1.7	2.0	2.2	2.0
18-C	1991	T	Nr Island at mouth	26,800	39.7	45.6	105	1.2	1.6	1.5	1.4
18-C	1991	T	Nr Island at mouth	26,700	46.9	67.5	147	1.5	2.4	2.0	2.0

[dashed box] = Above TEL [solid box] = Above PEL

Bowlees Creek

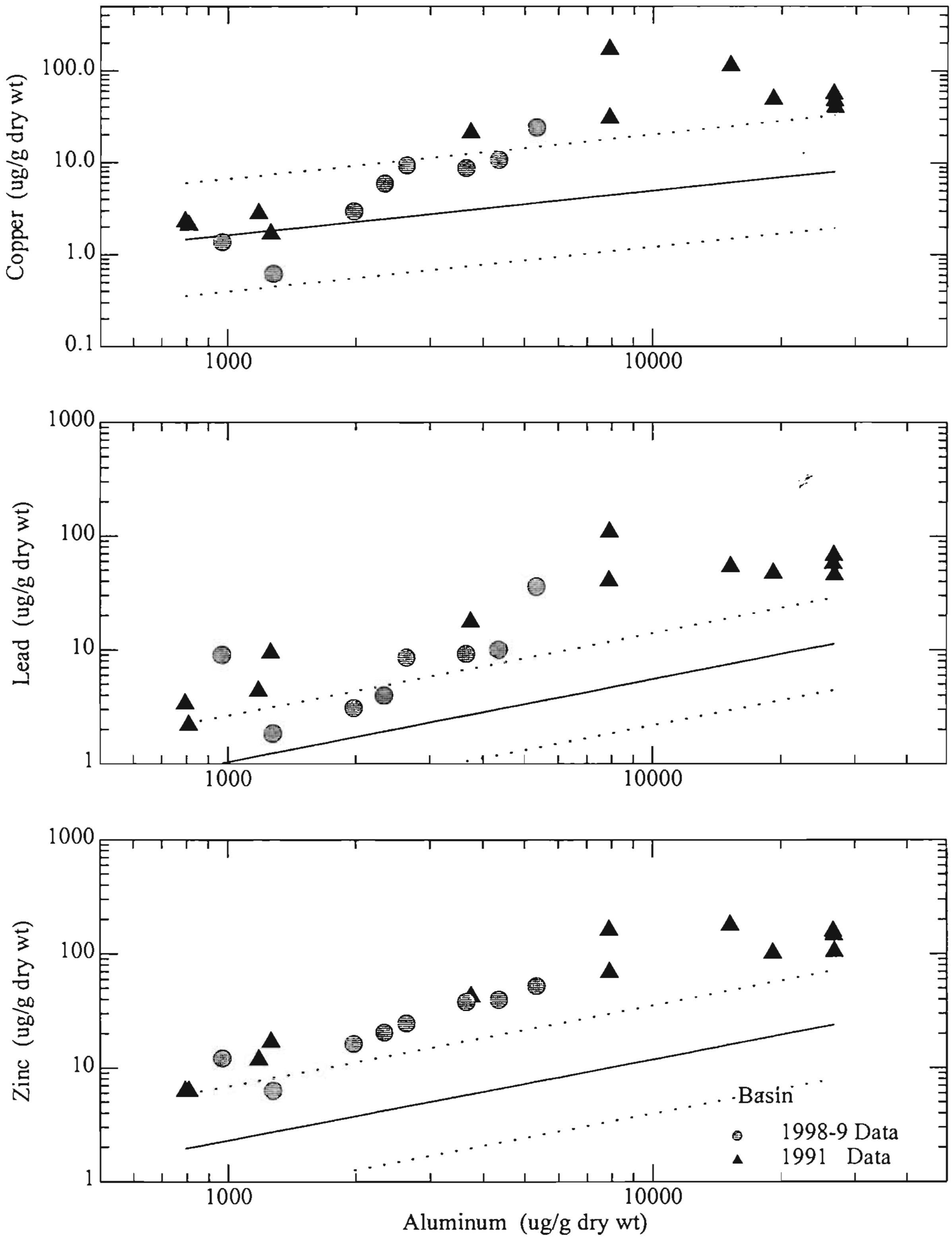

Figure 20. Sediment metal concentrations from the Bowlees Creek watershed illustrated with the linear relationship (and 95% confidence intervals) of metal to aluminum in pristine sediments.

Viewing all sediment data for general patterns, copper enrichment appears restricted to the lower Creek, indicating an area of either precipitation and sediment accumulation, or of localized activities such as marina operations. Lead and zinc were also more enriched near the mouth of Bowlees Creek, but, like Cedar Hammock, had selected stations in the upper watershed that were enriched, particularly for lead.

None of the sediments collected recently in Bowlees Creek exceeded the PEL values which would indicate biological impacts in coastal waters. Only one station, BC-2 (LPD1-1) exceeded TEL values for both copper and lead. In the 1991 data which was collected further downstream and in Sarasota Bay, many more samples exceeded TELs and copper exceeded PEL values at one station. The differing depositional environment and the accumulation of fines can again be observed in the aluminum data, as was described for Cedar Hammock Creek.

Bowlees Creek bulk sediment PAH concentrations (**Table 14**) were approximately one fifth that observed in Cedar Hammock Creek and were the lowest of all the watersheds surveyed. As a result many fewer sites exceeded PEL or TEL levels for biological impacts. Stations BC-7, BC-3, and BC-2 (downstream of subbasins OND1-4, APD1-1, LPD1-2, respectively) were the only sites to exceed PEL values, and typically for only two or less compounds. Three of the remaining four stations had values which exceeded TEL levels for one or more compounds, while Station BC-5 (APD1-2) had no exceedances. After normalizing to organic matter, Station BC-4 (subbasin LPD1-2) had the highest total PAH concentration within Bowlees Creek, exceeding 600,000 μg/kg but stations were still less contaminated overall then the Cedar Hammock Creek stations. Stations BC-3, BC-7, and BC-1 (subbasins APD1-1, OND1-4, and OND1-5, respectively) also have relatively high PAH for the amount of observed organic matter. Fluoranthene, followed by pyrene, chrysene and benzo(b)fluoranthene were those compounds in highest abundance.

PAH data from sediments at the mouth of Bowlees Creek (1991 data) ranged between 29,000 and 181,000 ug/kg of organic matter. These data were closer in range to the 1999 data from the same watershed, implying that sources within the watershed are more evenly distributed, with the exception of station BC-4.

Whitaker Bayou

The Whitaker Bayou watershed was divided into 27 basins with the downstream end terminating to the west of U.S. 41. There are reports that flow can leave the watershed to the north, via the Pearce Canal, connecting eventually with the Manatee River, but that was not observed under the conditions sampled. Flows originate from just to the east of the Sarasota-Bradenton Airport, and several large lakes which act as wet detention areas. There are a variety of land uses, ranging from older residential areas along the Old Bradenton Road, to both new and old light industrial parks on both sides of U.S. 301. Residential land use totals 24% (SFMD) and 15% (MFR/HDR), with comparable areas (16%) of commercial (OTHER) and industrial. Approximately 30% of the watershed is classified as open lands. Most of the major drainage is in open ditches with subsurface systems in residential areas and individual commercial interests.

Table 14. Polynuclear aromatic hydrocarbons (PAH) in the sediments of the Bowlees Creek watershed. Averages and sums computed only if analytical values were greater than the method detection limit.

Compound	BC-1	BC-2	BC-3	BC-4	BC-5	BC-6	BC-7	BC-7R	Average
(ug/kg dry wt)									
Acenaphthene	< 330	< 89	< 62	380 X	< 68	< 60	< 320	< 330	0
Acenaphthylene	< 130	< 36	< 25	< 130	< 27	< 24	< 130	< 130	0
Anthracene	36	< 7.1	67	78	< 5.4	< 4.8	< 26	< 27	0
Benzo(a)anthracene	140	80	520 F42	500	7	13	150	180	88
Benzo(a)pyrene	74 X	120	410 F42	400	17 X	18	200 X	220	114
Benzo(b)fluoranthene	220	190	780 F42	600	29	32	350	380	198
Benzo(g,h,i)perylene	< 66	160 X	510 X	560 X	29 X	32	400 X	310 X	193
Benzo(k)fluoranthene	98 X	75 X	300 F42	290	10 X	13	140	160	81
Chrysene	170	120	750 F42	770	15	31	260	300	152
Dibenzo(a,h)anthracene	< 66	< 18	120 X	130	< 14	17 X	< 64	170 X	47
Fluoranthene	690	44	2200 F42	1800	37	59	600	860	389
Fluorene	< 66	< 18	13 X	< 65	< 14	< 12	< 64	< 67	0
Indeno(1,2,3-cd)pyrene	100	120	360 F42	340	< 14	17 X	170 X	230	104
Naphthalene	< 130	< 36	< 25	< 130	< 27	< 24	< 130	< 130	0
Phenanthrene	260	60	640 F42	700	< 5.4	17	130	150	74
Pyrene	370	180	1200 F42	1200	21	36	390	490	234
1-Methylnaphthalene	< 130	< 36	88 X	200	< 27	< 24	< 130	< 130	0
2-Methylnaphthalene	< 130	42 X	300 X	< 130	< 27	< 24	< 130	180 X	45
Sum of detectable PAH	2,158	1,191	8,258	7,948	165	285	2,790	3,630	1718

[dotted box] = Above TEL   [solid box] = Above PEL

ns   F42 - Diluted for analysis   X - Minimal precision btwn columns

Compound	BC-1	BC-2	BC-3	BC-4	BC-5	BC-6	BC-7	BC-7R	Average
Percent Organics	2.3	5.4	3.5	1.3	2.6	0.3	2.2	2.4	
(ug/kg dry wt of organics)									
Acenaphthene				29,231					0
Acenaphthylene									0
Anthracene	1,565		1,914	6,000					0
Benzo(a)anthracene	6,087	1,481	14,857	38,462	269	4,333	6,818	7,500	2,365
Benzo(a)pyrene	3,217	2,222	11,714	30,769	654	6,000	9,091	9,167	3,114
Benzo(b)fluoranthene	9,565	3,519	22,286	46,154	1,115	10,667	15,909	15,833	5,441
Benzo(g,h,i)perylene		2,963	14,571	43,077	1,115	10,667	18,182	12,917	5,360
Benzo(k)fluoranthene	4,261	1,389	8,571	22,308	385	4,333	6,364	6,667	2,219
Chrysene	7,391	2,222	21,429	59,231	577	10,333	11,818	12,500	4,404
Dibenzo(a,h)anthracene			3,429	10,000		5,667		7,083	1,594
Fluoranthene	30,000	815	62,857	138,462	1,423	19,667	27,273	35,833	10,524
Fluorene			371						0
Indeno(1,2,3-cd)pyrene	4,348	2,222	10,286	26,154		5,667	7,727	9,583	2,872
Naphthalene									0
Phenanthrene	11,304	1,111	18,286	53,846		5,667	5,909	6,250	2,228
Pyrene	16,087	3,333	34,286	92,308	808	12,000	17,727	20,417	6,369
1-Methylnaphthalene			2,514	15,385					0
2-Methylnaphthalene		778	8,571					7,500	938
Sum of detectable PAH	93,826	22,056	235,943	611,385	6,346	95,000	126,818	151,250	47,427

The results of overall rankings based on densities of present-day potential sources, multisector industries, and modeled stormwater loadings appear in Appendix H-2, and are illustrated in **Figure 21**. The areas sampled were at the downstream ends of subbasins B6 and A4, WB7, D7, D5, D2, B3-4, and WB3 with stations ranked in order of increasing contamination potential. As a rule, the highest ranked basins were in the southeastern, central, and northwestern portions of the watershed. **Figure 22** illustrates the stations sampled and consolidated basins that each station represents. A surface sheen was observed at a number of stations during sampling.

Metals data and enrichment ratios for Whitaker Bayou in both 1991 and 1999 appear in **Table 15** and **Figure 23**. Overall, metals enrichment were higher in this watershed than in Cedar Hammock or Bowlees Creek. Of the 1999 data, only three values could be considered unenriched. Many lead and copper values were more than 5 times greater than would be expected for pristine sediments. One zinc value (WB-5 at subbasin D2) was nearly 15 times greater than expected. Maximum enrichment of copper in 1999 was 2.8 at subbasin WB3 near the Sarasota Kennel Club. The same location recorded the maximum lead enrichment ratio (5.5). Biological impacts threshold levels (TEL) were exceeded for some metals at four of the seven sites within the watershed, but no concentrations exceeded PEL values. This is again due to the water velocities of the drainageways sampled, in which fines and the associated contaminants do not typically settle.

For the Whitaker Bayou subbasins, observed enrichments of metals was more consistent with some of the modeled loadings. Subbasin WB3 was modeled with the highest pounds per acre of copper, lead, and zinc (Appendix G-2). The sediment enrichment at the station downstream of this subbasin was the highest in copper and lead, and was over four times pristine values for zinc. In contrast, however, modeled values for subbasins D1, D2, and D3 were only 40-50% of the maximum observed within the basin, but the station representing these subbasins was the most enriched overall. Whether intentional on not, there are clearly some activities in both Whitaker Bayou and the other watersheds which contribute metals beyond the amounts typically observed in the stormwater database.

For Whitaker Bayou, there were no stations co-located in both 1991 and 1999, but assuming that enrichment ratios have been stable as observed in Cedar Hammock and Bowlees Creek, some interesting geographic patterns emerge. First, taking zinc for example, the high levels observed at one station (WB-5) do not always extend downstream to the next station. This implies that sources of metals are less than the available binding sites on sediments (WB-4) and aid in determining source regions. Secondly, the Riverside Drive station sampled in 1991 (20-1) was relatively clean, indicating that for the rate of metals release in the northern watershed, contamination is retained above Riverside Drive. The drainage entering Whitaker Bayou below Riverside Drive (subbasins D9, D8, and D7) was sampled at the downstream end of subbasin D8 (WB-3), with enrichment values of 0.3, 2.1, and 4.4 for copper, lead, and zinc, respectively. The enriched sediments observed at Station 20-A, therefore, appear to originate downstream of Riverside Drive and subbasin D7, i.e. in subbasins D8, D9, WB7 , and/or WB8. A variety of interests are known to be active in the region, most notably a marina and a long standing domestic waste discharge.

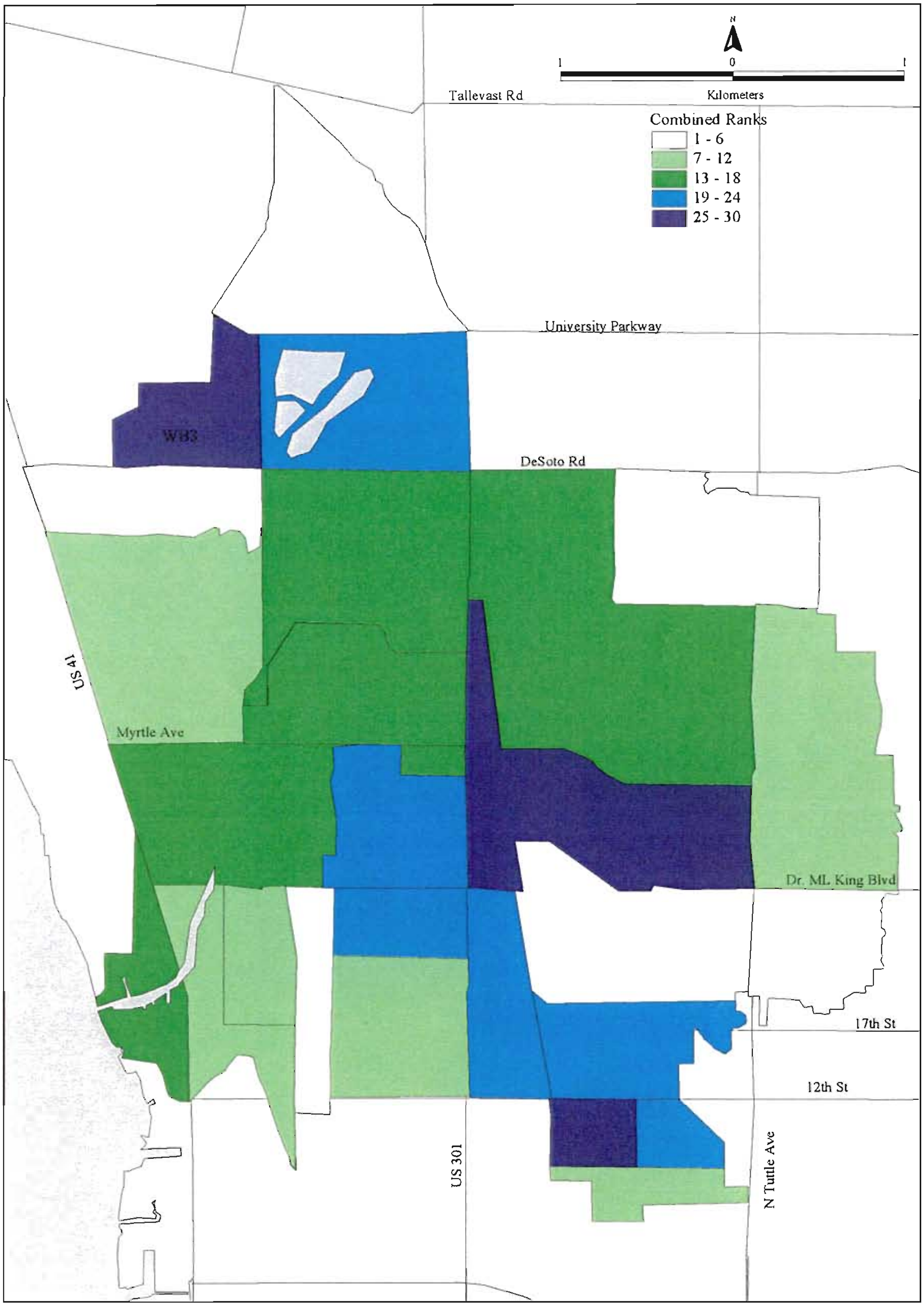

Figure 21. Combined ranks of the density of potential contaminant sources based on present day industry presence, multi-sector industries and estimated metals loadings in stormwater, Whitaker Bayou.

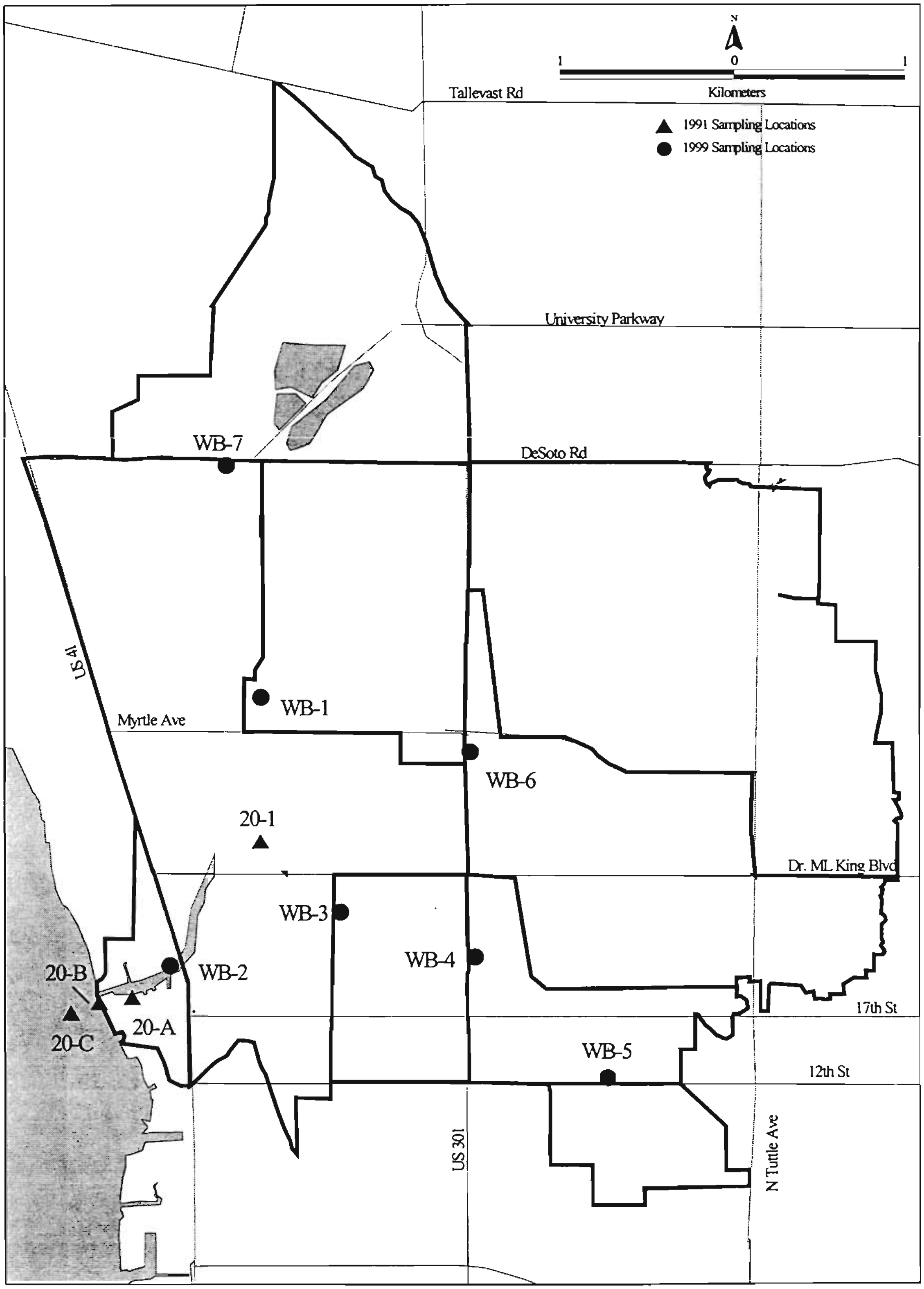

Figure 22. Consolidated subbasins and location of sediment samplings conducted in 1991 and 1999, Whitaker Bayou watershed.

Table 15. Sediment metal concentrations from samples collected in 1998, 1997, and 1991, Whitaker Bayou. Enrichment ratios computed as the ratio of sediment concentration to the upper 95th percentile of the values of pristine sediments. Shaded values are from analyses using less rigorous digestion methods. 'T' indicates tidally influenced station.

Station	Date	Tidal	Description	Aluminum ug/g dry wt	Copper ug/g dry wt	Lead ug/g dry wt	Zinc ug/g dry wt	Enrichment Ratio Copper	Enrichment Ratio Lead	Enrichment Ratio Zinc	Enrichment Ratio Mean
WB-1	1999	-	Central Ave near 39th St	8,550	36.8	9.3	57	2.0	0.7	1.8	1.5
WB-2	1999	T	Whitaker Bayou at US 41	6,150	25.1	26.9	171	1.6	2.7	6.8	3.7
WB-3	1999	-	22nd St near Maple Ave	1,350	2.6	6.8	38	0.3	2.1	4.4	2.3
WB-4	1999	-	US 301 near 19th St	3,310	11.5	18.3	99	1.0	2.9	6.1	3.3
WB-5	1999	-	12th St near Vilas Ave	3,370	14.3	33.4	244	1.2	5.3	14.9	7.1
WB-6	1999	-	US 301 near 34th St	3,270	10.3	27.8	41	0.9	4.5	2.6	2.7
WB-7	1999	-	Desoto Road at Dog Track	7,330	47.8	62.0	118	2.8	5.5	4.2	4.2
20-1	1991	T	Riverside Dr	7,430	11.1	24.7	48	0.6	2.2	1.7	1.5
20-1	1991	T	Riverside Dr	12,700	11.1	15.1	41	0.5	0.9	1.0	0.8
20-A	1991	T	At marina	15,900	104.0	88.8	310	4.2	4.5	6.3	5.0
20-A	1991	T	At marina	15,000	108.0	75.0	301	4.4	4.0	6.4	4.9
20-A	1991	T	At marina	16,600	83.1	66.9	189	3.3	3.3	3.7	3.4
20-A	1991	T	At marina	15,300	83.4	73.7	202	3.4	3.9	4.2	3.8
20-B	1991	T	At mouth of Whitaker	838	1.5	2.8	8	0.2	1.2	1.3	0.9
20-B	1991	T	At mouth of Whitaker	788	6.1	0.7	7	1.0	0.3	1.2	0.8
20-C	1991	T	Near entrance markers	2,380	2.1	5.6	7	0.2	1.1	0.5	0.6
20-C	1991	T	Near entrance markers	1,290	9.8	3.0	6	1.3	0.9	0.7	1.0

[dashed box] = Above TEL   [solid box] = Above PEL

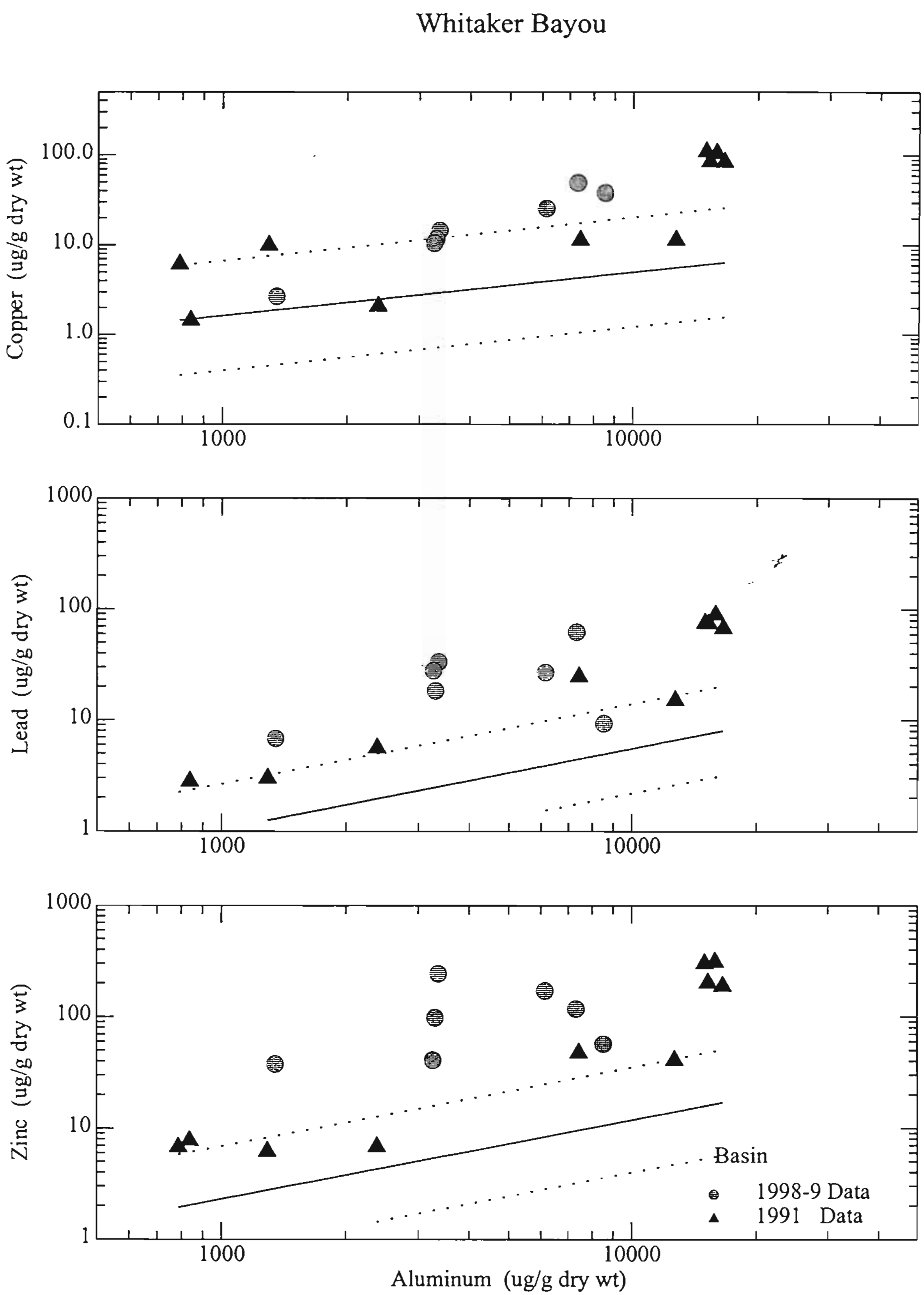

Figure 23. Sediment metal concentrations from the Whitaker Bayou watershed illustrated with the linear relationship (and 95% confidence intervals) of metal to aluminum in pristine sediments.

Whitaker Bayou watershed sediments were generally higher in bulk concentrations of PAH than any of the other watersheds (**Table 16**), with the exception of Cedar Hammock Creek. Five of the seven stations exceeded PEL values for one or more compounds and three of the five exceeded PEL values for five or more compounds. These three stations were not only contaminated in bulk, but values per weight of organics were also high. Stations WB-2, WB-5, and WB-7 (or subbasins WB8 at U.S. 41, D2 at 12^{th} St, and WB3 at the Sarasota Kennel Club) recorded total PAH of 346,000 ug/kg, 921,000 ug/kg, and 90,000 ug/kg of organic matter. Sediments at Station WB-4 contained 166,000 ug/kg organic matter. Fluoranthene and pyrene, followed by chrysene and benzo(b)fluoranthene were the most prevalent compounds. Similar to the other watersheds, methylated and high molecular weight compounds indicate a mixed origin of combustion and petroleum sources. Data from 1991 and the tidal waters of the Bayou ranged between undetectable and 50,000 ug PAH / kg of organic matter. PAH sources apparently originate from within the watershed, particularly upstream of WB-5 and WB-2, rather than from activities in or near the tidal waters.

Phillippi Creek

Phillippi Creek was the largest watershed investigated, and had its area subdivided into 14 subbasins. The most downstream portion is delineated at U.S. 41. The watershed extends northward as far as University Parkway, and well east of I-75. Much of the watershed is residential, with some newer light industrial developments along the Interstate 75 corridor. Almost 54% of the watershed is classified as OPEN, with 11% as either commercial (OTHER) or industrial. The remainder is dominated by residential (SFMD) at 29%. Drainage in surface ditches or canals predominates for the major conveyances.

The results of combined rankings based on densities of present-day potential sources, multisector industries, and modeled stormwater loadings appear in Appendix H-3 and are illustrated in **Figure 24**. Due to the size and number of subbasins in Phillippi Creek, ten samples were collected within the watershed, including one station to cover an area which was low ranked but represented a large portion (32%) of the total watershed. The stations were sampled downstream of Centergate, Branch AA, and Main A as a single area, Lateral AC, Branch C, Linwood, Main C, Branch BA (and MainB), Lateral AB, L-Phillippi, M-Phillippi, and Redbug, in order of ascending contamination potential (**Figure 25**). The highest ranked basins were in the western portion of the watershed, along U.S. 41, Tuttle, and Lockwood Ridge Road, along Proctor Road, as well as the northeastern portion drained by Main C. A surface sheen was especially prominent near the intersection of Main C and I-75, which was sampled during a period of increasing flows in response to thunderstorms in the vicinity.

Metals data and enrichment ratios appear in **Table 17** and **Figure 26** for sediments collected in 1991 and 1999. Consistent with results in 1991, overall enrichment values within the watershed are low in comparison to Hudson Bayou, Whitaker Bayou and Cedar Hammock Creek. For all metals, 15 of 33 enrichment ratios were less than 1.0, and only three values equaled or exceeded 3.0. Station PC-7 (draining Lateral AB) was enriched in both lead and zinc (3.0 and 5.1 ratios, respectively), while PC-5 (at Main C) was enriched in copper (3.3 ratio). Stations below Redbug

Table 16. Polynuclear aromatic hydrocarbons (PAH) in the sediments of the Whitaker Bayou watershed. Averages and sums computed only if analytical values were greater than the method detection limit.

Compound (ug/kg dry wt)	WB-1	WB-2	WB-3	WB-4	WB-5	WB-6	WB-7	Average
Acenaphthene	<78	<500	<62	<670	<690	<710	<1400	0
Acenaphthylene	43	<200	<25	<270	<280	<280	<570	6
Anthracene	<6.2	140 X	<5	<53	350	<57	<110	70
Benzo(a)anthracene	80	1500	45	300	3200 *F42	140	660	846
Benzo(a)pyrene	86 X	1400	64 X	460 X	2800 *F42	160	1000	853
Benzo(b)fluoranthene	140	2300	110	770	4600 *F42	250	1800	1,424
Benzo(g,h,i)perylene	180 X	1600 X	110	680 X	3400 X	<140	1500	1,067
Benzo(k)fluoranthene	62	960	46	310	2000 *F42	95	750 X	603
Chrysene	160	2700 *F42	87	790	4900 *F42	280	1400	1,474
Dibenzo(a,h)anthracene	92	1600	190 X	<130	3590	<140	1200	953
Fluoranthene	260 X	6600 *F42	170	1500 X	13000 *F42	610	2600	3,534
Fluorene	<16	<100	<12	<130	<140	<140	<280	0
Indeno(1,2,3-cd)pyrene	76 X	1200 *F42	91	480	2200 *F42	<140	1300	764
Naphthalene	<31	<200	<25	<270	<280	<280	<570	0
Phenanthrene	49	2400 *F42	51	340	3400 *F42	200	420 X	980
Pyrene	180	3700	120	900	7400 *F42	410	1700	2,059
1-Methylnaphthalene	<31	380 X	<25	<270	1100 X	<280	<570	211
2-Methylnaphthalene	53 X	1200 X	<25	310 X	3300 X	<280	610 X	782
Sum of detectable PAH	1,461	27,680	1,084	6,840	55,240	2,145	14,940	15,627

(dotted box) = Above TEL (solid box) = Above PEL
F42 - Diluted for analysis X - Minimal precision btwn columns

Compound	WB-1	WB-2	WB-3	WB-4	WB-5	WB-6	WB-7	Average
Percent Organics	5.9	8.0	1.3	4.1	6.0	3.7	16.6	
(ug/kg dry wt of organics)								
Acenaphthene								0
Acenaphthylene	729							104
Anthracene		1,750			5,833			1,083
Benzo(a)anthracene	1,356	18,750	3,462	7,317	53,333	3,784	3,976	13,140
Benzo(a)pyrene	1,458	17,500	4,923	11,220	46,667	4,324	6,024	13,159
Benzo(b)fluoranthene	2,373	28,750	8,462	18,780	76,667	6,757	10,843	21,805
Benzo(g,h,i)perylene	3,051	20,000	8,462	16,585	56,667		9,036	16,257
Benzo(k)fluoranthene	1,051	12,000	3,538	7,561	33,333	2,568	4,518	9,224
Chrysene	2,712	33,750	6,692	19,268	81,667	7,568	8,434	22,870
Dibenzo(a,h)anthracene	1,559	20,000	14,615		59,833		7,229	14,748
Fluoranthene	4,407	82,500	13,077	36,585	216,667	16,486	15,663	55,055
Fluorene								0
Indeno(1,2,3-cd)pyrene	1,288	15,000	7,000	11,707	36,667		7,831	11,356
Naphthalene								0
Phenanthrene	831	30,000	3,923	8,293	56,667	5,405	2,530	15,378
Pyrene	3,051	46,250	9,231	21,951	123,333	11,081	10,241	32,163
1-Methylnaphthalene		4,750			18,333			3,298
2-Methylnaphthalene	898	15,000		7,561	55,000		3,675	11,733
Sum of detectable PAH	24,763	346,000	83,385	166,829	920,667	57,973	90,000	241,374

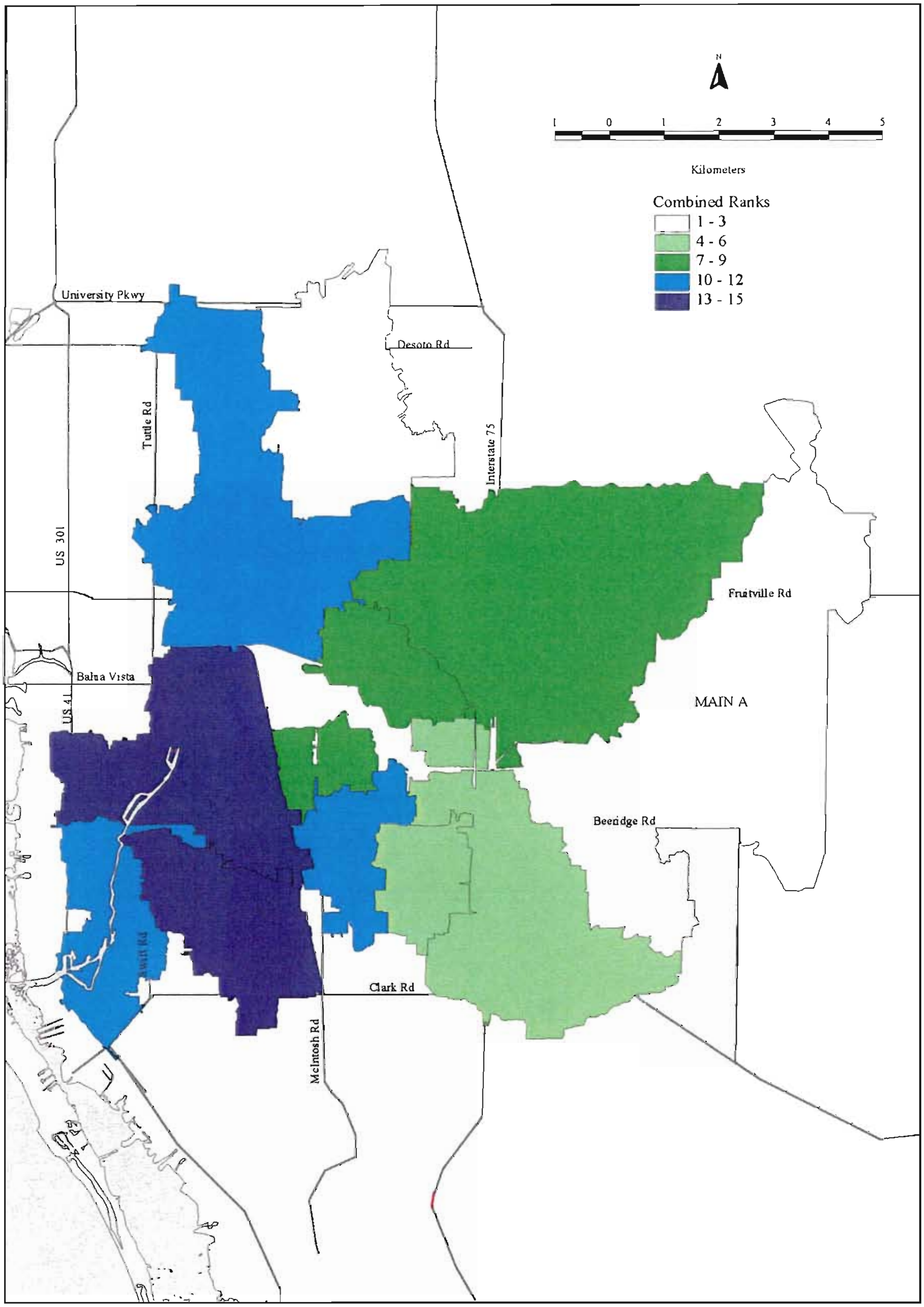

Figure 24. Combined ranks of the density of potential contaminant sources based on present day industry presence, multi-sector industries and estimated metals loadings in stormwater, Phillippi Creek.

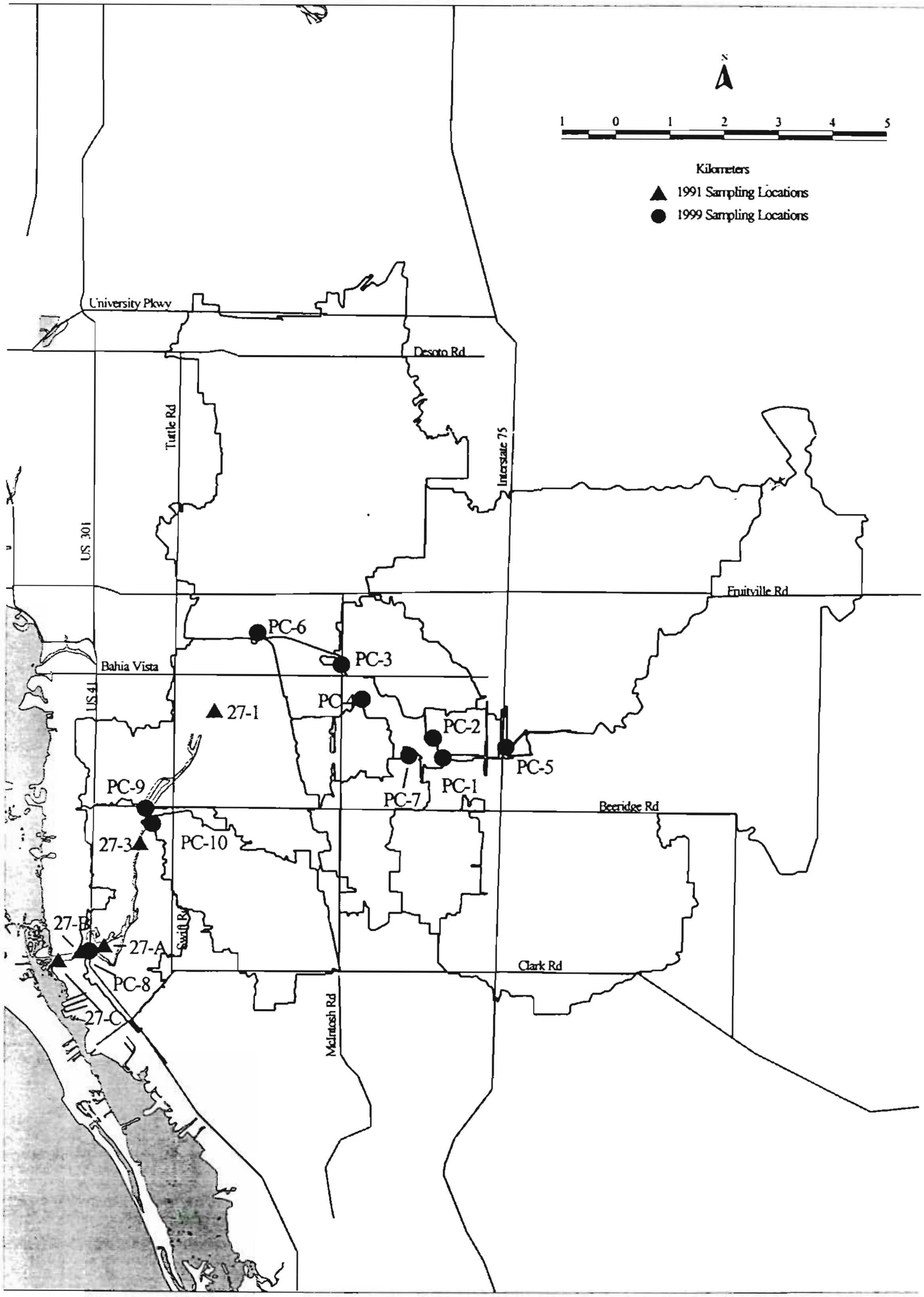

Figure 25. Consolidated subbasins and location of sediment samplings conducted in 1991 and 1999, Phillippi Creek watershed.

Table 17. Sediment metal concentrations from samples collected in 1998, 1997, and 1991, Phillippi Creek. Enrichment ratios computed as the ratio of sediment concentration to the upper 95th percentile of the values of pristine sediments. Shaded values are from analyses using less rigorous digestion methods. 'T' indicates tidally influenced station.

				Aluminum	Copper	Lead	Zinc	Enrichment Ratio			
Station	Date	Tidal	Description	ug/g dry wt	ug/g dry wt	ug/g dry wt	ug/g dry wt	Copper	Lead	Zinc	Mean
PC-1	1999	-	Winewood Dr	5,580	4.9	6.7	23	0.3	0.7	1.0	0.7
PC-2	1999	-	Colonial Oaks Blvd	15,990	41.4	8.9	93	1.6	0.4	1.9	1.3
PC-2R	1999	-	Colonial Oaks Blvd	10,440	24.3	6.4	51	1.2	0.4	1.4	1.0
PC-3	1999	-	McIntosh near Little John Tr	4,980	5.1	5.7	31	0.4	0.7	1.5	0.9
PC-4	1999	-	Trails Dr near Suwannee Ct	3,360	1.2	10.2	15	0.1	1.6	0.9	0.9
PC-5	1999	-	Main C at Porter Lake Dr	36,890	125.2	34.4	66	3.3	0.9	0.7	1.6
PC-6	1999	-	Beneva, N of Parkland Ave	3,690	3.7	5.6	16	0.3	0.8	0.9	0.7
PC-7	1999	-	Lalani Dr at Webber St	3,410	6.4	19.3	84	0.5	3.0	5.1	2.9
PC-8	1999	T	Phillippi Creek @ US41	6,360	20.6	18.0	49	1.3	1.8	1.9	1.7
PC-9	1999	T	Bee Ridge Rd near Jaffa Dr	4,150	13.8	18.5	38	1.1	2.5	2.0	1.9
PC-10	1999	-	Brookside near Bryce Ln	1,400	3.5	8.0	22	0.5	2.4	2.5	1.8
Site 1	1998	-	Coburn Rd, E. of I-75	15,200	63.9	27.6	98	2.6	1.5	2.0	2.0
Site 2	1998	-	Bahia Vista St Bridge	462	0.6	2.2	8	0.1	1.4	1.9	1.1
27-1	1991	-	Bahia Vista St Bridge	3,840	6.3	6.2	19	0.5	0.9	1.0	0.8
27-1	1991	-	Bahia Vista St Bridge	3,020	6.4	6.6	14	0.6	1.1	0.9	0.9
27-2	1991	T	Dnstrm of Bee Ridge Rd	9,470	50.3	41.1	133	2.6	3.1	3.9	3.2
27-2	1991	T	Dnstrm of Bee Ridge Rd	11,600	54.1	45.0	127	2.5	2.9	3.2	2.9
27-3	1991	T	Phillippi Creek @ US41	1,170	4.7	5.3	7	0.7	1.8	0.9	1.1
27-3	1991	T	Phillippi Creek @ US41	2,530	9.3	8.4	18	0.9	1.6	1.3	1.3
27-A	1991	T	Upstrm uf US41	1,250	2.7	4.5	6	0.4	1.4	0.7	0.8
27-A	1991	T	Upstrm uf US41	713	3.4	3.8	4	0.6	1.8	0.8	1.1
27-A	1991	T	Upstrm uf US41	1,240	3.8	3.6	7	0.5	1.2	0.8	0.8
27-A	1991	T	Upstrm uf US41	1,470	4.6	3.2	9	0.6	0.9	0.9	0.8
27-B	1991	T	Phillippi Creek @ US41	2,800	10.9	30.5	19	1.0	5.5	1.3	2.6
27-B	1991	T	Phillippi Creek @ US41	1,720	3.6	10.0	7	0.4	2.6	0.6	1.2
27-B	1991	T	Phillippi Creek @ US41	1,630	5.8	12.0	8	0.7	3.2	0.8	1.6
27-B	1991	T	Phillippi Creek @ US41	2,460	7.9	7.9	14	0.8	1.6	1.0	1.1
27-C	1991	T	Mouth of Phillippi Creek	1,210	0.9	2.3	2	0.1	0.8	0.2	0.4
27-C	1991	T	Mouth of Phillippi Creek	1,160	1.3	2.4	3	0.2	0.8	0.4	0.5

[dashed box] = Above TEL [double-line box] = Above PEL

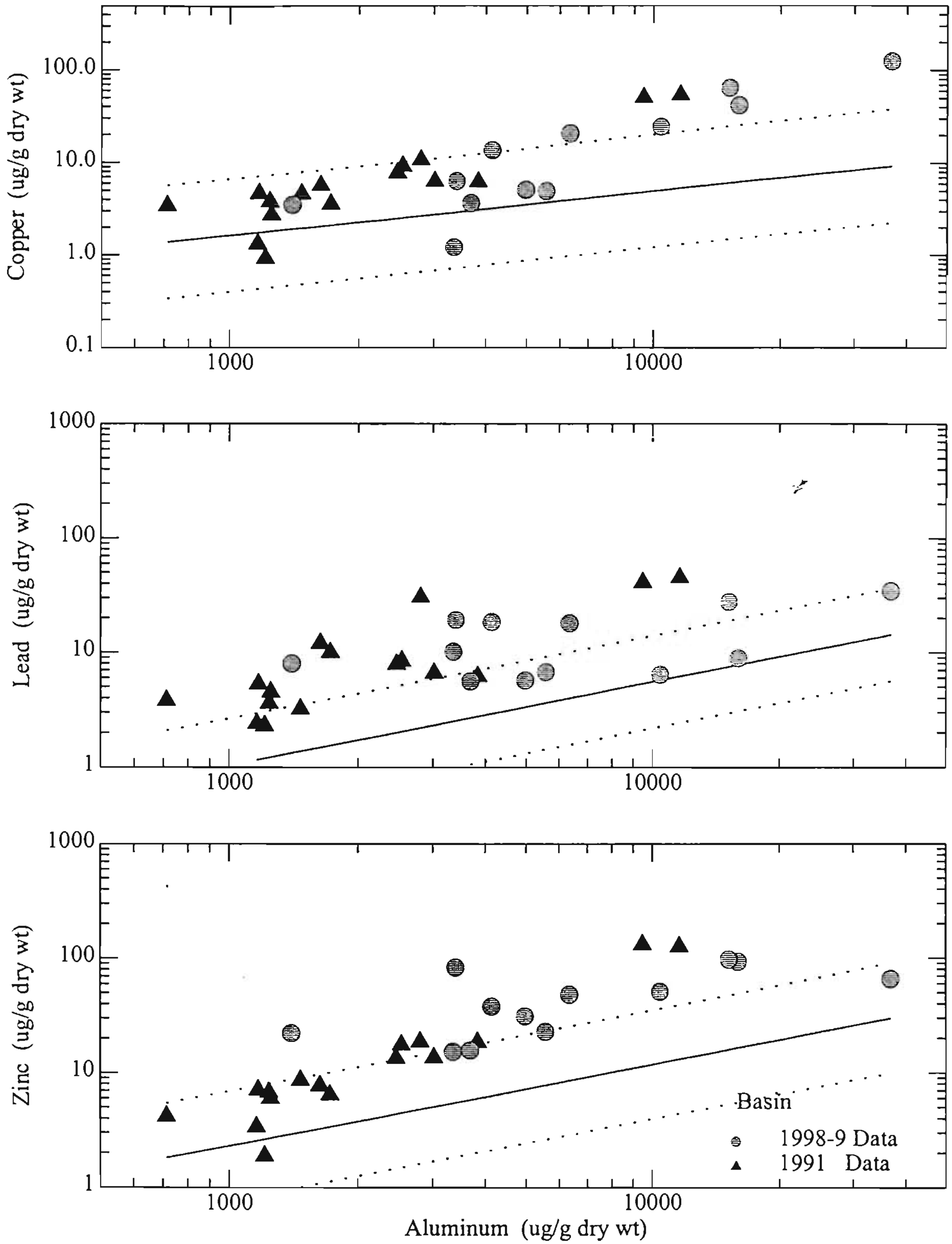

Figure 26. Sediment metal concentrations from the Phillippi Creek watershed illustrated with the linear relationship (and 95% confidence intervals) of metal to aluminum in pristine sediments.

(PC-10) and at Bee Ridge (PC-9) were also higher for lead and zinc than the remaining stations sampled and indicate a source upstream.

Data from 1991 and 1995 were generally consistent (27-2 and PC-9). Stations 27-B and PC-8 were also similar for copper and zinc, but some occasionally high values of lead enrichment (up to 5.5) were observed in 1991. Noteworthy for Phillippi Creek is the relative lack of enriched sediments near the mouth. Flows are obviously higher at times than in the other watersheds, due to the size of the basin. The depositional environment also appears to occur further downstream than was sampled, based on the relatively low aluminum concentrations at the mouth of the Creek. Nevertheless, as enrichment ratios should normalize for these effects, there appears to be a comparative lack of metals contamination in this region. Copper exceeded TEL values at two stations (PC-2 and PC-8, Colonial Oaks and U.S. 41), and exceeded PEL levels at PC-5 (Main C). Lead was also higher than the TEL value at PC-5.

Modeled point and non-point source support the results found in the Phillippi Creek watershed in general but not in the particular. Watershed average loading rates (in lbs/ac/yr) were the lowest of any of the five watersheds for both copper, lead, and zinc, consistent with the relatively few enriched stations. The stations with the highest metals enrichment ratios within the Phillippi Creek watershed, however, were not from those subbasins with the highest loading rates and were instead 25-30% of the maximum loading rates calculated.

With the exception of a single station, PAH contamination (**Table 18**) in the Phillippi Creek watershed, based on data normalized to organic matter, was the smallest of any of the five priority watersheds. Data from 1991 were similarly low in comparison, ranging between undetectable and 24,000 ug/kg of organic matter. Examining bulk concentrations, only two stations, PC-6 and PC-7 (subbasins Branch BA and Lateral AB) had concentrations which exceeded PEL values for probable biological impacts. Of the two stations, however, PC-7 had 12 compounds or categories with probable impacts, in contrast to only one compound at Station PC-6. Six other stations also had compounds which exceeded TEL levels, but generally only for two to four compounds. While the Phillippi Creek stations as a group contained the lowest PAH for the quantity of organic matter present, Station PC-7 (Lateral AB) also contained the highest concentration (951,000 ug/kg of organics) of any station sampled in any watershed. Fluoranthene and pyrene were the most prevalent compounds. PAH contamination is apparently limited to isolated basins within the Phillippi Creek watershed.

Table 18. Polynuclear aromatic hydrocarbons (PAH) in the sediments of the Phillippi Creek watershed. Averages and sums computed only if analytical values were greater than the method detection limit.

Compound	PC-1	PC-2	PC-2R	PC-3	PC-4	PC-5	PC-6	PC-7	PC-8	PC-9	PC-10	Average
(ug/kg dry wt)												
Acenaphthene	< 70	< 170	< 140	< 83	< 61	< 160	98 X	610 X	< 1000	< 72	< 320	79
Acenaphthylene	99	82	< 54	120	< 24	< 64	< 28	< 160	< 420	< 29	< 130	33
Anthracene	< 5.6	< 14	< 11	< 6.7	< 4.9	< 13	< 5.6	930	< 83	< 5.8	< 26	103
Benzo(a)anthracene	8.4	< 14	< 11	18	< 4.9	35	99	5200 •F42	87	69	56	605
Benzo(a)pyrene	19 X	< 14	< 11	44 X	< 4.9	56	120	4100 •F42	140	89 X	78 X	498
Benzo(b)fluoranthene	26	18	12	77	8.3 X	82	230	6200 •F42	220	140	150	764
Benzo(g,h,i)perylene	54 X	48	< 27	89	< 12	86 X	270 X	5700 •F42	< 210	150	< 65	694
Benzo(k)fluoranthene	12 X	< 14	< 11	32 X	15 X	34 X	100 X	2700 •F42	93	58 X	51	332
Chrysene	19	< 14	13	48	< 4.9	54	220	6000 •F42	130	120	110	720
Dibenzo(a,h)anthracene	< 14	< 34	< 27	34	< 12	< 32	< 14	2400 X	< 210	61 X	< 65	270
Fluoranthene	48 X	< 34	< 27	73	< 12	120	430 •F42	18000 •F42	220	180 X	330	2099
Fluorene	< 14	< 34	< 27	< 17	< 12	< 32	< 14	270	< 210	< 14	< 65	30
Indeno(1,2,3-cd)pyrene	19 X	< 34	< 27	50	< 12	44	74 •F42	3300 •F42	< 210	91	< 65	387
Naphthalene	< 28	< 69	< 54	< 33	< 24	< 64	< 28	< 160	< 420	< 29	< 130	0
Phenanthrene	18 X	< 14	11	14	< 4.9	29	110	5200 •F42	< 83	26	64	598
Pyrene	22	< 34	< 27	44	< 12	69	330	9800 •F42	250	150	170 X	1168
1-Methylnaphthalene	< 28	< 69	< 54	70 X	< 24	< 64	< 28	270 X	< 420	< 29	< 130	38
2-Methylnaphthalene	< 28	< 69	< 54	< 33	< 24	< 64	< 28	2600 X	< 420	< 29	< 130	289
Sum of detectable PAH	344	148	36	713	23	609	2,081	73,280	1,140	1,134	1,009	8708

[dotted box] = Above TEL   [solid box] = Above PEL
F42 - Diluted for analysis   X - Minimal precision btwn columns

Compound	PC-1	PC-2	PC-2R	PC-3	PC-4	PC-5	PC-6	PC-7	PC-8	PC-9	PC-10	Average
Percent Organics	3.9	11.5	6.2	7.0	1.9	17.0	4.4	7.7	8.6	10.3	1.9	
(ug/kg dry wt of organics)												
Acenaphthene							2,227	7,922				923
Acenaphthylene	2,538	713		1,714								451
Anthracene								12,078				1,098
Benzo(a)anthracene	215			257		206	2,250	67,532	1,012	670	2,947	6,498
Benzo(a)pyrene	487			629		329	2,727	53,247	1,628	864	4,105	5,368
Benzo(b)fluoranthene	667	157	194	1,100	437	482	5,227	80,519	2,558	1,359	7,895	8,304
Benzo(g,h,i)perylene	1,385	417		1,271		506	6,136	74,026		1,456		7,613
Benzo(k)fluoranthene	308			457	789	200	2,273	35,065	1,081	563	2,684	3,652
Chrysene	487		210	686		318	5,000	77,922	1,512	1,165	5,789	7,830
Dibenzo(a,h)anthracene				486				31,169		592		2,878
Fluoranthene	1,231			1,043		706	9,773	233,766	2,558	1,748	17,368	22,643
Fluorene								3,506				319
Indeno(1,2,3-cd)pyrene	487			714		259	1,682	42,857		883		4,182
Naphthalene												0
Phenanthrene	462		177	200		171	2,500	67,532		252	3,368	6,458
Pyrene	564			629		406	7,500	127,273	2,907	1,456	8,947	12,662
1-Methylnaphthalene				1,000				3,506				410
2-Methylnaphthalene								33,766				3,070
Sum of detectable PAH	8,831	1,287	581	10,186	1,226	3,582	47,295	951,688	13,256	11,010	53,105	94,357

V. SUMMARY

A variety of existing information was compiled to identify the subbasins within the Sarasota Bay priority watersheds which were the likely sources of the noteworthy sediment contamination documented in Lowery, et al. (1993). Sediments from the identified groups of subbasins were sampled and data combined with existing sediment quality data to determine the locus of contamination and to allow prioritization of subbasins for treatment activities.

Industry and business types within the various watersheds were assigned as *potential* contamination sources for pesticides, metals, and polynuclear aromatic hydrocarbons. Source potential was based on raw materials, manufacturing processes, probable activities, and related issues (such as volume of vehicle traffic). No adjustment for the relative size of an individual business within a given industry category was possible, with small businesses receiving equal weighting with large entities. It should be emphasized that poor housekeeping practices were assumed to be the rule rather than the exception. Under this assumption, raw materials would be stored outside and uncovered, and waste materials and products were assumed to be discarded such that stormwater runoff would be contaminated. As a result, the number of potential sources are undoubtedly an overestimate of actual conditions.

The number of potential contaminant sources within a subbasin, by contaminant category, was used to compute the density (number per acre) of potential sources. Qualitative rankings for each contaminant category (pesticides, metals, and PAH) were assigned based on density and the individual contaminant ranks averaged to identify basins with a high likelihood of contamination. For Hudson Bayou, rankings were developed for two time periods, 1972 and 1998, using all businesses identified by either the City Directory (1972) or by the current records of several Sarasota County departments. The remaining basins were ranked using present-day indsutries (1998-1999). In addition, the industries within the watersheds identified by USEPA as having a high risk of contamination (multi-sector industries) were also used to develop a ranking.

Land use within the watersheds was also used to compute quantitative stormwater loadings based on an extensive and recent data set. Point sources were incorporated as appropriate. The non-point source loadings reflect generalized activities within a particular land use and cannot account for spills, unusual activities, or particular industries or classes of industries within a watershed. (Lack of agreement between modeled loadings and normalized sediment concentrations are indicative of an these types of unusual activities that are not captured by generalized land use and runoff data.) Combined non-point and point source loading rates (pounds per acre pre year) were also used to rank subbasins and identify those subbasins with the higher potential contaminant loads. Loadings were available for metals, but the low levels of pesticides and PAH in present-day stormwater precluded quantifying the organic parameters.

Once groups of basins were identified, sediment sampling was used to confirm contamination or eliminate basins from further consideration. Samples were collected from surficial sediments to examine relatively recent deposition. Sampling was restricted in some cases since much of the drainage is in piped or closed conveyances with minimal sediment accumulation. Some watersheds were subdivided into many more subbasins than samples that had been budgeted for sampling. As a result, the new samples collected under this project may reflect discharges from a combination of subbasins and low ranking or inaccessible areas of the watershed drainage may not have been sampled.

No chlorinated pesticides above the method detection limits were found in the 1998-9 watershed samples, regardless of the amount of organic matter in the sediments. Pesticides found within the priority tributaries in 1991 were apparently from sources which are no longer active, or were from the unsampled portions of the watershed. Additionally, bulk concentrations of pesticides in the generally coarser sediments may simply have been above method detection limits.

The drainageways sampled during the project are designed to transport large volumes of water, and typically do not accumulate sediment fines (with the disproportionate contaminant loads). Fines instead are transported downstream and tend to settle where velocities are reduced, at the mouths of the various tributaries. As a result, exceedances of probable and threshold biological impacts due to contaminant concentrations (using criteria developed for coastal waters as a convenient yardstick) are much reduced in the watershed stations from the frequency observed in 1991 data. In the earlier work, sediments were collected from the depositional regions of the tributary mouths and bulk contaminant concentrations were higher, overall. In order to identify the sources of contaminants, normalization techniques were used which would account for the differing depositional environments.

The use of metal enrichment ratios and PAH concentrations per weight of organic matter permit the intercomparison of subbasins under differing hydrological environments for geographic source delineation. The results of the metals analyses performed under this project are summarized in **Figure 27**. Metal enrichment ratios for copper, lead, and zinc are illustrated for all watersheds and stations. Ratios greater than one are considered anthropogenically enriched. Agreement between replicate samples from the same site and time was often good (indicating a more consistent source), but in the case of Hudson Bayou was quite variable. The variability between samples from the same site is interpreted as intermittent contamination events or transport of more contaminated sediments from the upper watershed under periodic storm event conditions. With highly variable sediment concentrations, a continuous point source discharge is unlikely. Stations co-located between 1991 and 1998-9 showed fairly stable patterns of metals enrichment over time. In some instances, highly contaminated sediments did not extend downstream to the next sampled site. This result may be a product of the relative size and proportional contribution of the contaminated basin with respect to the remaining watershed area.

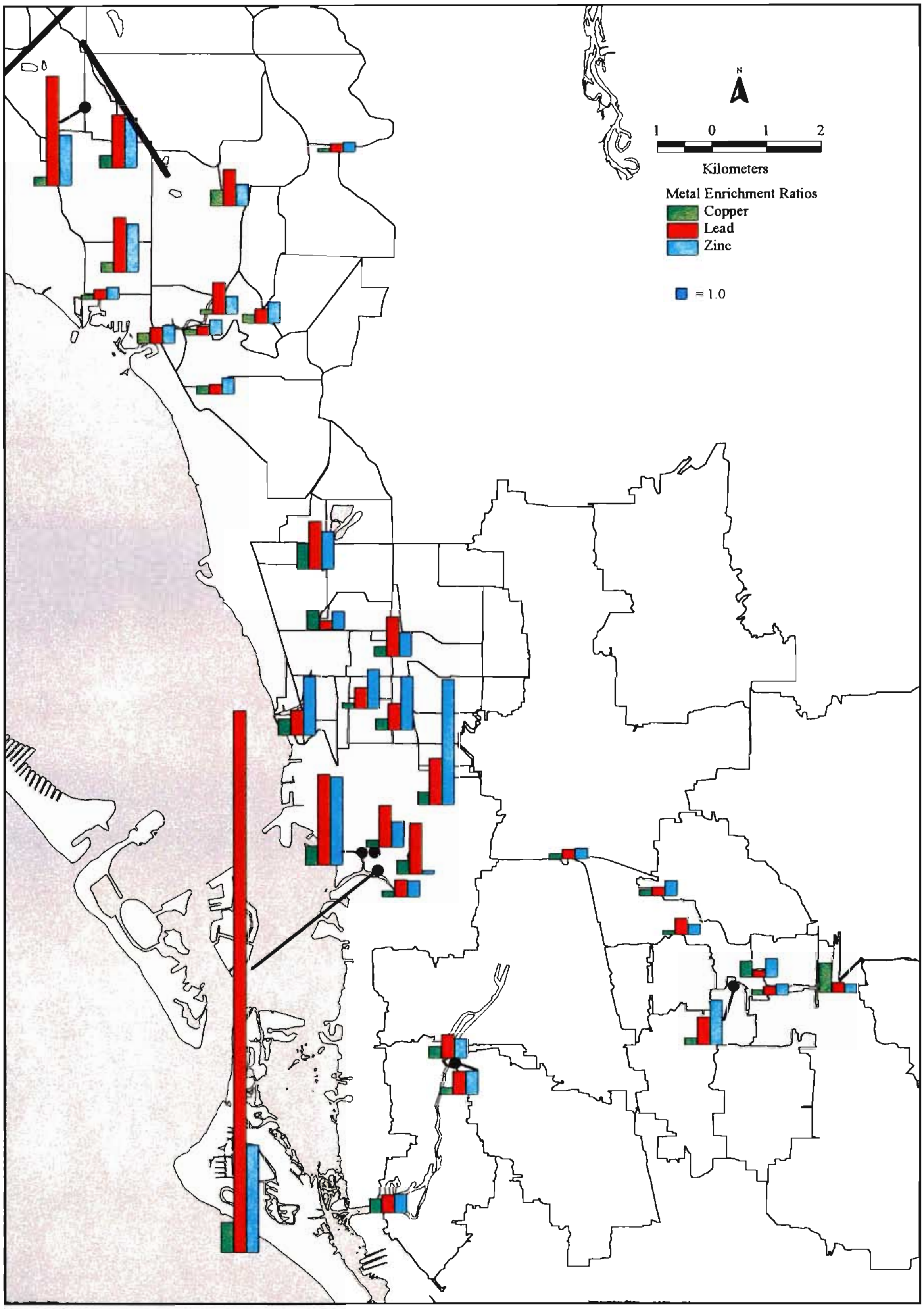

Figure 27. Sediment metal enrichment ratios of copper, lead, and zinc for 1998-1999 samples collected in Sarasota Bay National Estuary Program priority watersheds. Values above 1.0 are considered anthropogenically enriched.

Examining all stations together, it can be seen that metal enrichment is more prevalent in the Cedar Hammock Creek, Whitaker Bayou and Hudson Bayou watersheds, and that lead or zinc were the most commonly enriched metals among all of the stations. In particular, the lead enrichment from a station within Hudson Bayou dwarfed all other contaminated areas.
At the discharge from the lower central basins of Hudson Bayou, lead is enriched between 30-40 times over what could be expected in pristine sediments. Farther upstream in the basin, lead is only 4 times greater than expected. Lead and zinc at the lower central basins are also present in concentrations at which biological effects can be expected. Sediment concentrations are also very non-homogeneous, indicating either an intermittent discharge or stormwater transfer from some upstream reservoir. Three of the five lower central subbasins were ranked highly for both multi-sector industry density and stormwater loading, but regional stormwater loadings do not account for the degree of contamination apparently originating within the lower central subbasins. Other than the central basins of Hudson Bayou, metals contamination was higher in regions draining the downtown area and was generally consistent with the loadings based on stormwater modeling. Sediments from areas of the tidal Hudson Bayou that were recently dredged appear reduced in concentration over 1991 levels.

In the Cedar Hammock Creek watershed, metals sources appear to be concentrated in the upper watershed, but earlier data indicate a copper source near the mouth of the tributary or historical that has now been eliminated. Bowlees Creek also reported slightly higher concentrations in the upper watershed than in the sediments near the mouth, with the exception of a 1991 station near U.S.41. Again this geographic pattern could indicate either a source near the mouth, or historical contamination which has been removed or reduced from within the watershed. There were selected areas of Whitaker Bayou with substantial zinc contamination. Sediments near U.S.41 were even more enriched than areas immediately upstream and may reflect historical or continuing inputs from activities near the mouth. In particular, copper concentrations were high in 1991 in the tidal portions of the Bayou where marina activities and wastewater discharges may contribute. For Phillippi Creek, most metal contamination was concentrated in the lower watershed with enrichment values of 2-3 times pristine levels. One station, however, reported substantial zinc concentrations (PC-7). Biological effects likely due to the metal concentrations in 1998-9 were limited to one station in Phillippi Creek, and one station in Hudson Bayou, although it should be emphasized that sediments were not necessarily collected from depositional environments.

As may be expected when examining a variety of contaminants and contaminant classes, spatial and temporal patterns of contamination vary by individual parameter. For PAH, sediments are even more non-homogenous at a given station than are metals, implying a variable input. Compounds present are indicative of both petroleum and combustion products contamination. Despite not having sampled depositional environments, PAH concentrations were sufficient in many instances to make biological effects probable, particularly in the case of Cedar Hammock Creek (3 of 4 stations) and Whitaker Bayou (5 of 7 stations). **Figure 28** illustrates the combined results from 1998-1999 sampling. PAH data are illustrated as the percentage of the maximum value of ug/kg of organic matter.

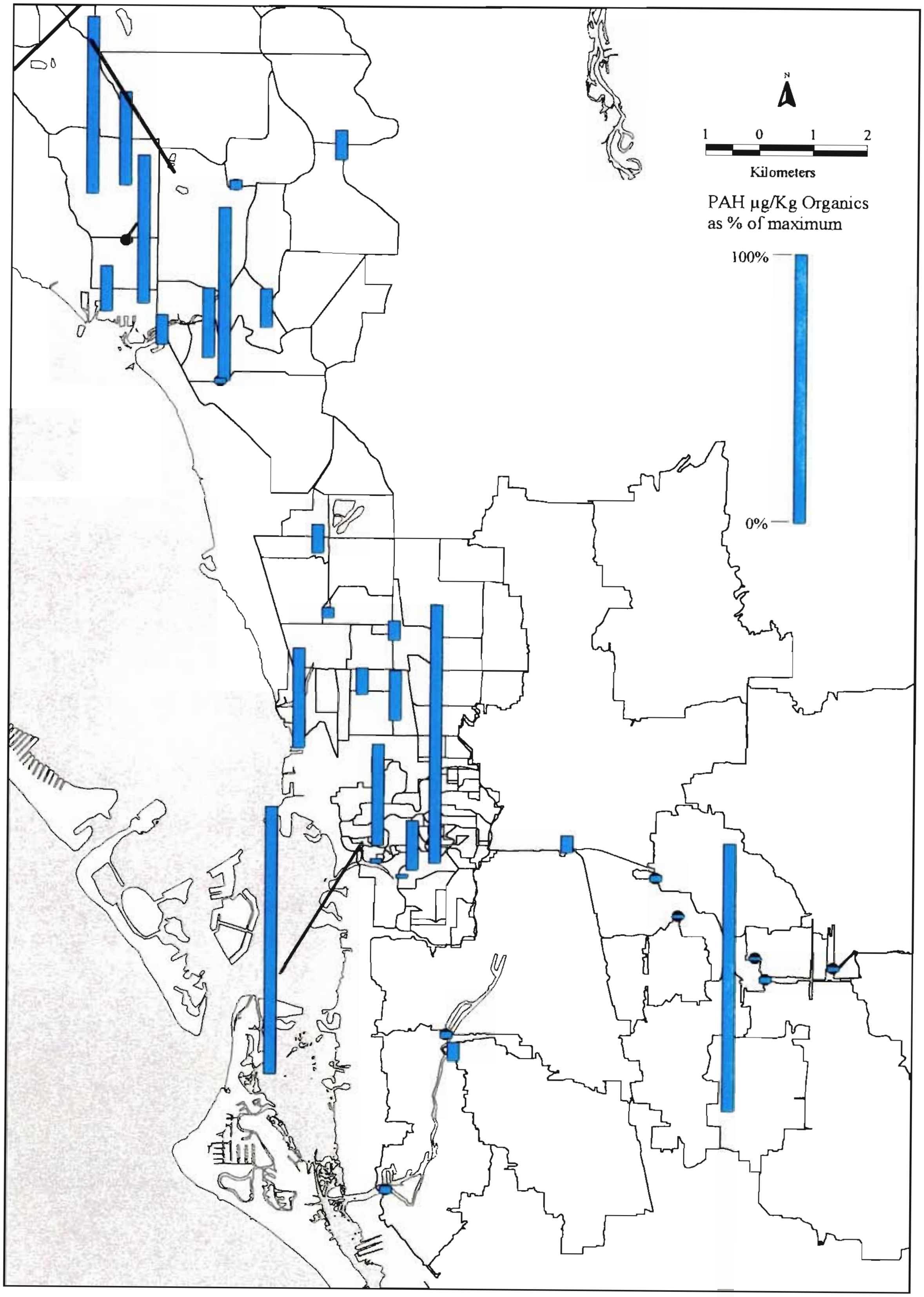

Figure 28. Sediment concentrations of polynuclear aromatic hydrocarbons for 1998-1999 samples collected in Sarasota Bay National Estuary Program priority watersheds. Data normalized to sediment organic content and presented as a percentage of the maximum value found.

The midpoint of the bar illustrating PAH concentrations is roughly coincident with the station location. High levels of PAH are concentrated in the upper Cedar Hammock Creek watershed, several of the lower stations in Bowlees Creek, near the mouth and at station WB-5 in Whitaker Bayou and at several stations in Hudson Bayou. The Hudson Bayou with the high lead contamination was not the highest for PAH within this watershed. The highest normalized concentrations of PAH within Hudson Bayou were found in sediments downstream of the downtown region. The PAH levels in Phillippi Creek sediments were typically the lowest of all basins with the exception of one station which was the maximum for the study (PC-7) with over 951,000 ug/kg of organic matter.

For metals, controlling discharges and source identification within the lower central subbasins of Hudson Bayou is a clear priority to reduce lead contamination. The source of excessive lead in Hudson Bayou is predominantly located within the lower central subbasins and discharge to the Bayou apparently continues based on the presence of lead in the surficial sediments. Lead at this station is not the product of generalized urban land uses, as the sediment lead concentrations do not agree well with modeled lead discharges from the subbasins. An unusual metals source is present in the lower central region. Metals contamination varies substantially by watershed and subbasin but is generally more prevalent in the Cedar Hammock Creek, Whitaker Bayou, and Hudson Bayou watersheds.

PAH concentrations appear to be a more serious problem for biota within the sampled basins as many more station exceeded probable effects levels. Some watersheds had pervasive concentrations of PAH; Cedar Hammock Creek, lower Bowlees Creek, and Hudson Bayou. Other watersheds, such as Phillippi Creek, were comparatively free of PAH with a few notable exceptions. In this instance, PAH contamination appears to be an episodic event that is not mirrored in the remainder of the watershed.

Regionalized treatment systems or activities may be an effective approach for addressing watersheds with pervasive contamination and no single station representing the majority of the contamination. Regionalized systems are less justifiable if contamination is limited to a few areas. Placement of systems for removal of contaminants clearly should follow a thorough assessment of watershed contamination as unlikely sources of significant contamination can override expected contaminant loads based on density of industry or modeled point and non-point source loads. Dredging with sediment removal can apparently expose sediments with lower concentration values for metals, but continued monitoring will be necessary to determine whether the reduced concentrations are lasting, or whether the sources(s) will continue to contaminate the newly deposited sediments.

The methodology used in this project identified subbasins with contamination potential. New samples, coupled with existing data, depicted spatial patterns of contamination. Some parameters are apparently no longer contributed by the watershed, while others remain as a significant pollutant. Not all observed contamination was consistent with predicted loadings or density of historical or present day industries, indicating that unusual or watershed-specific activities can account for a substantial portion of contaminant loads.

VI. LITERATURE CITED

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APPENDICES

Appendix A-1. Business categories in the 1972 Sarasota City Directory and potential contaminant categories of pesticides (P), metals (M), and hydrocarbons (H).

CATEGORY	P	M	H	CATEGORY	P	M	H
Adding Machines		M	H	Blowers And Exhaust Fans-MFRS		M	H
Agricultural Implement Dealers		M	H	Blue Prints			H
Air Conditioning		M	H	Boat Builders		M	H
Air Conditioning & Heating		M	H	Boat Chartering And Renting Service		M	H
Air Conditioning Equipment & Supplies		M	H	Boat Dealers-Repair And Supplies		M	H
Air Conditioning Sales & Serivce		M	H	Boat Storage		M	H
Aircraft Dealers		M	H	Boats		M	H
Airports		M	H	Bottlers-Carbonated Beverages		M	H
Aluminum MFRS		M	H	Bottlers-Mineral Water		M	H
Aluminum Fabrication		M	H	Brokers-Yacht		M	H
Aluminum Products-MFRS		M	H	Builders Hardware		M	H
Aluminum-Store Fronts		M	H	Building Materials And Supplies		M	
Ammunition MFRS		M		Buildings-Prefabricated Steel		M	
Amusement Devices-MFRS		M	H	Bus Lines		M	H
Amusement-Places Of	P			Business Machines-Sales And Service		M	H
Antenna Service		M	H	Cabinet Makers			H
Antiques-Dealers And Restorers			H	Cabs-Taxi		M	H
Appliance Service		M	H	Cash Register-Dealers And Repairing		M	H
Appliances And Tires		M	H	Cemeteries	P		
Armored Car Service		M	H	Ceramic Products		M	H
Armories		M	H	Chemicals-MFRS		M	H
Art Goods		M		Citrus Fruit Growers And Shippers	P		
Artists' Materials		M		Clubs	P		
Artists-Commercial		M	H	Clubs- Private	P		
Auto Leasing		M	H	Clubs- Tennis-Private	P		
Automatic Transmission Service		M	H	Communicating Systems		M	H
Automatic Transmissions		M	H	Concrete Blocks And Bricks		M	H
Automobile Accessories And Parts MF		M	H	Concrete Prducts-Mfrs		M	H
Automobile Accessories And Parts-Re		M	H	Concrete Products		M	H
Automobile Accessories And Parts-Wh		M	H	Concrete Products-Mfrs		M	H
Automobile Body And Fender Repairin		M	H	Concrete-Prestressed		M	H
Automobile Body Repairers		M	H	Concrete-Ready Mix		M	H
Automobile Dealers		M	H	Contractor-Plumbing		M	
Automobile Dealers-Used Cars		M	H	Contractors- Painting And Decoratin			H
Automobile Garages		M	H	Contractors- Pipe Line		M	H
Automobile Painters		M	H	Contractor's Supplies and Equipment		M	H
Automobile Parking		M	H	Contractors-Asphalt		M	H
Automobile Radiator Repairers		M	H	Contractors-Builders And Developers		M	H
Automobile Renting		M	H	Contractors-Commercial		M	H
Automobile Repairing		M	H	Contractors-Electrical		M	H
Automobile Tire Dealers And Repaire		M	H	Contractors-Excavating And Grading		M	H
Automobile Trailer Equipment		M	H	Contractors-Fence Erecting		M	
Automobile Trailers-DLRS		M	H	Contractors-Heating And Ventilating		M	H
Automobile Trailers-Rental		M	H	Contractors-Marine		M	H
Automobile Transport Service		M	H	Contractors-Paving		M	H
Automobile Trimmers And Trimmings		M	H	Contractors-Road		M	H
Automobile Washing		M	H	Contractors-Roofing And Siding		M	H
Automobile Washing And Polishing		M	H	Contractors-Sewer And Drain		M	
Automobile-Air Conditioning		M	H	Contractors-Stucco		M	
Awnings & Canopies		M		Contractors-Waterproofing			H
Bakers-Wholesale And Manufacturing	P			Dairy Products	P		
Battery Dealers And Service		M		Department Store-5 Cent to $1.00		M	H
Beer Distributors		M	H	Department Stores		M	H
Bicycles Dealers And Repairers		M	H	Display Racks-Wire		M	

CATEGORY	P	M	H
Doors-Folding		M	
Electric Motors		M	H
Electric Motors And Generators-Dlrs		M	H
Electrical Appliances		M	H
Electrical Appliances-Sales And Ser		M	H
Electrical Contractors		M	H
Electrical Equipment And Supplies-D		M	H
Electronic Equipment And Supplies		M	H
Engravers-Photo		M	
Equipment Rentals		M	H
Expressing And Moving		M	H
Exterminators	P		
Fastener MFRS		M	H
Fertilizer and Seeds	P		
Filter Mfrs		M	H
Fire Apparatus and Supplies		M	H
Fire Extinguishers		M	H
Fire Protection Service		M	H
Food Products Mrfs-Prepared	P		
Fruit Gift-Growers and Shippers	P		
Fruit Growers	P		
Fuel and Range Oil		M	H
Fuel Oil		M	H
Funeral Directors		M	
Funeral Directors' Supplies			
Furniture Finishers			H
Furniture Mfrs		M	H
Furniture Repairing			H
Furniture Repairs			H
Garage Door Mfrs		M	H
Garbage Collection Service		M	H
Garden and Lawn Implements-Dealers	P		
Garden Supplies	P		
Gardeners-Landscape	P		
Gas Appliances-Sales And Service		M	H
Gas Liquefied Petroleum-Bottled and		M	H
Gas-Bottled		M	H
Gasoline Stations		M	H
Glass Dealers-Stained and Leaded		M	H
Glass Mfrs		M	H
Glassware Mfrs		M	H
Golf Cars		M	H
Golf Courses-Private	P		
Golf Courses-Public	P		
Gunsmiths		M	H
Hardware Dealers-Whol and Jobbers		M	H
Hardware-Retail		M	H
Heating and Air Conditioning Contra		M	H
Heating and Ventilating-Contractors		M	H
Heating Apparatus and Appliances		M	H
Hose Mfrs		M	H
Household Appliances Repairers		M	H
Household Appliances-Dealers		M	H
Household Appliances-Mfrs		M	H
Hydraulic Equipment and Supplies			H
Ice Dealers		M	H
Industrial Supplies-Whol		M	
Ink Mfrs-Writing		M	H
Iron and Steel Work		M	H
Irrigation Companies		M	H
Irrigation Equipment and Supplies-D		M	H
Junk Dealers		M	H
Kitchen Cabinets and Equipment			H
Laboratories		M	H
Landscape Gardeners	P		
Landscaping	P		
Lawn Mower Repairs		M	H
Lighting Equipment Dealers		M	H
Locksmiths		M	H
Lumber - Retail		M	H
Machine Dealers		M	H
Machinery Manufacturers		M	H
Machinists		M	H
Marinas		M	H
Marine Supplies		M	H
Memorial Parks	P		
Metal Dealers		M	H
Metal Goods Mfr		M	H
Mimeographing		M	H
Molding Manufacturers		M	H
Motor Scooters		M	H
Motorcycle Dealers		M	H
Moving and Storage		M	H
Moving Vans		M	H
Newspapers		M	H
Nurserymen	P		
Offset Printing		M	H
Oil And Gasoline Wholesale		M	H
Oil Burners-Sales And Service		M	H
Oil Refiners		M	H
Oils & Lubricants-Dealers		M	H
Oils And Gasoline-Wholesale		M	H
Ornamental Iron Works		M	H
Paint			H
Paint and Body Shops-Automobile		M	H
Painting-Industrial		M	H
Paint-Marine and Automotive		M	H
Paint-Retail		M	H
Parking Lots-Paving and Grading		M	H
Parks and Playgrounds	P		
Pest Control	P		
Pesticides-Wholesale-Distributors		P	
Photo Finishers		M	
Photographers		M	
Photographic Apparatus Dealers & Re			
Photographic Developing and Printin		M	
Piers, Docks and Wharves		M	H
Plastic Products-Mfrs		M	H
Platers		M	H
Plumbers		M	H

CATEGORY	P	M	H	CATEGORY	P	M	H
Plumbing Contractors		M	H	Television Sets-Sales and Service		M	H
Plumbing Fixtures and Supplies-Whol		M	H	Termite Proofing	P		
Plumbing Supplies-Dealers		M	H	Tile Mfrs-Building		M	H
Power Tools and Equipment		M	H	Tire Dealers and Repairing		M	H
Printers		M	H	Tire Dealers-Whol		M	H
Printers' Supplies and Equipment		M	H	Tool Mfrs		M	H
Printers-Book and Commercial		M	H	Tools-Rentals		M	H
Publishers		M	H	Trailer Dealers		M	H
Pump Repairers		M	H	Trailer Parts and Furniture		M	H
Radio and Television Repairing		M	H	Transfer Companies		M	H
Radio and Television Sets-Sales And		M	H	Transportation Lines		M	H
Refrigeration-Commercial and Indust		M	H	Tree Surgery	P		
Refrigerators-Sales and Service		M	H	Trucking		M	H
Refrigerators-Whol		M	H	Trucks-Leasing		M	H
Rental Centers		M	H	Trucks-Motor		M	H
Rental Equipment-Tools		M	H	Trucks-Repairing		M	H
Repair Shops		M	H	TV-Weekly Cable Guide		M	H
Repairs-Authorized Service		M	H	Used Cars		M	H
Roofers		M	H	Utilities		M	H
Saw Filers, Setters and Repairers		M	H	Utilities-Water-Sewer		M	H
Scientific Instrument Repairers		M	H	Vacuum Cleaners-Dealers and Repairi		M	H
Scientific Instruments-Mfrs		M	H	Vacuum Cleaners-Mfrs		M	H
Screens		M	H	Venetian Blinds-Mfrs		M	H
Seeds-Whol	P			Water Pumps-Sales and Service		M	H
Septic Tank Cleaners		M	H	Water Softener Service		M	H
Sheet Metal and Duct Work		M	H	Water Supply Companies			
Sheet Metal Workers		M	H	Welders and Brazers		M	H
Sheet Metal Workers Supplies		M	H	Welding		M	H
Shopping Centers		M	H	Welding and Cutting Apparatus		M	H
Sign Painters and Mfrs		M	H	Well Drillers and Borers		M	H
Sod-Certified	P			Wire and Iron Work		M	H
Sodding-Commercial Residential	P			Wire Roe and Cable Dealers		M	H
Storm Doors and Windows		M	H	Wiring-Electrical		M	H
Television Repairing		M	H				

Appendix A-2. Number, density, and relative ranking of the contamination potential of historical (1972) businesses, Hudson Bayou watershed.

Subbasin	Basin size (acres)	Potential Sources per Subbasin # Pest.	# Metals	# Hydroc.	#Pest./acre	#Metals/acre	#Hydroc./acre	Ranks Pest./acre	Ranks Metals/acre	Ranks Hydroc./acre	Averge Rank
020101	9.8	0	1	1	0.000	0.102	0.102	1	40	41	**27.3**
020102	16.9	0	1	1	0.000	0.059	0.059	1	39	39	**26.3**
020104	31.0	0	4	2	0.000	0.129	0.065	1	42	40	**27.7**
020105	38.5	0	11	10	0.000	0.286	0.260	1	47	47	**31.7**
020107	30.9	0	12	11	0.000	0.388	0.356	1	49	50	**33.3**
020203	93.7	1	24	24	0.011	0.256	0.256	47	46	46	**46.3**
020302	117.4	0	1	1	0.000	0.009	0.009	1	34	34	**23.0**
020304	26.7	0	1	1	0.000	0.037	0.037	1	37	37	**25.0**
020306	17.1	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020307	27.0	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020308	146.8	1	1	0	0.007	0.007	0.000	45	33	1	**26.3**
020310	67.9	1	0	0	0.015	0.000	0.000	48	1	1	**16.7**
020311	104.6	0	2	2	0.000	0.019	0.019	1	35	35	**23.7**
020314	27.0	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020316	5.6	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020317	52.8	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020318	47.8	1	0	0	0.021	0.000	0.000	50	1	1	**17.3**
020320	25.8	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020321	94.6	0	3	3	0.000	0.032	0.032	1	36	36	**24.3**
020323	23.5	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020324	4.3	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020325	25.5	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020328	7.2	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020330	19.6	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020331	12.5	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020332	33.1	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020333	23.6	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020334	3.1	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020401	9.1	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020402	3.7	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**

Subbasin	Basin size (acres)	Potential Sources per Subbasin # Pest.	# Metals	# Hydroc.	#Pest./acre	#Metals/acre	#Hydroc./acre	Ranks Pest./acre	Ranks Metals/acre	Ranks Hydroc./acre	Averge Rank
020403	4.9	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020404	8.0	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020405	3.6	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020406	7.1	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020407	2.7	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020409	15.4	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020411	10.9	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020412	5.0	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020413	65.4	1	8	8	0.015	0.122	0.122	49	41	42	**44.0**
020414	6.7	0	3	3	0.000	0.451	0.451	1	51	51	**34.3**
020415	5.0	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020416	10.8	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020417	2.4	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020418	2.0	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020419	10.9	0	4	3	0.000	0.367	0.276	1	48	49	**32.7**
020420	3.4	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020422	18.8	0	8	5	0.000	0.426	0.266	1	50	48	**33.0**
020501	63.2	0	10	9	0.000	0.158	0.142	1	43	43	**29.0**
020601	212.2	0	10	9	0.000	0.047	0.042	1	38	38	**25.7**
020701	128.6	1	24	24	0.008	0.187	0.187	46	44	44	**44.7**
020801	31.2	1	6	6	0.032	0.192	0.192	51	45	45	**47.0**

Appendix B-1. Present day SIC codes and descriptions of industries witin the priority watersheds. Contamination potential for metals (M), pesticides (P), and PAH(H). Potential =1; unlikely=0.

SIC	DESCRIP	M	P	H	SIC	DESCRIP	M	P	H
0161	VEGETABLE & MELON CROPS	0	1	0	3448	MFG OF PREFABRICATED METAL BUILDINGS	1	0	1
0174	CITRUS FRUIT CROPS	0	1	0	3449	MFG OF MISCELLANEOUS METALWORK	1	0	1
0181	ORNAMENTAL NURSERY PRODUCTS	0	1	0	3451	MFG OF SCREW MACHINE PRODUCTS	1	0	1
0191	GENERAL FARMS, PRIMARILY CROP GROWING	0	1	0	3469	MFG OF MISCELLANEOUS METAL STAMPINGS	1	0	1
0721	CROP PLANTING & PROTECTION SERVICES	0	1	0	3471	PLATING & POLISHING	1	0	1
0782	LAWN & GARDEN SERVICES	..	1	0	3479	METAL COATING & ALLIED SERVICES	1	0	1
0783	ORNAMENTAL SHRUB & TREE SERVICES	0	1	0	3492	MFG OF FLUID POWER VALUES & HOSE FITTINGS	1	0	1
1541	CONSTRUCTION OF INDUSTRIAL BUILDINGS & WARE	1	0	1	3493	MFG OF STEEL SPRINGS, EXCEPT WIRE	1	0	1
1542	OTHER NON-RESIDENTIAL CONSTRUCTION	1	0	1	3496	MFG OF MISCELLANEOUS FABRICATED WIRE PRODUC	1	0	1
1611	HIGHWAY & STREET CONSTRUCTION	1	0	1	3499	MFG OF MISCELLANEOUS FABRICATED METAL PROD	1	0	1
1629	OTHER HEAVY CONSTRUCTION	1	0	1	3531	MFG OF CONSTRUCTION MACHINERY	1	0	1
1711	PLUMBING, HEATING & AIR-CONDITIONING	1	0	1	3541	MFG OF MACHINE TOOLS, METAL CUTTING TYPE	1	0	1
1721	PAINTING & PAPER HANGING	0	0	1	3545	MFG OF MACHINE TOOL ACCESSORIES	1	0	1
1731	ELECTRICAL WORK	1	0	1	3549	MFG OF MISCELLANEOUS METALWORKING MACHINE	1	0	1
1761	ROOFING, SIDING & SHEETMETAL WORK	1	0	1	3564	MFG OF BLOWERS & FANS	1	0	1
1771	CONCRETE WORK	1	0	1	3565	MFG OF PACKAGING MACHINERY	1	0	1
1781	WATER WELL DRILLING	1	0	1	3569	MFG OF GENERAL INDUSTRY MACHINERY	1	0	1
1791	STRUCTURAL STEEL ERECTION	1	0	1	3579	MFG OF MISCELLANEOUS OFFICE MACHINES	1	0	1
1794	EXCAVATION WORK	0	0	1	3585	MFG OF REFRIGERATION & HEATING EQUIPMENT, AI	1	0	1
2086	MFG OF BOTTLED & CANNED SOFT DRINKS	0	1	1	3599	MFG OF MISCELLANEOUS INDUSTRIAL MACHINERY	1	0	1
2099	MFG OF MISCELLANEOUS FOOD PREPARATIONS	0	1	1	3613	MFG OF SWITCHGEAR & SWITCHBOARD APPARATUS	1	0	1
2269	OTHER FINISHING PLANTS	1	0	1	3621	MFG OF MOTORS & GENERATORS	1	0	1
2434	MFG OF WOOD KITCHEN CABINETS	0	0	1	3625	MFG OF RELAYS & INDUSTRIAL CONTROLS	1	0	1
2439	MFG OF MISCELLANEOUS STRUCTURAL WOOD MEMB	1	0	1	3629	MFG OF ELECTRICAL INDUSTRIAL APPARATUS	1	0	1
2499	MISCELLANEOUS WOOD PRODUCTS MFG	1	0	1	3639	MFG OF MISCELLANEOUS HOUSEHOLD APPLIANCES	1	0	1
2511	MFG OF WOOD HOUSEHOLD FURNITURE	0	0	1	3643	MFG OF CURRENT-CARRYING WIRING SERVICES	1	0	1
2514	MFG OF METAL HOUSEHOLD FURNITURE	1	0	1	3645	MFG OF RESIDENTIAL LIGHTING FIXTURES	1	0	1
2521	MFG OF WOOD OFFICE FURNITURE	0	0	1	3646	MFG OF COMMERCIAL LIGHTING FIXTURES	1	0	1
2522	MFG OF OFFICE FURNITURE, EXCEPT WOOD	1	0	1	3661	MFG OF TELEPHONE & TELEGRAPH APPARATUS	1	0	1
2541	MFG OF WOOD PARTITIONS & FIXTURES	0	0	1	3663	MFG OF RADIO & TV COMMUNICATIONS EQUIPMENT	1	0	1
2591	MFG OF DRAPERY HARDWARE, BLINDS & SHADES	1	0	1	3669	MFG OF MISCELLANEOUS COMMUNICATIONS EQUIP	1	0	1
2672	MISCELLANEOUS PAPER-COATED & LAMINATED MFG	0	0	1	3675	MFG OF ELECTRONIC CAPACITORS	1	0	1
2711	NEWSPAPERS	1	0	1	3679	MFG OF MISCELLANEOUS ELECTRONIC COMPONENTS	1	0	1
2721	PERIODICALS	1	0	1	3695	MFG OF MAGNETIC & OPTICAL RECORDING MEDIA	1	0	1
2731	BOOK PUBLISHING	1	0	1	3699	MFG OF MISCELLANEOUS ELECTRICAL EQUIPMENT &	1	0	1
2741	MISCELLANEOUS PUBLISHING	1	0	1	3711	MFG OF MOTOR VEHICLES & CAR BODIES	1	0	1
2752	COMMERCIAL PRINTING, LITHOGRAPHIC	1	0	1	3714	MFG OF MOTOR VEHICLE PARTS & ACCESSORIES	1	0	1
2759	MISCELLANEOUS COMMERCIAL PRINTING	1	0	1	3728	MFG OF MISCELLANEOUS AIRCRAFT PARTS & EQUIP	1	0	1
2789	BOOKBINDING & RELATED WORK	1	0	1	3732	BOAT BUILDING & REPAIRING	1	0	1
2799	MISCELLANEOUS PRINTING & PUBLISHING	1	0	1	3799	MFG OF MISCELLANEOUS TRANSPORTATION EQUIPM	1	0	1
2851	MFG OF PAINTS & ALLIED PRODUCTS	1	0	1	3822	MFG OF ENVIRONMENTAL CONTROLS & INSTRUMENT	1	0	1
2869	MISCELLANEOUS INDUSTRIAL ORGANIC CHEMICALS	1	0	1	3823	MFG OF PROCESS CONTROL INSTRUMENTS	1	0	1
2893	MFG OF PRINTING INK	1	0	1	3825	MFG OF INSTRUMENTS TO MEASURE ELECTRICITY	1	0	1
2899	MFG OF MISCELLANEOUS CHEMICAL PREPARATIONS	1	0	1	3827	MFG OF OPTICAL INSTRUMENTS & LENSES	1	0	1
2951	MFG OF ASPHALT PAVING MIXTURES & BLOCKS	1	0	1	3841	MFG OF SURGICAL & MEDICAL INSTRUMENTS	1	0	1
2952	MFG OF ASPHALT FELTS & COATINGS	1	0	1	3842	MFG OF SURGICAL APPLICANCES & SUPPLIES	1	0	1
3089	MFG OF MISCELLANEOUS PLASTIC PRODUCTS	1	0	1	3845	MFG OF ELECTROMEDICAL EQUIPMENT	1	0	1
3211	MFG OF FLAT GLASS	1	0	1	3873	MFG OF WATCHES, CLOCKS, WATCHCASES & PARTS	1	0	1
3231	MFG OF PURCHASED GLASS PRODUCTS	1	0	1	3914	MFG OF SILVERWARE & PLATED WARE	1	0	1
3253	MFG OF CERAMIC WALL & FLOOR TILE	1	0	1	3931	MFG OF MUSICAL INSTRUMENTS	1	0	1
3261	MFG OF VITREOUS PLUMBING & BATHROOM FIXTURE	1	0	1	3949	MFG OF MISCELLANEOUS SPORTING & ATHLETIC GO	1	0	1
3269	MFG OF MISCELLANEOUS POTTERY PRODUCTS	1	0	1	3993	MFG OF SIGNS & ADVERTISING SPECIALTIES	1	0	1
3272	MFG OF MISCELLANEOUS CONCRETRE PRODUCTS	1	0	1	3999	MISCELLANEOUS MANUFACTURING INDUSTRIES	1	0	1
3273	MFG OF READY-MIX CONCRETE	1	0	1	4119	MISCELLANEOUS LOCAL PASSENGER TRANSPORTATI	1	0	1
3281	MFG OF CUT STONE & STONE PRODUCTS	0	0	1	4121	TAXICABS	1	0	1
3312	BLAST FURNACES & STEEL MILLS	1	0	1	4131	INTERCITY & RURAL BUS TRANSPORTATION	1	0	1
3354	MFG OF ALUMINUM EXTRUDED PRODUCTS	1	0	1	4212	LOCAL TRUCKING WITHOUT STORAGE	1	0	1
3363	MFG OF ALUMINUM DIE CASTINGS	1	0	1	4213	TRUCKING, EXCEPT LOCAL	1	0	1
3399	MFG OF MISCELLANEOUS PRIMARY METAL PRODUCT	1	0	1	4214	LOCAL TRUCKING WITH STORAGE	1	0	1
3429	MFG OF MISCELLANEOUS HARDWARE	1	0	1	4215	COURIER SERVICES, EXCEPT BY AIR	1	0	1
3433	MFG OF HEATING EQUIPMENT, EXCEPT ELECTRIC	1	0	1	4231	TRUCKING & TERMINAL FACILITIES	1	0	1
3441	MFG OF FABRICATED STRUCTURAL METAL	1	0	1	4311	U.S. POSTAL SERVICE - POST OFFICE	1	0	1
3442	MFG OF METAL DOORS, SASH, AND TRIM	1	0	1	4493	MARINAS	1	0	1
3443	MFG OF FABRICATED PLATE WORK (BOILER SHOP)	1	0	1	4499	MISCELLANEOUS WATER TRANSPORTATION SERVICE	1	0	1
3444	MFG OF SHEET METALWORK	1	0	1	4513	AIR COURIER SERVICES	1	0	1
3446	MFG OF ARCHITECTURAL METALWORK	1	0	1	4581	AIRPORTS, FLYING FIELDS & SERVICES	1	0	1

SIC	DESCRIP	M	P	H	SIC	DESCRIP	M	P	H
4789	MISCELLANEOUS TRANSPORTATION SERVICES	1	0	1	5984	LIQUIFIED PETROLEUM GAS DEALERS	1	0	1
4932	GAS & OTHER SERVICES COMBINED	1	0	1	7261	FUNERAL SERVICES & CREMATORIES, UNDERTAKERS	1	0	0
4952	SEWER & SEWAGE UTILITY SYSTEMS	1	0	0	7334	PHOTOCOPYING, XEROXING & DUPLICATING SERVIC	1	0	1
4953	REFUSE SYSTEMS (LANDFILLS, ETC.)	1	1	1	7335	COMMERCIAL PHOTOGRAPHY	1	0	0
4959	MISCELLANEOUS SANITARY SERVICES	1	0	1	7336	COMMERCIAL ART & GRAPHIC DESIGN	1	0	1
5012	CARS, AUTOMOBILES & OTHER MOTOR VEHICLES	1	0	1	7342	DISINFECTING & PEST CONTROL SERVICES, EXTERMI	0	1	0
5015	USED CARD, AUTO & MOTOR VEHICLE PARTS	1	0	1	7353	HEAVY CONSTRUCTION EQUIPMENT RENTAL	1	0	1
5033	ROOFING, SIDING & INSULATION	0	0	1	7359	MISCELLANEOUS EQUIPMENT RENTAL & LEASING	1	0	1
5039	MISCELLANEOUS CONSTRUCTION MATERIALS	1	0	1	7384	PHOTOFINISHING LABORATORIES	1	0	0
5051	METALS SERVICE CENTERS & OFFICES	1	0	1	7394	EQUIPMENT RENTAL & LEASING	1	0	1
5063	ELECTRICAL APPARATUS & EQUIPMENT	1	0	0	7513	TRUCK RENTAL & LEASING, NO DRIVERS	1	0	1
5074	PLUMBING & HYDRONIC HEATING SUPPLIES	1	0	0	7514	PASSENGER CAR RENTAL	1	0	1
5083	FARM & GARDEN MACHINERY	1	0	1	7515	PASSENGER CAR LEASING	1	0	1
5084	INDUSTRIAL MACHINERY & EQUIPMENT	1	0	1	7519	UTILITY TRAILER RENTAL	1	0	1
5093	SCRAP & WASTE MATERIALS (JUNKYARDS, ETC.)	1	0	1	7532	TOP & BODY REPAIR & PAINT SHOPS	1	0	1
5141	GROCERIES, GENERAL LINE	0	1	0	7533	AUTO EXHAUST SYSTEM REPAIR SHOPS	1	0	1
5162	PLASTIC MATERIALS & BASIC SHAPES	0	0	1	7534	TIRE RETREADING & REPAIR SHOPS	1	0	1
5169	MISCELLANEOUS CHEMICALS & ALLIED PRODUCTS	0	0	1	7537	AUTOMOTIVE TRANSMISSION REPAIR SHOPS	1	0	1
5172	MISCELLANEOUS PETROLEUM PRODUCTS	0	0	1	7538	GENERAL AUTOMOTIVE REPAIR SHOPS	1	0	1
5198	PAINTS, VARNISHES & RELATED SUPPLIES	0	0	1	7539	MISCELLANEOUS AUTO REPAIR SHOPS (AC,BRAKES..)	1	0	1
5211	LUMBER & OTHER BUILDING MATERIALS	1	0	0	7549	MISCELLANEOUS AUTOMOTIVE SERVICES	1	0	1
5231	PAINT, GLASS & WALLPAPER STORES	0	0	1	7622	RADIO & TELEVISION REPAIR	1	0	1
5261	RETAIL NURSERIES & GARDEN STORES	0	1	0	7623	REFRIGERATION SERVICE & REPAIR	1	0	1
5311	DEPARTMENT STORES	1	0	1	7629	ELECTRICAL REPAIR SHOPS	1	0	1
5399	MISCELLANEOUS GENERAL MERCHANDISE STORES	1	0	1	7692	WELDING REPAIR	1	0	1
5411	GROCERY STORES	1	0	1	7694	ARMATURE REWINDING SHOPS	1	0	1
5511	NEW & USED CAR DEALERS	1	0	1	7699	MISCELLANEOUS REPAIR SERVICES	1	0	1
5521	USED CAR DEALERS	1	0	1	7992	PUBLIC GOLF COURSES	0	1	0
5531	AUTO & HOME SUPPLY STORES	1	0	1	7999	MISCELLANEOUS AMUSEMENT & RECREATION SERVI	0	1	0
5541	GASOLINE SERVICE STATIONS, GAS STATIONS	1	0	1	8733	NONCOMMERCIAL RESEARCH ORGANIZATIONS	1	1	1
5551	BOAT DEALERS	1	0	1	8734	TESTING LABORATORIES	1	1	1
5571	MOTORCYCLE DEALERS	1	0	1	9199	MISC. GENERAL GOVERNMENT (MAINT.SHOPS, ETC.)	1	0	1
5599	MISCELLANEOUS AUTOMOTIVE DEALERS	1	0	1	9221	GOVT POLICE PROTECTION	1	0	1
5722	HOUSEHOLD APPLIANCE STORES	1	0	1	9224	GOVT FIRE PROTECTION	1	0	1

Appendix B-2. Number, density, and relative ranking of the contamination potential of present day (1998) businesses, Hudson Bayou watershed.

Subbasin	Basin size (acres)	Potential Sources per Basin # Pest.	# Metals	# Hydroc.	#Pest./acre	#Metals/acre	#Hydroc./acre	Ranks Pest./acre	Ranks Metals/acre	Ranks Hydroc./acre	Averge Rank
020101	9.8	0	1	1	0.000	0.102	0.102	1	43	42	28.7
020102	16.9	1	0	0	0.059	0.000	0.000	51	1	1	17.7
020104	31.0	0	3	3	0.000	0.097	0.097	1	42	41	28.0
020105	38.5	1	5	5	0.026	0.130	0.130	48	46	47	47.0
020107	30.9	1	8	8	0.032	0.259	0.259	50	50	50	50.0
020203	93.7	1	28	26	0.011	0.299	0.278	47	51	51	49.7
020302	117.4	0	5	5	0.000	0.043	0.043	1	36	37	24.7
020304	26.7	0	0	0	0.000	0.000	0.000	1	1	1	1.0
020306	17.1	0	0	0	0.000	0.000	0.000	1	1	1	1.0
020307	27.0	0	0	0	0.000	0.000	0.000	1	1	1	1.0
020308	146.8	0	1	1	0.000	0.007	0.007	1	30	31	20.7
020310	67.9	0	1	1	0.000	0.015	0.015	1	32	32	21.7
020311	104.6	0	1	2	0.000	0.010	0.019	1	31	34	22.0
020314	27.0	0	0	0	0.000	0.000	0.000	1	1	1	1.0
020316	5.6	0	0	0	0.000	0.000	0.000	1	1	1	1.0
020317	52.8	0	0	0	0.000	0.000	0.000	1	1	1	1.0
020318	47.8	0	1	2	0.000	0.021	0.042	1	33	35	23.0
020320	25.8	0	0	0	0.000	0.000	0.000	1	1	1	1.0
020321	94.6	0	6	6	0.000	0.063	0.063	1	38	39	26.0
020323	23.5	0	1	1	0.000	0.043	0.043	1	35	36	24.0
020324	4.3	0	0	0	0.000	0.000	0.000	1	1	1	1.0
020325	25.5	0	0	0	0.000	0.000	0.000	1	1	1	1.0
020328	7.2	0	0	0	0.000	0.000	0.000	1	1	1	1.0
020330	19.6	0	0	0	0.000	0.000	0.000	1	1	1	1.0
020331	12.5	0	0	0	0.000	0.000	0.000	1	1	1	1.0
020332	33.1	1	0	0	0.030	0.000	0.000	49	1	1	17.0
020333	23.6	0	0	0	0.000	0.000	0.000	1	1	1	1.0
020334	3.1	0	0	0	0.000	0.000	0.000	1	1	1	1.0
020401	9.1	0	0	0	0.000	0.000	0.000	1	1	1	1.0
020402	3.7	0	0	0	0.000	0.000	0.000	1	1	1	1.0

Subbasin	Basin size (acres)	Potential Sources per Basin # Pest.	# Metals	# Hydroc.	#Pest./acre	#Metals/acre	#Hydroc./acre	Ranks Pest./acre	Ranks Metals/acre	Ranks Hydroc./acre	Averge Rank
020403	4.9	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020404	8.0	0	0	1	0.000	0.000	0.126	1	1	46	**16.0**
020405	3.6	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020406	7.1	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020407	2.7	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020409	15.4	0	1	0	0.000	0.065	0.000	1	39	1	**13.7**
020411	10.9	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020412	5.0	0	1	1	0.000	0.200	0.200	1	49	49	**33.0**
020413	65.4	0	7	8	0.000	0.107	0.122	1	44	44	**29.7**
020414	6.7	0	1	1	0.000	0.150	0.150	1	48	48	**32.3**
020415	5.0	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020416	10.8	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020417	2.4	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020418	2.0	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020419	10.9	0	1	0	0.000	0.092	0.000	1	40	1	**14.0**
020420	3.4	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020422	18.8	0	1	1	0.000	0.053	0.053	1	37	38	**25.3**
020501	63.2	0	7	7	0.000	0.111	0.111	1	45	43	**29.7**
020601	212.2	2	7	4	0.009	0.033	0.019	46	34	33	**37.7**
020701	128.6	0	18	16	0.000	0.140	0.124	1	47	45	**31.0**
020801	31.2	0	3	2	0.000	0.096	0.064	1	41	40	**27.3**

Appendix B-3. Number, density, and relative ranking of the contamination potential of present day (1998-9) businesses, Cedar Hammock Creek and Bowlees Creek watersheds.

Sub-basin	Basin Size (acres)	Potential Sources per Basin # Pest.	# Metals	# Hydroc.	#Pest./acre	#Metals/acre	#Hydroc./acre	Ranks Pest./acre	Ranks Metals/acre	Ranks Hydroc./acre	Average Rank
CHE1-1	1166.9	4	104	104	0.003	0.089	0.089	6	8	8	**7.3**
CHE1-2	1197.2	1	23	23	0.001	0.019	0.019	3	6	5	**4.7**
CHS1-1	812.3	1	12	15	0.001	0.015	0.018	3	5	4	**4.0**
CHS1-2	283.0	2	3	4	0.007	0.011	0.014	8	3	3	**4.7**
CHW1-1	150.4	0	2	4	0.000	0.013	0.027	1	4	6	**3.7**
CHW1-2	723.6	2	34	36	0.003	0.047	0.050	6	7	7	**6.7**
CHW2-1	327.8	1	1	2	0.003	0.003	0.006	6	1	2	**3.0**
CHW2-2	1449.6	2	9	7	0.001	0.006	0.005	3	2	1	**2.0**

Sub-basin	Basin Size (acres)	Potential Sources per Basin # Pest.	# Metals	# Hydroc.	#Pest./acre	#Metals/acre	#Hydroc./acre	Ranks Pest./acre	Ranks Metals/acre	Ranks Hydroc./acre	Average Rank
APD1-1	473.6	1	13	15	0.002	0.027	0.032	5.5	5	5	**5.2**
APD1-2	858.6	0	20	20	0.000	0.023	0.023	1	3	3	**2.3**
BPD1-1	327.8	0	35	37	0.000	0.107	0.113	1	9	9	**6.3**
LPD1-1	446.5	1	8	9	0.002	0.018	0.020	5.5	2	2	**3.2**
LPD1-2	924.5	0	23	23	0.000	0.025	0.025	1	4	4	**3.0**
OND1-1	345	0	18	20	0.000	0.052	0.058	1	6	6.5	**4.5**
OND1-2	652.7	2	36	38	0.003	0.055	0.058	8	7	6.5	**7.2**
OND1-3	691.7	8	87	99	0.012	0.126	0.143	11	10	10	**10.3**
OND1-4	394.5	1	24	25	0.003	0.061	0.063	8	8	8	**8.0**
OND1-5	510.4	2	6	6	0.004	0.012	0.012	10	1	1	**4.0**
OND1-6	350	1	57	59	0.003	0.163	0.169	8	11	11	**10.0**

Appendix B-4. Number, density, and relative ranking of the contamination potential of present day (1998-9) businesses, Whitaker Bayou watershed.

Sub-basin	Basin Size (acres)	Potential Sources per Basin # Pest.	# Metals	# Hydroc.	#Pest./acre	#Metals/acre	#Hydroc./acre	Ranks Pest./acre	Ranks Metals/acre	Ranks Hydroc./acre	Average Rank
A1	300.6	2	3	2	0.007	0.010	0.007	19.5	5	4	**9.5**
A2	209.1	0	1	0	0.000	0.005	0.000	1	3	1	**1.7**
A3	522.0	2	22	23	0.004	0.042	0.044	16.5	18	18	**17.5**
A4	297.8	2	12	11	0.007	0.040	0.037	19.5	17	16	**17.5**
B1	122.8	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
B2	273.0	0	5	4	0.000	0.018	0.015	1	9	7	**5.7**
B3-4	296.0	1	21	26	0.003	0.071	0.088	15	21	21.5	**19.2**
B5	16.2	0	1	1	0.000	0.062	0.062	1	19	19	**13.0**
B6	185.1	4	29	24	0.022	0.157	0.130	25	23	23	**23.7**
C	145.9	0	4	4	0.000	0.027	0.027	1	13	12	**8.7**
D1	42.0	1	9	11	0.024	0.214	0.262	26	24	24.5	**24.8**
D2	49.1	2	12	13	0.041	0.244	0.265	27	26	26	**26.3**
D3	55.7	0	1	1	0.000	0.018	0.018	1	9	9.5	**6.5**
D4	133.6	2	32	35	0.015	0.240	0.262	23	25	24.5	**24.2**
D5	113.3	1	46	48	0.009	0.406	0.424	22	27	27	**25.3**
D6	160.8	0	6	5	0.000	0.037	0.031	1	15	14	**10.0**
D7	77.5	0	3	3	0.000	0.039	0.039	1	16	17	**11.3**
D8	72.0	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
D9	80.9	0	2	2	0.000	0.025	0.025	1	11.5	11	**7.8**
WB1	273.0	0	5	5	0.000	0.018	0.018	1	9	9.5	**6.5**
WB2	239.7	1	19	21	0.004	0.079	0.088	16.5	22	21.5	**20.0**
WB3	121.8	2	8	9	0.016	0.066	0.074	24	20	20	**21.3**
WB4	130.5	1	1	1	0.008	0.008	0.008	21	4	5	**10.0**
WB5	312.9	2	4	4	0.006	0.013	0.013	18	6	6	**10.0**
WB6	240.3	0	6	7	0.000	0.025	0.029	1	11.5	13	**8.5**
WB7	118.2	0	2	2	0.000	0.017	0.017	1	7	8	**5.3**
WB8	93.8	0	3	3	0.000	0.032	0.032	1	14	15	**10.0**

Appendix B-5. Number, density, and relative ranking of the contamination potential of present day (1998-9) businesses, Phillippi Creek watershed.

Sub-basin	Basin Size (acres)	Potential Sources per Basin # Pest.	# Metals	# Hydroc.	#Pest./acre	#Metals/acre	#Hydroc./acre	Ranks Pest./acre	Ranks Metals/acre	Ranks Hydroc./acre	Average Rank
BRANCH AA	3374.0	7	21	23	0.002	0.006	0.007	6	4	4	**4.7**
BRANCHBA	4421.4	17	53	65	0.004	0.012	0.015	9.5	6	6	**7.2**
BRANCHC	1029.7	1	17	21	0.001	0.017	0.020	3.5	8	8	**6.5**
CENTERGATE	900.9	1	4	6	0.001	0.004	0.007	3.5	2	4	**3.2**
LATERAL AB	1099.9	7	38	42	0.006	0.035	0.038	14	11.5	12	**12.5**
LATERAL AC	303.5	1	8	10	0.003	0.026	0.033	7	9.5	10	**8.8**
LINWOOD	617.6	3	9	11	0.005	0.015	0.018	12.5	7	7	**8.8**
L-PHILLIPPI	1588.5	7	103	107	0.004	0.065	0.067	9.5	14	14	**12.5**
MAIN A	7458.1	6	14	19	0.001	0.002	0.003	3.5	1	1	**1.8**
MAIN B	2803.8	4	13	16	0.001	0.005	0.006	3.5	3	2	**2.8**
MAIN C	6314.3	23	163	183	0.004	0.026	0.029	9.5	9.5	9	**9.3**
M-PHILLIPPI	3098.1	11	107	110	0.004	0.035	0.036	9.5	11.5	11	**10.7**
REDBUG	1947.8	10	86	96	0.005	0.044	0.049	12.5	13	13	**12.8**
UPPER-PHILL	844.4	0	7	6	0.000	0.008	0.007	1	5	4	**3.3**

Appendix C-1. Multisector designations, descriptions, and applicable SIC code ranges

SECTOR	SECTOR NAME	DESCRIPTION	RANGE OF SIC COD		
A	TIMBER PRODUCTS	GENERAL SAWMILLS AND PLANNING MILLS	2421		
A	TIMBER PRODUCTS	WOOD PRESERVING	2491		
A	TIMBER PRODUCTS	LOG STORAGE AND HANDLING	2411		
A	TIMBER PRODUCTS	HARDWOOD DIMENSION AND FLOORING MILLS	2426		
A	TIMBER PRODUCTS	SPECIAL PRODUCT SAWMILLS, NOT ELSEWHERE CLASSIFIED	2429		
A	TIMBER PRODUCTS	MILLWORK, VENEER, PLYWOOD, AND STRUCTURAL WOOD	2430	-	2439
A	TIMBER PRODUCTS	WOOD CONTAINERS	2440	-	2449
A	TIMBER PRODUCTS	WOOD BUILDINGS AND MOBILE HOMES	2450	-	2459
A	TIMBER PRODUCTS	RECONSTITUTED WOOD PRODUCTS	2493		
A	TIMBER PRODUCTS	WOOD PRODUCTS NOT ELSEWHERE CLASSIFIED	2499		
B	PAPER AND ALLIED PRODUCTS MANUFACTURING	PULP MILLS	2610	-	2619
B	PAPER AND ALLIED PRODUCTS MANUFACTURING	PAPER MILLS	2620	-	2629
B	PAPER AND ALLIED PRODUCTS MANUFACTURING	PAPERBOARD MILLS	2630	-	2639
B	PAPER AND ALLIED PRODUCTS MANUFACTURING	PAPERBOARD CONTAINERS AND BOXES	2650	-	2659
B	PAPER AND ALLIED PRODUCTS MANUFACTURING	CONVERTED PAPER AND PAPERBOARD PROD EXCPT CONTAINRS AND BOXES	2670	-	2679
C	CHEMICAL AND ALLIED PRODUCTS MANUFACTURING	INDUSTRIAL INORGANIC CHEMICALS	2810	-	2819
C	CHEMICAL AND ALLIED PRODUCTS MANUFACTURING	PLASTICS, SYNTH RESINS,RUBBER, CELLULOSE,MANMADE FIBERS EXCPT GLASS	2820	-	2829
C	CHEMICAL AND ALLIED PRODUCTS MANUFACTURING	DRUGS	2830	-	2839
C	CHEMICAL AND ALLIED PRODUCTS MANUFACTURING	SOAPS, DETERGENTS, AND CLEANING PREPARATIONS; PERFUMES, COSMETICS	2840	-	2849
C	CHEMICAL AND ALLIED PRODUCTS MANUFACTURING	PAINTS, VARNISHES, LACQUERS, ENAMELS AND ALLIED PRODUCTS	2850	-	2859
C	CHEMICAL AND ALLIED PRODUCTS MANUFACTURING	INDUSTRIAL ORGANIC CHEMICALS	2860	-	2869
C	CHEMICAL AND ALLIED PRODUCTS MANUFACTURING	AGRICULTURAL CHEMICALS	2870	-	2879
C	CHEMICAL AND ALLIED PRODUCTS MANUFACTURING	MISCELLANEOUS CHEMICAL PRODUCTS	2890	-	2899
D	ASPHALT PAVING AND ROOFING MATERIAL MFCTRS AND LUBRICANT MFCTRS	ASPHALT PAVING AND ROOFING MATERIALS	2950	-	2959
D	ASPHALT PAVING AND ROOFING MATERIAL MFCTRS AND LUBRICANT MFCTRS	MISCELLANEOUS PRODUCTS OF PETROLEUM AND COAL	2990	-	2999
E	GLASS, CLAY, CEMENT, CONCRETE, AND GYPSUM PRODUCT MANUFACTURING	FLAT GLASS	3210	-	3219
E	GLASS, CLAY, CEMENT, CONCRETE, AND GYPSUM PRODUCT MANUFACTURING	GLASS AND GLASSWARE, PRESSED OR BLOWN	3220	-	3229
E	GLASS, CLAY, CEMENT, CONCRETE, AND GYPSUM PRODUCT MANUFACTURING	GLASS PRODUCTS MADE OF PURCHASED GLASS	3230	-	3239
E	GLASS, CLAY, CEMENT, CONCRETE, AND GYPSUM PRODUCT MANUFACTURING	HYDRAULIC CEMENT	3240	-	3249
E	GLASS, CLAY, CEMENT, CONCRETE, AND GYPSUM PRODUCT MANUFACTURING	STRUCTURAL CLAY PRODUCTS	3250	-	3259
E	GLASS, CLAY, CEMENT, CONCRETE, AND GYPSUM PRODUCT MANUFACTURING	POTTERY AND RELATED PRODUCTS	3260	-	3269
E	GLASS, CLAY, CEMENT, CONCRETE, AND GYPSUM PRODUCT MANUFACTURING	NON-CLAY REFRACTORIES	3297		
E	GLASS, CLAY, CEMENT, CONCRETE, AND GYPSUM PRODUCT MANUFACTURING	CONCRETE, GYPSUM AND PLASTER PRODUCTS	3270	-	3279
E	GLASS, CLAY, CEMENT, CONCRETE, AND GYPSUM PRODUCT MANUFACTURING	MINERALS AND EARTH'S, GROUND, OR OTHERWISE TREATED	3295		
F	PRIMARY METALS	STEEL WORKS, BLAST FURNACES, AND ROLLING AND FINISHING MILLS	3310	-	3319
F	PRIMARY METALS	IRON AND STEEL FOUNDARIES	3320	-	3329
F	PRIMARY METALS	PRIMARY SMELTING AND REFINING OF NONFERROUS METALS	3330	-	3339
F	PRIMARY METALS	SECONDARY SMELTING AND REFINING OF NONFERROUS METALS	3340	-	3349
F	PRIMARY METALS	ROLLING, DRAWING, AND EXTRUDING OF NONFERROUS METALS	3350	-	3359
F	PRIMARY METALS	NONFERROUS FOUNDARIES (CASTINGS)	3360	-	3369
F	PRIMARY METALS	MISCELLANEOUS PRIMARY METAL PRODUCTS	3390	-	3399
G	METAL MINING (ORE MINING AND DRESSING)	IRON ORES	1010	-	1019

SECTOR	SECTOR NAME	DESCRIPTION	RANGE OF SIC COD		
G	METAL MINING (ORE MINING AND DRESSING)	COPPER ORES	1020	-	1029
G	METAL MINING (ORE MINING AND DRESSING)	LEAD AND ZINC ORES	1030	-	1039
G	METAL MINING (ORE MINING AND DRESSING)	GOLD AND SILVER ORES	1040	-	1049
G	METAL MINING (ORE MINING AND DRESSING)	FERROALLOY ORES, EXCEPT VANADIUM	1060	-	1069
G	METAL MINING (ORE MINING AND DRESSING)	METAL MINING SERVICES	1080	-	1089
G	METAL MINING (ORE MINING AND DRESSING)	MISCELLANEOUS METAL ORES	1090	-	1099
H	COAL MINES AND COAL MINING-RELATED FACILITIES	COAL MINES AND COAL MINING RELATED FACILITIES	1200	-	1299
I	OIL AND GAS EXPLORATION	CRUDE PETROLEUM AND NATURAL GAS	1310	-	1319
I	OIL AND GAS EXPLORATION	NATURAL GAS LIQUIDS	1320	-	1329
I	OIL AND GAS EXPLORATION	OIL AND GAS FIELD SERVICES	1380	-	1389
J	MINERAL MINING AND DRESSING	DIMENSION STONE	1410	-	1419
J	MINERAL MINING AND DRESSING	CRUSHED AND BROKEN STONE EXCEPT RIP RAP	1420	-	1429
J	MINERAL MINING AND DRESSING	NONMETALLIC MINERALS EXCEPT FUELS	1480	-	1489
J	MINERAL MINING AND DRESSING	SAND AND GRAVEL	1440	-	1449
J	MINERAL MINING AND DRESSING	CLAY, CERAMIC, AND REFRACTORY MATERIALS	1450	-	1459
J	MINERAL MINING AND DRESSING	CHEMICAL AND FERTILIZER MINERAL MINING	1470	-	1479
K	HAZARDOUS WASTE TREATMENT STORAGE OR DISPOSAL FACILITIES	HAZARDOUS WASTE TREATMENT STORAGE AND DISPOSAL			
L	LANDFILLS AND LAND APPLICATION SITES	LANDFILLS AND LAND APPLICATION SITES			
M	AUTOMOBILE SALVAGE YARDS	AUTOMOBILE SALVAGE YARDS	5015		
N	SCRAP RECYCLING FACILITIES	SCRAP RECYCLING FACILITIES	5093		
O	STEAM ELECTRIC GENERATING FACILITIES	STEAM ELECTRIC GENERATING FACILITIES			
P	LAND TRANSPORTATION	RAILROAD TRANSPORTATION	4000	-	4099
P	LAND TRANSPORTATION	LOCAL AND HIGHWAY PASSENGER TRANSPORATION	4100	-	4199
P	LAND TRANSPORTATION	MOTOR FREIGHT TRANSPORATION AND WAREHOUSING	4200	-	4299
P	LAND TRANSPORTATION	UNITED STATES POSTAL SERVICE	4300	-	4399
P	LAND TRANSPORTATION	PETROLEUM BULK STATIONS AND TERMINALS	5171		
Q	WATER TRANSPORTATION	WATER TRANSPORTATION	4400	-	4499
R	SHIP AND BOAT BUILDING OR REPAIRING YARDS	SHIP AND BOAT BUILDING OR REPAIRING YARDS	3730	-	3739
S	AIR TRANSPORTATION FACILITIES	AIR TRANSPORTATION	4500	-	4599
T	TREATMENT WORKS	TREATMENT WORKS			
U	FOOD AND KINDRED PRODUCTS	MEAT PRODUCTS	2010	-	2019
U	FOOD AND KINDRED PRODUCTS	DAIRY PRODUCTS	2020	-	2029
U	FOOD AND KINDRED PRODUCTS	CANNED, FROZEN,PRESERVED FRUITS, VEGETABLES AND FOOD SPECIALTIES	2030	-	2039
U	FOOD AND KINDRED PRODUCTS	GRAIN MILL PRODUCTS	2040	-	2049
U	FOOD AND KINDRED PRODUCTS	BAKERY PRODUCTS	2050	-	2059
U	FOOD AND KINDRED PRODUCTS	SUGAR AND CONFECTIONERY PRODUCTS	2060	-	2069
U	FOOD AND KINDRED PRODUCTS	FATS AND OILS	2070	-	2079
U	FOOD AND KINDRED PRODUCTS	BEVERAGES	2080	-	2089
U	FOOD AND KINDRED PRODUCTS	MISCELLANEOUS FOOD PREPARATION AND KINDRED PRODUCTS	2090	-	2099
V	TEXTILE MILLS, APPAREL, AND OTHER FABRIC PRODUCT MANUFACTURING	TEXTILE MILL PRODUCTS	2200	-	2299
V	TEXTILE MILLS, APPAREL, AND OTHER FABRIC PRODUCT MANUFACTURING	APPAREL AND OTHER FINISHED PRODUCTS MADE FROM FABRICS	2300	-	2399
W	FURNITURE AND FIXTURES	FURNITURE AND FIXTURES	2500	-	2599
W	FURNITURE AND FIXTURES	WOOD KITCHEN CABINETS	2434	-	2434
X	PRINTING AND PUBLISHING	PRINTING AND PUBLISHING	2700	-	2799

SECTOR	SECTOR NAME	DESCRIPTION	RANGE OF SIC COD		
Y	RUBBER, MISCELLANEOUS PLASTIC PRODUCTS, AND MISC MFCTRING IND	TIRES AND INNER TUBES	3010	-	3019
Y	RUBBER, MISCELLANEOUS PLASTIC PRODUCTS, AND MISC MFCTRING IND	RUBBER AND PLASTICS FOOTWEAR	3020	-	3029
Y	RUBBER, MISCELLANEOUS PLASTIC PRODUCTS, AND MISC MFCTRING IND	GASKETS, PACKING,SEALING DEVICES, RUBBER, PLASTICS HOSE AND BELTING	3050	-	3059
Y	RUBBER, MISCELLANEOUS PLASTIC PRODUCTS, AND MISC MFCTRING IND	FABRICATED RUBBER PRODUCTS, NOT ELSEWHERE CLASSIFIED	3060	-	3069
Y	RUBBER, MISCELLANEOUS PLASTIC PRODUCTS, AND MISC MFCTRING IND	MISCELLANEOUS PLASTICS PRODUCTS	3080	-	3089
Y	RUBBER, MISCELLANEOUS PLASTIC PRODUCTS, AND MISC MFCTRING IND	MUSICAL INSTRUMENTS	3930	-	3939
Y	RUBBER, MISCELLANEOUS PLASTIC PRODUCTS, AND MISC MFCTRING IND	DOLLS, TOYS, GAMES AND SPORTING AND ATHLETIC GOODS	3940	-	3949
Y	RUBBER, MISCELLANEOUS PLASTIC PRODUCTS, AND MISC MFCTRING IND	PENS, PENCILS AND OTHER ARTIST'S MATERIALS	3950	-	3959
Y	RUBBER, MISCELLANEOUS PLASTIC PRODUCTS, AND MISC MFCTRING IND	COSTUME JEWELRY, NOVELTIES, BUTTONS, NOTIONS, EXCPT PRECIOUS METALS	3960	-	3969
Y	RUBBER, MISCELLANEOUS PLASTIC PRODUCTS, AND MISC MFCTRING IND	MISCELLANEOUS MANUFACTURING INDUSTRIES	3990	-	3999
Z	LEATHER TANNING AND FINISHING	LEATHER TANNING AND FINISHING	3110	-	3119
AA	FABRICATED METAL PRODUCTS	CUTLERY, HANDTOOLS, AND GENERAL HARDWARE	3420	-	3429
AA	FABRICATED METAL PRODUCTS	FABRICATED STRUCTURAL METAL PRODUCTS	3440	-	3449
AA	FABRICATED METAL PRODUCTS	SCREW MACHINE PRODUCTS, AND BOLTS, NUTS, SCREWS, RIVETS, WASHERS	3450	-	3459
AA	FABRICATED METAL PRODUCTS	METAL FORGINGS AND STAMPINGS	3460	-	3469
AA	FABRICATED METAL PRODUCTS	ELECTROPLATING, PLATING. POLISHING, ANODIZING AND COLORING	3471		
AA	FABRICATED METAL PRODUCTS	MISCELLANEOUS FABRICATED METAL PRODUCTS	3490	-	3499
AA	FABRICATED METAL PRODUCTS	JEWELRY, SILVERWARE AND PLATED WARE	3910	-	3919
AA	FABRICATED METAL PRODUCTS	COATING, ENGRAVING, AND ALLIED SERVICES	3479		
AB	TRANSPORATION EQUIPMENT, INDUSTRIAL OR COMMERCIAL MACHINERY	INDUSTRIAL AND COMMERCIAL MACHINERY			
AC	ELECTRONIC, ELECTRICAL, PHOTOGRAPHIC AND OPTICAL GOODS	ELECTRONIC, ELECTRICAL			
AC	ELECTRONIC, ELECTRICAL, PHOTOGRAPHIC AND OPTICAL GOODS	MEASURING, ANALYZING, CONTROLLING INSTRMNT; PHOTOGRAPHIC, OPTICAL			

Appendix C-2

X. Storm Water Discharges Associated With Industrial Activity From Printing and Publishing Facilities

1. Industry Profile

On November 16, 1990 (55 FR 47990) EPA promulgated the regulatory definition of ``storm water discharge associated with industrial activity." This definition includes point source discharges of storm water from eleven categories of facilities, including ``-category (xi) facilities classified as Standard Industrial Classification (SIC) code-27." Facilities eligible for coverage under this section include book printing (SIC Code 2732); commercial printing, lithographic (SIC Code 2752); commercial printing, gravure (SIC Code 2754); commercial printing, not elsewhere classified (SIC Code 2759); and platemaking and related services (SIC Code 2796).

This section establishes special condition for storm water discharges associated with industrial activities at printing and publishing facilities. The SIC codes of these facilities are in category (xi) of the definition of storm water discharges associated with industrial activity. Storm water discharges from facilities in this category are only regulated where precipitation and storm water runoff come into contact with areas associated with industrial activities, and significant materials. Significant materials include, but are not limited to, raw materials, waste products, finished products, intermediate products, by-products, and other materials associated with industrial activities.

When an industrial facility, described by the above eligibility provisions of this section, has industrial activities being conducted on-site that meet the description(s) of industrial activities in another section(s), that industrial facility shall comply with any and all applicable monitoring and pollution prevention plan requirements of the other section(s) in addition to all applicable requirements in this section. The monitoring and pollution prevention plan terms and conditions of this multi-sector permit are additive for industrial activities being conducted at the same industrial facility (co-located industrial activities). The operator of the facility shall determine which other monitoring and pollution prevention plan section(s) of this permit (if any) are applicable to the facility.

The printing and publishing industry is composed of a heterogeneous collection of more than 38,000 companies that range in size from a few employees to several thousand.{98} Some companies are involved in both printing and publishing, while others are exclusively one or the other. The industrial activities of these facilities are similar, but the finished products vary. The finished products include magazines, newspapers, books, and labels. The printing activities covered under this section occur strictly indoors, and are separated into distinct operations. They include book printing, commercial printing (lithographic and gravure), and platemaking for printing purposes. The lithographic printing operation, which is based on the premise that grease and water do not mix, consists of a printing plate or cylinder, ink, a blanket and paper. Areas on the printing plate which will be transferred are coated with grease, and the rest of the plate is kept moist with water. The ink adheres to the grease and is repelled by the water. The printing image is then transferred to a blanket, which is transferred to paper. The gravure printing process uses printing plates or cylinders, ink, and paper. In the gravure process, the image is engraved on the printing plate or cylinder, the ink is then picked up by the engraved cells and directly transferred to paper. Other printing methods include screen, letter press, and flexographic printing. In the platemaking process, plates are cut from metal (usually steel), formed, engraved with the image, and coated with copper sulfate or chromic acid. The plates are later used in the printing processes described above.

|{98} ``Economic Analysis of Proposed Effluent Guidelines,
|Printing Industry." Office of Planning and Evaluation,
|EPA. August 1974.

Aside from the specific printing activities, other types of industrial activities are shared by facilities covered under this section. For example, the majority of these facilities have outdoor material handling and storage activities, and share the same types of raw and waste materials.

The primary raw materials utilized by this industry group include paper (including wax paper and card stock at some facilities), printing inks (hydrocarbon based, solvent based), and solvents. Other raw materials include steel (for facilities which manufacture printing plates), toner, paints, lubricating fluids, fuels, coating materials, and adhesives/glues. The paper products are stored indoors because exposure to precipitation would destroy the quality. The other raw materials arrive at the facilities in drums and either remain in the drums or are stored in aboveground or underground tanks, depending on the facilities' space and primary activity. The outdoor storage areas for drums are sometimes covered, but when the drums are directly exposed to precipitation, the storage areas are diked. Within the facilities, drums are stored on wooden pallets or skids, which may become contaminated from spills of the stored materials. After use the pallets and skids are stored outside for disposal and have the potential to contaminate storm water discharges.

Both nonhazardous and hazardous wastes are produced from the printing process. Hazardous wastes including ink wastes, solvent wastes, and waste chromic and sulfuric acid. These wastes are generated in small quantities at some of the facilities within this industrial group. Solvent wastes result from cleaning of printing plates and metal cutting operations. Ink wastes are generated from the cleaning of printing plates and from excess ink used in printing. Chromic and sulfuric acid wastes are generated from facilities which manufacture and coat rotogravure printing plates.

Nonhazardous wastes from this industry group include waste paper, paper dust, scrap steel, and used wooden pallets. All of these waste materials have the potential to pollute storm water discharges.

Significant materials exposed to storm water at these facilities may include raw materials and waste materials. They include solvents (toluene, xylene, acetone, 1,1,1-trichloroethane), fuels (gasoline and diesel), inks, metal, lubricating oils, pallets, copper, chromium, acids (sulfuric and chromic), oil and grease, and waste paper. Some of these materials may be directly exposed to storm water, while others may be covered. Pollutants that may be associated with these materials include TSS, pH, heavy metals, oil and grease, and COD.

Material handling activities such as loading and unloading areas, and liquid transfer (solvents from outdoor storage tanks to facility) may be exposed to storm water discharges. Exposure of these areas to storm water may be minimized by covering of the shipping/receiving and liquid transfer areas.

For those facilities engaged in fueling and vehicle maintenance, gasoline and diesel fuel are frequently stored outdoors in aboveground storage tanks and drums. Most vehicles and equipment require oil, hydraulic fluids, antifreeze, and other fluids that may leak and contaminate storm water discharges. 2. Pollutants Found in Storm Water Discharges From Printing and Publishing Facilities

The impact of industrial activities on storm water discharges at printing and publishing facilities will vary. Factors at a site which influence the water quality include geographic location, hydrogeology, the industrial activities exposed to storm water discharges, the facility's size, the types of pollution prevention measures/best management practices in place, and the type, duration, and intensity of storm events. Taken together or separately, these factors determine how polluted the storm water discharges will be at a given facility. Additionally, pollutant sources other than storm water, such as illicit connections,{99} spills, and other improperly dumped materials, may increase the pollutant loading discharged into Waters of the United States. Table X-1 lists industrial activities that commonly occur at printing and publishing facilities, the pollutant sources at these facilities, and the pollutants associated with these activities. Table X-1 identifies heavy metals, oil and other parameters as potential pollutants associated with printing and publishing facilities.

|{99} Illicit connections are contributions of unpermitted
|non-storm water discharges to storm sewers from any number
|of sources including improper connections, dumping or
|spills from industrial facilities, commercial establishments,
|or residential dwellings. The probability of illicit
|connections at facilities manufacturing transportation
|equipment, industrial or commercial machinery is low
|but it may be applicable at some operations.

Based on the similarities of the facilities included in this sector in terms of industrial activities and significant materials, EPA believes it is appropriate to discuss the potential pollutants at printing and publishing facilities as a whole and not subdivide this sector. Therefore, Table X-2 lists data for selected parameters from facilities in the printing and publishing sector. These data include the eight pollutants that all facilities were required to monitor for under Form 2F, as well as the pollutants that EPA has determined may merit further monitoring. 3. Options for Controlling Pollutants

In evaluating options for controlling pollutants in storm water discharges, EPA must achieve compliance with the technology-based standards of the Clean Water Act [Best Available Technology (BAT) and Best Conventional Technology)]. The Agency does not believe that it is appropriate to establish specific numeric effluent limitations or a specific design or performance standard in this section for storm water discharges associated with industrial activity from printing and publishing facilities to meet BAT/BCT standards of the Clean Water Act. Instead, this section establishes requirements for the development and implementation of site-specific storm water pollution prevention plans consisting of a set of Best Management Practices (BMPs) that are sufficiently flexible to address different sources of pollutants at different sites.

Certain BMPs are implemented to prevent and/or minimize exposure of pollutants from industrial activities to storm water discharges. EPA believes the most effective BMPs for reducing pollutants in storm water discharges are exposure minimization practices. Exposure minimization practices lessen the potential for storm water to come into contact with pollutants. Good housekeeping practices ensure that facilities are sensitive to routine and nonroutine activities which may increase pollutants in storm water discharges. The BMPs which address good housekeeping and exposure minimization are easily implemented, inexpensive, and require little, if any, maintenance. BMP expenses may include construction of roofs for storage areas or other forms of permanent cover and the installation of berms/dikes. Other BMPs such as detention/retention ponds and filtering devices may be needed at these facilities because of the contaminant level in the storm water discharges. The types of BMPs implemented will depend on the type of discharge, types and concentrations of contaminants, and the volume of the flow.

The selection of the most effective BMPs will be based on site-specific considerations such as: facility size, climate, geographic location, geology/hydrology and the environmental setting of each facility, and volume and type of discharge generated. Each facility will be unique in that the source, type, and volume of contaminated storm water discharges will differ. In addition, the fate and transport of pollutants in these discharges will vary. EPA believes that the management practices discussed herein are well suited mechanisms to prevent or control the contamination of storm water discharges associated with printing and publishing facilities.

Part 1 group application data indicate that BMPs have not been widely implemented at the representative sampling facilities. Less than 10 percent of the sampling subgroup reported that they store some materials indoors; less than 10 percent store hazardous wastes under roof; and less than 5 percent cover drums or have sealed drums. However, 45 percent of the subgroup utilize some type of covering; 45 percent implement good housekeeping practices; and more than 40 percent have training on pollution prevention.

The measures commonly used to reduce pollutants in storm water discharges associated with printing and publishing facilities are generally simple and easy to implement. Table X-3 identifies best management practices (BMPs) associated with different activities that routinely occur at printing and publishing facilities. 4. Storm Water Pollution Prevention Plan Requirements.

EPA believes that pollution prevention is the most effective approach for controlling contaminated storm water discharges from printing and publishing facilities. The requirements included in the pollution prevention plan provide a flexible framework for the development and implementation of site-specific controls to minimize the pollutants in storm water discharges. This flexibility is necessary because each facility is unique in that the source, type, and volume of contaminated storm water discharge will vary from site to site.

Under today's permit, all facilities must prepare and implement a storm water pollution prevention plan. The pollution prevention plan requirement reflects EPA's decision to allow operators of printing and publishing facilities to utilize BMPs as the BAT/BCT level of control for the storm water discharges covered by this section. The pollution prevention plan requirements in this section are consistent with the general requirements presented in the front of this fact sheet, which are based on EPA's storm water general permits finalized on September 9, 1992 (57 FR 41236), and September 25, 1992 (57 FR 44438), for discharges in nonauthorized NPDES States.

There are two major objectives to a pollution prevention plan: 1) to identify sources of pollution potentially affecting the quality of storm water discharges associated with industrial activity from a facility; and 2) to describe and ensure implementation of practices to minimize and control pollutants in storm water discharges associated with industrial activity from a facility.

Specific requirements for a pollution prevention plan for printing and publishing facilities are described below.

a. Contents of the Plan. Storm water pollution prevention plans are intended to aid operators of printing and publishing facilities to evaluate all potential prevention sources at a site, and assist in the selection and implementation of appropriate measures designed to prevent, or control, the discharge of pollutants in storm water runoff. EPA has developed guidance entitled Storm Water Management for Industrial Activities: ``Developing Pollution Prevention Plans and Best Management Practices,'' EPA, 1992, (EPA 832-R-92-006) to assist permittees in developing and implementing pollution prevention measures.

(1) Description of Potential Pollutant Sources. Each storm water pollution prevention plan must describe activities, materials, and physical features of the facility that may contribute pollutants to storm water runoff or, during periods of dry weather, result in dry weather flows. This assessment of potential storm water pollutant source will support subsequent efforts to identify and set priorities for necessary changes in materials, materials management practices, or site features, as well as aid in the selection of appropriate structural and nonstructural control techniques. Plans must describe the following elements:

(a) Site Map-The plan must contain a map of the site that shows the pattern of storm water drainage, structural and nonstructural features that control pollutants in storm water runoff and process wastewater discharges, surface water bodies (including wetlands), places where significant materials {100} are exposed to rainfall and runoff, and locations of major spills and leaks that occurred in the 3 years prior to the date of the submission of a Notice of Intent (NOI) to be covered under this permit. The map must also indicate the direction of storm water flow. An outline of the drainage area for each outfall must be provided; the location of each outfall and monitoring points must be indicated; and the types of discharges contained in the drainage areas of the outfalls (*e.g.*, storm water and air conditioner condensate) must be identified. An estimation of the total site acreage utilized for each industrial activity (*e.g.*, storage of raw materials, waste materials, and used equipment) must be provided. These areas include liquid storage tanks, stockpiles, holding bins, used equipment, and empty drum storage. These areas are considered to be significant potential sources of pollutants at printing and publishing facilities.

|{100} Significant materials include, `` * * * but
|[are] not limited to: raw materials, fuels, materials
|such as solvents, detergents, and plastic pellets; finished
|materials such as metallic products; * * * hazardous
|substances designated under section 101(14) of CERCLA;
|any chemical facilities are required to report pursuant
|to section 313 of Title III of SARA; fertilizers; pesticides;
|and waste products such as ashes, slag, and sludge that
|have the potential to be released with storm water discharge."
|(40 CFR 122.26(b)(12)). Significant materials commonly
|found at transportation equipment, industrial or commercial
|machinery manufacturing facilities include raw and scrap
|metals; solvents; used equipment; petroleum based products;
|waste materials or by-products used or created by the
|facility.

(b) Inventory of Exposed Materials-Facility operators are required to carefully conduct an inspection of the site to identify significant materials that are or may be exposed to storm water discharges. The inventory must address materials that within 3 years prior to the date of the submission of a Notice of Intent (NOI) to be covered under this permit have been handled, stored, processed, treated, or disposed of in a manner to allow exposure to storm water. Findings of the inventory must be documented in detail in the pollution prevention plan. At a minimum, the plan must describe the method and location of on-site storage or disposal; practices used to minimize contact of materials with precipitation and runoff; existing structural and nonstructural controls that reduce pollutants in storm water; existing structural controls that limit process wastewater discharges; and any treatment the runoff receives before it is discharged to surface waters or through a separate storm sewer system. The description must be updated whenever there is a significant change in the type or amounts of materials, or material management practices, that may affect the exposure of materials to storm water.

(c) Significant Spills and Leaks-The plan must include a list of any significant spills and leaks of toxic or hazardous pollutants that occurred in the 3 years prior to the date of the submission of a Notice of Intent (NOI) to be covered under this permit. Significant spills include, but are not limited to, releases of oil or hazardous substances in excess of reportable quantities under Section 311 of CWA (see 40 CFR 110.10 and 117.21) or Section 102 of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) (see 40 CFR 302.4). Significant spills may also include releases of oil or hazardous substances that are not in excess of reporting requirements and releases of materials that are not classified as oil or a hazardous substance.

(d) Non-storm Water Discharges-Each pollution prevention plan must include a certification, signed by an authorized individual, that discharges from the site have been tested or evaluated for the presence of non-storm water, the results of any test and/or evaluation conducted to detect such discharges, the test method or evaluation criteria used, the dates on which tests or evaluations were performed, and the on-site drainage points directly observed during the test or evaluation. Pollution prevention plans must identify and ensure the implementation of appropriate pollution prevention measures for any non-storm water discharges. (e) Sampling Data-Any existing data describing the quality or quantity of storm water discharges from the facility must be summarized in the plan. The description should include a discussion of the methods used to collect and analyze the data. Sample collection points should be identified in the plan and shown on the site map.

(f) Summary of Potential Pollutant Sources-The description of potential pollutant sources should clearly point to activities, materials, and physical features of the facility that have a reasonable potential to contribute significant amounts of pollutants to storm water. Any such activities, materials, or features must be addressed by the measures and controls subsequently described in the plan. In conducting the assessment, the facility operator must consider the following activities: raw materials (liquid storage tanks, stockpiles, holding bins), waste materials (empty drum storage), and used equipment storage areas. The assessment must list any significant pollutant parameter(s) (*i.e.*, total suspended solids, oil and grease, etc.) associated with each source.

(2) Measures and Controls. Permittees must select, describe, and evaluate the pollution prevention measures, BMPs, and other controls that will be implemented at the facility. Source reduction measures include preventive maintenance, spill prevention, good housekeeping, training, and proper materials management. If source reduction is not an option, EPA supports the use of source control measures. These include BMPs such as material covering, water diversion, and dust control. If source reduction or source control are not available, then recycling or waste treatment are other alternatives. Recycling allows the reuse of storm water, while treatment lowers pollutant concentrations prior to discharge. Since the majority of printing and publishing activities occur indoors, the BMPs identified above are geared towards only those activities that occur outdoors or that otherwise have a potential to contribute pollutants to storm water discharges.

Pollution prevention plans must discuss the reasons each selected control or practice is appropriate for the facility and how each of the potential pollutant sources will be addressed. Plans must identify the time during which controls or practices will be implemented, as well the effect the controls or practices will have on storm water discharges from the site. At a minimum, the measures and controls must address the following components:

(a) Good Housekeeping-Permittees must describe protocols established to reduce the possibility of mishandling chemicals or equipment and training employees in good housekeeping techniques. Specifics of this plan must be communicated to appropriate plant personnel.

(b) Preventive Maintenance-Permittees are required to develop a preventive maintenance program that includes regular inspections and maintenance of storm water BMPs. Inspections should assess the effectiveness of the storm water pollution prevention plan. They allow facility personnel to monitor the components of the plan on a regular basis. The use of a checklist is encouraged, as it will ensure that all of the appropriate areas are inspected and provide documentation for record-keeping purposes.

(c) Spill Prevention and Response Procedures-Permittees are required to identify proper material handling procedures, storage requirements, containment or diversion equipment, and spill removal procedures to reduce exposure of spills to storm water discharges. Areas and activities which are high risks for spills at printing and publishing facilities include raw material unloading and product loading areas, material storage areas, and waste management areas. These activities and areas and their drainage points must be described in the plan.

(d) Inspections-Qualified personnel must inspect designated equipment and areas of the facility at the proper intervals specified in the plan. The plan should identify areas which have the potential to pollute storm water for periodic inspections. Records of inspections must be maintained on-site.

(e) Employee Training-Permittees must describe a program for informing and educating personnel at all levels of responsibility of the components and goals of the storm water pollution prevention plan. A schedule for conducting this training should be provided in the plan. Where appropriate, contractor personnel must also be trained in relevant aspects of storm water pollution prevention. Topics for employee training should include good housekeeping, materials management, and spill response procedures. EPA recommends that facilities conduct training annually at a minimum. However, more frequent training may be necessary at facilities with high turnover of employees or where employee participation is essential to the storm water pollution prevention plan.

(f) Record-keeping and Internal Reporting Procedures-Permittees must describe procedures for developing and retaining records on the status and effectiveness of plan implementation. This includes the success and failure of BMPs implemented at the facility.

(g) Sediment and Erosion Control-Permittees must identify areas, due to topography, activities, soils, cover materials, or other factors that have a high potential for soil erosion. Measures to eliminate erosion must be identified in the plan.

(h) Management of Runoff-Permittees must provide an assessment of traditional storm water management practices that divert, infiltrate, reuse, or otherwise manage storm water so as to reduce the discharge of pollutants. Based on this assessment, practices to control runoff from these areas must be identified and implemented as required by the plan.

(3) Comprehensive Site Compliance Evaluation. The storm water pollution prevention plan must describe the scope and content of comprehensive site evaluations that qualified personnel will conduct to: (1) Confirm the accuracy of the description of potential sources contained in the plan, (2) determine the effectiveness of the plan, and (3) assess compliance with

the terms and conditions of this section. Comprehensive site compliance evaluations must be conducted once a year for printing and publishing facilities. The individual(s) who will conduct the evaluations must be identified in the plan and should be members of the pollution prevention team. Evaluation reports must be retained for at least 3 years after the date of the evaluation.

Based on the results of each evaluation, the description of potential pollution sources, and measures and controls, the plan must be revised as appropriate within 2 weeks after each evaluation. Changes in the measures and controls must be implemented.

Appendix C-3

Table X-1. Printing and Publishing Facilities

Description of Industrial Activities, Potential Pollutant Sources, and Associated Pollutants {i,ii,iii}

Activity	Pollutant source	Pollutant
Plate Preparation	using ink (lithography, letterpress, screen printing, flexography), etch baths, applying lacquer	solvent, heavy metal, toxic waste ink with solvents chromium, lead.
Printing	using ink (lithography, letterpress, screen printing, flexography), gravure	heavy metal waste (dust and sludge) ink-sludges with chromium or lead, ink-toxic wastes with metals, solvents.
Clean up	used plates: type, die, press blankets and rollers	ink-toxic wastes with metals, solvents.
Stencil Preparation for Screen Printing.	lacquer stencil film, photoemulsion, blockout (screen filler)	solvents, photographic processing wastes.
Material Handling: Transfer, Storage, Disposal.	spills and leaks from material handling equipment	fuel, oil, heavy metals.
	spills and leaks from aboveground tanks	fuel, oil, heavy metals, material being stored.
	solvents; trash; petroleum products	heavy metals, spent solvents, oil.
Photoprocessing	developing negatives and prints ..	heavy metals, spent solvents.

{i} EPA, Pollution Prevention Programs, Opportunities in Printing. Philadelphia, PA. October 1990.
{ii} University of Pittsburgh Trust, Center for Hazardous Materials Research Fact Sheet, Pollution Prevention: Strategies for the Printing Industry.
{iii} EPA, Resource Conservation and Recovery Act (RCRA) document, Does Your Business Produce Hazardous Waste as Many Small Businesses Do. Printing and Allied Industries, EPA/530-SW-90-027g, April 15, 1990

Appendix C-4

Table X-2 Printing and Publishing Facilities

Statistics for Selected Pollutants Reported by Printing and Publishing Facilities Submitting Part II Sampling Data{i} (mg/L)

Pollutant Sample type	No. of Facilities		No. of Samples		Mean		Minimum		Maximum		Median		95th Percentile		99th Percentile	
	Grab	Comp {ii}	Grab	Comp	Grab	Comp	Grab	Comp	Grab	Comp	Grab	Comp	Grab	Comp	Grab	Comp
BOD5	15	15	33	33	12.8	7.7	0.0	0.0	61.8	27.0	9.0	6.40	45.9	24.05	94.1	1.9
COD	15	15	33	33	64.5	45.97	0.0	0.0	239.0	171.0	49.0	40.0	241.5	203.0	492.9	432.1
Nitrate + Nitrite Nitrogen.	15	14	27	26	1.18	1.22	0.00	0.0	5.80	5.30	0.73	0.82	3.46	3.25	6.14	5.40
Total Kjeldahl Nitrogen.	15	15	33	33	3.01	1.78	0.00	0.0	10.00	6.70	1.50	0.98	11.61	5.64	25.09	10.65
Oil & Grease.	15	N/A	33	N/A	10.7	N/A	0.0	N/A	98.0	N/A	1.0	N/A	51.1	N/A	149.7	N/A
pH	14	N/A	26	N/A	N/A	N/A	5.4	N/A	8.6	N/A	7.0	N/A	8.3	N/A	8.9	N/A
Total Phosphorus	15	15	33	33	0.34	0.33	0.00	0.0	1.80	2.10	0.16	0.13	1.34	1.25	3.03	2.84
Total Suspended Solids.	15	15	33	33	88	29	0	0	660	104	30	26	445	121	1383	263

{i} Applications that did not report the units of measurement for the reported values of pollutants were not included in these statistics. Values reported as non-detect or below detection limit were assumed to be 0.

II iiComposite samples.

Appendix C-5
Table X-3 Printing and Publishing Facilities
General Storm Water BMPS for Printing and Publishing Facilities{i,ii,iii,iv}

Activity	Best management practices (BMPs)
Plate Preparation	use aqueous-developed lithographic plates or wipe-on plates.
Printing........................	use press wipes as long as possible before discarding or laundering; dirty ones for the first pass, clean ones for the second pass.
	squeeze or centrifuge solvent out of dirty rags.
	set up an in-house dirty rag cleaning operation if warranted or send to approved industrial laundries, if available.
	dedicated press for inks with hazardous pigments/solvents.
	segregate used oil from solvents or other materials.
	use water-based inks in gravure and flexographic printing process.
Clean up........................	label sinks as to proper disposal of liquids.
	keep equipment in good condition.
	use doctor blades and squeegees to remove as much ink as possible prior to cleaning with solvent and rags.
	control solvent use during equipment cleaning, use only what you need.
	designate special areas for draining or replacing fluids.
	substitute nontoxic or less toxic cleaning solvents.
	recover waste solvents on-site with batch distillation if warranted or utilize professional solvent recyclers.
	centralize liquid solvent cleaning in one location.
	have refresher courses in operating and safety procedures.
Stencil Preparation for Screen Printing.	recapture excess ink from silkscreen process before washing the screen to decrease amount of ink used and cleaning emulsion used
Material Handling and Storage Areas.	store containerized materials (fuels, paints, inks, solvents, etc.) in a protected, secure location and away from drains.
	store reactive, ignitable, or flammable liquids in compliance with the local fire code.
	identify potentially hazardous materials, their characteristics, and use.
	eliminate/reduce exposure to storm water.
	control excessive purchasing, storage, and handling of potentially hazardous materials.
	keep records to identify quantity, receipt date, service life, users, and disposal routes secure and carefully monitor hazardous materials to prevent theft, vandalism, and misuse of materials.
	educate personnel for proper storage, use, cleanup, and disposal of materials.
	maintain good integrity of all storage tanks.
	inspect storage tanks to detect potential leaks and perform preventive maintenance.
	provide sufficient containment for outdoor storage areas for the larger of either 10 percent of the volume of all containers or 110 percent of the volume of the largest tank.
	use temporary containment where required by portable drip pans.
	use spill troughs for drums with taps
	train employees on proper filling and transfer procedures
	inspect piping systems (pipes, pumps, flanges, couplings, hoses, valves) for failures or leaks.
	handle solvents in designated areas away from drains, ditches, and surface waters. Locate designated areas preferably indoors or under a shed.
	if spills occur,
	stop the source of the spill immediately.
	contain the liquid until cleanup is complete.
	deploy oil containment booms if the spill may reach the water.
	cover the spill with absorbent material.
	keep the area well ventilated.
	dispose of cleanup materials properly.
	do not use emulsifier or dispersant.

{i} EPA, Pollution Prevention Programs, Opportunities in Printing. Philadelphia, PA. October 1990.
{ii} University of Pittsburgh Trust, Center for Hazardous Materials Research Fact Sheet, Pollution Prevention: Strategies for the Printing Industry.
{iii} EPA, Resource Conservation and Recovery Act (RCRA) document, Does Your Business Produce Hazardous Waste as Many Small Businesses Do. Printing and Allied Industries, EPA/530-SW-90-027g, April 15, 1990.
{iv} NPDES Storm Water Group Applications-Part 1. Received by EPA March 18, 1991 through December 31, 1992.

Appendix C-6. Multisector designations, descriptions, and presence within priority watersheds.

Sector	Sector Description	Hudson Bayou	Cedar Hammock	Bowlees Creek	Whitaker Bayou	Phillippi Creek
B	PAPER AND ALLIED PRODUCTS MANUFACTURING					X
C	CHEMICAL AND ALLIED PRODUCTS MANUFACTURING	X		X	X	X
D	ASPHALT PAVING AND ROOFING MATERIAL MFCTRS AND LUBRICANT MFCTRS			X		
E	GLASS, CLAY, CEMENT, CONCRETE, AND GYPSUM PRODUCT MANUFACTURING		X	X	X	X
F	PRIMARY METALS			X	X	X
M	AUTOMOBILE SALVAGE YARDS			X		
N	SCRAP RECYCLING FACILITIES			X	X	
P	LAND TRANSPORTATION	X	X	X	X	X
Q	WATER TRANSPORTATION			X	X	X
R	SHIP AND BOAT BUILDING OR REPAIRING YARDS	X	X	X	X	
S	AIR TRANSPORTATION FACILITIES	X		X	X	X
U	FOOD AND KINDRED PRODUCTS			X	X	X
V	TEXTILE MILLS, APPAREL, AND OTHER FABRIC PRODUCT MANUFACTURING		X	X		
W	FURNITURE AND FIXTURES	X	X	X	X	X
X	PRINTING AND PUBLISHING	X	X	X	X	X
Y	RUBBER, MISCELLANEOUS PLASTIC PRODUCTS, AND MISC MFCTRING IND	X	X	X	X	X
AA	FABRICATED METAL PRODUCTS	X	X	X	X	X

Appendix C-7. Number, density, and relative ranking of the contamination potential of multi-sector industries in 1998, Hudson Bayou watershed.

	Basin size	Potential sources per basin						Ranks	Ranks	Ranks	Average
Subbasin	(acres)	# Pest.	# Metals	# Hydroc.	#Pest./acre	#Metals/acre	#Hydroc./acre	Pest./acre	Metals/acre	Hydroc./acre	Rank
020101	9.8	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020102	16.9	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020104	31.0	0	1	1	0.000	0.032	0.032	1	44	44	**29.7**
020105	38.5	0	2	2	0.000	0.052	0.052	1	48	48	**32.3**
020107	30.9	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020203	93.7	0	2	2	0.000	0.021	0.021	1	41	41	**27.7**
020302	117.4	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020304	26.7	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020306	17.1	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020307	27.0	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020308	146.8	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020310	67.9	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020311	104.6	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020314	27.0	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020316	5.6	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020317	52.8	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020318	47.8	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020320	25.8	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020321	94.6	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020323	23.5	0	1	1	0.000	0.043	0.043	1	45	45	**30.3**
020324	4.3	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020325	25.5	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020328	7.2	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020330	19.6	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020331	12.5	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020332	33.1	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020333	23.6	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020334	3.1	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020401	9.1	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020402	3.7	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**

Subbasin	Basin size (acres)	Potential sources per basin # Pest.	# Metals	# Hydroc.	#Pest./acre	#Metals/acre	#Hydroc./acre	Ranks Pest./acre	Ranks Metals/acre	Ranks Hydroc./acre	Average Rank
020403	4.9	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020404	8.0	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020405	3.6	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020406	7.1	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020407	2.7	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020409	15.4	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020411	10.9	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020412	5.0	0	1	1	0.000	0.091	0.091	1	50	50	**33.7**
020413	65.4	0	3	3	0.000	0.046	0.046	1	46	46	**31.0**
020414	6.7	0	1	1	0.000	0.150	0.150	1	51	51	**34.3**
020415	5.0	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020416	10.8	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020417	2.4	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020418	2.0	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020419	10.9	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020420	3.4	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
020422	18.8	0	1	1	0.000	0.053	0.053	1	49	49	**33.0**
020501	63.2	0	2	2	0.000	0.032	0.032	1	42	42	**28.3**
020601	212.2	0	1	1	0.000	0.005	0.005	1	40	40	**27.0**
020701	128.6	0	6	6	0.000	0.047	0.047	1	47	47	**31.7**
020801	31.2	0	1	1	0.000	0.032	0.032	1	43	43	**29.0**

Appendix C-8. Number, density, and relative ranking of the contamination potential of multi-sector industries in 1998-9, Cedar Hammock Creek and Bowlees Creek watersheds.

Subbasin	Basin size (acres)	Potential sources per basin # Pest.	# Metals	# Hydroc.	#Pest./acre	#Metals/acre	#Hydroc./acre	Ranks Pest./acre	Ranks Metals/acre	Ranks Hydroc./acre	Average Rank
CHE1-1	1166.90	0	11	11	0.000	0.009	0.009	1	7	7	5
CHE1-2	1197.20	0	4	4	0.000	0.003	0.003	1	5	4	**3.3**
CHS1-1	812.30	0	3	3	0.000	0.004	0.004	1	6	5.5	**4.2**
CHS1-2	283.00	0	0	1	0.000	0.000	0.004	1	1	5.5	**2.5**
CHW1-1	150.40	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
CHW1-2	723.60	0	11	11	0.000	0.015	0.015	1	8	8	**5.7**
CHW2-1	327.80	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
CHW2-2	1449.60	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**

Subbasin	Basin size (acres)	Potential sources per basin # Pest.	# Metals	# Hydroc.	#Pest./acre	#Metals/acre	#Hydroc./acre	Ranks Pest./acre	Ranks Metals/acre	Ranks Hydroc./acre	Average Rank
APD1-1	473.6	0	5	7	0.000	0.011	0.015	1	5	6	**4.0**
APD1-2	858.6	0	11	11	0.000	0.013	0.013	1	7	4	**4.0**
BPD1-1	327.8	0	12	15	0.000	0.037	0.046	1	9	9	**6.3**
LPD1-1	446.5	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
LPD1-2	924.5	0	6	6	0.000	0.006	0.006	1	3	3	**2.3**
OND1-1	345	0	4	6	0.000	0.012	0.017	1	6	7	**4.7**
OND1-2	652.7	0	6	9	0.000	0.009	0.014	1	4	5	**3.3**
OND1-3	691.7	2	34	44	0.003	0.049	0.064	11	10	10	**10.3**
OND1-4	394.5	0	7	7	0.000	0.018	0.018	1	8	8	**5.7**
OND1-5	510.4	0	1	1	0.000	0.002	0.002	1	2	2	**1.7**
OND1-6	350	0	27	29	0.000	0.077	0.083	1	11	11	**7.7**

Appendix C-9. Number, density, and relative ranking of the contamination potential of multi-sector industries in 1998-9, Whitaker Bayou watershed.

	Basin size	Potential sources per basin						Ranks	Ranks	Ranks	Average
Subbasin	(acres)	# Pest.	# Metals	# Hydroc.	#Pest./acre	#Metals/acre	#Hydroc./acre	Pest./acre	Metals/acre	Hydroc./acre	Rank
A1	300.6	0	1	1	0.000	0.003	0.003	1	7	7	**5.0**
A2	209.1	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
A3	522.0	0	11	12	0.000	0.021	0.023	1	19	18	**12.7**
A4	297.8	0	3	4	0.000	0.010	0.013	1	12	14.5	**9.2**
B1	122.8	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
B2	273.0	0	2	2	0.000	0.007	0.007	1	10	10	**7.0**
B3-4	296.0	0	9	12	0.000	0.030	0.041	1	23	22	**15.3**
B5	16.2	0	1	1	0.000	0.062	0.062	1	25	25	**17.0**
B6	185.1	0	8	9	0.000	0.043	0.049	1	24	23	**16.0**
C	145.9	0	2	2	0.000	0.014	0.014	1	16	16	**11.0**
D1	42.0	0	3	4	0.000	0.071	0.095	1	26.5	27	**18.2**
D2	49.1	1	1	3	0.020	0.020	0.061	27	18	24	**23.0**
D3	55.7	0	1	1	0.000	0.018	0.018	1	17	17	**11.7**
D4	133.6	0	3	5	0.000	0.022	0.037	1	20	21	**14.0**
D5	113.3	0	8	8	0.000	0.071	0.071	1	26.5	26	**17.8**
D6	160.8	0	2	2	0.000	0.012	0.012	1	14	13	**9.3**
D7	77.5	0	1	1	0.000	0.013	0.013	1	15	14.5	**10.2**
D8	72.0	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
D9	80.9	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
WB1	273.0	0	1	1	0.000	0.004	0.004	1	8.5	8.5	**6.0**
WB2	239.7	0	7	7	0.000	0.029	0.029	1	22	19	**14.0**
WB3	121.8	0	3	4	0.000	0.025	0.033	1	21	20	**14.0**
WB4	130.5	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
WB5	312.9	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
WB6	240.3	0	1	1	0.000	0.004	0.004	1	8.5	8.5	**6.0**
WB7	118.2	0	1	1	0.000	0.008	0.008	1	11	11	**7.7**
WB8	93.8	0	1	1	0.000	0.011	0.011	1	13	12	**8.7**

Appendix C-10. Number, density, and relative ranking of the contamination potential of multi-sector industries in 1998-9, Phillippi Creek watershed.

Subbasin	Basin size (acres)	Potential sources per basin # Pest.	# Metals	# Hydroc.	#Pest./acre	#Metals/acre	#Hydroc./acre	Ranks Pest./acre	Ranks Metals/acre	Ranks Hydroc./acre	Average Rank
BRANCH AA	3374.0	0	4	6	0.000	0.001	0.002	1	7	8	**5.3**
BRANCHBA	4421.4	0	5	5	0.000	0.001	0.001	1	7	6.5	**4.8**
BRANCHC	1029.7	0	1	1	0.000	0.001	0.001	1	7	6.5	**4.8**
CENTERGATE	900.9	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
LATERAL AB	1099.9	0	5	5	0.000	0.005	0.005	1	11	10.5	**7.5**
LATERAL AC	303.5	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**
LINWOOD	617.6	0	2	2	0.000	0.003	0.003	1	9	9	**6.3**
L-PHILLIPPI	1588.5	1	12	13	0.001	0.008	0.008	14	14	12.5	**13.5**
MAIN A	7458.1	0	2	3	0.000	0.000	0.000	1	1	1	**1.0**
MAIN B	2803.8	0	1	1	0.000	0.000	0.000	1	1	1	**1.0**
MAIN C	6314.3	0	39	52	0.000	0.006	0.008	1	12	12.5	**8.5**
M-PHILLIPPI	3098.1	0	13	14	0.000	0.004	0.005	1	10	10.5	**7.2**
REDBUG	1947.8	0	13	19	0.000	0.007	0.010	1	13	14	**9.3**
UPPER-PHILL	844.4	0	0	0	0.000	0.000	0.000	1	1	1	**1.0**

Appendix D-1. Land use characteristics (as % of basin) of nationwide MS4 NPDES sites.

Site Location	Commercial	Heavy Industry	Highway	Industrial	Light Industry	Multi-Family Residential	Office	Mixed Land Use	Open	Other Urban	Public	Residential	Single Family Residential	Water	Forest
Ann Arbor, MI	100														
Ann Arbor, MI	100														
Ann Arbor, MI			100												
Ann Arbor, MI											100				
Ann Arbor, MI											100				
Ann Arbor, MI											100				
Ann Arbor, MI											100				
Atlanta, GA	100														
Atlanta, GA	10										90				
Atlanta, GA			100												
Atlanta, GA			100												
Atlanta, GA			95						5						
Atlanta, GA											100				
Boston, MA	70										30				
Boston, MA			97								3				
Boston, MA	2							10		9	79				
Boston, MA								8		1	91				
Boston, MA								8		1	91				
Chesapeake, VA	40							40				16	4		
Chesapeake, VA						100									
Chesapeake, VA	100														
Chesapeake, VA				94				6							
Chesapeake, VA	9				85			6							
Chesapeake, VA												100			
Chesapeake, VA												100			
Chesapeake, VA					6							75	19		
Clayton County, GA	95								5						
Clayton County, GA			100												
Cobb County, GA	90		10												
Cobb County, GA	97								3						
Cobb County, GA											100				
Cobb County, GA	10										90				
Columbus, OH	95							5							
Columbus, OH			100												
Columbus, OH			100												
Columbus, OH											100				
Columbus, OH	10										90				
Corpus Christi, TX	100														
Corpus Christi, TX			100												
Corpus Christi, TX			100												
Corpus Christi, TX											100				
Corpus Christi, TX											100				
DeKalb County, GA			100												
DeKalb County, GA	10		90												
DeKalb County, GA										5	95				
DeKalb County, GA											100				
DeKalb County, GA										5	95				
DeKalb County, GA											100				
East Point, GA			100												
Escambia County, FL								8			92				
Escambia County, FL											100				
Escambia, FL	100														
Escambia, FL	95														
Escambia, FL			100												
Flint, MI	59		27					8			5				
Flint, MI	70										30				
Flint, MI			100												
Flint, MI	28										72				
Flint, MI	5							15			80				
Fulton County, GA	95								5						
Fulton County, GA	100														
Fulton County, GA			100												
Grand Rapids, MI			99												
Grand Rapids, MI	89										11				
Grand Rapids, MI			100												
Grand Rapids, MI	15		2					20			63				
Grand Rapids, MI								100							
Grand Rapids, MI	20										80				
Grand Rapids, MI	1							5			94				
Grand Rapids, MI	25										75				
Grand Rapids, MI	3		2								95				
Grand Rapids, MI	10							14			76				
Gwinnett County, GA	100														
Gwinnett County, GA			100												
Gwinnett County, GA											100				
Jacksonville, FL	26.24	15.16									58.6				
Jacksonville, FL	9.55		66.82					2.3			16.57				
Jacksonville, FL	4.73	3.02	52.6					2.49			37.16				
Jacksonville, FL											100				
Jacksonville, FL											100				
Knoxville, TN	5	8			26			35				26			
Knoxville, TN	55							11		16		18			
Knoxville, TN	3		48					31		8		10			
Knoxville, TN	9		18					43		16		14			

Site Location	Commercial	Heavy Industry	Highway	Industrial	Light Industry	Multi-Family Residential	Office	Mixed Land Use	Open	Other Urban	Public	Residential	Single Family Residential	Water	Forest
Knoxville, TN		16	22		7							55			
Marietta, GA	97									3					
Monterey Bay, CA			90												
Monterey Bay, CA							100								
Monterey Bay, CA							100								
Monterey Bay, CA											100				
Newport News, VA				14		67	18								
Newport News, VA	10			20		66		4							
Newport News, VA					100										
Newport News, VA								14							
Newport News, VA					64							36			
Newport News, VA					100										
Newport News, VA								100							
Newport News, VA								100							
Newport News, VA								40				60			
Newport News, VA								8				92			
Norfolk, VA	49		44							7					
Norfolk, VA	100														
Norfolk, VA	100														
Norfolk, VA	100														
Norfolk, VA	100														
Norfolk, VA					100										
Norfolk, VA					5							95			
Norfolk, VA					5							95			
Norfolk, VA										5		95			
Orlando, FL	100														
Orlando, FL	100														
Orlando, FL			100												
Orlando, FL											100				
Orlando, FL											100				
Oxnard, CA	100														
Oxnard, CA			100												
Oxnard, CA			90					10							
Oxnard, CA											100				
Oxnard, CA											100				
Palm Beach, FL	7		1					2		25	55		9		
Palm Beach, FL	100														
Palm Beach, FL	80									15	5				
Palm Beach, FL	5		95												
Palm Beach, FL										6	67		27		
Palm Beach, FL											100				
Palm Beach, FL											100				
Roswell, GA											100				
San Diego, CA	15		8					60			16				
San Diego, CA	8		4					57			30				
San Diego, CA	100														
San Diego, CA	94										6				
San Diego, CA	18		82												
San Diego, CA	13		22					45			20				
San Diego, CA	15		1					33			51				
San Diego, CA	22		2					31			45				
San Diego, CA	15		2					20			63				
San Diego, CA								10			90				
San Diego, CA	14							3			83				
San Diego, CA	20		67					13			1				
Sarasota, FL	100														
Sarasota, FL			100												
Sarasota, FL								100							
Sarasota, FL												100			
Sarasota, FL												100			
Sarasota, FL												100			
Sarasota, FL												100			
St. Petersburg, FL							100								
St. Petersburg, FL	100														
St. Petersburg, FL			100												
St. Petersburg, FL											100				
St. Petersburg, FL											100				
Topeka, KS	100														
Topeka, KS			100												
Topeka, KS					100										
Topeka, KS												100			
Topeka, KS	83				6							12			
Topeka,KS												89		11	
Tucson, AZ	100														
Tucson, AZ			100												
Tucson, AZ					5						95				
Tucson, AZ							100								
Tucson, AZ												100			
Tulsa, OK	90							10							
Tulsa, OK	85		5					10							
Tulsa, OK	90								10						
Tulsa, OK	5		90					5							
Tulsa, OK	5		90					5							
Tulsa, OK								10			90				
Tulsa, OK								10			90				
Virginia Beach, VA								100							

Site Location	Commercial	Heavy Industry	Highway	Industrial	Light Industry	Multi-Family Residential	Office	Mixed Land Use	Open	Other Urban	Public	Residential	Single Family Residential	Water	Forest
Virginia Beach, VA	79									13	8				
Virginia Beach, VA			100												
Virginia Beach, VA			100												
Virginia Beach, VA								33	9		56		2		
Virginia Beach, VA	16		12					16			56				
Virginia Beach, VA											100				
Virginia Beach, VA										5	95				
Virginia Beach, VA											93		3	4	
Waco, TX	60		30					10							
Waco,TX	100														
Waco,TX	15		60					25							
Waco,TX											100				
Waco,TX											100				
Warren, MI	100														
Warren, MI			100												
Warren, MI											100				
Warren, MI	25										75				
Worcester, MA	60							40							
Worcester, MA	10		90												
Worcester, MA	10		90												
Worcester, MA	25		75												
Worcester, MA	2							5			93				

Appendix E-1. Land use designations (FLUCCS) and assignments within the study area.

FLUCCS - Land Use	Assignment	FLUCCS - Land Use	Assignment
1500 Industrial	INDUSTRIAL	5300 extractive	OPEN
1300 Residential - High Density	MFR/HDR	5300 Reservoirs	OPEN
1310 Single Family - High Density	MFR/HDR	5330 lake	OPEN
1320 Moblie Home	MFR/HDR	5340 lake	OPEN
1330 Multi-Family - Low Rise	MFR/HDR	5400 Estuarine Waters bays and estuaries	OPEN
1340 Multi-Family High Rise	MFR/HDR	6100 swamp	OPEN
1100 - Residential Low Density	OPEN	6150 - Wetland Forest	OPEN
1110 Single Family - Low Density	OPEN	6150 Stream and lake swamps	OPEN
1480 Open Space cemetery	OPEN	6210 - Wetland Forest	OPEN
1790 Recreational Active	OPEN	6300 - Wetland Forest	OPEN
1800 Recreational	OPEN	6300 Wetland forested mixed	OPEN
1820 Recreation golf course	OPEN	6400 nonforested wetland	OPEN
1830 - Recreation Racetrack	OPEN	6410 - nonforested wetlands	OPEN
1850 Community Recreation	OPEN	6410 Freshwater Marshes	OPEN
1850- park	OPEN	6430 nonforested wetland	OPEN
1860 Community Recreation	OPEN	6430 Wet Prairies	OPEN
1890 Other Recreational	OPEN	6440 Aquatic Vegetation	OPEN
1900 Open Land Urban	OPEN	6440 nonforested wetland	OPEN
1900 Open lands other	OPEN	6450 nonforested wetland	OPEN
1940 Undeveloped land	OPEN	6530 Intermittent Ponds	OPEN
2100 Agri Cropland And Pastuer	OPEN	8330 Utlities water supply	OPEN
2100 Agri Intensive cropland	OPEN	1370 RV Park	OTHER
2110 Agri Intensive Improved Pasture	OPEN	1400 Commercial & Services	OTHER
2140 Agri Intensive row crop	OPEN	1400 Retail and mixed Commercial	OTHER
2200 Agri Intensive	OPEN	1410 Retail and Mixed Commercial	OTHER
2200 Agri Tree Crops	OPEN	1410 Retail& Services	OTHER
2400 Agri Intensive	OPEN	1430 Office	OTHER
2400 Agri Nurseries	OPEN	1470 Retail and Mixed Commercial	OTHER
2410 Agri Intensive Tree Nuirsery	OPEN	1700 - Institutional	OTHER
2430 Agri Intensive ornamental	OPEN	1710 Educational Facility	OTHER
2500 Agri Intensive	OPEN	1720 Other Institutional - religious	OTHER
2590 Agri Intensive	OPEN	1720 Religious	OTHER
2600 Agri Other open lands rural	OPEN	1740 Medical and Healthcare	OTHER
2600 other openland - rural	OPEN	1750 Governmental	OTHER
3100 rangeland herbaceous	OPEN	1770 Other Institutional	OTHER
3200 Rangeland Shrub Brushland	OPEN	8100 - Utilities Transportation	OTHER
3300 rangeland mixed	OPEN	8100 Transportation	OTHER
4100 upland forest	OPEN	8110 - Utilities Transportation Airport	OTHER
4110 Upland Forests Pine flatwoods	OPEN	8120 - Utlilities Transportaion Railroad	OTHER
4200 Upland Forest	OPEN	8140 road	OTHER
4200 Upland HardwoodForests	OPEN	8200 Communications	OTHER
4250 Upland Forest temperate hardwood	OPEN	8200 Communications	OTHER
4340 Upland Forest hardwood conifer mixed	OPEN	8200 utlities Communication facility	OTHER
4340 Upland Forest mixed coniferous/hardwood	OPEN	8300 Utilities	OTHER
4400 Tree Plantations	OPEN	8310 utilities electrical facility	OTHER
5100 stream	OPEN	8320 utilites electral transmission	OTHER
5100 Streams And Waterways	OPEN	8340 Utilites wastewater treatmentr	OTHER
5200 lakes	OPEN	8350 Utilities Solid Waste Disposal	OTHER
5230 - Retention	OPEN	1200 - Residential Med Density	SFMD
5240 retention pond	OPEN	1210 Single Family - Med Density	SFMD

Appendix E-2. Land use by category and subbasin in the Hudson Bayou watershed.

Subbasin	Land Use Category					Total
	Open	SFMD	MFR/HDR	Other	Industrial	
020101	-	-	9.3	0.5	-	9.8
020102	-	-	6.9	10.0	-	16.9
020104	-	-	22.7	8.3	-	31.0
020105	-	-	21.6	16.8	-	38.5
020107	-	-	2.0	28.9	-	30.9
020203	-	4.3	17.9	69.5	1.9	93.7
020302	8.0	58.7	6.2	44.6	-	117.5
020304	-	19.4	4.9	2.5	-	26.7
020306	-	17.1	-	-	-	17.1
020307	-	27.0	-	-	-	27.0
020308	7.9	99.3	-	39.8	-	147.0
020310	22.8	42.8	-	2.3	-	67.9
020311	5.6	46.4	0.0	52.5	-	104.6
020314	-	26.7	-	0.4	-	27.0
020316	-	5.6	-	-	-	5.6
020317	-	52.8	-	-	-	52.8
020318	-	41.2	-	6.7	-	47.8
020320	-	25.4	-	0.3	-	25.7
020321	3.0	35.1	5.1	51.3	-	94.6
020323	-	23.5	-	-	-	23.5
020324	-	4.3	-	-	-	4.3
020325	-	18.6	-	6.9	-	25.5
020328	-	6.6	-	0.7	-	7.2
020330	-	9.3	9.5	0.8	-	19.6
020331	-		12.5	-	-	12.5
020332	-	9.8	23.3	-	-	33.1
020333	2.3	-	20.9	0.5	-	23.7
020334	-	-	3.1	-	-	3.1
020401	-	9.1	-	-	-	9.1
020402	-	3.7	-	-	-	3.7
020403	-	4.9	-	-	-	4.9
020404	-	8.0	-	-	-	8.0
020405	-	3.6	-	-	-	3.6
020406	-	7.1	-	-	-	7.1
020407	-	2.7	-	-	-	2.7
020409	-	15.3	-	0.1	-	15.4
020411	-	2.6	3.2	5.1	-	10.9
020412	-	-	-	5.0	-	5.0
020413	6.3	0.2	31.7	27.2	-	65.4
020414	3.4	-	1.1	2.2	-	6.7
020415	0.6	-	3.8	-	-	4.5
020416	-	10.4	-	0.4	-	10.9
020417	-	2.4	-	-	-	2.4
020418	-	2.0	-	-	-	2.0
020419	-	-	1.1	9.8	-	10.9
020420	-	2.1	-	1.3	-	3.4
020422	-	6.7	2.2	9.9	-	18.8
020501	-	29.6	1.9	25.6	6.1	63.2
020601	5.1	58.2	12.3	125.3	-	201.0
020701	13.6	0.3	36.4	76.4	1.9	128.6
020801	3.1	7.5	2.2	16.1	2.2	31.2
TOTAL	10.1	24.1	7.2	51.4	7.1	1,753.9
Percentage	0.6	1.4	0.4	2.9	0.4	100.0

Appendix E-3. Land use by category and subbasin in the Cedar Hammock Creek and Bowlees Creek watersheds.

Subbasin	Land Use Category					Total
	Open	SFMD	MFR/HDR	Other	Industrial	
CHE1-1	115.4	49.3	472.4	529.8	-	1,166.9
CHE1-2	167.5	6.3	824.3	199.1	-	1,197.2
CHS1-1	41.0	26.5	486.1	258.8	-	812.3
CHS1-2	10.5	-	226.4	46.1	-	283.0
CHW1-1	3.4	3.1	127.1	16.8	-	150.4
CHW1-2	119.4	46.7	385.5	140.3	31.7	723.6
CHW2-1	76.0	329.9	189.4	89.3	-	684.6
CHW2-2	414.3	126.7	779.3	125.9	3.4	1,449.6
TOTAL	947.5	588.5	3,490.5	1,406.1	35.1	6,467.6
Percentage	14.6	9.1	54.0	21.7	0.5	100.0

Subbasin	Land Use Category					Total
	Open	SFMD	MFR/HDR	Other	Industrial	
APD1-1	157.0	3.3	287.5	6.6	19.2	473.6
APD1-2	164.2	16.2	0.2	615.6	62.4	858.6
BPD1-1	24.5	20.6	232.7	50.0	-	327.8
LPD1-1	95.4	44.6	192.0	97.8	16.8	446.5
LPD1-2	153.0	17.7	651.3	102.5	-	924.5
OND1-1	48.1	25.4	107.2	122.3	42.0	345.0
OND1-2	263.4	18.5	208.1	132.0	30.7	652.7
OND1-3	235.3	20.4	118.2	102.0	215.8	691.7
OND1-4	74.9	5.2	146.6	79.5	88.3	394.5
OND1-5	117.2	38.6	304.2	50.4	-	510.4
OND1-6	116.6	-	9.5	5.1	218.9	350.0
TOTAL	1,449.6	210.5	2,257.6	1,363.8	694.0	5,975.4
Percentage	24.3	3.5	37.8	22.8	11.6	100.0

Appendix E-4. Land use by category and subbasin in the Whitaker Bayou and Phillippi Creek watersheds.

Subbasin	Land Use Category: Open	SFMD	MFR/HDR	Other	Industrial	Total
A1	57.5	83.4	152.5	7.1	-	300.6
A2	209.1	-	-	-	0.0	209.1
A3	330.6	46.0	25.9	48.0	71.5	522.0
A4	42.2	3.7	145.6	31.5	74.8	297.8
B1	2.1	114.3	0.0	6.3	-	122.8
B2	52.7	147.4	2.4	27.0	8.0	237.5
B3-4	66.6	73.2	1.8	137.9	16.5	296.1
B5	12.8	1.7	-	0.4	1.2	16.2
B6	26.5	5.8	-	1.8	150.9	185.1
C	1.5	120.5	0.7	22.0	1.2	145.9
D1	24.1	5.2	-	-	12.7	42.0
D2	5.2	7.3	-	-	36.7	49.1
D3	6.5	2.7	43.9	0.2	2.5	55.7
D4	5.4	20.9	-	7.9	99.5	133.6
D5	21.0	0.9	-	37.8	53.7	113.4
D6	18.1	11.3	38.9	39.5	53.0	160.8
D7	-	46.8	13.8	14.9	1.9	77.5
D8	10.5	25.7	12.6	13.6	9.6	72.0
D9	0.7	42.9	37.4	-	-	80.9
WB1	220.7	-	-	25.9	26.4	273.0
WB2	73.5	-	-	82.5	83.7	239.7
WB3	19.6	-	0.2	101.8	0.2	121.8
WB4	43.7	-	68.1	18.7	-	130.5
WB5	48.4	158.9	71.6	28.9	5.0	312.9
WB6	16.2	87.5	65.4	65.7	5.5	240.3
WB7	6.8	60.8	10.9	26.8	12.9	118.2
WB8	11.5	49.4	6.2	26.7	-	93.8
TOTAL	1,333.4	1,116.3	698.0	773.0	727.6	4,648.2
Percentage	28.7	24.0	15.0	16.6	15.7	100.0

Subbasin	Land Use Category: Open	SFMD	MFR/HDR	Other	Industrial	Total
BRANCHAA	2,119.3	661.7	241.9	351.0	-	3,374.0
BRANCHBA	1,594.6	1,721.3	503.7	599.5	2.4	4,421.4
BRANCHC	391.0	508.1	30.2	96.8	3.6	1,029.8
CENTERGATE	437.6	227.2	191.7	44.5	-	900.9
LATERAL AB	243.4	636.2	131.0	89.3	0.0	1,099.9
LATERAL AC	122.4	155.5	-	15.3	10.3	303.5
LINWOOD	23.4	573.3	-	20.9	-	617.6
L-PHILLIPPI	347.6	789.4	136.7	314.8	-	1,588.5
MAIN A	6,494.5	529.5	47.1	385.1	2.0	7,458.1
MAIN B	1,718.1	578.5	325.8	181.4	-	2,803.8
MAIN C	4,670.8	592.7	13.3	579.2	458.4	6,314.3
M-PHILLIPPI	346.7	1,923.9	388.1	424.9	14.6	3,098.1
REDBUG	423.1	1,032.8	193.9	221.1	77.0	1,947.8
UPPER PHILL	266.5	480.0	38.2	56.9	2.8	844.4
TOTAL	19,198.9	10,410.0	2,241.6	3,380.5	571.1	35,802.1
Percentage	53.6	29.1	6.3	9.4	1.6	100.0

Appendix F-1. Telephone contacts used for point source loadings determinations.

Facility ID	Description	Date of Initial Call	First Contact	Second Contact	Response	Data Received
FLA134333	Atlantic WRF	07/30/99	John Ryan 378-6128	John Knowles 316-1534	Disposal is deepwell injection	N/A
FLA0040771	City of Sarasota	08/02/99	Doug Taylor 955-2325		Whitaker Discharge during prior 12 months is 3.85 mgd. Averaged 4.0 mgd over past 8 years	Yes - Cu, Pb and Zn
FLA0032808	Southgate AWWTP	07/30/99	Michael Acosta 925-3088	Karen 925-3088	AADF = 1.2 mgd	Yes - Cu, Pb, and Zn
FLA013382	Kensington Park -Monica Pkwy	08/04/99	Ron Fishkind 922-3518 / 351-1094		1998-99 AADF=0.304 mgd. Discharges at Kensington Park 27th St.	No Metal Data Collected
FLA13456	Kensington Park - 27th St.	08/04/99	Ron Fishkind 922-3518 / 351-1094		1998-99 AADF = 0.085 mgd	No Metal Data Collected
FLA013385	Meadowwood WWTP	07/30/99	Bob 371-5605		Last Monitoring 12/98. Will call back with results.	No
FLA013372	Bee Ridge WRF	07/30/99	Ken Stephens 316-1289	Trish Hindel 316-1732	Will Fax Results	Yes- Cu, Pb and Zn
FLA013427	Dolomite Utilities - Tri Par Estates	07/30/99	Ward Wright 377-9456		AADF ≐ 0.250 mgd	Yes - Cu, Pb and Zn. Used 0.5 * MDL for Cu and Pb.

Appendix F-2. Discharge facilities reviewed .

NAME	LOCATION	Type	TREATMENT	Design Capacity (MGD)	Disposal	LAT	LONG	SUBBASIN	BASIN	Reason For Rejection
KENSINGTON PARK UTILITIES MONICA PARKWAY WWTP	3700 MONICA PARKWAY	Private	TRICKLING FILTER ACTIVATED SLUDGE	0.456	Reuse	27.35770	82.49790	BRANCHEA	Phillipi	Retained
SYLVAN LEA S/D	1730 SUGARBERRY LANE	Private	TYPE III EXTENDED AERATION	0.030	Reuse	27.31667	82.43000	MAIN C	Phillipi	Reject - Point Source < 5% of Sub-basin stormwater load
BAHIA VISTA ESTATES	3901 BAHIA VISTA ST	Private	TYPE III CONTACT STABILIZATION	0.040	Reuse	27.32583	82.49333	UPPER PHILL	Phillipi	Reject - Point Source < 5% of Sub-basin stormwater load
MEADOWOOD WWTP	4860 17TH STREET	Private	EXTENDED AERATION	0.984	Reuse	27.35186	82.47108	BRANCHEA	Phillipi	Retained
SOUTH GATE AWWTP	3209 PINE VALLEY DRIVE	Private	TYPE I MULTI-TRAIN TWO STAGE BIOLOGICAL PROCESS	1.360	Disposal	27.31543	82.50608	M-PHILLIPPI	Phillipi	Reject - Point Source < 5% of Sub-basin stormwater load
CAMELOT LAKES WWTP	5580 AXMINSTER DRIVE	Private	TYPE II EXTENDED AERATION	0.168	Reuse	27.27336	82.44741	BRANCHAA	Phillipi	Reject - Point Source < 5% of Sub-basin stormwater load
BARCLAY HOUSE APARTMENTS WWTP	3900 S LOCKWOOD RIDGE DRIVE	Private	EXTENDED AERATION	0.008	Reuse	27.29528	82.50139	M-PHILLIPPI	Phillipi	Reject - Point Source < 5% of Sub-basin stormwater load
SARASOTA, CITY OF - R/O PLANT	1642 12TH STREET	Public				27.34724	82.53056			Out of Watershed
LAKE TIPPECANOE CONDOMINIUMS WWTP	4636 TIPPECANOE TRAIL	Private	CONVENTIONAL ACTIVATED SLUDGE	0.040	Reuse	27.28917	82.47694	LATERAL AB	Phillipi	Reject - Point Source < 5% of Sub-basin stormwater load
PETERSON MANUFACTURING	155 CATTLEMAN ROAD	Private	EXTENDED AERATION	0.003		27.33417	82.44806	MAIN C	Phillipi	Reject - Point Source < 5% of Sub-basin stormwater load
BEE RIDGE WRF	4001 IONA ROAD	County	TYPE I / BARDENPHO	1.500	Reuse	27.30066	82.39956	MAIN A	Phillipi	Reject - Point Source < 5% of Sub-basin stormwater load
OAKWOOD GARDEN WWTP	4035 SOUTH SCHOOL AVENUE	Private	TYPE III EXTENDED AERATION	0.009	Disposal	27.28656	82.52611	L-PHILLIPPI	Phillipi	Reject - Point Source < 5% of Sub-basin stormwater load
YODER'S TOO RESTAURANT	3434 BAHIA VISTA	Private	EXTENDED AERATION	0.003		27.32139	82.50333	M-PHILLIPPI	Phillipi	Reject - Point Source < 5% of Sub basin stormwater load
HOUGHTON WAGMAN PARTNERSHIP, LTD.	7839 FRUITVILLE ROAD	Private	EXTENDED AERATION TO A PERCOLATION / EVAPORATION POND	0.003	Disposal	27.34111	82.41444	MAIN C	Phillipi	Reject - Point Source < 5% of Sub-basin stormwater load
DOLOMITE UTILITIES TRI-PAR WWTP	1450 BLIND BROOK DRIVE	Private	COMPLETE MIX ACTIVATED SLUDGE, CHLORINATION, FILTRATION, PUBLIC ACCESS SPRAY IRRIGATION ON ROLLING GREEN GOLF COURSE	0.300	Reuse	27.37532	82.53984	A4	Whitaker	Retained
CAPE SAGE WWTP	4001 SOUTH TAMIAMI TRAIL	Private	TYPE III EXTENDED AERATION	0.003	Disposal	27.29694	82.53000	L-PHILLIPPI	Phillipi	Reject - Point Source < 5% of Sub-basin stormwater load
DOLOMITE UTILITIES TRADE CENTER WWTP	369 SARASOTA CENTER BLVD.	Private	EXTENDED AERATION TO DUAL PONDS / TYPE III	0.015	Reuse	27.34667	82.40667	MAIN C	Phillipi	Reject - Point Source < 5% of Sub-basin stormwater load
PROCTOR ROAD WWTP	WORCESTER ROAD SOUTH OF WILKINSON	County	EXTENDED AERATION to dual drainfields	0.025	Reuse	27.28779	82.51026	REDBUG	Phillipi	Reject - Point Source < 5% of Sub-basin stormwater load
MEDICAL CENTER OF SARASOTA WWTP	3920 BEE RIDGE ROAD	Private	TYPE III EXTENDED AERATION	0.015	Disposal	27.29694	82.49056	M-PHILLIPPI	Phillipi	Reject - Point Source < 5% of Sub-basin stormwater load
BEEKMAN PLACE UTILITY WWTP	290 COCOANUT AVENUE	Private	TYPE III CONTACT STABILIZATION	0.090	Reuse	27.37500	82.48889	MAIN B	Phillipi	Reject - Point Source < 5% of Sub-basin stormwater load
LAKE FOREST CONDOMINIUM	4062 LAKE FOREST DRIVE	Private	EXTENDED AERATION	0.031	Reuse	27.29694	82.49250	M-PHILLIPPI	Phillipi	Reject - Point Source < 5% of Sub-basin stormwater load
LONGWOOD RUN UTILITIES WWTP	6250 LONGWOOD BLVD.	Private	TYPE II EXTENDED AERATION	0.215	Reuse	27.38564	82.48123	MAIN B	Phillipi	Reject - Point Source < 5% of Sub-basin stormwater load
KENSINGTON PARK UTILITIES 27TH STREET	2461 DR. MARTIN LUTHER KING JR. DRIVE	Private	EXTENDED AERATION	0.175	Reuse	27.35985	82.51979	B3-4	Whitaker	Retained - Discharge from both facilities at this location.
OAK HAMMOCK PROF.CTR.(BENEVA CREEK)	3845 BEE RIDGE ROAD	Private	EXTENDED AERATION	0.010		27.32583	82.48833	UPPER PHILL	Phillipi	Reject - Point Source < 5% of Sub-basin stormwater load
DOLOMITE UTILITIES FRUITVILLE WWTP	1616 WENDEL KENT ROAD	Private	CONTACT STABILIZATION	0.400	Reuse	27.36592	82.44559	MAIN C	Phillipi	Reject - Point Source < 5% of Sub-basin stormwater load
WOODBRIDGE ESTATES	N OF WILKINSON W SWIFT ROAD	Private	EXTENDED AERATION	0.015		27.29417	82.51694	REDBUG	Phillipi	Reject - Point Source < 5% of Sub-basin stormwater load
SARASOTA COUNTY AREA TRANSIT FACILITY	5308 PINKNEY AVENUE	County				27.27472	82.48222	REDBUG	Phillipi	Intermittent Stormwater Discharge
P.F.L. WEST AUTOMOTIVE CENTER	2344 12TH STREET	Private				27.34722	82.52361	D2	Whitaker	Intermittent Stormwater Discharge
LAUREL OAK COUNTRY CLUB/ GOLF COURSE OP.	2875 DICK WILSON DRIVE	Private				27.29778	82.42028	MAIN A	Phillipi	Reject - Point Source < 5% of Sub-basin stormwater load
ATLANTIC WRF	BAHIA VISTA DR.	County	SEWAGE TREATMENT PLANT	1.750	Disposal	27.31501	82.46948	UPPER PHILL	Phillipi	Deep Well Injection
SARASOTA, CITY OF, WWTP	1850 12TH STREET	City	MODIFIED BARDENPHO	10.200	Both	27.34842	82.53309		Whitaker	Retained
SOUTHBAY UTILITIES	1600 SOUTH TAMIAMI TRAIL	Private	TYPE II / CONTACT STABILIZATION ACTIVATED SLUDGE DOMESTIC WASTEWATER TREATMENT PLANT	0.225	Reuse	27.17611	82.48483		Hudson	Out of Watershed

Appendix G-1. Computed point and non-point source loadings and ranks by basin for Hudson Bayou.

Subbasin	Basin size (acres)	Copper			Lead			Zinc			Average Rank
		lb/yr	lb/ac/yr	Rank	lb/yr	lb/ac/yr	Rank	lb/yr	lb/ac/yr	Rank	
20101	9.8	0.870	0.089	7	1.164	0.119	8	0.770	0.079	5	**6.7**
20102	16.9	2.679	0.159	42	2.897	0.171	45	15.401	0.911	40	**42.3**
20104	31.0	3.619	0.117	30	4.336	0.140	31	12.783	0.412	9	**23.3**
20105	38.4	5.323	0.139	36	6.006	0.156	37	25.874	0.674	34	**35.7**
20107	30.9	6.268	0.203	50	6.332	0.205	50	44.509	1.440	50	**50.0**
20203	93.6	17.281	0.185	48	17.796	0.190	48	113.772	1.216	48	**48.0**
20302	117.5	16.456	0.140	37	17.787	0.151	35	97.632	0.831	37	**36.3**
20304	26.8	3.088	0.115	29	3.618	0.135	29	13.416	0.501	26	**28.0**
20306	17.1	1.901	0.111	13	2.232	0.131	13	8.432	0.493	13	**13.0**
20307	27.0	3.002	0.111	18	3.524	0.131	17	13.313	0.493	17	**17.3**
20308	147.0	19.447	0.132	34	21.367	0.145	34	110.259	0.750	35	**34.3**
20310	67.9	5.245	0.077	3	6.072	0.089	2	24.646	0.363	8	**4.3**
20311	104.5	16.248	0.155	41	17.145	0.164	41	103.734	0.993	43	**41.7**
20314	27.1	3.053	0.113	27	3.569	0.132	27	13.781	0.509	29	**27.7**
20316	5.6	0.623	0.111	23	0.731	0.131	23	2.761	0.493	23	**23.0**
20317	52.8	5.871	0.111	22	6.892	0.131	22	26.035	0.493	22	**22.0**
20318	47.9	5.996	0.125	32	6.793	0.142	32	30.634	0.640	32	**32.0**
20320	25.7	2.887	0.112	26	3.379	0.131	26	12.986	0.505	27	**26.3**
20321	94.5	15.157	0.160	43	15.997	0.169	43	96.314	1.019	44	**43.3**
20323	23.5	2.613	0.111	17	3.067	0.131	17	11.587	0.493	20	**18.0**
20324	4.3	0.478	0.111	10	0.561	0.131	10	2.120	0.493	10	**10.0**
20325	25.5	3.525	0.138	35	3.885	0.152	36	19.798	0.776	36	**35.7**
20328	7.3	0.882	0.121	31	1.009	0.138	30	4.332	0.593	31	**30.7**
20330	19.6	1.984	0.101	9	2.464	0.126	9	5.818	0.297	7	**8.3**
20331	12.5	1.027	0.082	4	1.422	0.114	5	0.000	0.000	1	**3.3**
20332	33.1	3.004	0.091	8	3.930	0.119	7	4.832	0.146	6	**7.0**
20333	23.7	1.823	0.077	2	2.484	0.105	4	0.770	0.032	4	**3.3**
20334	3.1	0.255	0.082	5	0.353	0.114	6	0.000	0.000	1	**4.0**
20401	9.1	1.012	0.111	11	1.188	0.131	11	4.487	0.493	11	**11.0**
20402	3.7	0.411	0.111	16	0.483	0.131	16	1.824	0.493	16	**16.0**
20403	4.9	0.545	0.111	14	0.640	0.131	14	2.416	0.493	14	**14.0**
20404	8.0	0.889	0.111	18	1.044	0.131	17	3.945	0.493	17	**17.3**
20405	3.6	0.400	0.111	24	0.470	0.131	24	1.775	0.493	24	**24.0**
20406	7.1	0.789	0.111	21	0.927	0.131	21	3.501	0.493	21	**21.0**
20407	2.7	0.300	0.111	15	0.352	0.131	15	1.331	0.493	15	**15.0**
20409	15.4	1.722	0.112	25	2.018	0.131	25	7.698	0.500	25	**25.0**
20411	10.9	1.629	0.149	39	1.781	0.163	40	9.137	0.838	38	**39.0**
20412	5.0	1.056	0.211	51	1.056	0.211	51	7.701	1.540	51	**51.0**
20413	65.4	8.372	0.128	33	9.378	0.143	33	41.989	0.642	33	**33.0**
20414	6.7	0.555	0.083	6	0.590	0.088	1	3.388	0.506	28	**11.7**
20415	4.4	0.312	0.071	1	0.432	0.098	3	0.000	0.000	1	**1.7**
20416	10.8	1.241	0.115	28	1.442	0.134	28	5.744	0.532	30	**28.7**
20417	2.4	0.267	0.111	12	0.313	0.131	12	1.183	0.493	12	**12.0**
20418	2.0	0.222	0.111	18	0.261	0.131	17	0.986	0.493	17	**17.3**
20419	10.9	2.160	0.198	49	2.195	0.201	49	15.093	1.385	49	**49.0**
20420	3.4	0.508	0.149	38	0.549	0.161	38	3.038	0.893	39	**38.3**
20422	18.8	3.017	0.160	44	3.216	0.171	44	18.551	0.987	42	**43.3**
20501	63.2	10.948	0.173	47	11.151	0.176	46	68.839	1.089	46	**46.3**
20601	200.9	33.947	0.169	46	35.461	0.177	47	221.672	1.103	47	**46.7**
20701	128.6	19.814	0.154	40	20.836	0.162	39	122.427	0.952	41	**40.0**
20801	31.1	5.170	0.166	45	5.230	0.168	42	33.837	1.088	45	**44.0**

Appendix G-2. Computed point and non-point source loadings and ranks by basin for Cedar Hammock Creek, Bowlees Creek, and Whitaker Bayou.

Subbasin	Basin size (acres)	Copper lb/yr	Copper lb/ac/yr	Copper Rank	Lead lb/yr	Lead lb/ac/yr	Lead Rank	Zinc lb/yr	Zinc lb/ac/yr	Zinc Rank	Average Rank
CHE1-1	1166.9	156.208	0.134	8	172.093	0.147	8	840.267	0.720	6	7.3
CHE1-2	1197.2	110.491	0.092	3	136.667	0.114	3	898.542	0.751	7	4.3
CHS1-1	812.3	97.554	0.120	7	113.430	0.140	7	411.640	0.507	3	5.7
CHS1-2	283.0	28.340	0.100	5	35.497	0.125	6	232.707	0.822	8	6.3
CHW1-1	150.4	14.337	0.095	4	18.413	0.122	5	27.413	0.182	1	3.3
CHW1-2	723.6	66.508	0.092	2	79.596	0.110	2	514.499	0.711	5	3.0
CHW2-1	684.6	71.104	0.104	6	83.471	0.122	4	300.162	0.438	2	4.0
CHW2-2	1449.6	104.722	0.072	1	131.802	0.091	1	813.049	0.561	4	2.0

Subbasin	Basin size (acres)	Copper lb/yr	Copper lb/ac/yr	Copper Rank	Lead lb/yr	Lead lb/ac/yr	Lead Rank	Zinc lb/yr	Zinc lb/ac/yr	Zinc Rank	Average Rank
APD1-1	473.6	25.395	0.054	3	34.546	0.073	3	217.199	0.459	3	3.0
APD1-2	858.6	131.845	0.154	11	132.164	0.154	11	956.258	1.114	11	11.0
BPD1-1	327.8	31.975	0.098	9	39.730	0.121	10	253.386	0.773	9	9.3
LPD1-1	446.5	41.387	0.093	8	48.319	0.108	8	309.720	0.694	8	8.0
LPD1-2	924.5	77.138	0.083	7	98.066	0.106	7	631.816	0.683	7	7.0
OND1-1	345.0	37.467	0.109	10	41.347	0.120	9	277.490	0.804	10	9.7
OND1-2	652.7	47.038	0.072	4	53.972	0.083	4	361.070	0.553	4	4.0
OND1-3	691.7	33.529	0.048	2	37.661	0.054	2	251.593	0.364	2	2.0
OND1-4	394.5	29.414	0.075	5	34.148	0.087	5	229.684	0.582	5	5.0
OND1-5	510.4	39.936	0.078	6	50.298	0.099	6	313.972	0.615	6	6.0
OND1-6	350.0	1.854	0.005	1	2.155	0.006	1	14.616	0.042	1	1.0

Subbasin	Basin size (acres)	Copper lb/yr	Copper lb/ac/yr	Copper Rank	Lead lb/yr	Lead lb/ac/yr	Lead Rank	Zinc lb/yr	Zinc lb/ac/yr	Zinc Rank	Average Rank
A1	300.6	23.309	0.078	14	29.743	0.099	15	161.015	0.536	13	14.0
A2	209.1	0.000	0.000	1	0.000	0.000	1	0.000	0.000	1	1.0
A3	522.0	17.385	0.033	8	19.092	0.037	8	115.135	0.221	8	8.0
A4	297.8	19.040	0.064	9	23.713	0.080	11	154.410	0.518	11	10.3
B1	122.8	14.048	0.114	21	16.259	0.132	22	66.125	0.538	14	19.0
B2	237.5	22.285	0.094	16	25.212	0.106	16	115.935	0.488	9	13.7
B3-4	296.0	37.420	0.126	26	38.893	0.131	21	249.808	0.844	26	24.3
B5	16.2	0.284	0.018	5	0.318	0.020	5	1.520	0.094	5	5.0
B6	185.1	1.034	0.006	2	1.147	0.006	2	5.683	0.031	2	2.0
C	145.9	18.104	0.124	25	20.455	0.140	26	93.805	0.643	21	24.0
D1	42.0	0.578	0.014	3	0.679	0.016	3	2.564	0.061	3	3.0
D2	49.1	0.807	0.016	4	0.948	0.019	4	3.580	0.073	4	4.0
D3	55.7	3.941	0.071	10	5.378	0.097	14	32.933	0.591	17	13.7
D4	133.6	3.985	0.030	7	4.388	0.033	7	22.427	0.168	7	7.0
D5	113.3	8.081	0.071	11	8.098	0.071	9	58.634	0.517	10	10.0
D6	160.8	12.796	0.080	15	14.244	0.089	12	94.194	0.586	16	14.3
D7	77.5	9.489	0.122	23	10.830	0.140	25	55.928	0.722	23	23.7
D8	72.0	6.774	0.094	17	7.670	0.106	17	42.690	0.593	19	17.7
D9	80.9	7.839	0.097	19	9.849	0.122	19	47.838	0.591	18	18.7
WB1	273.0	5.470	0.020	6	5.470	0.020	6	39.889	0.146	6	6.0
WB2	239.7	17.421	0.073	12	17.421	0.073	10	127.028	0.530	12	11.3
WB3	121.8	21.524	0.177	27	21.530	0.177	27	156.964	1.288	27	27.0
WB4	130.5	9.537	0.073	13	11.689	0.090	13	77.379	0.593	20	15.3
WB5	312.9	29.658	0.095	18	34.994	0.112	18	174.016	0.556	15	17.0
WB6	240.3	28.985	0.121	22	32.745	0.136	23	191.096	0.795	25	23.3
WB7	118.2	13.315	0.113	20	14.835	0.126	20	79.038	0.669	22	20.7
WB8	93.8	11.640	0.124	24	12.791	0.136	24	69.904	0.745	24	24.0

Appendix G-3. Computed point and non-point source loadings and ranks by basin for Phillippi Creek.

Subbasin	Basin size (acres)	Copper			Lead			Zinc			Average Rank
		lb/yr	lb/ac/yr	Rank	lb/yr	lb/ac/yr	Rank	lb/yr	lb/ac/yr	Rank	
Branch AA	3374.0	167.587	0.050	4	188.029	0.056	4	1039.666	0.308	4	**4.0**
Branch BA	4421.4	359.386	0.081	9	408.590	0.092	8	2131.752	0.482	9	**8.7**
Branch C	1029.7	79.424	0.077	7	90.204	0.088	7	421.201	0.409	7	**7.0**
Centergate	900.9	50.410	0.056	5	60.861	0.068	5	317.467	0.352	6	**5.3**
Lateral AB	1099.9	100.355	0.091	11	116.797	0.106	11	544.742	0.495	10	**10.7**
Lateral AC	303.5	20.517	0.068	6	23.524	0.078	6	100.196	0.330	5	**5.7**
Linwood	617.6	68.156	0.110	14	79.241	0.128	14	314.883	0.510	12	**13.3**
L-Phillippi	1588.5	165.502	0.104	12	185.088	0.117	12	971.782	0.612	14	**12.7**
Main A	7458.1	144.067	0.019	1	155.793	0.021	1	887.733	0.119	1	**1.0**
Main B	2803.8	129.406	0.046	3	150.892	0.054	3	797.329	0.284	3	**3.0**
Main C	6314.3	189.320	0.030	2	201.200	0.032	2	1193.737	0.189	2	**2.0**
M-Phillippi	3098.1	335.549	0.108	13	385.017	0.124	13	1880.270	0.607	13	**13.0**
Redbug	1947.8	177.462	0.091	10	203.560	0.105	10	988.258	0.507	11	**10.3**
Uper Phill	844.4	68.519	0.081	8	79.007	0.094	9	351.547	0.416	8	**8.3**

Appendix H-1. Combined rankings of subbasins in Hudson Bayou for potential contaminant sources due to historical activities, present day industry, multi-sector facilities, and modeled point and non-point source stormwater runoff.

Subbasin	Historical	Present	Multi-Sector	Modeled	Combined	Final Basin Rank
020101	27.3	28.7	1.0	6.7	15.9	31
020102	26.3	17.7	1.0	42.3	21.8	38
020104	27.7	28.0	29.7	23.3	27.2	41
020105	31.7	47.0	32.3	35.7	36.7	47
020107	33.3	50.0	1.0	50.0	33.6	46
020203	23.0	49.7	27.7	48.0	37.1	50
020302	25.0	24.7	1.0	36.3	21.8	37
020304	1.0	1.0	1.0	28.0	7.8	18
020306	1.0	1.0	1.0	13.0	4.0	8
020307	23.7	1.0	1.0	17.3	10.8	24
020308	1.0	20.7	1.0	34.3	14.3	29
020310	1.0	21.7	1.0	4.3	7.0	15
020311	1.0	22.0	1.0	41.7	16.4	33
020314	1.0	1.0	1.0	27.7	7.7	17
020316	24.3	1.0	1.0	23.0	12.3	27
020317	1.0	1.0	1.0	22.0	6.3	12
020318	1.0	23.0	1.0	32.0	14.3	30
020320	1.0	1.0	1.0	26.3	7.3	16
020321	1.0	26.0	1.0	43.3	17.8	34
020323	1.0	24.0	30.3	18.0	18.3	35
020324	1.0	1.0	1.0	10.0	3.3	6
020325	1.0	1.0	1.0	35.7	9.7	21
020328	1.0	1.0	1.0	30.7	8.4	19
020330	1.0	1.0	1.0	8.3	2.8	5
020331	1.0	1.0	1.0	3.3	1.6	2
020332	1.0	17.0	1.0	7.0	6.5	13
020333	1.0	1.0	1.0	3.3	1.6	3
020334	1.0	1.0	1.0	4.0	1.8	4
020401	1.0	1.0	1.0	11.0	3.5	7
020402	1.0	1.0	1.0	16.0	4.8	10
020403	1.0	1.0	1.0	14.0	4.3	9
020404	1.0	16.0	1.0	17.3	8.8	20
020405	1.0	1.0	1.0	24.0	6.8	14
020406	1.0	1.0	1.0	21.0	6.0	11
020407	34.3	1.0	1.0	15.0	12.8	28
020409	1.0	13.7	1.0	25.0	10.2	22
020411	1.0	1.0	1.0	39.0	10.5	23
020412	1.0	33.0	33.7	51.0	29.7	43
020413	1.0	29.7	31.0	33.0	23.7	40
020414	32.7	32.3	34.3	11.7	27.8	42
020415	1.0	1.0	1.0	1.7	1.2	1
020416	33.0	1.0	1.0	28.7	15.9	32
020417	29.0	1.0	1.0	12.0	10.8	25
020418	25.7	1.0	1.0	17.3	11.3	26
020419	26.3	14.0	1.0	49.0	22.6	39
020420	44.7	1.0	1.0	38.3	21.3	36
020422	46.3	25.3	33.0	43.3	37.0	49
020501	16.7	29.7	28.3	46.3	30.3	45
020601	44.0	37.7	27.0	46.7	38.8	51
020701	17.3	31.0	31.7	40.0	30.0	44
020801	47.0	27.3	29.0	44.0	36.8	48

Appendix H-3. Combined rankings of subbasins in Phillippi Creek for potential contaminant sources due to present day industry, multi-sector facilities, and modeled point and non-point source stormwater runoff.

Subbasin	Historical	Present	Multi-Sector	Modeled	Combined	Final Basin Rank
Branch AA		3.2	5.3	4.0	4.2	4
Branch BA		12.5	4.8	8.7	8.7	10
Branch C		8.8	4.8	7.0	6.9	7
Centergate		6.5	1.0	5.3	4.3	5
Lateral AB		9.3	7.5	10.7	9.2	11
Lateral AC		8.8	1.0	5.7	5.2	6
Linwood		2.8	6.3	13.3	7.5	8
L-Phillippi		3.3	13.5	12.7	9.8	12
Main A		4.7	1.0	1.0	2.2	1
Main B		7.2	1.0	3.0	3.7	2
Main C		12.5	8.5	2.0	7.7	9
M-Phillippi		10.7	7.2	13.0	10.3	13
Redbug		12.8	9.3	10.3	10.8	14
Uper Phill		1.8	1.0	8.3	3.7	3