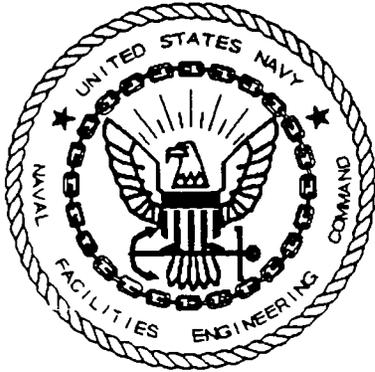


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TECHNICAL MEMORANDUM PRELIMINARY RESULTS OF ZONE J SAMPLING CNC
CHARLESTON SC
12/11/1997
ENSAFE INC.

**COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY
NAVAL BASE CHARLESTON
CHARLESTON, SOUTH CAROLINA
CTO-29**

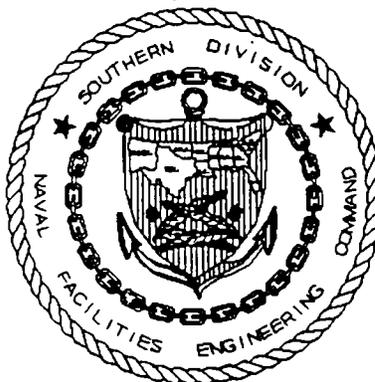


**TECHNICAL MEMORANDUM
PRELIMINARY RESULTS OF ZONE J
SAMPLING**

Prepared for:

**DEPARTMENT OF THE NAVY
SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING
COMMAND
CHARLESTON, SOUTH CAROLINA**

**SOUTHDIV CONTRACT NUMBER:
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December 11, 1997

Release of this document requires the prior notification of the Commanding Officer of the Naval Base Charleston, Charleston, South Carolina.

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Technical Review Comments to Tetra Tech EM, Inc. 's Approach to Determination of Sediment Background Concentrations in the Cooper River

General Comments:

The overall report is written poorly and does not provide a consistent and understandable approach for meeting the objective(s) of the study. The strategy for background determination appears to be the primary objective, but throughout Section 6 it was unclear what specific methods would be employed to meet that objective. The following are general comments relative to the report.

1. It is unclear to the reader how the information presented in the first 22 pages of the Strategy Report will be incorporated into the overall objective of determining background values within the Cooper River and adjacent water bodies. Will concentrations produced throughout the system be incorporated into a database for statistical interpretation?
2. Most of the 'data gaps' referred to in paragraph 1 of Section 6.0 do not appear to be data gaps at all, but tasks related to the overall objective.
3. How does the second sentence of paragraph 2, Section 6.0 differ significantly from the sampling and analysis plan put forth to the Navy for the Zone J RFI (E/A&H, 1996)?
4. It is unclear, and not clearly stated, how determination of background values will be used by the risk management team for risk decisions.
5. The overall purpose of the report changes throughout the document. Initially the primary objective is background concentration determination but within Section (numbering is confusing and out of order) 6.1.1 and 6.2, testing and evaluation of potential risk endpoints are addressed.
6. Several issues need to be addressed relative to the approach for data interpretation as presented in Section 6.2.
 - Six samples per 'background' site may not be adequate for calculating the mean and may produce large standard deviations. In addition, without a systemated approach to sampling the background sites, the large variation in sediment type throughout the system may bias the results from bulk sediment analysis. This issue needs to be addressed by the sampling rationale (i.e., random, stratified random sampling, etc.).
 - As these are environmental samples, it can be assumed that data sets (distributions) will be skewed (Gilbert, 1987) so that the symmetric normal distribution will not be a suitable model for estimating means, quantiles, or proportions. Thus, another distribution model that adequately fits the skewed data will be required. Transformation to a lognormal distribution may provide the best method for interpretation of the population statistics.

- No specific statistical tests which will be applied to the data are presented. The authors only allude to graphical methods that are available for visually assessing the distributions.
 - It is unclear how sample 'locations' can be identified graphically. Spatial extent of screening exceedances can be visually presented using either kriging techniques, Thiessen polygonal analysis, or ARCINFO presentation.
 - The text uses NOAA ER-L and ER-M as screening criteria, but EPA Region IV has developed Sediment Screening Values (SSVs)(EPA, 1996) based not only on Long et al.'s (1995) study, but also on two other sediment effects studies (MacDonald, 1994 and Long and Morgan, 1991).
7. Throughout the strategy section (6.1) the authors refer to a Navy "Sediment Management Strategy" for the Cooper River and surrounding areas and also suggests Navy may develop "technical policy" for CNSY sediments. The sediment management programs referred to in the document are in no way related to the objective for this study. The programs identified were developed for national and regional assessment programs. It is not our understanding that the Navy has been directed to establish such a program.
 8. Although the authors indicate that physical parameters will be collected simultaneously with the chemical data there is no discussion on how this information will be incorporated into the analysis. Grain-size and/or TOC normalization (see NOAA, 1991 and Michelsen, 1992) would provide a start to observing relative trends between selected background locations. Also, metal-to-aluminum ratios have been determined for several east coast estuaries (Windom et al., 1989, Schropp et al., 1990, and Hanson and Evans, 1991) and thus may provide a measure of the anthropogenic input for inorganic contaminants.
 9. Pertinent information on depositional patterns and historical water quality trends near CNSY could be determined using methods developed under USGS's National Water-Quality Assessment (NAWQA) Program (Leahy, et al., 1990). As described in Van Metre et al., (1997), collected sediment cores can be sampled and analyzed for major and minor elements, organic parameters, physical parameters, and age dated using cesium-137. Depth-integrated profiles will show peaks and trends that may be correlated to historical water quality. But, at this point, we agree with the authors that this should not be considered a primary objective of the study.
 10. EnSafe suggests that the approach to background determination be a much simpler process than that proposed by this document:
 - Historical information will provide ranges and means of concentrations observed throughout the system and then can be spatially presented as figures. This will determine the portions of the system that are relatively more contaminated than others. Most of this data has already been digested and the time to analyze would be minimal. The next step will be to determine the number of samples per selected background site (using a

Prespecified Variance Technique, ie., as means in selected portions of the system are already known from historical information, then by preselecting a variance (V), a sample number (n) can be calculated. Sample data can then be tested for normality, if non-normal then log transformation will be employed. Median values from background locations can be compared (ie., via Mann-Whitney Rank Sum test) to determine if they are statistically different. This method will determine if sediment concentrations (for each contaminant) are different between selected background sites. A similar comparison can then be made to the sediment data collected by EnSafe at CNSY.

CHARLESTON NAVAL SHIPYARD
ECOLOGICAL RISK ASSESSMENT
BACKGROUND STRATEGY
DRAFT REVIEW SUMMARY REPORT

Prepared for

U.S. Environmental Protection Agency
Region 4
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1.0 INTRODUCTION

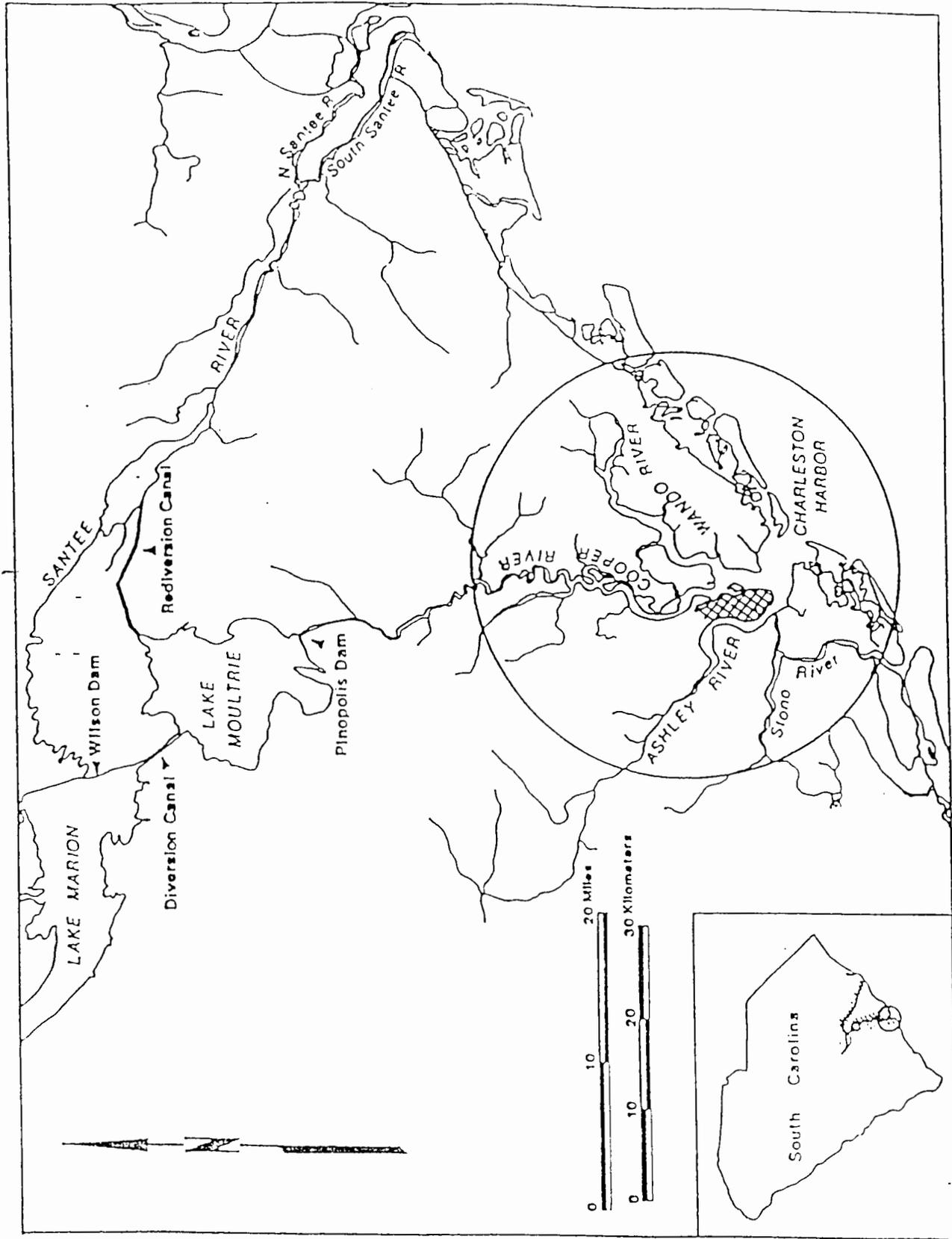
On July 17, 1997, Tetra Tech EM Inc. (Tetra Tech) received a task order to provide technical assistance to EPA in conducting oversight of an ecological risk assessment at the Charleston Naval Shipyard (CNSY) in Charleston, South Carolina. The scope of the task order included providing technical assistance in the form of development of a background sampling strategy that could be used to determine the contamination from the CNSY and its effect on ecological receptors within the Cooper River. Once the task order was received, Tetra Tech assembled a team of ecological risk assessors of varying expertise to develop a background sampling strategy to address these two primary issues: (1) define the background levels of metals that would exist in the sediments in the Cooper River if no contamination from industry had occurred and (2) define the background levels and location of all contaminants that are attributable to CNSY activities.

To develop the background sampling strategy for CNSY, Tetra Tech divided the task into two separate activities. The first activity involved conducting an exhaustive search of all the information available to date on the natural system of the Cooper River and types and locations of industries discharging to the river. After the available information had been gathered, this report was prepared to summarize the factors that played a part in the sedimentation, contaminant transport, and ecology of the Cooper River in the area of the CNSY. This report summarizes information obtained during the literature search conducted for this work assignment. Much of the information presented in this report is summarized as it was presented in *A Physical and Ecological Characterization of the Charleston Harbor Estuarine System*, Final Report (Van Dolah and others, et. al. 1990), which was prepared by the Marine Resources Research Institute (MRRI) and submitted to the South Carolina Coastal Council. The document will be referred to in this report as the MRRI report. Much of the work being conducted in the Cooper River and Charleston harbor is ongoing and therefore Tetra Tech could not get access to the results of ongoing studies that have not been published. Regardless of whether the strategy contained in this report is employed at CNSY, the ecological studies being conducted in the Charleston harbor and the Cooper River should be revisited as the studies are published and updated to incorporate the information into the risk assessment.

The report presents individual sections detailing and discussing the environmental setting, physical characteristics of the Cooper River, the biological community, the industrial sources and the proposed background sampling strategy.

2.0 ENVIRONMENTAL SETTING

The Charleston Harbor is located in the central portion of South Carolina's coastline and is formed by the confluence of the Cooper, Ashley, and Wando Rivers (see Figure 1). Each of these rivers has unique characteristics in terms of size, freshwater flow, and degree of anthropogenic stress. Together these rivers comprise more than 26,000 hectares of valuable coastal marshlands and open-water habitat, and they form the third largest estuarine drainage area in the state (Tiner 1977 and National Oceanic and Atmospheric Association [NOAA], 1985, as cited in Van Dolah and others 1990). This report will focus primarily on the Cooper River and its watershed area.



Source: Van Dolah, Robert F., Priscilla H. Wendt, and Elizabeth L. Wenner. 1990. A Physical and Ecological Characterization of the Charleston Harbor Estuarine System. Final Report. May.

SANTEE-COOPER DRAINAGE SYSTEM

**FIGURE 1
STUDY AREA MAP**

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The Cooper River has the greatest concentration of industrial and port facilities among the three rivers forming the Charleston Harbor estuary. The majority of these facilities are located along the western shoreline and include U.S. Navy port facilities, commercial facilities associated with the State Ports Authority, and private industry. To accommodate ship traffic, a 10.7 meter deep navigation channel is maintained in the lower Cooper River and extends 32 kilometers (km) upstream from the mouth of the river (US Army Corps of Engineers [COE] 1966b, 1975, as cited in Van Dolah 1990). A more detailed description of the industrial influence in the Cooper River is presented in Section 5.0 of this report.

3.0 PHYSICAL CHARACTERISTICS OF THE COOPER RIVER

The Cooper River and the Charleston Harbor estuary have undergone significant anthropogenic changes during the past several hundred years; however, the most intensive changes have occurred since 1942. Prior to 1942, the Cooper River was a tidal slough having an average freshwater discharge of about 170 cubic feet per second (ft³/sec) and a drainage basin of about 1,190 square miles (mi²).

During the late 1930s, the South Carolina Public Services Authority (SCPSA) began a hydroelectric project that ultimately diverted about 88 percent of the Santee River flow into the Cooper River; the project was completed in 1942. The Santee River drainage basin extends from the western North Carolina Blue Ridge Province to the mouth of the river between Georgetown and McClellanville, South Carolina (approximately 15,700 mi²). Upon completion of the diversion project, the average freshwater discharge to the Cooper River was greater than 15,000 ft³/sec, while flow through the Santee River channel decreased to about 2,170 ft³/sec. The resulting increase in freshwater flow through the Cooper River changed Charleston Harbor from a well mixed to a partially stratified estuary. In addition, the change to a salt-wedge estuary and subsequent deepening of the navigational channels in the harbor and the Cooper River resulted in extreme shoaling in the harbor.

Prior to diversion, navigational channels in the harbor and Cooper River were nearly self-maintaining; annual maintenance dredging in the harbor averaged about 21,700 cubic yards (yd³). By 1982, annual dredging of about 7,600,000 yd³ was required to maintain navigational channels in the inner harbor. In response to the dramatically increased shoaling in the harbor, a rediversion project was undertaken by the COE. At project completion in 1985, about 70 percent of the original flow was restored to the Santee River channel. The flow was rediverted to the Santee River through a canal (see Figure 1), and average monthly freshwater discharge to Cooper River decreased to about 4,270 ft³/sec.

The sections below provide details of the physical dynamics of the river and the harbor and summarizes available data on sediments in the area.

3.1 Physical Dynamics

This section discusses the following physical dynamics of the estuary: salinity, freshwater discharge and flow, and tidal influences.

3.1.1 Salinity

Prior to the diversion of the Santee River, the average salinity in Charleston Harbor was about 30 parts per thousand (ppt). Between 1942 and 1985, freshwater discharge resulting from diversion of Santee River water into the Cooper River reduced average salinity to about 17 ppt. Prior to diversion the harbor's salinity structure was mixed; after diversion the structure was only partially mixed and saline stratification was evident. The salinity structure since rediversion does not appear to have returned to prediversion conditions.

Assuming the 1 ppt isohaline as an indicator, Kjerfve, and others (1990) found that the upstream limit of salt-water migration varied between 36 and 45 km upriver from Fort Sumter (at the seaward end of Charleston Harbor) under high tide conditions. The study also found that the tidal range of spring and neap tides was not a good indicator of the upstream limit of estuarine conditions. At 30 km upriver, the highest salinity occurred during the smallest tides. Contrary to expectations, the salinity did not intrude farther upstream on spring tides. With the nearly constant average freshwater discharge, the study concluded that far-field forcing from near-coastal waters and the lower estuary, primarily due to meteorological (wind) forcing, is an important factor in driving salinity upstream in the Cooper River.

Davis and others (1990) reported that the Cooper River is polyhaline (greater than 18 ppt) from river km 0 to about 21; mesohaline (5 to 18 ppt) from river km 21 to 35; and oligohaline (greater than 5 ppt) from river km 35 to the Pinopolis dam (river km 54). The mean surface salinity in the lower harbor was reported to be 26 ppt during the period from 1986 to 1988. Salinity declined gradually in the upstream direction to station COM (see Figure 2) at river km 43.5, where the river became limnetic. Bottom salinity averaged about 32 ppt at the harbor entrance; decreasing gradually in the upstream direction to station COH at river km 24.9, and decreasing more rapidly until limnetic conditions were reported at station COL at river km 39.8. The difference in mean combined surface and bottom salinities between low and high tide averaged 3.7 ppt. Mean surface and bottom salinities at high tide averaged 3.2 ppt higher than low tide salinities. Stations in the lower Cooper River showed smaller changes in salinity between high and low tides (1 to 2 ppt) than stations in the upper portions of the river which showed changes of 5 to 8 ppt between low and high tide conditions. The Cooper River was found to be most stratified between stations COD (river km 10.6) and station COI (river km 28.6).

3.1.2 Freshwater Discharge and Flow

As a consequence of diversion, the average salinity in Charleston Harbor decreased from about 30.0 ppt to about 16.8 ppt, gravitational circulation became the dominant estuarine circulation mode, and the salinity structure became partially mixed (stratified). In 1944, 2 years after the diversion project was completed, the ship channel was deepened from 30 feet to 35 feet. Deepening the navigational channels further strengthened the gravitational circulation forces and compounded shoaling problems by causing greater landward transport of marine sands.

In response to dramatically increased shoaling in the harbor, a rediversion project was undertaken. At completion in 1985, about 70 percent of the original flow was restored to the Santee River channel,

and average monthly freshwater discharge to the Cooper River decreased to about 4,270 ft³/sec. This flow rate is sufficient to maintain hydroelectric power generation and prevent saline water from entering the Durham Creek Canal, which would contaminate the Back River reservoir near Bushy Park. It is not known if the decreased freshwater flow through Cooper River is low enough to reduce gravitational circulation in the harbor.

The monthly average freshwater discharge through the Pinopolis dam is fairly uniform (about 4,270 ft³/sec); however, significant diurnal variations in freshwater flow are known to occur.

3.1.3 Tidal Influence

The entire Cooper River system experiences semidiurnal tidal influence. The average tidal range is about 5.9 to 6.6 feet in the Charleston Harbor estuary. Tides propagate up the Cooper River with high water occurring at Back River Reservoir about 5 hours and 45 minutes later than high water at the Customs House in downtown Charleston; low tide at Back River Reservoir occurs about 5 hours and 57 minutes later than at the Customs House. The greatest tidal ranges occur during the full and new moon phases (spring tides), and the smallest tidal ranges occur during the first and third quarters of the lunar cycle (neap tides).

Some degree of tidal amplification has been observed as far upriver as Snow Point. As the flood tide propagates upriver of Snow Point, high tide elevations decline relative to tidal elevations at the Customs House. For example, the high tide elevation at the Back River Reservoir is 0.17 times the tidal elevation at the Customs House. Conversely, low tide elevations are higher at certain points upriver than at the Customs House. For example, at Bonneau Ferry on the East Branch of the Cooper River, low tide elevation is 1.79 times the low tide elevation at the Customs House (Tidelog 1997).

3.2 Sediments

The subsections below discuss the physical characteristics of and contaminants found in sediments in the harbor.

3.2.1 Physical Characteristics

Sediments in Charleston Harbor are derived from marine and fluvial sources. Sediment deposition is influenced by freshwater inflow, gravitational circulation, and dredging operations. The saltwater wedge, which resulted from diversion of the Santee River water into the Cooper River, is principally responsible for sedimentation in the lower Charleston Harbor estuary. Sediment deposition in this area occurs as bedload encounters a point of no-net motion at the saltwater-freshwater interface. Sediments carried in the saltwater wedge move upstream and downstream with the tidal cycle, dropping out of suspension where current energy is insufficient for transport. The sediments may become resuspended and redeposited during subsequent tidal cycles. Although the freshwater discharge at the Pinopolis dam has been significantly reduced by the rediversion project, it does not appear that the estuary has

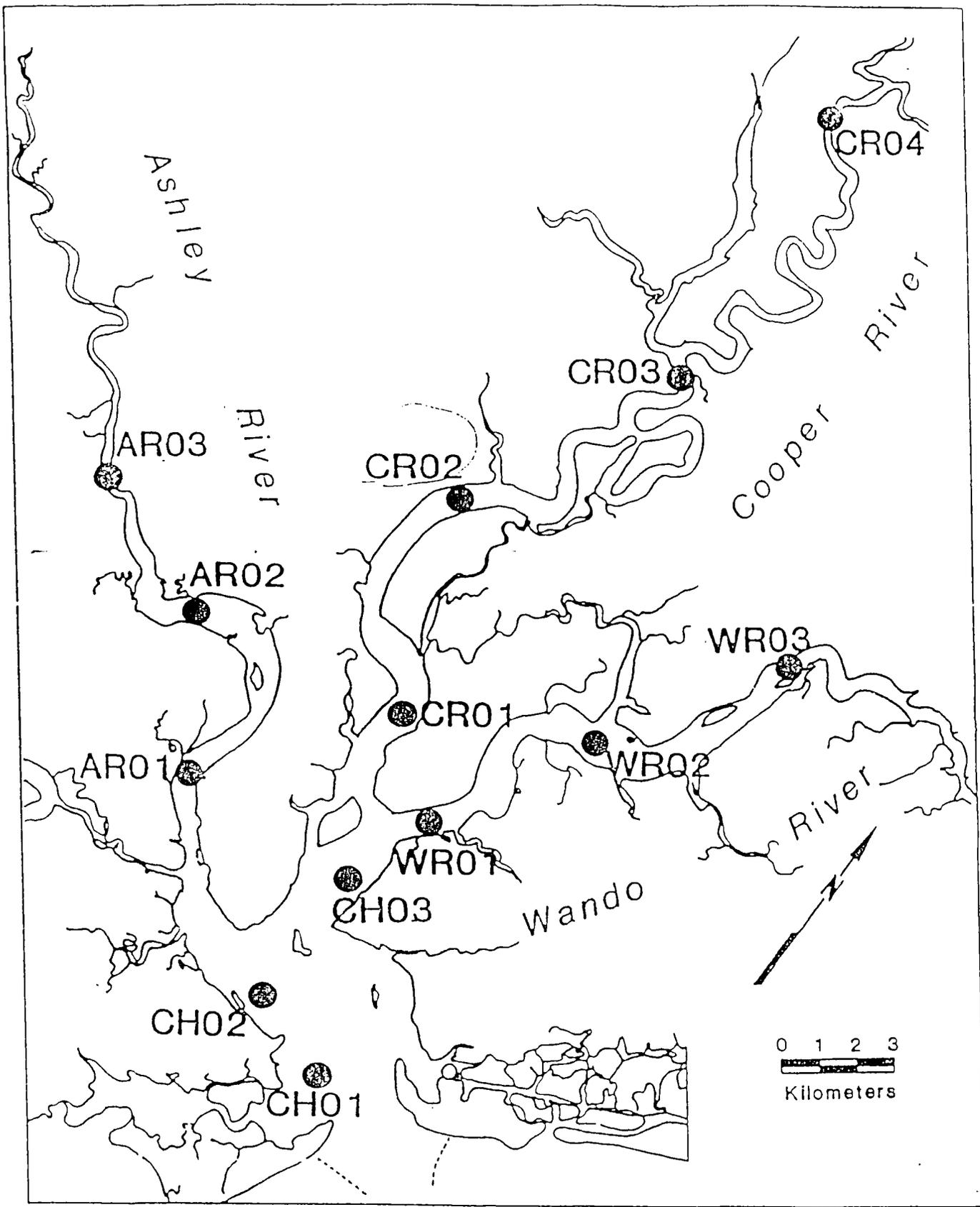
returned to its prediversion, well-mixed condition; as a result, the saltwater wedge is still present in the Cooper River.

A significant portion of the sediment deposition is caused by flocculation, as negatively charged clay particles in suspension encounter the higher salinity of the estuary and lose their negative charge. Neihesisel and Weaver (1967) compared ratios of various clay minerals to determine the source of these sediments. Analyses of both bedload and suspended load indicated that sediments transported down the Cooper River were primarily silts and clays. The clay mineralogy ratios were indicative of a Piedmont source, suggesting that significant amounts of sediment were being transported from inland sources through the Santee Cooper lakes and into the Cooper River itself. It was also determined that the silts and clays were being deposited on the western shoals in the inner harbor and the Cooper River upstream to CNSY.

In addition to flocculation of the clay-sized fraction, marine sands were determined to be the main cause of shoaling in the navigational channels of the harbor. Marine sands, originating from the shallow coastal waters, were found to dominate the sediment in the navigation channels from the harbor entrance to about 18 km upriver. The transport of marine sands into the harbor probably results from the predominant longshore littoral drift along the Isle of Palms and Sullivan's Island into the harbor. Once the sands enter the harbor, they are transported landward as bedload and as near-bottom, suspended load through the navigation channels by flood tides.

The MRRI report details a 4-year sediment study of the estuary, including the Cooper River. The objectives of the study were (1) to compare sediment characteristics at several index sites during the period of rediversion in conjunction with macrobenthic infaunal sampling; (2) describe the spatial distribution of surficial sediments in the harbor basin and lower reaches of the Ashley, Cooper, and Wando Rivers; and (3) compare sedimentological data from this study with data collected prior to rediversion.

The MRRI Study found that sediment sampling stations located in the harbor basin had the greatest variability in sediment composition between stations and over time. Sediments obtained from the harbor basin stations showed no consistent seasonal variation and did not relate to the initiation of rediversion. Sand, silt, and clay fractions dominated the sediment composition and were highly variable; however, organic matter and calcium carbonate (shell hash) content were also highly variable. Of the three harbor basin stations, station CH02 (see Figure 3), located offshore of James Island, was the most variable in sediment composition. At station CH02, the sand fraction ranged from 3.1 percent to 78.75 percent; the silt fraction ranged from 4.54 percent to 72.02 percent; the clay fraction ranged from 8.62 percent to 75.01 percent; calcium carbonate ranged from 1.03 percent to 47.13 percent; and the organic content ranged from 2.23 percent to 15.06 percent by weight during the period November 1984 to November 1988.



Source: Van Dolah, Robert F., Priscilla H. Wendt, and Elizabeth L. Wenner. 1990. A Physical and Ecological Characterization of the Charleston Harbor Estuarine System. Final Report. May.

FIGURE 3
MRRI BENTHIC SAMPLING STATION MAP

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Four sediment sampling stations in the Cooper River (CR01, CR02, CR03, and CR04) were also monitored during the period from November 1984 to November 1988. Station CR01 was located most downstream and closest to the harbor basin (offshore of the former Naval Station Charleston, upstream of Shipyard Creek); it had the greatest percentage of fine-grained sediments of the Cooper River stations and showed significant fluctuations in relative abundance of various grain size fractions. Station CR01 clay percentages ranged from 21.17 percent to 86.15 percent (average 55.54 percent), silt fractions ranged from 5.29 percent to 75.03 percent (average 28.99 percent), sand content ranged from 1.06 percent to 72.58 percent (average 13.26), and calcium carbonate ranged from 0.23 percent to 20.96 percent (average 2.23 percent). The organic content by weight ranged from 2.47 percent to 14.71 percent (average 11.59 percent by weight).

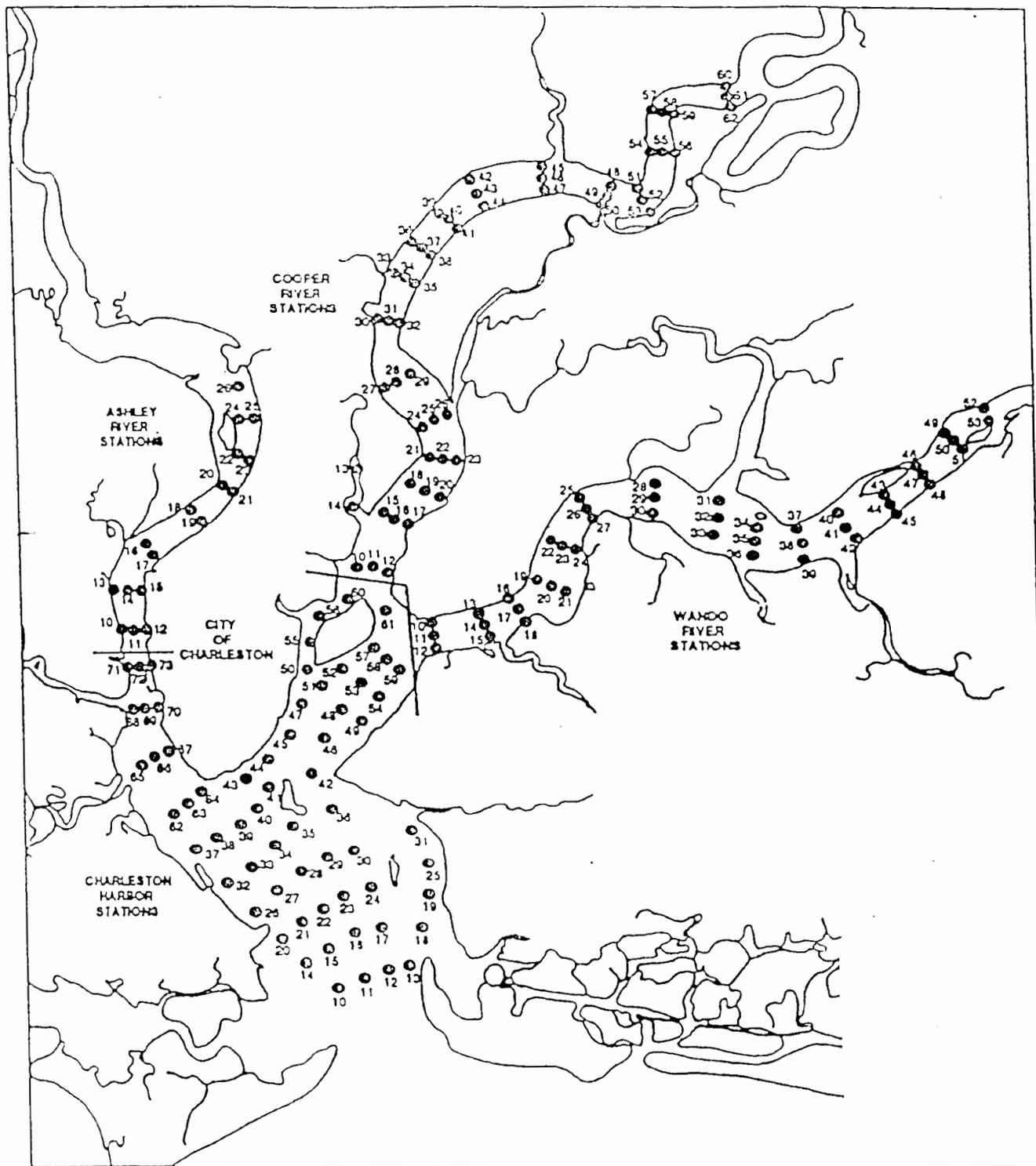
The 72.58 percent sand content was determined from samples collected during the middle of February 1988; it appears to be anomalously high and correlates with an anomalously low organic content (2.47 percent by weight) and silt fraction (5.29 percent). In addition, the lowest percentage of clay (21.17 percent) was also recorded from this sampling event. Given that these anomalous grain-size distributions were not consistent, the MRRRI Study attributed the observed anomalies to errors in sampling location.

The remaining Cooper River stations (CR02, CR03, and CR04) had uniformly high percentages of moderate to well sorted, medium sand-sized sediment in their respective grain-size distributions. Station CR02 (located offshore of the North Charleston State Ports Authority terminal) had an average sand content of 95.02 percent for the 19 sampling events; station CR03 had an average sand content of 94.80 percent; and station CR04 had an average sand content of 90.32 percent. There was one anomalously low sand content percentage in the CR04 record (November 11, 1985) that did not correlate with any other anomalies in any other station sediment records in the Cooper River. The average sand content for station CR04 was 95.23 percent when the anomalous sand content percentage was filtered out. The relative abundance of silt, clay, calcium carbonate, and organic matter in the upstream samples was uniformly low with the exception of the above-mentioned anomaly.

Sediment sampling results revealed no seasonal trends in the grain-size distributions for the four Cooper River stations. The study also revealed no significant effects of rediversion on sediment characteristics at the upriver Cooper River stations. At station CR01, the percentage of calcium carbonate decreased immediately upon the initiation of rediversion and represented less than 1 percent by weight of the total sample volumes collected during the remainder of the study. The sand fraction at station CR01 also decreased relative to rediversion, while the silt and clay fractions increased. Organic materials were also a significant component of the sediments at station CR01 relative to other Cooper River stations.

3.2.2 Contaminants

Mathews and Darr (1990) reported organic and inorganic contaminants from the same sampling stations used in the MRRRI Study (see Figure 4). In addition, 178 stations were sampled and analyzed for trace metals in August 1988. Mercury, copper, and chromium were detected in 29, 40, and 79 percent of



Source Van Dolah, Robert F., Priscilla H. Wendt, and Elizabeth L. Wenner. 1990. A Physical and Ecological Characterization of the Charleston Harbor Estuarine System. Final Report. May.

FIGURE 4
MRR SEDIMENT CONTAMINANT
SAMPLING STATION MAP

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sediment samples, respectively. Organic chemicals were found in 2 of 24 sediment samples. Most of the organic compounds detected were polynuclear aromatic hydrocarbons, although a wide variety of organic chemicals were detected.

Chromium was the most widespread of the trace metals in this study and was found in sediment samples at concentrations as great as 81.18 milligrams/kilogram (mg/kg). The maximum chromium concentration was found in a sample collected at station CR13, located on Shipyard Creek, near the MacAlloy Corporation (MacAlloy) plant. Elevated chromium concentrations were found to be associated with industrialized areas and fine-grained sediments.

Copper was also widely distributed in sediments sampled throughout the study area, with a high concentration of 39.95 mg/kg. High copper concentrations correlated with the distribution of fine-grained sediments.

Lead was detected in sediment samples collected from five stations throughout the study area; concentrations ranged from 40.9 to 88.1 mg/kg.

Mercury was detected in organism tissue and/or sediments from about half of the sampling stations. Mercury concentrations in sediments ranged from nondetected to 25.7 micrograms/kilogram ($\mu\text{g}/\text{kg}$). Various polynuclear aromatic hydrocarbons were detected in relatively high concentrations at one sampling station in the Ashley River, near the U.S. Highway 17 bridge (station AR01).

In 1994, Gulf Engineers and Consultants (GEC) conducted a sediment sampling and analysis program for the COE Charleston District. The project consisted of collecting 11 vibracore sediment samples, preparing lithologic descriptions of retrieved cores, and analyzing samples for polynuclear aromatic hydrocarbons, phenol, phthalate esters (EPA method 8270); polychlorinated biphenyls; organochlorine pesticides (EPA method 8080); arsenic (EPA method 7060); lead (EPA method 7421); antimony (EPA method 7041); selenium (EPA method 7740); thallium (EPA method 7841); silver, beryllium, cadmium, chromium, copper, nickel, zinc (EPA method 6010); mercury (EPA method 7470); cyanide (EPA method 335.3); sulfides (EPA method 376.2); total organic carbon (TOC) (EPA method 9060); and total suspended solids (EPA method 160.2). Analyses of the various constituents were conducted on elutriates of the sediment samples for both total and dissolved phase compounds. One aqueous background sample was also collected and analyzed for the same parameters as the sediment elutriate samples. Analytical results are summarized below.

TOC concentrations ranged from 2,170 to 7,880 mg/kg (average 4,052 mg/kg).

No total or dissolved-phase polynuclear aromatic hydrocarbons or phthalate esters were reported above the detection limit of 10 $\mu\text{g}/\text{L}$.

No total or dissolved-phase polychlorinated biphenyl aroclors were reported above the detection limit of 0.5 $\mu\text{g}/\text{L}$.

The detection limits for the organochlorine pesticides ranged from 0.05 to 0.5 $\mu\text{g/L}$, depending on the compound. No total or dissolved phase organochlorine pesticides were reported above their respective detection limits.

Arsenic, antimony, and selenium were detected above detection limits in the total and dissolved phases, and lead was detected in a single sample in the dissolved phase. Three samples had total arsenic concentrations ranging from 30.0 to 49.7 $\mu\text{g/L}$ (average 38.4 $\mu\text{g/L}$). The background sample had a reported total arsenic concentration of 22.6 $\mu\text{g/L}$. Two samples had dissolved-phase arsenic concentrations of 21.9 and 22.3 $\mu\text{g/L}$, respectively; however, the two samples (CH10 and CH11) that had dissolved-phase arsenic concentrations above the detection limit did not have total arsenic concentrations above the detection limit of 20 $\mu\text{g/L}$. Six samples had total antimony concentrations ranging from 32.6 to 55.3 $\mu\text{g/L}$ (average 44.01 $\mu\text{g/L}$); the same six samples also had dissolved-phased antimony concentrations ranging from 31.5 to 48.6 $\mu\text{g/L}$ (average 37.21 $\mu\text{g/L}$). Sample CH8 had a higher reported dissolved phase concentration of antimony (48.6 $\mu\text{g/L}$) than the reported total antimony concentration (32.6 $\mu\text{g/L}$).

Selenium was the most widely detected metal in the sediment sample elutriates, occurring in 8 of 11 total metals analyses and in 7 of 11 dissolved metals analyses. Total selenium concentrations ranged from 22.6 to 87.8 $\mu\text{g/L}$ (average 43.82 $\mu\text{g/L}$). Dissolved selenium concentrations ranged from 22.5 to 50.0 $\mu\text{g/L}$ (average 39.44 $\mu\text{g/L}$). Two samples had higher dissolved-phase selenium concentrations than total selenium concentrations (CH3 and CH6). The reported presence of selenium in eastern United States sediments is unusual; however, selenium has been reported as a naturally occurring element in western North Carolina (Carter 1997). All laboratory data reports were flagged to indicate that dilutions of the sample aliquots were required for metals and sulfides analyses due to matrix interferences. Contrary to the results of Mathews and Darr (1990), no chromium nor copper concentrations were reported above their respective detection limits.

Dissolved lead was reported at a concentration of 24.0 $\mu\text{g/L}$ in sample CH5; no total lead concentrations greater than the detection limit were reported.

No total or dissolved-phase cyanide or sulfide concentrations were reported in any sample above their respective detection limits. Total suspended solids concentrations ranged from 15.0 (background sample) to 167 mg/L.

4.0 BIOLOGICAL COMMUNITY

The Charleston Harbor estuarine system supports a diverse biological community, including a diverse assemblage of marine fish and crustaceans. It provides seasonal nursery habitat for adults and juveniles of many species and a permanent, year-round habitat for residents (Wenner and others 1984 as cited in Van Dolah 1990). The following sections of this report focus on the aquatic community directly related to the Cooper River. However, as indicated in the Environmental Sensitivity Index map, included in Appendix A, the land and marsh areas within and adjacent to CNSY also provide habitat for a wide variety of wading birds, raptors, and mammals that rely on aquatic resources in the area.

4.1 Benthic Species Present in the Cooper River

During a 4-year study conducted by MRRI, 8,028 macrofaunal organisms representing 122 taxa were collected at four stations located throughout the Cooper River (see Figure 3). Mean abundances ranged from a low of 3.67 individuals/grab at station CR02 in summer 1988 to a high of 286.33 individuals per grab sample at station CR01 in spring 1988. Despite the wide range of abundances, this variable exhibited no apparent trends with respect to site, season, or year of collection. Similarly there was no obvious difference in the total abundance of benthic organisms before and after redirection. Species richness and diversity also show no consistent trends with respect to season, site, or year of collection. However, there was a general tendency toward greater species richness near the mouth of the river (Van Dolah 1990). Total abundance, broken out into the most prevalent species collected during the study, is presented in Figure 5.

4.2 Crustacean Species Present in the Cooper River

An examination of decapod crustaceans captured in the harbor basin and the Cooper River during the 4-year MRRI showed that of the 40 species collected, 8 species comprised 92 percent of the total number of decapods collected, with panaeid shrimp generally being the numerically dominant crustacean each of the 4 years. The eight most abundant species are presented in Table 4-1.

4.3 Finfish Species Present in the Cooper River

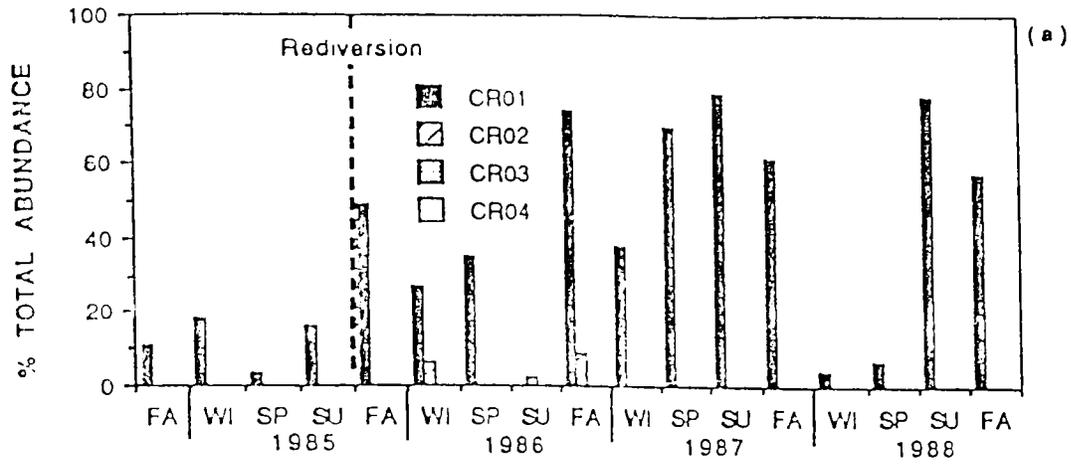
During the 4-year study conducted by MRRI, 99 species of finfish were collected from the five stations in the harbor basin and the Cooper River. The 10 numerically dominant species accounted for 94 percent of the total number of fish caught in any 1 year. A list of the 10 numerically dominant species is included as Table 4-2. Over the course of the study, there was a general increase in the number of individuals and taxa taken but a general decrease in the mean weight.

5.0 INDUSTRIAL ACTIVITY

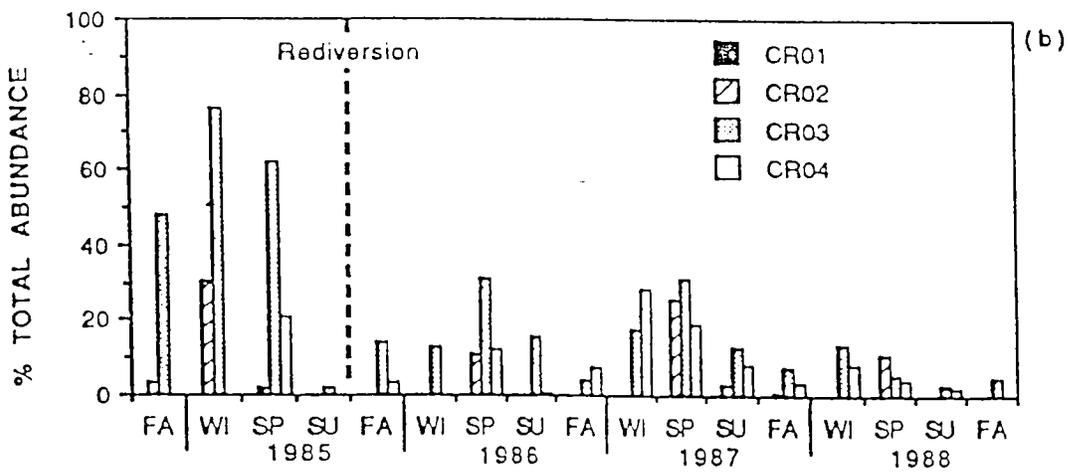
Over the past century, the Charleston area has supported various types of industry, including phosphate mining operations, manufacturing, shipyards, a naval base with an active shipyard, and a naval weapons station. At the turn of the century, commercial land areas adjacent to the north ends of the Cooper and Wando Rivers as well as the small islands that separate the two rivers were largely used for agriculture with limited industry dotting the west side of the Cooper River.

The early 1900s brought increased port traffic to the city as the Navy began operations at the Charleston Naval Base, including the CNSY, along the Cooper River, and numerous industrial companies set up shop on the banks of the rivers and its tributaries. The Charleston Peninsula was changing from an agricultural and residential area to an industrial area and an active port city with Westvaco operating its paper products plant, the MacAlloy Corporation (MacAlloy) operating its ferrochromium plant, W.R. Grace and Company (W.R. Grace) operating its fertilizer company, numerous companies operating petroleum storage terminals and pipelines, shipyards opening up, and

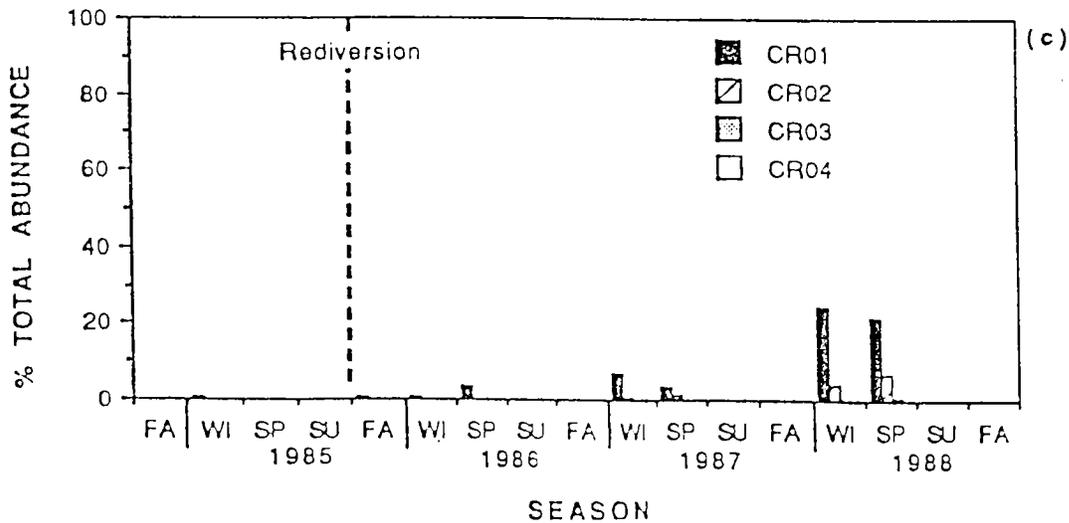
Paraprionospio pinnata



Scolecopleides viridis



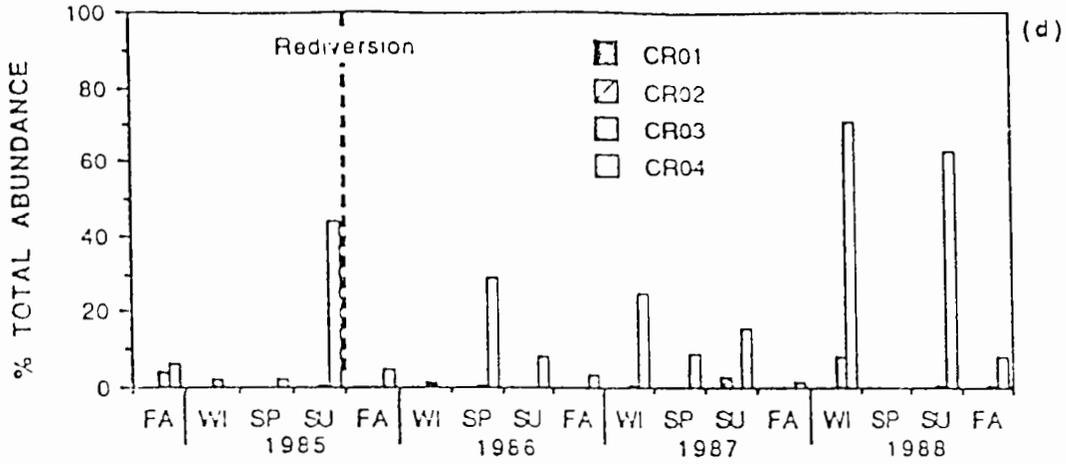
Streblospio benedicti



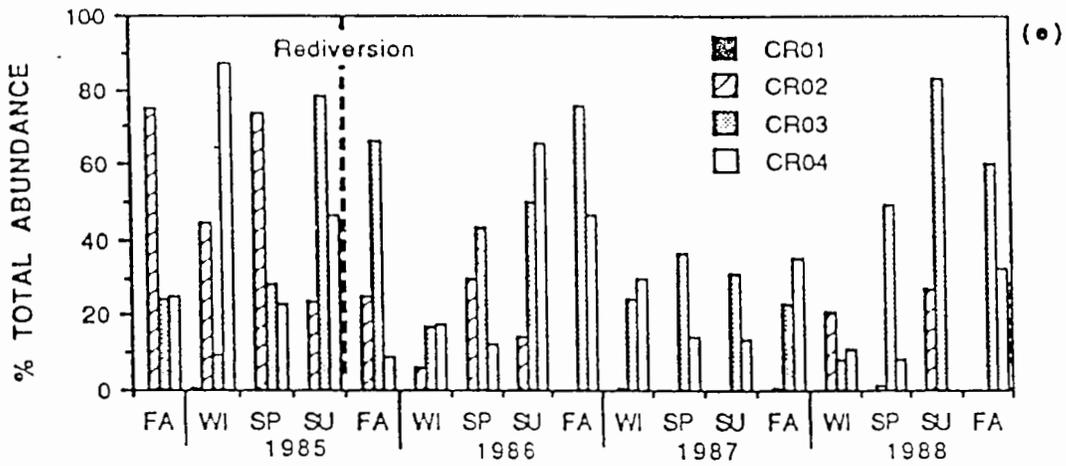
Source: Van Dolah, Robert F., Priscilla H. Wendt, and Elizabeth L. Wenner. 1990. A Physical and Ecological Characterization of the Charleston Harbor Estuarine System. Final Report. May.

FIGURE 5
MRRRI BENTHIC TOTAL ABUNDANCE
GRAPHS

Gammarus tigrinus



Lepidactylus dytiscus



Melita nitida

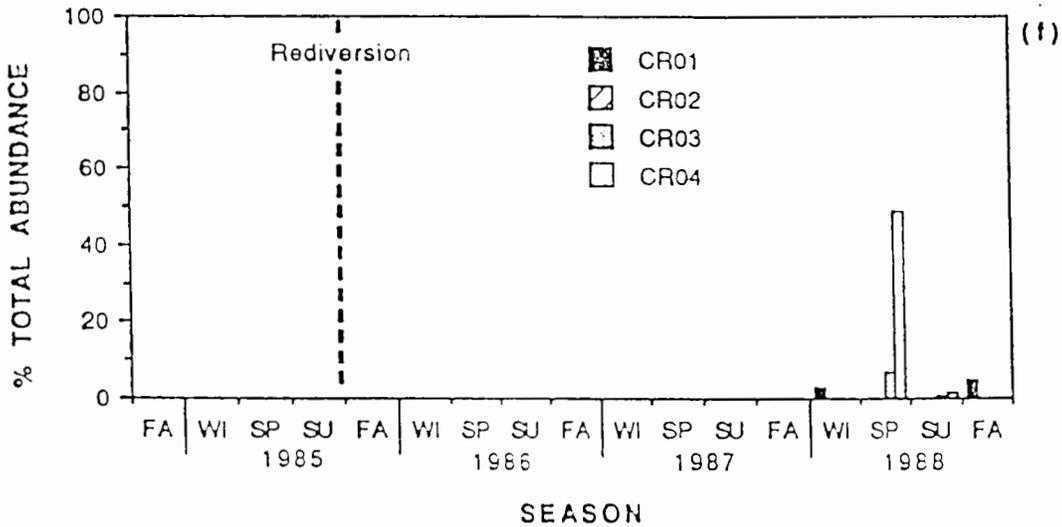
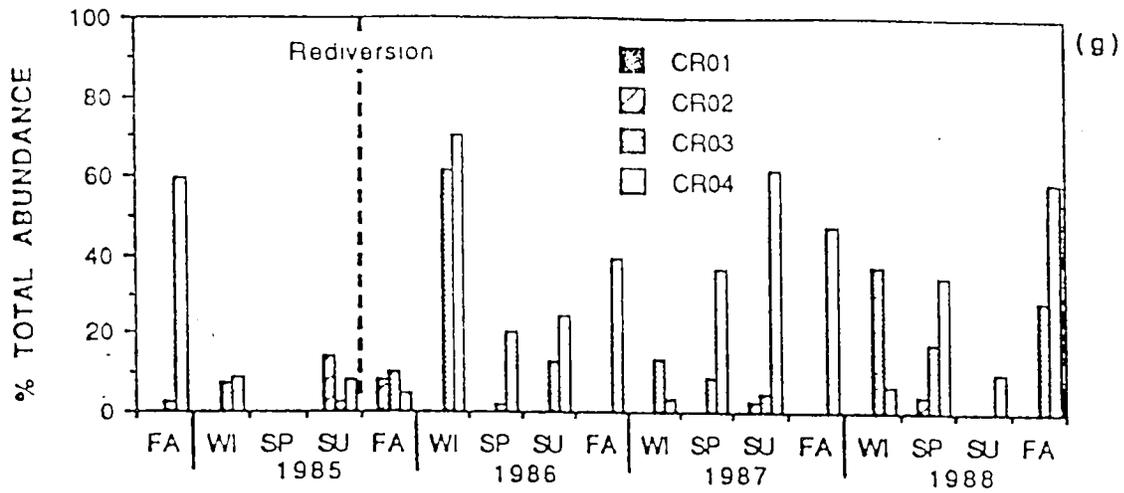


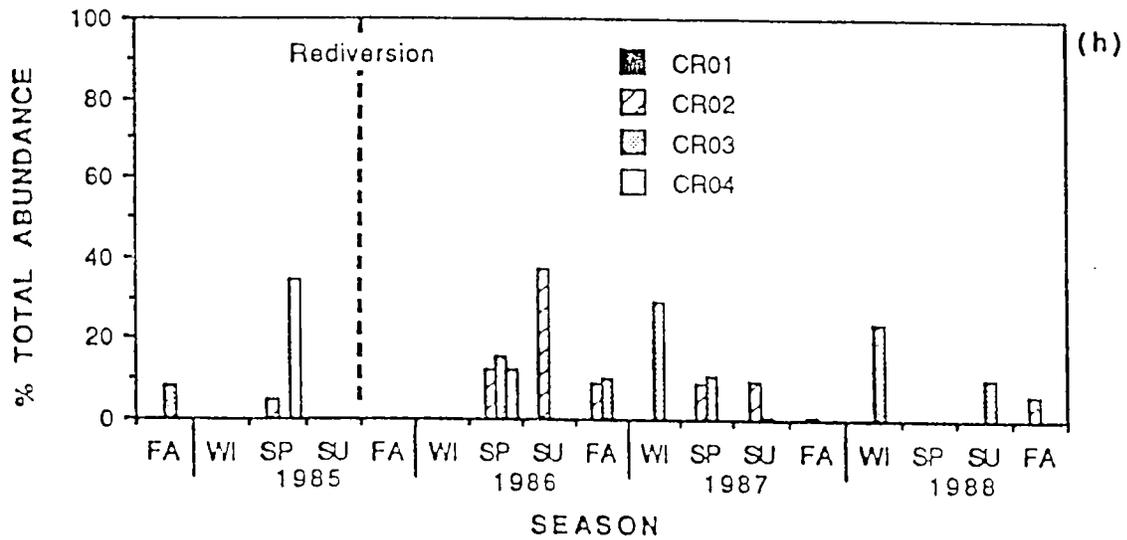
FIGURE 5 (Continued)
MRR BENTHIC TOTAL ABUNDANCE
GRAPHS

Source: Van Dolah, Robert F., Priscilla H. Wendt, and Elizabeth L. Wenner. 1990. A Physical and Ecological Characterization of the Charleston Harbor Estuarine System. Final Report. May.

Chiridotea almyra



Chiridotea stenops



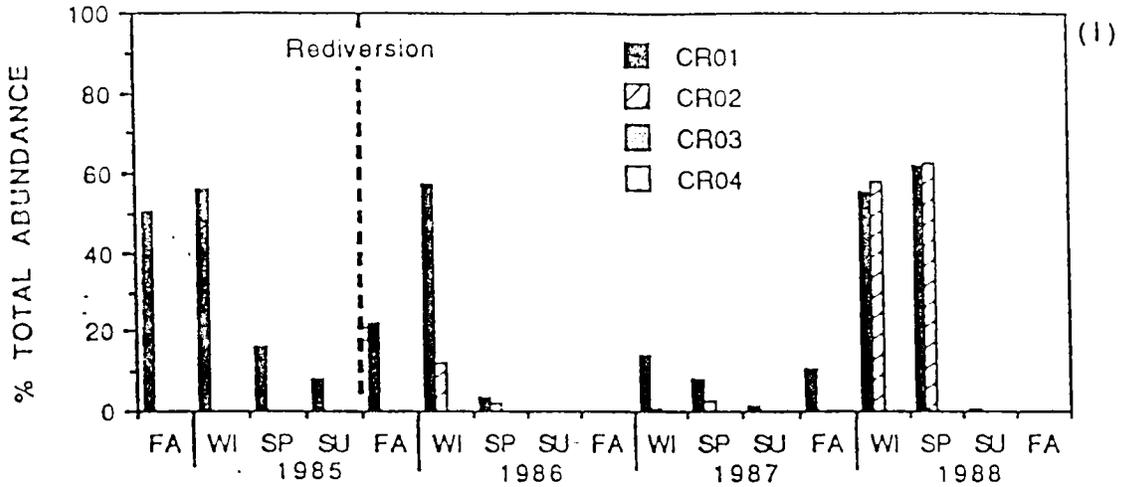
Source: Van Dolah, Robert F., Priscilla H. Wendt, and Elizabeth L. Wenner. 1990. A Physical and Ecological Characterization of the Charleston Harbor Estuarine System. Final Report. May.

FIGURE 5 (Continued)
MRRRI BENTHIC TOTAL ABUNDANCE
GRAPHS

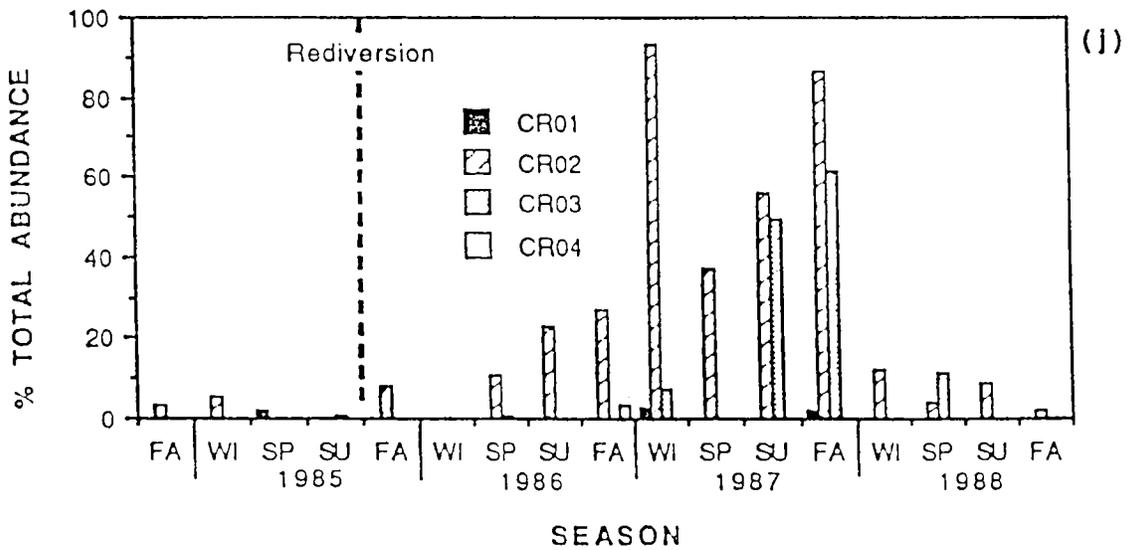


TETRA TECH EM INC.

Mulinia lateralis



Nematoda



Source: Van Dolah, Robert F., Priscilla H. Wendi, and Elizabeth L. Wenner. 1990. A Physical and Ecological Characterization of the Charleston Harbor Estuarine System. Final Report. May.

FIGURE 5 (Continued)
MRRRI BENTHIC TOTAL ABUNDANCE
GRAPHS

**TABLE 4-1
 DOMINANT FISHES PRESENT IN THE
 HARBOR BASIN AND COOPER RIVER^a**

Scientific Name	Common Name
<i>Anchoa mitchilli</i>	Bay Anchovy
<i>Stellifer lanceolatus</i>	Star Drum
<i>Leiostomus xanthurus</i>	Spot
<i>Micropogonias undulatus</i>	Croaker
<i>Cynoscion regalis</i>	Weakfish
<i>Bairdiella chrysoura</i>	Silver Perch
<i>Urophycis regius</i>	Spotted hake
<i>Ictalurus catus</i>	White Catfish
<i>Brevoortia tyrannus</i>	Menhaden
<i>Symphurus plagiusa</i>	Tonguefish

**TABLE 4-2
 DOMINANT DECAPODS PRESENT IN THE
 HARBOR BASIN AND COOPER RIVER^a**

Scientific Name	Common Name
<i>Penaeus setiferus</i>	White Shrimp
<i>Penaeus aztecus</i>	Brown Shrimp
<i>Trachypenaeus constrictus</i>	Roughneck
<i>Palaemonetes vulgaris</i>	Grass Shrimp
<i>Callinectes sapidus</i>	Blue Crab
<i>Callinectes similis</i>	Lesser Blue Crab
<i>Penaeus duorarum</i>	Pink Shrimp
<i>Rithropanopeus harrisi</i>	Mud Crab

Notes:

^a List presented in order of numerical abundance as collected by trawl.

the State Ports Authority (SPA) starting operations at two terminals.

The sections below discuss industrial activities along the Cooper and Wando Rivers and their tributaries.

5.1 COOPER RIVER AND ITS TRIBUTARIES

The Cooper River and several of its tributaries (Shipyards Creek, Noisette Creek, Filbin Creek, Goose Creek, and Back River) became increasingly crowded with industry once the Naval Base settled on the west bank of the Cooper River, north of the downtown historic area of Charleston. (see Appendix B).

Shipyards Creek, which is heavily industrialized, is currently home to several docks and cranes used for ship and boat building and repairs, numerous industrial facilities, petroleum storage areas and pipeline terminals, a County incinerator and wastewater treatment facility, and a coal off-loading area. These facilities make up the majority of the southwest side of the creek, and the Naval Base property occupies the majority of the northeast edge of the creek. COE has maintained a suitable depth for boat traffic in Shipyards Creek through periodic dredging. Some of the dredged spoils have been deposited along the banks at the mouth of the creek and along the southern tip of the Naval Base property (Ensafe/Allen & Hoshall 1996, Socha 1997).

In the early 1940s, MacAlloy opened a ferrochromium plant on a 125-acre site located along the south side of Shipyards Creek, just north of where it empties into the Cooper River (see Appendix B). MacAlloy produces ferrochromium, an alloy of iron and chromium ore used to manufacture high-grade steel for defense weapons. It also manufactures other ferroalloys, including manganese, silicon, silicon-manganese and chromium-silicon as well as small quantities of specialty alloys. The facility has numerous old and active surface impoundments on the property that are used to store treated trivalent chromium slurry.

The facility has four permitted outfalls to Shipyards Creek that discharge surface water runoff, process wastes, and treated water. The Toxic Release Inventory (TRI) report for the facility indicates that MacAlloy consistently discharges chromium and ethylene glycol into Shipyards Creek. An EPA report (1994) concluded that the facility was improperly treating and managing its electrostatic precipitator dust and its sludges. During the EPA investigation, analysis of one sediment sample collected near the National Pollution Discharge and Elimination System (NPDES) outfall 001 at the facility resulted in the detection of total chromium at 3,100 mg/kg. Analyses of surface water samples collected from three different areas at the facility showed total chromium concentrations of 8,800 µg/L, 8,300 µg/L, and 32,000 µg/L and estimated concentrations of hexavalent chromium of 7,200 µg/L, 8,800 µg/L, and 32,000 µg/L, respectively (EPA 1994).

W.R. Grace, a phosphatic fertilizer maker, was also located along the bank of Shipyards Creek. During its operation, the facility was permitted to discharge wastewater and surface water runoff to Shipyards Creek; the wastewater contained ammonia, phosphoric acid, ammonium nitrate, and sulfuric acid. Before the facility closed in 1987, it was investigated by EPA for possible listing on the National

Priorities List (NPL) due to hazardous waste contamination at the site; however, it was not listed on the NPL at that time.

The Chevron Corporation (Chevron) has a large petroleum storage facility on Shipyard Creek, south of MacAlloy; the facility has a permit that allows it to discharge wastewater into the creek. The NPDES permit requires the facility to monitor for the standard parameters and TOC, dissolved lead, benzene, ethyl benzene, and xylene. The Toxic Release Inventory (TRI) report for this facility indicates that the discharged wastewater contains limited amounts of zinc, although the NPDES permit does not require the monitoring of this parameter.

The County of Charleston has a steam-generating waste incinerator located on Shipyard Creek, upcreek from MacAlloy. The facility, which began commercial operation in 1989, is operated by Foster Wheeler Resource Recovery. The facility has four permitted NPDES discharge points and it monitors its wastewater discharge for the standard NPDES monitoring parameters including flow, Total Suspended Solids (TSS), Biological Oxygen Demand (BOD), temperature, oil and grease, free available oxidants, and pH.

The Felix C. Davis Wastewater treatment plant is also located on Shipyard Creek and has a NPDES permit for one discharge point; discharges are monitored for Dissolved Oxygen (DO), BOD, pH, TSS, total nitrogen, flow, total residual chlorine, and fecal coliform.

Charleston Shipbuilders, which has a NPDES permit to discharge wastewater from one point, is located at the headwater area of the creek. The facility monitors its wastewater for the standard monitoring parameters.

The headwaters of Shipyard Creek are formed in an industrial area of North Charleston (see Appendix B). The area is densely populated with housing, industrial buildings, shopping malls, the naval base property, and other urban-type buildings. As a result, it is highly likely that the surface water runoff from this area contains petroleum products, metals, volatile organic compounds (VOC), and semivolatile organic compounds (SVOC) that may have contributed to the contamination of Shipyard Creek. In a recent project conducted on tidal creeks, sediment samples collected in the upper reach of Shipyard Creek contained elevated levels of chromium, copper, lead, and zinc. Some of the sediment samples from Shipyard Creek taken during this study had chromium concentrations that exceed the Effects Range Medium (EMR) value (Long and others 1995). In addition, data from the study revealed that samples collected from the creek consistently had elevated metals levels. (Holland and others May 1997).

Upriver from Shipyard Creek, the Naval Base operated its numerous docks and drydocks. The Naval Base and, more directly, CNSY, were responsible for repairs, overhauls, and maintenance of Navy ships, including nuclear-powered vessels. Docks, drydocks, cranes, waste-handling facilities, and offices on the Naval Base were part of the shipyard until its closure in April 1996. The shipyard generated numerous wastes and by-products from ship maintenance operations that may have contributed to the contamination of the water and sediments in the Cooper River.

The Navy constantly pumped sediments from this area through piping that was erected on the bottom of the river; sediments were pumped directly across the river to Clouter Island, the main dredge spoil area (see Appendix B) (Socha 1997). When the Naval Base and CNSY were closed in 1996, the Navy discontinued dredging around the docks because it was no longer necessary. However, to accommodate NOAA, the Coast Guard, and several private industries who have begun using the docks, the Navy has resumed dredging sediments from around the docks.

Continuing upriver, Noisette Creek flows through the base property and into the Cooper River. Unlike Shipyard Creek, this creek is relatively undeveloped and is not dredged for ship traffic on a regular basis. (Van Dolah 1997). The naval base straddles the creek at the lower reach, and only one industry, GRA-GEN, a wood products company, was located on the creek. The TRI report for GRA-GEN indicates that methyl ethyl ketone was released into the waterway and onto the land prior to 1992; however, the report does not indicate any releases after 1992.

Numerous petroleum companies with storage terminals and pipelines occupy land adjacent to the Cooper River and directly north of the naval base. The Marathon Oil Company, Texaco Lubricants, Koch Refining, and Amerada Hess all have facilities between the naval base and Westvaco.

According to the TRI report, the U.S. Defense Logistics Agency, which has a tank farm and is a support location for the military in the Charleston area, has discharged VOCs into Filbin Creek, which discharges into the Cooper River between the petroleum companies and Westvaco.

The Westvaco Facility is located upriver from the shipyard and the oil companies, directly north of the I-526 bridge (see Appendix B). The facility began operations with one mill in 1937 and currently has two separate operations: the pulp and paper division and the chemical division. The pulp and paper division makes paper products, and the chemical division determines uses for the by-products from the paper producing process (Cox 1997). The facility has two permitted NPDES outfalls that discharge treated wastewater containing VOCs, catechol, phenols, hydrochloric acid, sulfuric acid, and sodium sulfate into the Cooper River. The Westvaco facility is reported in the TRI report as one of the top 50 air and water releasers of toxic wastes in the country.

Adjacent to the Westvaco property is the SPA North Charleston Terminal, which is responsible for off-loading a substantial number of containers and grain from ships. This facility does not have a NPDES permit. Slightly upriver from the container terminal is the U.S. Army Logistics Area, which is a military off-loading and deployment area. This area, in conjunction with the SPA Terminal, has numerous docks and cranes used for the off-loading operations.

About 5 miles upriver from the SPA Terminal is an industrial park that houses Mobay Chemical Company and a South Carolina Electric and Gas Power Station; Amoco Chemical Company also has a facility in the area located along Grove Creek (see Appendix B). These companies have released ammonia, manganese compounds, SVOCs, VOCs, barium compounds, zinc compounds, and cobalt compounds into the Cooper River or its tributaries, according to the TRI reports. In addition, all three of the facilities have NPDES permits that allow them to discharge wastewater into the Cooper River.

5.2 WANDO RIVER AND ITS TRIBUTARIES

Although it is largely undeveloped, the Wando River does have a few industries along its banks. The SPA Wando Container Terminal is located upriver of Hobcaw Creek (see Appendix B). The building of this terminal in conjunction with the North Charleston Terminal has enabled Charleston to become one of the busiest container port cities on the eastern seaboard. The terminal has numerous docks and cranes used for off-loading containers from large ships before they are placed on the lots or into trucks. The facility does not have a NPDES permit.

About 5 miles upriver from the SPA Wando Terminal is Detyens Shipyard. The shipyard is responsible for general shipyard activities such as ship and boat storage, maintenance, repairs, and painting. The facility has a NPDES permit for two storm water runoff outfalls. The storm water is monitored for the standard NPDES parameters including BOD, Chemical Oxygen Demand, oil and grease, TSS, pH, and flow).

6.0 BACKGROUND SAMPLING STRATEGIES

During the course of completing this task order the following data gaps were identified:

- Identify approaches to characterizing the upstream and downstream boundaries of sediment deposition in the study area be determined.
- Identify locations where background samples should be collected.
- Determine if the dredging history in the study area affected the transport of contaminants within the river system.
- Determine if the dredging history within the study area affected the use of this area as habitat for ecological receptors.
- Determine if it is financially and technically feasible to conduct an investigation that could distinguish between contamination resulting from CNSY or from other industry along the Cooper River.

In trying to fill these data gaps, Tetra Tech identified many possible strategies; however, the last data gap seemed to be where most strategies fell out. Tetra Tech determined a more accurate and feasible approach to background at the CNSY would be to first determine if the sediment adjacent and down stream from CNSY was different in constituents or magnitude from the sediment contamination up stream from CNSY or in other similar (but less industrialized) rivers. If this approach does not yield sufficient answers from which to make risk management decisions a more detailed approach may have to be attempted. However, the approach described in the following sections should provide a good

starting point for any strategy that the CNSY partnering team agrees on.

During the final stages of this task order, Tetra Tech conducted a conference call to select the final sampling strategy out of all the possible strategies. The conference resulted in categorizing the strategies as follows: (1) strategies that were not technically feasible for use at CNSY (2) strategies that were technically feasible but were not cost-effective (information they would yield was not worth the cost in time and money) and (3) the proposed strategy for CNSY.

Some of the strategies that were deemed not technically feasible for use at CNSY are:

- Using tracer chemicals to delineate the vertical and lateral extent of the study area to be included in the ecological risk assessment.
- Using clay mineralogy ratios to determine the vertical downward limit of contamination in the study area.

In both cases the above strategies were determined to be too broad to provide specific information on the origin of contaminants. For example, with the tracer chemical strategy a good tracer chemical would have to be identified, then enough samples would have to be taken to fully characterize the deposition area for that chemical. The most likely tracer chemical Tetra Tech found was tributyltin; however, since CNSY wasn't the only user of this paint additive, the results of the strategy could be simply that tributyltin is equally distributed all depositional areas in the Cooper River and Charleston harbor due to multiple sources. The clay mineralogy strategy could be useful in determining how the diversion and rediversion projects have changed the sediment deposition rate and location within the Cooper River. However, it probably could not give specific enough information to differentiate between CNSY contamination and contamination from other areas within the Cooper River. Therefore, neither of these strategies were deemed to be useful at the current time for the CNSY ecological risk assessment.

The remaining subsections present strategies that would provide useful information in filling the data gaps listed above. The modeling strategy described below was excluded based primarily on the time and cost involved in obtaining any useful information using the model. The strategy is discussed here because it may be a possible alternative in future phases. Section 6.2 presents the strategy being proposed for CNSY.

Conducting sediment transport modeling could potentially provide useful information; however, due to the cost and time involved in conducting the strategy, it is not recommended at this stage of the investigation. The sediment transport modeling strategy is briefly presented below in case the team is interested in using it at a later time during the investigation.

Modeling

Sediment deposition and resuspension patterns are complex within the Charleston Harbor Estuary and the adjacent Cooper River. Several factors contribute to the complex nature of sedimentation within

the estuary; (1) diversion of about 15,000 ft³/min of freshwater from the Santee River drainage basin from 1940 to 1985, and the subsequent change from a mixed to partially stratified salinity structure and hydrodynamics within the system (2) near constant dredging of navigational channels and berthing piers subsequent to diversion and attendant resuspension of sediments, especially silt and clay sized particles, (3) re-diversion of about 70 percent of the freshwater flow from the Cooper River back into the Santee River channel in 1985 and the accompanying change in salinity structure and hydrodynamics, and (4) probable resuspension of sediments within the navigational channels and adjacent to berthing piers from propeller wash during the passage of large ocean-going vessels.

Several large-scale storm events have also occurred within the system during the period of Navy activities (1900 to 1996). The most recent and perhaps most significant storm event during the period was the passage of Hurricane Hugo, which made landfall at Sullivan's Island (at the seaward entrance to the estuary) and produced a storm surge of about 13 feet elevation above mean sea level within the Charleston Harbor. The effect of this magnitude of storm surge on sediment redistribution has not been studied.

An obvious challenge in developing a meaningful background sediment sampling strategy relative to the naval base is to determine reasonable geographic boundaries or constraints within the estuary regarding maximum transport distances for contaminants emanating from Naval facilities at the base. The United States Geological Survey (USGS) has developed a numerical model for hydrodynamics and sediment transport that could be applied to the Charleston Harbor estuary system.

Cheng and Casulli (1992) developed a semi-implicit, finite difference, hydrodynamic model called Tidal, Residual, Intertidal Mudflat (TRIM) that has already been applied to the Charleston Harbor Estuary as part of the Charleston Harbor Project (Hader, 1997). McDonald and Cheng (1996) used TRIM coupled with a sediment transport submodel to analyze sediment transport in San Francisco Bay. The accuracy of the results produced by the model were limited primarily by the lack of basic understanding relating to processes controlling erosion and deposition, especially with respect to cohesive sediments.

Discussions with Cheng (1997), Conrads (1997), and Hader (1997), as well as electronic correspondence with McDonald (1997), revealed several significant limitations to the practicality of using the TRIM model to predict maximum possible sediment transport distance from the Charleston Navy Base. TRIM, as it is currently available, is a two-dimensional, depth-averaged hydrodynamic model that can be coupled with a sediment transport submodel. The partially stratified nature of the Cooper River and the harbor may confound the usefulness of a two-dimensional model. A three-dimensional version of TRIM is apparently under development; however, the future release date is not known. In addition, the TRIM model as it is currently configured does not perform well when spatial variability of sediment properties and multiple sediment size classes are significant factors (McDonald and Cheng 1996).

Although, the hydrodynamic component of the model has been applied to Charleston Harbor, the sediment transport submodel has not. Discussions with Hader (1997) indicated that even if adequate

and sufficient sediment data are currently available, several years of work would probably be required to calibrate and validate the model. In the event that sufficient and appropriate sediment data input parameters are not available, additional field work would be required prior before applying of the model. It should also be noted that field measurement of sediment erosion and deposition properties are difficult to obtain. In either case, the cost associated with using numerical modeling as a means to predict past contaminant transport within the Cooper River would be significant. For the reasons discussed, it is recommended that numerical modeling of sediment transport within the Cooper River and Charleston Harbor not be pursued at this time as part of the overall sediment background

6.1 RECOMMENDED STRATEGY FOR CNSY

The following sections present the strategy Tetra Tech recommends to the CNSY partnering team to develop and apply background concentrations. Tetra Tech believe this methodology will provide enough information to make a risk management decisions at CNSY; however, in addition, data will be gathered in a phased approach that will limit the cost of the investigation.

Application of this method may change once all trustees have reviewed the strategy and the partnering team agrees on the final strategy. One of the first steps that needs to be completed is to decide, with input from all applicable trustees, on an overall management strategy for the Cooper River and surrounding area that can be accepted by everyone on the team. Without this input, it will be difficult to focus the study, and could result in delays in the later phases of the risk assessment.

Within the context of the CNSY and Cooper River system, ecological effects potentially associated with contaminated sediments must be interpreted within a chemical and biological setting, especially when interactions between the sediment-associated chemicals and exposure media influence the interpretation of risks on a case-by-case basis. Currently, ecological risks associated with sediments may be evaluated according to various assessment strategies, all reflected in programs reviewed during the development of the CNSY sediment strategy. In general, two basic strategies are available to evaluate ecological risks. Specifically, chemically based and toxicity based approaches have made significant contributions to evaluations of sediment quality and ecological risks associated with contaminated sediments (Chapman 1986, Burton 1992).

From an ecotoxicological perspective, ecological effects and exposure assessments are complex interrelated functions that yield estimates of hazard and risks associated with environmental contaminants in various matrices, such as sediments sampled at a site. In many respects, sediment quality programs currently instituted use integrated assessment approaches to a varying extent; such programs include the EPA's National Sediment Management Program, NOAA's National Status and Trends Program, Washington State programs in the Puget Sound, and analogous approaches.

While the U.S. Navy has little regulatory precedent within the Cooper River system upon which its sediment strategy can be developed, relatively well established sediment programs may support decisions regarding a sediment strategy for CNSY. Although no federal regulations specify requirements for the development of sediment quality guidelines, the tasks ahead of the U.S. Navy for

its facilities on the Cooper River suggest that the past experience of state and federal agencies could benefit the U.S. Navy in developing similar technical policy for contaminated sediments at CNSY.

Sediment testing methods are proposed below for the background study and ecological risk assessment at CNSY and adjacent open water areas. The sediment strategy uses a technical framework and analytical parameters that are consistent with national and regional sediment programs, which are briefly summarized as follows:

- The EPA Office of Water administers the National Sediment Management Strategy and an international joint commission (consisting of the EPA, Great Lakes States, U.S. Fish and Wildlife Service, and National Biological Survey) implements sediment management under the Great Lakes National Program.
- NOAA administers the National Status and Trends Program and the National Benthic Surveillance Project.
- Washington State Department of Ecology administers the program, and the Puget Sound Water Quality Authority implements sediment management in the Puget Sound.

EPA's National Sediment Management Strategy suggests four guiding principles of an effective sediment management program:

- In-place sediments should be protected from future contamination to ensure beneficial use of surface waters.
- Pollution prevention and source controls should be the developed goals for maintaining uncontaminated sediments.
- Sediments at high-risk sites should be remediated in place where natural recovery processes were limited and cleanup would not cause greater problems than leaving the site alone.
- Sediment contamination should be assessed using consistent methods to derive estimates of sediment contamination on a geographic basis.

The proposed CNSY background sediment strategy integrates both chemically- and toxicity-based approaches into a tiered approach as described in Section 6.2.1.

6.1.1 Tiered Approach For CNSY

Based on the recommended approaches provided in the sediment management strategies described above and communications with an EPA Region 4 ecologist and the NOAA Region 4 Coastal Resource Coordinator (CRC), Tetra Tech has developed the proposed strategy to address background concerns at CNSY. The two-tiered strategy is discussed below.

Tier 1

Tier 1 should consist of about 20 sediment samples collected from four general areas near CNSY. The two areas located for collecting background or reference samples are as follows:

- six sediment samples collected in the marsh habitat along the Cooper River, upstream of CNSY, for comparison to downgradient samples (see Appendix B).
- six sediment samples collected in marsh areas along the Wando River, to characterize relatively undisturbed sediments associated with this reference location (see Appendix B).

After data on the bulk chemistry from these sample locations have been received, a background value for each contaminant should be derived by calculating the arithmetic mean concentration of each contaminant. This mean concentration should be used to screen site and downgradient data; however, this screening must be performed using some degree of professional judgement. For example, if one sample contains unusually high levels of a contaminant compared to other background samples, that sample location should be eliminated from the calculation of background values. This process will most likely require coordination between the whole team to make these types of decisions.

The on-site and downgradient sampling locations should be selected as follows:

- 4 additional sediment samples collected near dry docks at CNSY to identify potential contaminant gradients attributed to releases during dry dock operations (to be determined using current sampling data)
- 4 sediment samples collected in the Cooper River downstream of CNSY, to identify contamination within downstream marsh habitat (to be determined using current sampling data)

Tier 1 should involve collecting data on the bulk chemistry and physical characteristics as discussed in later sections of this report. This information should be used to screen the on-site data already collected and the new on-site and downgradient samples collected during this phase of the investigation. Once all the data have been screened, a presentation should be made to the team to identify both the chemicals and the locations that exceeded the established background levels. The presentation should highlight the degree, number and locations of exceedences. This information can then be used by the team and trustees to determine the potential for unacceptable risk posed to ecological receptors as a result of activities at CNSY.

Two data interpretation methods and management strategies can be used. For example, if future management of the Cooper River emphasizes recreational use and protection of the fishery, data may be interpreted using primarily the Wando River reference locations. However, on the other hand, if future management of the Cooper River includes industrial, residential, and commercial uses, data may

be interpreted primarily using samples collected from upstream in the Cooper River.

Scientific Management Decision Point

After the chemical data from Tier 1 has been gathered and presented to the partnering team, a decision must be made whether Tier 2 is necessary. This decision should be made by the partnering team and all applicable trustees. Once a decision is made to conduct Tier 2 testing, the partnering team must agree on the endpoints of concern based on (1) the types of chemicals remaining after background screening, (2) the locations of the contamination (for example, under piers and close to CNSY sources or in marsh areas that may represent the depositional areas for the watershed), and (3) the testing methods to be used to evaluate potential risk to the endpoints.

Tier 2

Tier 2 sampling should expand on the Tier 1 sampling to address data gaps and uncertainties associated with contaminated sediments. Tier 2 sampling may or may not be necessary if Tier 1 sampling data are adequate to characterize sediment contamination at CNSY. If it is determined that Phase 2 sampling is necessary, CNSY will have to agree on a more focused assessment and measurement endpoints. Based on the contaminants that exceed background screening values and the endpoints agreed to by the team and the trustees, the partnering team will have to identify tests that should be used to link the two endpoints. An important part of Tier 2 efforts will be consulting with groups currently involved in biological investigations in the Charleston area to share the information gathered in Tier 1 and to obtain the most current data from other investigations. Some examples of data that should be gathered includes the following:

- Updated versions of work in the Charleston harbor and surrounding area being conducted by the South Carolina Department of Natural Resources.
- Updated versions of the TRIM model and potential sediment transport models that may be applied to the Charleston Harbor.

6.2.3 Tier 1 Sediment Testing Methods

The list below summarizes the chemical and biological testing methods recommended for the CNSY sediment strategy.

- Bulk sediment chemistry (total concentrations of inorganic and organic compounds)
 - These standardized analyses should be performed according to EPA's contract laboratory program statement of work (SW-846).
- Physicochemical analyses (total organic carbon, pH, grain size distribution)
 - Particle Size Characteristics: ASTM 1997b

- Total Organic Carbon content: ASTM 1997b
- *pH*: ASTM 1997b

6.2 DATA ANALYSIS AND INTERPRETATION

A variety of statistical methods are proposed for the CNSY sediment strategy, based on NOAA (Meador and others 1994), and they should be used to analyze data from the chemical analyses to present an expected large amount of data in a graphical format. This approach is recommended to facilitate interpretation and allow the Navy to evaluate possible interrelationships among the concentrations of the contaminants in sediment during the first tier and the potential for adverse effects in sediment macroinvertebrates in the second tier if necessary.

In accordance with Little and Smith (1987), the chemical data gathered during Tier 1 should be initially examined using graphical methods for multivariate outlier detection. Outlying samples should be located and identified using three-dimensional scatterplots (see Huber 1987), and the accuracy of their constituent values should be confirmed by reference to existing data, if available.

Other useful ways to display the Tier 1 data may include:

- Identifying graphically the sample locations over screening criteria, and discussing these exceedances by distribution. For example, are the exceedances equally distributed across the sampling grids or are most of the exceedances located nearer the CNSY side of the river.
- Identify graphically which samples are over ER-L and which are over ER-M level screening criteria.

If Tier 2 is necessary, comparison interval graphs may assist in comparing the concentrations of contaminants in sediment to laboratory-derived NOAELs or site-specific risk-based benchmarks for benthic macroinvertebrates. For comparison of constituents (background or anthropogenic) over a range of sites and receptors of concern, GT2 plots and floating-bar plots are recommended (Landahl 1994).

While it is relatively easy to calculate 95 percent confidence intervals for mean concentrations based on the number of samples (n) and the variability for each mean, it is not as easy to infer whether two means from a group of means are the same or different by examining plots of confidence intervals. Instead, a statistical technique similar to the confidence interval but more closely related to an analysis of variance (ANOVA) should be used for graphical comparisons. Calculating and plotting a "confidence interval" (Gabriel 1978, Sokal and Rohlf 1981) for each mean should be based on all of the following:

- Number of samples for that mean
- Variability about that mean
- Number of means being compared

7.0 CONCLUSIONS

Tetra Tech investigated several strategies to address background concerns at CNSY. Some of these strategies would have involved collecting large amounts of data (both in the form of field data and calculations) and required an extensive investment of time and money to complete. Time and money alone were not used to discount any potential strategies; however, the quality and reliability of the information provided by the strategy in relation to the cost of conducting the strategy was used to determine whether a strategy was suggested for use at CNSY.

The strategy recommended in this report was selected because it represents the best technical approach for the facility and its surroundings and can be conducted in a cost effective manner. This strategy may not answer all the issues present in the ecological risk assessment for CNSY; however, it should be helpful in determining if the sediments adjacent to and downstream from CNSY contain more contaminants and potential for risk to ecological receptors than other sediments in the surrounding Charleston Harbor. Other potential data gaps that may still need to be addressed by the CNSY partnering team include:

- Have risks present in downstream depositional areas (salt marsh areas that also provide quality habitat) been fully addressed by this risk assessment?
- Is the constant pressure of dredging preventing ecological receptors from using the majority of the study area? If so, should the study area for CNSY be refocused?
- Should a closer evaluation of potential ecological effects being caused at Clouter Island where dredge spoils of potentially the most contaminated sediment were disposed during CNSY's active period?

These data gaps should be addressed by the partnering team and included in the final ecological risk assessment being conducted at CNSY.

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TECHNICAL MEMORANDUM

TO: Tony Hunt, SOUTHDIV
FROM: EnSafe
DATE: December 11, 1997
SUBJECT: Preliminary Results of Zone J Sampling

1.0 INTRODUCTION

As part of the Naval Base Charleston RCRA Facility Investigation (NAVBASE RFI), sediment and surface water from offshore areas adjacent to NAVBASE were sampled during the Zone J investigation of the water bodies. Zone J consists of portions of the Cooper River, Shipyard Creek, and Noisette Creek and associated marsh areas.

The objective of this initial phase is to assess constituents present in the sediment and surface waters in the vicinity of the naval base and to identify areas which might be impacted by NAVBASE activities. Zone J sampling was conducted from May 19 to September 18, 1997. In addition to Zone J samples, results from the analysis of sediment and surface water samples collected during earlier zone investigations are also considered for the assessment of Zone J water bodies. This technical memorandum presents preliminary results for these samples. Correlations between constituents detected in Zone J and potential NAVBASE sources will be studied after the analytical data obtained during the Zone J RFI is compared to suitable background concentrations.

Site Description

Zone J, unlike other NAVBASE RFI zones, is totally aquatic and does not consider specific areas of concern or solid waste management units (AOCs/SWMUs) typical of land-based investigative zones. Although several unexploded ordnance (UXO) sites (AOCs 500, 501, and 502) were identified within the boundaries of Zone J, they are being addressed under a separate investigation and are not included in the Zone J RFI.

NAVBASE is located on western shore of the Cooper River and its 3.75 mile waterfront is dominated by 25 piers and five drydocks, and is protected along most of its length by a wooden and/or concrete seawall. Industrial areas along the naval base's shoreline are primarily associated with the repair and maintenance of large ships. Both Noisette Creek and Shipyard Creek are bordered by less industrial areas, but point-source discharges (i.e., NPDES outfalls) are present in these smaller water bodies. During the 1995 survey of NAVBASE's Ecological Study Areas, 54 outfalls were identified along the Cooper River, two in Shipyard Creek, and eight along the Noisette Creek shoreline.

This technical memorandum presents a cursory examination of preliminary data from sediment and surface water samples collected across Zone J. Ancillary analytical data from offshore samples collected as part of other zone-specific RFIs are also incorporated into the Zone J data set. The compilation of sample results for each water body is presented below. Lacking reference concentrations for Zone J, the USEPA Region IV surface water and sediment screening levels are also presented for preliminary comparisons. Sample-specific results are included in Attachment A of this memorandum.

Background Determination

As with other zone investigations at NAVBASE, a method for establishing suitable background concentrations is necessary for the Zone J RFI. Background concentrations may be used to identify above-normal concentrations of constituents and thus aid in the identification of contaminant sources impacting the study areas. A strategy for determining background is currently being designed by a USEPA contractor who, at the time of this writing, is compiling and reviewing existing data from numerous investigations, including those conducted in the Charleston Harbor and its watershed. This background information, once available, will be critical in determining the overall significance of the concentrations detected in the Zone J water bodies.

2.0 METHODS

Zone J sampling was conducted in accordance with the approved RFI work plan and subsequent technical memorandums which outlined an extensive, multi-phase sediment and surface water investigation and sampling program. The complexity of the NAVBASE RFI and decisions regarding the final scope of each individual zone investigation, however, resulted in several Zone J scope changes. The following is a summary of approved deviations from the Final Zone J RFI Work Plan.

Deviations from Zone J RFI Work Plan

Originally, the scope of the Zone J RFI involved assessing ecological risk associated with *all* Areas of Ecological Concern (AECs) at NAVBASE. In addition to the larger water bodies, Zone J initially included the assessment of all habitats which could potentially support wildlife such as isolated wetlands, woodlands, and drainage ditches, regardless of which zone they occupied. Since the acceptance of the Zone J work plan, however, the ecological risk assessment of these upland AECs has been deferred to the investigation of the zone in which they occur. With this approved change, the scope of the Zone J RFI focused on the investigation of the water bodies surrounding NAVBASE: the Cooper River, Shipyard Creek, and Noisette Creek.

In addition to a change in the sites included in Zone J, the actual number of samples had also been revised. The final work plan proposed that a top-, mid- and bottom-interval water sample be collected at each water sample location if the measured depth was over 3 feet. In a subsequent technical memorandum, however, it was agreed that the top-interval water samples be omitted since the results from sampling such a highly mobile and variable media would not prove useful for a Phase II contaminant assessment. Using the same rationale, it was also agreed that mid-interval samples be collected at only those proposed locations near known NAVBASE outfalls.

Incorporation of Data from Other Zones

To maximize the usefulness of all pertinent data collected during the RFI of NAVBASE, the Zone J RFI will incorporate sediment and surface water data obtained during other zone-specific investigations. Contaminant information obtained from these zone-specific RFIs is important for a complete assessment of possible impacts to the surrounding Zone J water bodies and is should assist in predicting potential contaminant sources and migration pathways.

Due to the varying scope of each zone's investigation and the suspected contaminants of potential concern at each AOC/SWMU, sediment and surface water samples were sometimes analyzed for parameters identified for a suspected source rather than for full-scan analysis. Several SWMU 2 sediment samples, for example, were only analyzed for metals since they were the constituents of concern at SWMU 2. Although this condition causes the total number of samples for some parameters to vary, it presents no significant reduction in the overall value of the data.

It is also important to note that the large scope of the basewide RFI compelled each zone to conduct its investigation using a sampling schedule independent of other zone investigations. This resulted in the collection dates to be several months apart. Such a staggered sampling schedule is not optimal when sampling aquatic systems, since conditions such as water temperature, salinity, pH, total suspended solids, etc. are constantly changing with tide and season, but such relatively current analytical data should not be excluded.

For duplicate samples, the concentrations of parameters detected in both the primary sample and its co-located duplicate are reported as an average concentration. For parameters unique to the duplicate sample, such as Appendix 9 parameters, the concentration is presented as a primary sample result. This post-analysis data adjustment may account for discrepancies noted in the concentrations reported in the original laboratory data and those presented in the summary tables.

Zone J Investigative Approach

Although study areas and sampling strategy have changed since the submittal of the Final Zone J RFI Work Plan, the proposed method adheres to the proposed three-phased investigative approach. This approach is designed to yield specific environmental data through source, pathway, and receptor identification.

During Phase I a preliminary assessment through field observations and literature searches determines general site information. For those areas which are potentially impacted from a NAVBASE AOC/SWMU and where human or ecological receptors exist or are indicated, a cursory sampling strategy is developed for Phase II, the contamination assessment. The sampling conducted in the second phase provides analytical data and characterizes site constituents. After Phase II, a preliminary risk characterization can be developed based on concentrations detected and the exposure potential of suspected receptors. This characterization will determine if the investigation of the site will proceed to the next phase.

If a risk potential is indicated during Phase II, the investigation advances to Phase III, the problem formulation and conceptual model stage. This third phase assesses risk to potential receptors through the use of select assessment endpoints for both ecological and human receptors. Typical ecological assessment endpoints for aquatic sites may include changes to local fish populations, ecosystem alterations, or other ecological effects. Human assessment endpoints typically include excess cancer indices and other toxic effects. These hypotheses are critically reviewed to determine if studies or data produced can support risk-management decisions.

In conjunction with problem formulation, a conceptual model is developed to select measurement endpoints that can be used to quantitatively express the contaminant hazards. Measurement

endpoints include environmental characteristics directly related to the assessment endpoint chosen, such as toxicity tests, community indices, or tissue burden studies.

Current Status of the Zone J RFI

The Zone J RFI has advanced to the Phase II contaminant assessment. A preliminary round of Phase II sampling has been completed in all Zone J water bodies and the resulting analytical data, along with data from other zone investigations, has been compiled, reviewed, and is presented in this memorandum. A meaningful Phase II preliminary risk characterization cannot yet be completed, however, since suitable background concentrations for sediment and surface water are not yet established. As with other zone investigations, these background values are necessary to determine if Zone J concentrations are attributed to NAVBASE activities or if it is possible that they originate from other sources. It is likely that the development of background concentrations will require substantial additional sampling. If this is not a viable alternative, it is expected that background values would be derived from historical data.

3.0 SAMPLING PROTOCOL

Several methods were used to establish Zone J sampling locations. As provided in the Zone J Work Plan, sampling points in both the Cooper River and Shipyard Creek were established using a sampling grid across the entire study area, with a higher density of samples located near the NAVBASE shoreline. In the smaller Noisette Creek, sampling locations were evenly spaced along the length of the creek with several samples collected at known outfalls. Samples were also collected from bordering marsh habitats. A global positioning system (GPS) was used to navigate the sampling vessel to each proposed Zone J sediment/surface water sampling point using coordinates generated from a computer mapping program. If access to the proposed sampling location was unavailable or obstructed, the sample was collected as close to the proposed location

as possible and the actual sampling point was re-surveyed in the field to accurately map the final Zone J sample locations.

Sample Collection Methods

Sediment and surface water were sampled in accordance with procedures outlined in the *Final Comprehensive Sampling and Analysis Plan* (CSAP, E/A&H, 1994).

Sediment samples were collected using either a petite ponar sampler or a Young grab sampler, each of which is a weighted dredge sampler that is lowered to the sediment and, upon impact, secures a grab sediment sample which is then winched to the surface for collection. Surface water and sediment samples were handled following methods approved in the CSAP and USEPA Region IV Standard Operating Procedures/Quality Assurance Manual.

All bottom-interval water samples were collected 12 inches above the substrate using a Kemmerer bottle, which is a messenger-activated device capable of sampling the water column at discrete depths. To measure physicochemical parameters, a water quality monitor (YSI) was deployed at each surface water sampling location to gather in-situ data on temperature, conductivity, salinity, pH, turbidity, specific conductance, total dissolved solids, dissolved oxygen, and oxidation/reduction potential. The sample-specific analytical data used for this assessment are tabulated in Attachment B.

4.0 PRELIMINARY ASSESSMENT

4.1 Sediment Chemistry

All Zone J sediment samples were analyzed for concentrations of volatile and semivolatile constituents, pesticide/PCBs, metals, cyanide, and organotin, as well as cation exchange capacity,

total organic carbon, oxidation/reduction potential, and particle size. Any modifications to these analyses are noted in each site-specific sampling summary.

The following paragraphs summarize the sediment data collected from each Zone J water body and compare detected concentrations to USEPA's 1995 Region IV Waste Management Division's Sediment Screening Values (SSVs) as appropriate. Once suitable reference values for Zone J sediments are developed and approved, it will be possible to better identify constituents of potential concern (COPCs).

Attachment C presents a compilation of figures which show the spatial distribution and concentration of the constituents relative to all Zone J sediments and USEPA's SSVs. For those parameters which do not have an SSV, the corresponding distribution figure will be presented when a comparison to background concentration can be made. For the purposes of these contaminant trend maps, posting of specific sample identification numbers was not considered crucial and might obscure the figure's overall clarity. Please refer to Figures 1, 3, and 5 for the site-specific sediment sample identification numbers and the locations of those sediments which contained a constituent at a concentration above its SSV.

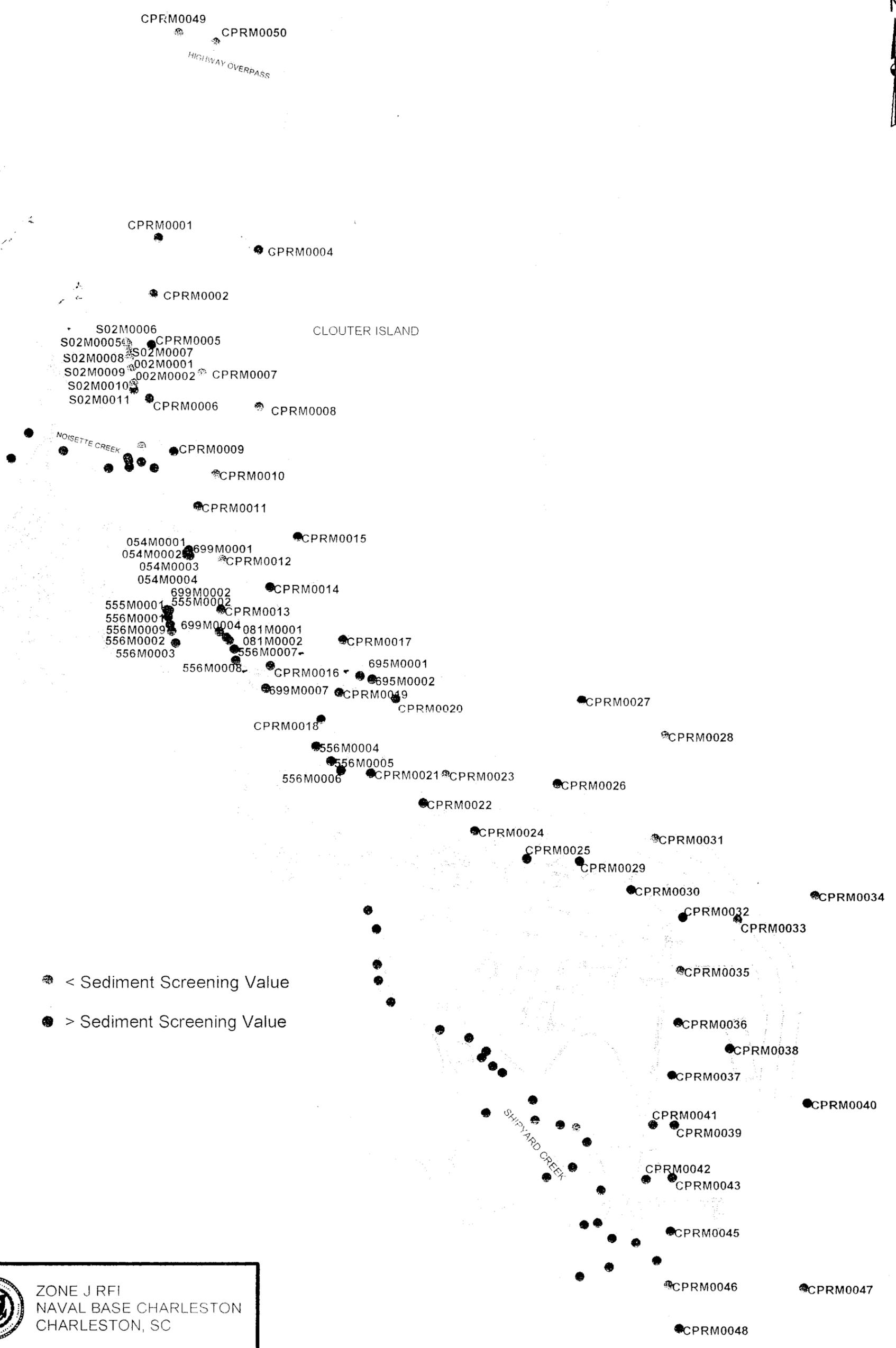
Cooper River

To date, 80 sediment samples have been collected from the Cooper River as part of the NAVBASE RFI. These include 48 Zone J samples, 17 Zone E sediment samples collected as part of the assessment of SWMUs 54 (abrasive blast area) and 81 (less-than-90-day accumulation area), and AOCs 555 (substation) and 556 (drydock discharges), nine river samples from Zone A (SWMU 2), four Zone L outfall samples (AOC 699 sewer outfalls adjacent to Zone E), and two from the Zone K RFI of AOC 695 (former ammunition depot at the southwestern portion of Clouter Island). Sediment sample locations and identification numbers for the Cooper River are

presented on Figure 1. Table 1 presents a summary of analytical results for Cooper River sediment samples and the parameter-specific figures in Attachment C show the distribution of SSV exceedances.

Volatile Organic Compounds — Acetone was found in 51 sediment samples from both Zone J and Zone E. The maximum concentration of acetone (4,100 $\mu\text{g}/\text{kg}$) was detected at CPR-21. The mean acetone concentration in Cooper River sediments is 491 $\mu\text{g}/\text{kg}$. As experienced in other NAVBASE RFIs, elevated concentrations of acetone may be a result from the decontamination process, specifically the rinsing of sample equipment with isopropyl alcohol. The equipment rinsate sample from the sampler used in the Cooper River, however, contained only 4.0 $\mu\text{g}/\text{L}$ acetone, so the concentrations detected in the sediment at CPR-21 may be valid. The four detections of the remaining two VOCs, chloroform and methylene chloride, were in all four Zone L outfall samples for AOC 699, however, no SSVs exist for these VOCs.

Semivolatile Organic Compounds — SVOCs were detected at 31 locations in the Cooper River. Eighteen of these locations had compound concentrations above their respective SSVs. The maximum reported SVOC concentration was 18,000 $\mu\text{g}/\text{kg}$ of fluoranthene (SSV = 330 $\mu\text{g}/\text{kg}$) at location 556-04, near Drydock 4. Elevated SVOC concentrations were also present in Zone J samples collected near the NAVBASE piers in Zone E and the northern portion of Zone I, but the highest concentrations were found primarily in the sediment near the drydocks (Zone E, AOC 556), indicating a possible release. These SVOCs include acenaphthene, acenaphthylene, and anthracene. Further upstream, 1,100 $\mu\text{g}/\text{kg}$ bis(2-ethylhexyl)phthalate (BEHP; SSV = 182 $\mu\text{g}/\text{kg}$) was detected in CPR-02, a nearshore sample approximately 1,000 feet north of the base.



- < Sediment Screening Value
- > Sediment Screening Value



ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 1
COOPER RIVER
SEDIMENT SAMPLE LOCATIONS

Table 1
COOPER RIVER SEDIMENT SUMMARY
Zone J - NAVBASE Charleston, Charleston, SC
(Also includes Zone A, E, K and L Results)

Parameter	Number of Detections	Range	Mean Concentration	SSV	Units	No. Exceeding SSV
Volatile Organics N=65						
2-Butanone (MEK)	36	3 - 130	37.75	NA	ug/kg	—
Acetone	51	10 - 4,100	490.84	NA	ug/kg	—
Carbon disulfide	30	3 - 24	11.17	NA	ug/kg	—
Chloroform	4	3 - 9	5.00	NA	ug/kg	—
Methylene chloride	4	5 - 22	10.50	NA	ug/kg	—
Semivolatile Organics N=65						
2-Methylnaphthalene	1	220 - 220	180.00	330	ug/kg	0
Acenaphthene	7	260 - 1,100	605.71	330	ug/kg	5
Acenaphthylene	1	350 - 350	350.00	330	ug/kg	1
Anthracene	15	86 - 2,500	775.73	330	ug/kg	9
Benzo(a)anthracene	21	120 - 6,400	1,216.19	330	ug/kg	11
Benzo(a)pyrene	16	53 - 5,500	1,252.38	330	ug/kg	9
Benzo(b)fluoranthene	12	83 - 4,300	898.58	NA	ug/kg	—
Benzo(g,h,i)perylene	9	120 - 3,300	1,031.11	NA	ug/kg	—
Benzo(k)fluoranthene	14	210 - 11,000	2,063.57	NA	ug/kg	—
bis(2-Ethylhexyl)phthalate (BEHP)	6	55 - 1,100	283.67	182	ug/kg	1
Carbazole	1	220 - 220	220.00	NA	ug/kg	—
Chrysene	24	99 - 10,000	1,385.76	330	ug/kg	12
Di-n-butylphthalate	4	68 - 200	121.50	NA	ug/kg	—
Di-n-octyl phthalate	1	290 - 290	290.00	NA	ug/kg	—
Dibenz(a,h)anthracene	7	90 - 1,500	611.43	330	ug/kg	5
Dibenzofuran	4	150 - 590	380.00	NA	ug/kg	—
Diethylphthalate	12	110 - 2,100	740.83	NA	ug/kg	—
Fluoranthene	28	54 - 18,000	2,490.93	330	ug/kg	18
Fluorene	5	320 - 760	602.00	330	ug/kg	4
Indeno(1,2,3-cd)pyrene	10	100 - 3,000	895.00	NA	ug/kg	—
Naphthalene	2	250 - 590	420.00	330	ug/kg	1
Phenanthrene	9	260 - 6,900	2,611.11	330	ug/kg	8
Pyrene	30	54 - 10,000	1,716.77	330	ug/kg	18
Pesticides/PCBs N=64						
4,4'-DDE	1	7.6 - 7.6	7.60	3.3	ug/kg	1
Endrin ketone	3	7.8 - 14	10.93	NA	ug/kg	—
Methoxychlor	1	45 - 45	45.00	NA	ug/kg	—
Inorganics N=80						
Aluminum (Al)	80	560 - 35,000	12,189.93	NA	mg/kg	—
Antimony (Sb)	12	0.53 - 23.2	3.88	12	mg/kg	1
Arsenic (As)	76	1.4 - 22.2	11.12	7.24	mg/kg	48
Barium (Ba)	80	3.2 - 90.8	22.77	NA	mg/kg	—
Beryllium (Be)	70	0.05 - 2.5	0.77	NA	mg/kg	—
Cadmium (Cd)	53	0.09 - 3.6	0.52	1	mg/kg	3
Chromium (Cr)	80	2.2 - 230	36.79	52.3	mg/kg	12
Cobalt (Co)	71	0.48 - 18.3	4.83	NA	mg/kg	—
Copper (Cu)	78	1.4 - 1,930	64.77	18.7	mg/kg	40
Lead (Pb)	80	0.75 - 996	51.33	30.2	mg/kg	14
Manganese (Mn)	80	9.2 - 865	263.31	NA	mg/kg	—
Mercury (Hg)	17	0.04 - 0.635	0.18	0.13	mg/kg	6
Nickel (Ni)	73	0.94 - 102	13.11	15.9	mg/kg	13
Selenium (Se)	13	0.54 - 10.5	1.89	NA	mg/kg	—
Silver (Ag)	11	0.19 - 0.85	0.57	2	mg/kg	0
Thallium (Tl)	8	0.85 - 3.3	1.62	NA	mg/kg	—
Tin (Sn)	19	4.8 - 546	47.35	NA	mg/kg	—
Vanadium (V)	80	2 - 82.4	32.88	NA	mg/kg	—
Zinc (Zn)	79	5.8 - 1,390	129.17	124	mg/kg	13
Cyanide N=72						
Cyanide (CN)	4	0.13 - 0.4	0.21	NA	mg/kg	—
Organotin N=58						
Tributyltin	1	52 - 52	52.00	NA	mg/kg	—

Table 1
COOPER RIVER SEDIMENT SUMMARY
Zone J - NAVBASE Charleston, Charleston, SC
(Also includes Zone A, E, K and L Results)

Parameter	Number of Detections	Range	Mean Concentration	SSV	Units	No. Exceeding SSV
Dioxins		N=2				
1234678-HpCDD	2	37.78 - 70.7	54.24	NA	ng/kg	—
1234678-HpCDF	2	3.23 - 7.86	5.55	NA	ng/kg	—
123678-HxCDD	2	1.69 - 2.76	2.23	NA	ng/kg	—
123678-HxCDF	1	1.16 - 1.16	1.16	NA	ng/kg	—
123789-HxCDD	2	2.54 - 3.06	2.80	NA	ng/kg	—
123789-HxCDF	1	0.94 - 0.94	0.94	NA	ng/kg	—
OCDD	2	723.95 - 970	846.98	NA	ng/kg	—
OCDF	2	6.23 - 22.4	14.32	NA	ng/kg	—
Total Hepta-Dioxins	2	156.05 - 377	266.53	NA	ng/kg	—
Total Hepta-Furans	1	7.86 - 7.86	7.86	NA	ng/kg	—
Total Hexa-Dioxins	2	68.9 - 95.97	82.44	NA	ng/kg	—
Total Hexa-Furans	2	2.1 - 3.07	2.59	NA	ng/kg	—
Total Penta-Dioxins	1	8.16 - 8.16	8.16	NA	ng/kg	—
Total Tetra-Dioxins	1	5.18 - 5.18	5.18	NA	ng/kg	—
Physicochemical Parameters		N=50				
Cation Exchange Capacity	50	2.3 - 92.1	38.38	NA	meq/kg	—
Redox	37	84 - 473	253.68	NA	mV	—
Total Organic Carbon (TOC)	50	0.17 - 6.5	2.60	NA	%	—

Notes:

Results from primary sample and its duplicate are presented as an average.

N = Number of samples collected

SSV = Sediment Screening Value for Hazardous Waste Sites, USEPA Region IV Waste Management Division, 1995

NA = Not available

— = Number of exceedances cannot be calculated.

ug/kg = micrograms/kilogram

mg/kg = milligrams/kilogram

ng/kg = nanograms/kilogram

meq/kg = milliequivalent/kilogram

mV = millivolt

Concentrations of benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, naphthalene, phenanthrene, and pyrene exceeded their respective SSVs. The most common SVOC compounds detected in substantial amounts were polynuclear aromatic hydrocarbons (PAHs). Based on these cursory findings, the elevated PAH concentrations near Zone E drydocks appear to be significant. Once suitable background concentrations for PAHs in the Cooper River are established, a better assessment can be presented.

Pesticides/PCBs — Pesticides were found at three locations in the Cooper River. The only pesticide detection which exceeded its SSV was 7.6 $\mu\text{g}/\text{kg}$ of DDE in the Zone E sample 556-05 collected between Drydocks 3 and 4.

Inorganics — Nine metals — antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc — were detected at concentrations above their respective SSVs. The SSV for arsenic (7.24 mg/kg) was exceeded at 48 locations, with the highest exceedance (22.2 mg/kg) detected at CPR-24 near Pier N. The SSV for copper (18.7 mg/kg) was exceeded at 40 locations with the maximum (1,930 mg/kg) detected in 556-05, near Drydocks 3 and 4. Lead's SSV of 30.2 mg/kg was exceeded at 14 locations. The maximum detection of lead was 996 mg/kg in 669-04, a Zone L outfall sample near Drydock 2. Both nickel and zinc concentrations exceeded their SSVs (15.9 and 124 mg/kg, respectively) at 13 locations. The maximum concentration of nickel, 102 mg/kg, was detected in sample 699-02 collected adjacent to AOC 555 (Pier D) and zinc's maximum concentration of 1,390 mg/kg was detected in 054-04, near Zone E's SWMU 54. Chromium was detected in 12 locations at concentrations above the 52.3 $\mu\text{g}/\text{kg}$ SSV with a maximum concentration of 230 $\mu\text{g}/\text{kg}$ reported at Zone K sample 699-02. The concentration of mercury in six sediment locations in the Cooper River were above 0.13 mg/kg, the SSV for mercury, with the highest concentration (0.635 mg/kg) detected in sample 054-04. With a concentration of 3.6 $\mu\text{g}/\text{kg}$, the sample collected at the base of Pier D (555-01) exhibited the

highest of three exceedances for cadmium's SSV of 1.0 $\mu\text{g}/\text{kg}$. Antimony's single exceedance, 23.2 mg/kg, was also detected in 054-04 at a concentration nearly twice the 12 mg/kg SSV.

Most inorganics in Cooper River sediment were widespread (see Attachment C) with the exception of lead, mercury, nickel, and zinc which were detected primarily in the Zone E sediment samples near the drydocks.

Particle Size — Sediment which passes through a No. 200 sieve (approximately 0.060 - 0.080 mm in diameter) is considered the silt-clay fraction or fine-grained sediment. With decreasing sediment particle (grain) size, the adsorption of metals and neutral organic chemicals to the particles increases, thus chemical contaminants in sediments are associated primarily with the fine-grained fraction of sediments.

In the Cooper River, the majority of the finer-grained sediments were detected in samples collected along the entire the NAVBASE shoreline from CPR-05 to CPR-48, with the finest sediment (100% passing through a No. 200 sieve) collected at CPR-18, near Pier J. Most of the coarser sediments (< 10 % passing) were from the more sandy samples collected further offshore, including upriver samples CPR-49 and -50 to CPR-46, collected at the mouth of Shipyard Creek.

Shipyard Creek

To date, 27 sediment samples have been collected from Shipyard Creek; 22 as part of the Zone J RFI and five as part of the Zone H RFI of SWMU 9, a former landfill. The Zone H samples were collected from the headwaters of the creek. The sediment sample locations for Shipyard Creek are presented on Figure 2. Table 2 presents a summary of analytical results for these sediment samples. Refer to Attachment C for the spatial distribution of SSV exceedances in Shipyard Creek sediment.



● 009M0002

● 009M0003

● 009M0004

● 009M0005

● 009M0001

SWMU 9

● SYCM0001

● SYCM0002

● SYCM0004

● SYCM0003

● SYCM0005

● SYCM0006

DREDGED MATERIALS AREA

● SYCM0007

● SYCM0008

● SYCM0009

● SYCM0010

● SYCM0011

● SYCM0012

● SYCM0013

● SYCM0014

● SYCM0015

● SYCM0016

● SYCM0017

TANK FARM

● SYCM0018

● SYCM0021

● SYCM0020

● SYCM0022

● SYCM0019

COOPER RIVER

○ < Sediment Screening Value

● > Sediment Screening Value



ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 2
SHIPYARD CREEK
SEDIMENT SAMPLE LOCATIONS

Table 2
SHIPYARD CREEK SEDIMENT SUMMARY
Zone J - NAVBASE Charleston, Charleston, SC

Parameter	Number of Detections	Range	Mean Concentration	SSV	Units	No. Exceeding SSV
Volatile Organics N=27						
2-Butanone (MEK)	13	5 - 52	19.50	NA	ug/kg	—
Acetone	8	99 - 7,600	1,491.13	NA	ug/kg	—
Carbon disulfide	18	5 - 150	23.31	NA	ug/kg	—
Semivolatile Organics N=27						
Benzo(a)anthracene	6	68.5 - 140	103.25	330	ug/kg	0
Benzo(a)pyrene	3	60 - 147.5	105.83	330	ug/kg	0
Benzo(b)fluoranthene	2	139 - 140	139.50	NA	ug/kg	—
Benzo(g,h,i)perylene	1	41 - 41	41.00	NA	ug/kg	—
Benzo(k)fluoranthene	1	87 - 87	87.00	NA	ug/kg	—
bis(2-Ethylhexyl)phthalate (BEHP)	6	51 - 1,600	570.17	182	ug/kg	3
Chrysene	5	70 - 180	132.40	330	ug/kg	0
Di-n-butylphthalate	6	45 - 200	117.50	NA	ug/kg	—
Di-n-octyl phthalate	1	110 - 110	110.00	NA	ug/kg	—
Diethylphthalate	2	830 - 1,400	1,115	NA	ug/kg	—
Fluoranthene	10	99 - 9,500	1,142.78	330	ug/kg	3
Indeno(1,2,3-cd)pyrene	1	100 - 100	100.00	NA	ug/kg	—
Phenanthrene	4	69 - 170	102.38	330	ug/kg	0
Pyrene	8	100 - 6,400	990.83	330	ug/kg	2
Pesticide/PCBs N=27						
4,4'-DDD	3	4 - 91	45.33	3.3	ug/kg	3
4,4'-DDE	5	4 - 150	57.80	3.3	ug/kg	5
4,4'-DDT	2	15 - 140	77.50	3.3	ug/kg	2
Aldrin	2	12 - 18	15.00	NA	ug/kg	—
Aroclor-1248	1	3,000 - 3,000	3,000	33	ug/kg	1
Aroclor-1254	3	110 - 690	436.67	33	ug/kg	5
Aroclor-1260	3	130 - 770	426.67	33	ug/kg	3
beta-BHC	1	7 - 7	7.00	NA	ug/kg	—
Inorganics N=27						
Aluminum (Al)	27	5,160 - 33,800	17,280.86	NA	mg/kg	—
Antimony (Sb)	9	0.56 - 2.9	1.22	12	mg/kg	0
Arsenic (As)	27	3.3 - 24.2	13.87	7.24	mg/kg	25
Barium (Ba)	27	14.7 - 37.4	23.91	NA	mg/kg	—
Beryllium (Be)	27	0.43 - 1.35	0.86	NA	mg/kg	—
Cadmium (Cd)	24	0.15 - 1	0.64	1	mg/kg	1
Chromium (Cr)	27	17.8 - 291	75.27	52.3	mg/kg	18
Cobalt (Co)	27	1.2 - 7.3	4.43	1	mg/kg	—
Copper (Cu)	27	10.7 - 228	35.58	18.7	mg/kg	16
Lead (Pb)	27	3.8 - 107	31.16	30.2	mg/kg	6
Manganese (Mn)	27	25.7 - 838	279.18	NA	mg/kg	—
Mercury (Hg)	6	0.02 - 0.69	0.30	0.13	mg/kg	4
Nickel (Ni)	27	6.5 - 37.3	18.36	15.9	mg/kg	16
Selenium (Se)	15	0.56 - 2.9	1.56	NA	mg/kg	—
Silver (Ag)	8	0.38 - 1.4	0.77	2	mg/kg	0
Thallium (Tl)	3	1.3 - 3.3	2.08	NA	mg/kg	—
Tin (Sn)	1	27.1 - 27.1	27.10	NA	mg/kg	—
Vanadium (V)	27	17.4 - 83.9	44.88	NA	mg/kg	—
Zinc (Zn)	27	39.2 - 387	98.60	124	mg/kg	3

Table 2
SHIPYARD CREEK SEDIMENT SUMMARY
Zone J - NAVBASE Charleston, Charleston, SC

Parameter	Number of Detections	Range	Mean Concentration	SSV	Units	No. Exceeding SSV
Dioxins						
	N=22					
1234678-HpCDD	22	0.89 - 267	45.12	NA	ng/kg	—
1234678-HpCDF	16	0.2 - 11.1	2.98	NA	ng/kg	—
123478-HxCDD	3	0.57 - 0.92	0.77	NA	ng/kg	—
123478-HxCDF	6	0.31 - 3.33	1.22	NA	ng/kg	—
1234789-HpCDF	1	0.49 - 0.49	0.49	NA	ng/kg	—
123678-HxCDD	10	0.57 - 3.39	1.66	NA	ng/kg	—
123678-HxCDF	1	0.53 - 0.53	0.53	NA	ng/kg	—
123789-HxCDD	13	1.33 - 8.75	3.28	NA	ng/kg	—
OCDD	22	17.1 - 2,540	521.84	NA	ng/kg	—
OCDF	19	0.34 - 55.3	8.32	NA	ng/kg	—
Total Hepta-Dioxins	22	0.09 - 1,990	240.75	NA	ng/kg	—
Total Hepta-Furans	17	0.47 - 8.89	3.12	NA	ng/kg	—
Total Hexa-Dioxins	21	2.38 - 201	68.63	NA	ng/kg	—
Total Hexa-Furans	13	0.2 - 13.4	3.27	NA	ng/kg	—
Total Penta-Dioxins	18	1.41 - 15.6	6.12	NA	ng/kg	—
Total Penta-Furans	3	1.34 - 3.14	2.40	NA	ng/kg	—
Total Tetra-Dioxins	19	0.88 - 16.8	5.13	NA	ng/kg	—
Total Tetra-Furans	2	0.42 - 1.03	0.73	NA	ng/kg	—
Physicochemical Parameters						
Total Organic Carbon (TOC)	27/27	0.71 - 46,000	5,706.30	NA	meq/kg	—
Cation Exchange Capacity	22/22	7.8 - 154	64.24	NA	mV	—
REDOX	22/22	112 - 299	219.95	NA	%	—

Notes:

Results from primary sample and its duplicate are presented as an average.

N = Number of samples collected

SSV = Sediment Screening Value for Hazardous Waste Sites, USEPA Region IV Waste Management Division, 1995

NA = Not available

— = Number of exceedances cannot be calculated.

ug/kg = micrograms/kilogram

mg/kg = milligrams/kilogram

ng/kg = nanograms/kilogram

meq/kg = milliequivalents/kilogram

mV = millivolts

Volatile Organic Compounds — Other than acetone, no significant individual compound was noticed and SSVs do not exist for the VOCs detected.

Semivolatile Organic Compounds — SVOCs were found at 10 of the 27 locations in Shipyard Creek. Three of these locations had concentrations exceeding their respective SSVs. The highest SVOC concentrations were of fluoranthene (9,500 $\mu\text{g}/\text{kg}$) and pyrene (6,400 $\mu\text{g}/\text{kg}$), both detected in 009-04, a Zone H sediment collected in the creek's headwaters. The mean concentrations in the creek was 1,143 $\mu\text{g}/\text{kg}$ fluoranthene and 991 $\mu\text{g}/\text{kg}$ pyrene, both still well above their SSV of 330 $\mu\text{g}/\text{kg}$. The SSV for BEHP was exceeded in three sediments, with a maximum concentration of 1,600 $\mu\text{g}/\text{kg}$ detected in SYC-03 collected in the central portion of Shipyard Creek near Zone H's SWMU 9. The mean concentration of BEHP in the entire creek is 570 $\mu\text{g}/\text{kg}$, still well above the SSV of 182 $\mu\text{g}/\text{kg}$. Considering the spatial distribution of SVOC constituents, the sediment samples collected at the mouth of the creek contained more individual SVOCs, but SSV exceedances were detected at locations along the creek's entire length (see Attachment C).

Pesticides/PCBs — Four pesticides — DDE, DDT, DDD, and aldrin — were found in the Zone H (SWMU 9) sediments collected in the headwaters of Shipyard Creek. Maximum concentrations of all four pesticides were detected in sample 009-05. The maximum concentration of DDE was 150 $\mu\text{g}/\text{kg}$ with a mean of 57.8 $\mu\text{g}/\text{kg}$, which still exceeds the 3.3 $\mu\text{g}/\text{kg}$ SSV. DDT also exceeded its SSV of 3.3 $\mu\text{g}/\text{kg}$ with a maximum concentration of 140 $\mu\text{g}/\text{kg}$ (mean = 77.5 $\mu\text{g}/\text{kg}$). Also present at elevated concentrations was DDD (maximum concentrations of 91 $\mu\text{g}/\text{kg}$ and a mean of 45.33 $\mu\text{g}/\text{kg}$). The SSV for DDD is also 3.3 $\mu\text{g}/\text{kg}$. Aldrin was also present in the headwaters with a maximum concentration of 18 $\mu\text{g}/\text{kg}$ and mean of 15 $\mu\text{g}/\text{kg}$, but no SSV exists for aldrin.

Three PCBs — Aroclor 1248, 1254, and 1260 — were detected in at least one headwater sediment collected in Shipyard Creek at concentrations greater than their SSV of 33 $\mu\text{g}/\text{kg}$. The maximum concentrations (3,000, 690, and 770 $\mu\text{g}/\text{kg}$, respectively) were all detected at Zone H sediment sample 009-04.

Inorganics — Eight metals — arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc — were detected in Shipyard Creek at concentrations exceeding their respective SSVs. The SSV for arsenic (7.24 mg/kg) was exceeded at 25 locations with its maximum concentration (24.2 mg/kg) detected in SYC-17, a sample near the base's shoreline approximately 1,000 feet from the mouth of the creek. Chromium's SSV (52.3 mg/kg) was exceeded at 18 locations and the SSV for nickel (15.9 mg/kg) was exceeded at 16 locations. The maximum concentrations for chromium and nickel (291 mg/kg and 37.3 mg/kg, respectively) were both detected in the Zone H sediment sample 009-04 collected farthest upstream. Copper's SSV (18.7 mg/kg) was also exceeded at 16 locations, with the highest detection (228 mg/kg) reported in 009-02 collected in the headwater portion of the creek. The SSV for lead (30.2 mg/kg) was exceeded at six locations with Zone H sample 009-04 containing the highest concentration (107 mg/kg). The concentration of mercury exceeded the 0.13 mg/kg SSV at four locations, with the highest detection at 009-04. The SSV of zinc (124 mg/kg) was also exceeded at three locations and its maximum concentration (387 mg/kg) was also at the upstream location 009-04. Cadmium's SSV was matched by a detection of 1.0 mg/kg at SYC-01, another upstream location.

Based on the mapping of detected metals concentrations exceeding SSVs (see figures in Attachment C), the distribution of most metals in Shipyard Creek sediment seems to be concentrated in its headwaters, with the Zone H samples containing moderate to high SSV exceedances.

Dioxins—Dioxin congeners were present in 22 Shipyard Creek sediment samples. Concentrations ranged from 0.09 to 2,540 nanograms per kilogram (ng/kg), however no SSVs exist for dioxins in sediment. Nearly all dioxin congeners, including the maximum concentration, were detected in one sample, SYC-14, collected near the shore opposite NAVBASE and adjacent to a commercial shipyard's floating drydock. Other locations in the central portion of the creek and around the mouth of Shipyard Creek also contained dioxins.

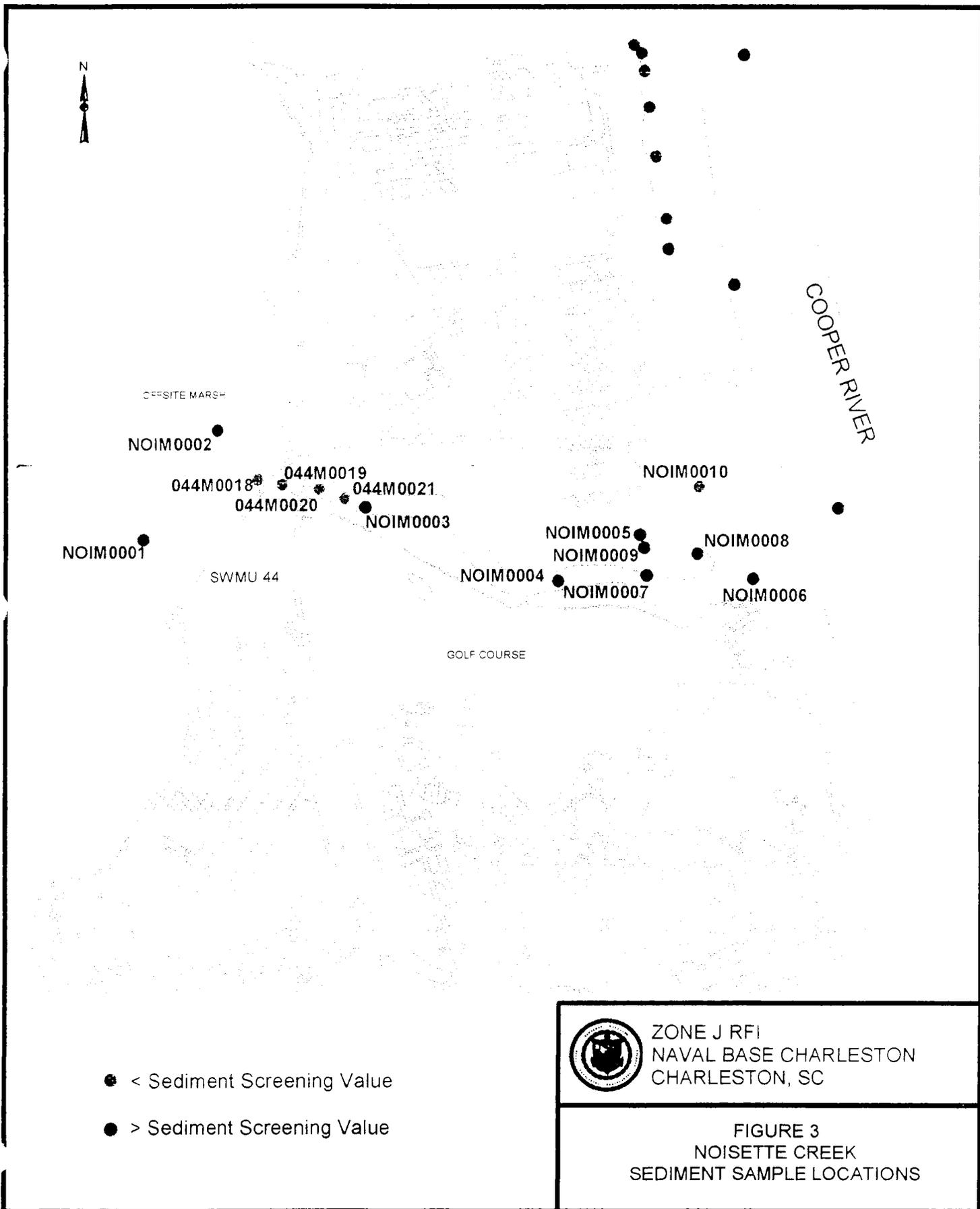
Particle Size — Fine-grained sediments in Shipyard Creek were wide-spread, but the smaller particle sizes (>90% passing through the No. 200 sieve) were reported in samples collected from the maintained channel and in the lower turning basin (SYC-19, -16, -08, and -14). The coarser sediments were detected in the samples from the marsh (SYC-18, -06, -21) , but the coarsest sample was from the edge of the dredged channel (SYC-20).

Noisette Creek

To date, 14 sediment samples have been collected from Noisette Creek as part of the NAVBASE RFI; 10 from the Zone J RFI and four TOC-only sediment samples collected during the Zone C RFI of SWMU 44. The sediment sample locations for Noisette Creek are presented on Figure 3. Table 3 presents a summary of analytical results for Noisette Creek sediment samples. The figures in Attachment C show the overall distribution of SSV exceedances in Noisette Creek.

Volatile Organic Compounds — No significant individual compound was noticed and no SSVs were applicable to the VOCs detected.

Semivolatile Organic Compounds — SVOCs were found at six of the 10 Zone J samples collected in Noisette Creek. Fourteen SVOCs were at concentrations above their SSVs. The highest detected SVOC was 2-methylphenol detected at NOI-02, an upstream sample collected in the



OFFSITE MARSH

NOIM0002

044M0018

044M0019

044M0020

044M0021

NOIM0003

NOIM0001

SWMU 44

NOIM0004

GOLF COURSE

NOIM0005

NOIM0009

NOIM0007

NOIM0010

NOIM0008

NOIM0006

COOPER RIVER

● < Sediment Screening Value

● > Sediment Screening Value



ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 3
NOISETTE CREEK
SEDIMENT SAMPLE LOCATIONS

Table 3
NOISETTE CREEK SEDIMENT SUMMARY
Zone J - NAVBASE Charleston, Charleston, SC

Parameter	Number of Detects	Range	Mean	SSV	Units	No. Exceeding SSV
Volatile Organics N=10						
2-Butanone (MEK)	5	5.00 - 19.00	10.20	NA	ug/kg	—
Acetone	6	33.00 - 350	140.33	NA	ug/kg	—
Carbon disulfide	7	10.00 - 52.00	26.43	NA	ug/kg	—
Semivolatile Organics N=10						
2,4-Dimethylphenol	1	1,200 - 1,200	1,200	NA	ug/kg	—
2-Methylnaphthalene	1	1,000 - 1,000	1,000	330	ug/kg	1
2-Methylphenol (o-Cresol)	1	4,300 - 4,300	4,300	NA	ug/kg	—
Anthracene	1	610 - 610	610	330	ug/kg	1
Benzo(a)anthracene	4	61 - 1,000	333	330	ug/kg	1
Benzo(a)pyrene	4	65 - 990	338	330	ug/kg	1
Benzo(b)fluoranthene	4	96 - 1,200	414	NA	ug/kg	—
Benzo(g,h,i)perylene	1	210 - 210	210	NA	ug/kg	—
Benzo(k)fluoranthene	2	190 - 760	475	NA	ug/kg	—
Chrysene	4	70 - 1,500	458	330	ug/kg	1
Dibenz(a,h)anthracene	1	150 - 150	150	330	ug/kg	0
Diethylphthalate	3	500 - 1,400	953	NA	ug/kg	—
Fluoranthene	5	100 - 1,500	530	330	ug/kg	2
Indeno(1,2,3-cd)pyrene	1	270 - 270	270	NA	ug/kg	—
Naphthalene	1	630 - 630	630	NA	ug/kg	—
Phenanthrene	3	83 - 160	118	330	ug/kg	0
Pyrene	6	65 - 950	349	330	ug/kg	2
bis(2-Ethylhexyl)phthalate (BEHP)	2	170 - 1,800	985	182	ug/kg	1
Pesticides/PCBs N=10						
Aroclor-1260	1	123 - 123	123	33	ug/kg	1
Inorganics N=10						
Aluminum (Al)	10	1,550 - 28,900	11,957	NA	mg/kg	—
Antimony (Sb)	1	1.10 - 1.10	1.10	12	mg/kg	0
Arsenic (As)	10	1.80 - 19.90	11.34	7.24	mg/kg	7
Barium (Ba)	10	3.20 - 44.40	20.24	NA	mg/kg	—
Beryllium (Be)	8	0.18 - 1.90	0.90	NA	mg/kg	—
Cadmium (Cd)	8	0.10 - 0.82	0.40	1	mg/kg	0
Chromium (Cr)	10	4.10 - 54.90	25.03	52.3	mg/kg	1
Cobalt (Co)	10	0.69 - 10.60	4.31	NA	mg/kg	—
Copper (Cu)	10	4.10 - 127.00	30.36	18.7	mg/kg	5
Iron (Fe)	10	1,810 - 31,700	17,347	NA	mg/kg	—
Lead (Pb)	10	6.80 - 126.00	39.24	30.2	mg/kg	5
Manganese (Mn)	10	11.30 - 233.00	129.22	NA	mg/kg	—
Mercury (Hg)	6	0.13 - 1.20	0.36	0.13	mg/kg	5
Nickel (Ni)	10	1.40 - 20.50	9.28	15.9	mg/kg	2
Tin (Sn)	1	48.10 - 48.10	48.10	NA	mg/kg	—
Vanadium (V)	10	3.70 - 81.20	34.61	NA	mg/kg	—
Zinc (Zn)	10	26.80 - 718.00	153.82	124	mg/kg	4
Physicochemical Parameter N=14						
Total Organic Carbon (TOC)	14	570.00 - 19,600.00	8,355.00	NA	mg/kg	—

Notes:

Results from primary sample and its duplicate are presented as an average.

N = Number of samples collected

SSV = Sediment Screening Value for Hazardous Waste Sites, USEPA Region IV Waste Management Division, 1995

NA = Not available

— = Number of exceedances cannot be calculated.

ug/kg = micrograms/kilogram

mg/kg = milligrams/kilogram

off-base marsh, at a concentration of 4,300 $\mu\text{g}/\text{kg}$. Naphthalene was detected in NOI-01, a sample adjacent to NOI-02, at a concentration of 630 $\mu\text{g}/\text{kg}$. No SSVs exist for these compounds. High concentrations of 2,4-dimethylphenol (1,200 $\mu\text{g}/\text{kg}$; no SSV), and 2-methylnaphthalene (1,000 $\mu\text{g}/\text{kg}$; SSV = 330 $\mu\text{g}/\text{kg}$) were also found in NOI-02. These constituents were not detected in any other Noisette Creek sample.

Other SVOCs detected at elevated concentrations are anthracene, BEHP, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, diethylphthalate, fluoranthene, and pyrene. The maximum concentrations of 11 of the 18 SVOCs detected in Noisette Creek were present at one sediment location, NOI-04, near the footbridge which crosses the central portion of the creek. Another sampling point approximately 900 feet upstream of the footbridge, NOI-03, and two points near the mouth of Noisette Creek (NOI-05 and NOI-06) are responsible for nearly all the remaining elevated SVOC concentrations.

Pesticides/PCBs — No pesticides were found in Noisette Creek sediment. Only one PCB congener, Aroclor 1260, was at a concentration above its SSV (33 $\mu\text{g}/\text{kg}$) and this detection (123 $\mu\text{g}/\text{kg}$) was in NOI-03 collected at the outfall at the north side of the creek, approximately 300 feet east of the Avenue D bridge.

Inorganics — Seven metals — arsenic, chromium, copper, lead, mercury, nickel, and zinc — were found at concentrations exceeding their respective SSVs. The SSV for arsenic (7.24 mg/kg) was exceeded at seven locations with the maximum concentration (19.9 mg/kg) detected in NOI-08, collected in the small coastal marsh immediately north of the creek's confluence with the Cooper River. The SSVs for copper (18.7 mg/kg), mercury (0.13 mg/kg), and lead (30.2 mg/kg) were each exceeded at five locations. The maximum concentrations for copper and lead (127 and 126 mg/kg, respectively) were detected in NOI-04, near the footbridge. Mercury's maximum

concentration (1.2 mg/kg) was at NOI-02, in the offsite marsh. Four sediment samples exceeded zinc's SSV of 124 mg/kg; the greatest exceedance 718 mg/kg detected in NOI-04, the footbridge sample. The SSV for nickel (15.9 mg/kg) was exceeded at two locations, 20.5 mg/kg at NOI-04 and 16.4 mg/kg at NOI-02, the offsite marsh sample. Chromium's SSV (52.3 mg/kg) was also slightly exceeded by a detection of 54.9 mg/kg at NOI-02.

Inorganic concentrations detected in creek sediment indicated no discernable pattern of contaminant distribution, with elevated concentrations present in the upper, central, and lower portions of the creek (see Attachment C).

Particle Size — The offsite sample (NOI-02) consisted of the finest-grained sediments (98% passing the No.200 sieve), with the samples from the tidal marsh at the mouth of the creek (NOI-08 and -07) also having fine grains. Sample NOI-03 was the coarsest-grained, with only 5% passing the sieve.

4.2 Surface Water Chemistry

All Zone J water samples were analyzed for concentrations of volatile and semivolatile constituents, pesticides/PCBs, metals, chlorides, and nitrate/nitrites, as well as pH, chemical oxygen demand, alkalinity, phosphorus, total organic content, and total suspended solids.

Attachment D presents a compilation of color figures that demonstrate the spatial distribution of constituents detected in Zone J surface water which exceed USEPA Region IV Saltwater Surface Water Screening Values (SSWSVs, USEPA 1995). The SSWSVs are based on conservative endpoints and sensitive ecological effects data which may or may not be applicable to Zone J and are presented here only as a preliminary screening tool. For those parameters for which an

SSWSV does not exist, the corresponding distribution figure will be presented when a comparison to background concentration can be made.

Cooper River

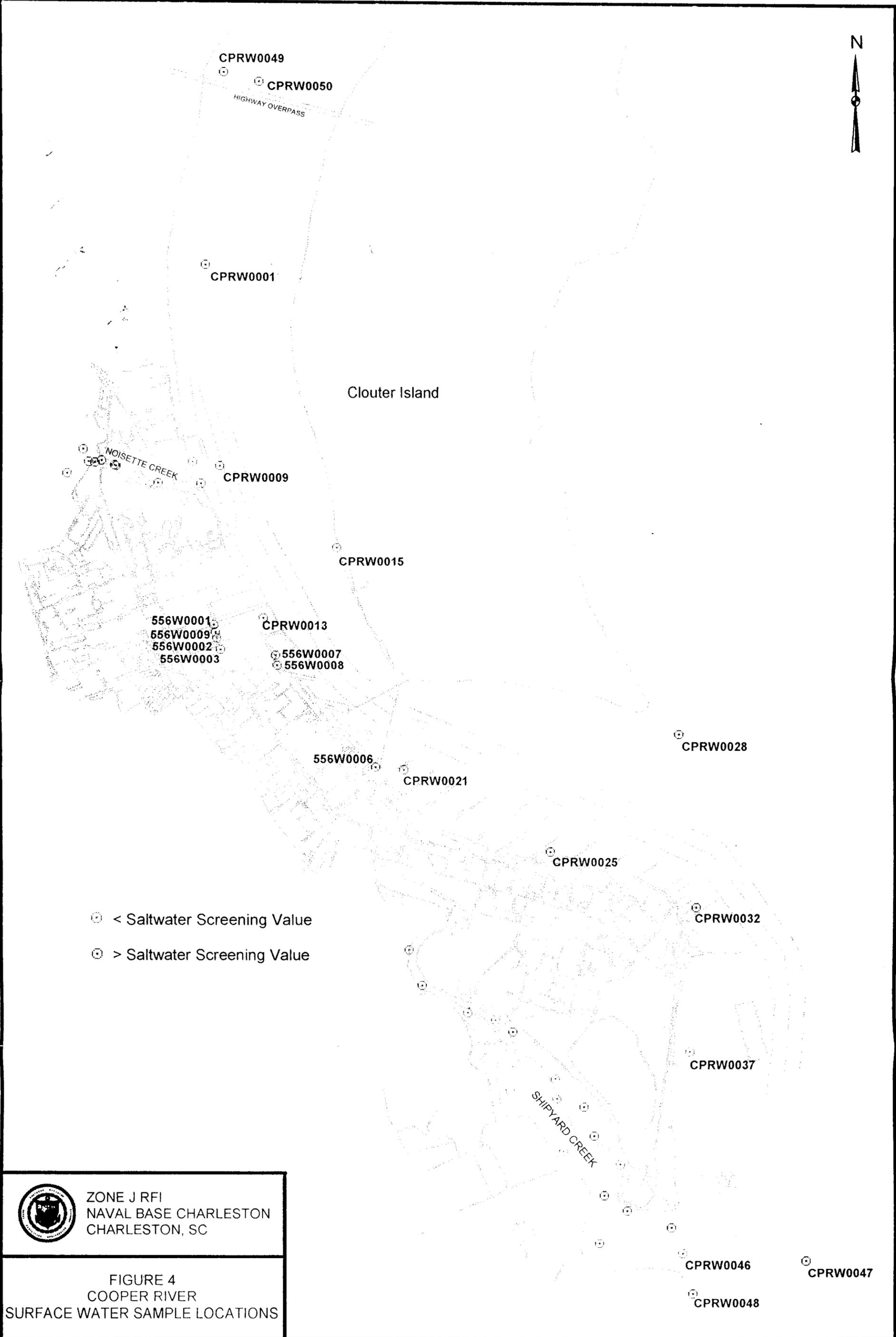
Surface water samples were collected at 14 Zone J grid-based locations in the Cooper River near NAVBASE. Three river locations were near visible NAVBASE outfalls and warranted the collection of a mid-depth sample. In addition to the 14 Zone J samples, seven bottom-interval water samples were also collected as part of the Zone E RFI of AOC 556 (drydock discharges).

Surface water sample identification numbers and SSWSV-exceedances for the Cooper River are presented on Figure 4. Table 4 presents a summary of the analytical results from both the Zone J and Zone E water analyses (bottom-samples only) conducted to date in the Cooper River.

Volatile Organic Compounds — Four VOCs — acetone, carbon disulfide, methylene chloride, and xylene — were detected in Cooper River surface water. Only the single detection of methylene chloride (3.0 $\mu\text{g/l}$) at CPR-01 could be compared to its SSWSV of 2,700 $\mu\text{g/L}$, which it was well below.

Semivolatile Organic Compounds — Two semivolatile organics exceeded their respective SSWSVs at three locations. The maximum concentration of di-n-butylphthalate (8.0 $\mu\text{g/L}$) was detected at CPR-49, exceeding its 3.4 $\mu\text{g/L}$ SSWSV. The other exceedance of di-n-butylphthalate (4.0 $\mu\text{g/L}$) was at CPR-21 near Pier K. The SSWSV for diethylphthalate (75.9 $\mu\text{g/L}$) was slightly exceeded by the maximum concentration detected (83.0 $\mu\text{g/L}$) at CPR-01. Both maximum SVOC concentrations were detected at upriver surface water locations north of NAVBASE.

Pesticides/PCBs — Only one pesticide, alpha-BHC, was detected at two sampling locations in the Cooper River and at concentrations well below the 1,400 $\mu\text{g/L}$ SSWSV. Both detections, one at



⊖ < Saltwater Screening Value

⊕ > Saltwater Screening Value



ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 4
COOPER RIVER
SURFACE WATER SAMPLE LOCATIONS

Table 4
COOPER RIVER SURFACE WATER SUMMARY
Zone J - NAVBASE Charleston, Charleston, SC
(Also includes Zone E Results)

Parameter	Number of Detections	Range	Mean Concentration	SSWSV	Units	No. Exceeding SSWSVs
Volatile Organics N=21						
Acetone	7	2.00 - 7.00	3.86	NA	ug/L	—
Carbon disulfide	2	2.00 - 2.00	2.00	NA	ug/L	—
Methylene chloride	1	3.00 - 3.00	3.00	2,700	ug/L	0
Xylene (Total)	1	2.00 - 2.00	2.00	NA	ug/L	—
Semivolatile Organics N=21						
Acenaphthalene	1	1.00 - 1.00	1.00	9.70	ug/L	0
BEHP	7	1.00 - 14.00	3.72	NA	ug/L	—
Di-n-butylphthalate	4	1.00 - 8.00	4.00	3.40	ug/L	2
Diethylphthalate	12	5.00 - 83.00	25.58	75.90	ug/L	1
Pyrene	1	1.00 - 1.00	1.00	NA	ug/L	—
Pesticides/PCBs N=21						
alpha-BHC	2	0.07 - 1.12	0.60	1,400	ug/L	0
Inorganics N=21						
Aluminum (Al)	21	55.40 - 5,430	1,236	NA	ug/L	—
Arsenic (As)	1	5.30 - 5.30	5.30	36	ug/L	0
Barium (Ba)	18	9.60 - 19.40	12.53	NA	ug/L	—
Beryllium (Be)	6	0.43 - 3.60	1.59	NA	ug/L	—
Cadmium (Cd)	1	0.38 - 0.38	0.38	9.30	ug/L	0
Chromium (Cr)	4	16.20 - 41.20	31.40	103.0/50.0	ug/L	0
Copper (Cu)	2	2.40 - 13.10	7.75	2.90	ug/L	1
Lead (Pb)	2	3.30 - 6.50	4.90	8.50	ug/L	0
Manganese (Mn)	15	4.30 - 124.00	27.86	NA	ug/L	—
Mercury (Hg)	1	1.10 - 1.10	1.10	0.03	ug/L	1
Nickel (Ni)	4	1.10 - 2.35	1.54	8.30	ug/L	0
Silver (Ag)	2	11.20 - 15.40	13.30	0.23	ug/L	2
Thallium (Tl)	7	5.00 - 6.70	5.64	21.30	ug/L	0
Tin (Sn)	13	50.20 - 458.00	338.71	NA	ug/L	—
Vanadium (V)	13	1.20 - 8.90	2.91	NA	ug/L	—
Zinc (Zn)	14	25.70 - 357.00	122.90	86	ug/L	4
Dioxins N=1						
1234678-HpCDF	1	7.52 - 7.52	7.52	NA	pg/L	—
OCDD	1	46.40 - 46.40	46.40	NA	pg/L	—
Total Hepta-Dioxins	1	7.59 - 7.59	7.59	NA	pg/L	—
Organotins N=15						
Tributyltin	1	28.00 - 28.00	28.00	0.01	ug/L	1
Physicochemical Parameters N=14						
Total Alkalinity	14	60.50 - 92.50	79.14	NA	mg/L	—
Chloride	14	7,250 - 13,500	10,789	NA	mg/L	—
Chemical Oxygen Demand	13	45.10 - 212	116.16	NA	mg/L	—
pH	14	6.58 - 7.73	7.44	6.5 - 8.5	SU	0
Total phosphorus	8	0.10 - 3.40	0.80	0.10	mg/L	7
Nitrate-Nitrite-N	10	0.05 - 0.18	0.09	NA	mg/L	—
TKN	14	0.30 - 0.82	0.53	NA	mg/L	—
Total Organic Carbon (TOC)	2	10.30 - 14.10	12.20	NA	mg/L	—
Total Suspended Solids (TSS)	5	32.00 - 86.00	53.20	NA	mg/L	—

Notes:

The results of primary surface water sample and its duplicate have been averaged.

N = Number of samples collected

SSWSV = Saltwater Surface Water Screening Value (Chronic) for Hazardous Waste Sites (USEPA, 1995)

NA = Not available

— = Number of exceedances cannot be calculated.

ug/L = micrograms/liter

pg/L = picograms/liter

mg/L = milligrams/liter

SU = standard units

CPR-46 (1.12 $\mu\text{g/L}$) and the other at nearby CPR-48 (0.07 $\mu\text{g/L}$) were collected south of the base were close to the shoreline below the mouth of Shipyard Creek. The adjacent Zone J samples in Shipyard Creek (SYC-19 and SYC-22) did not indicate alpha-BHC or any other pesticides.

Inorganics — Four metals — copper, mercury, silver, and zinc — detected in the Cooper River exceeded their respective SSWSVs at nine separate surface water sampling locations. Three of these were from sampling locations north of the base and include CPR-49, exhibiting the highest detection of copper (13.10 $\mu\text{g/L}$), CPR-50, with the maximum concentration of mercury (1.1 $\mu\text{g/L}$), and CPR-01, having the highest silver concentration (15.4 $\mu\text{g/L}$). The respective SSWSVs are 2.9 $\mu\text{g/L}$ copper, 0.03 $\mu\text{g/L}$ mercury, and 0.23 $\mu\text{g/L}$ silver. Five of the remaining six exceedances (see Table 4 and Attachment D) are evenly distributed along the NAVBASE shoreline between Noisette Creek and Pier X. There were three relatively high concentrations of zinc (340 $\mu\text{g/L}$ at CPR-28, 349 $\mu\text{g/L}$ at CPR-25, and 357 $\mu\text{g/L}$ at CPR-21) which significantly exceeded zinc's SSWSV of 86 $\mu\text{g/L}$. These three samples were collected near Piers K and Z and across the Cooper River at the mouth of Clouter Creek.

Dioxins — Three dioxin congeners were detected in a Zone E surface water sample (556-09) collected near Drydock 1, the only Cooper River surface water sample analyzed for dioxins. The congeners OCDD (46.4 picograms/liter [pg/L]), total hepta-dioxins (7.52 pg/L), and 1234678-HpCDF (7.52 pg/L) were all reported to be present in this sample. No SSWSVs exist for dioxins.

Organotins — One organotin, tributyltin, was detected at 28 $\mu\text{g/L}$ in the Zone E surface water collected at sample location 556-06, near Drydock 4. The advisory SSWSV for tributyltin is 0.01 $\mu\text{g/L}$, indicating a significant exceedance at this location.

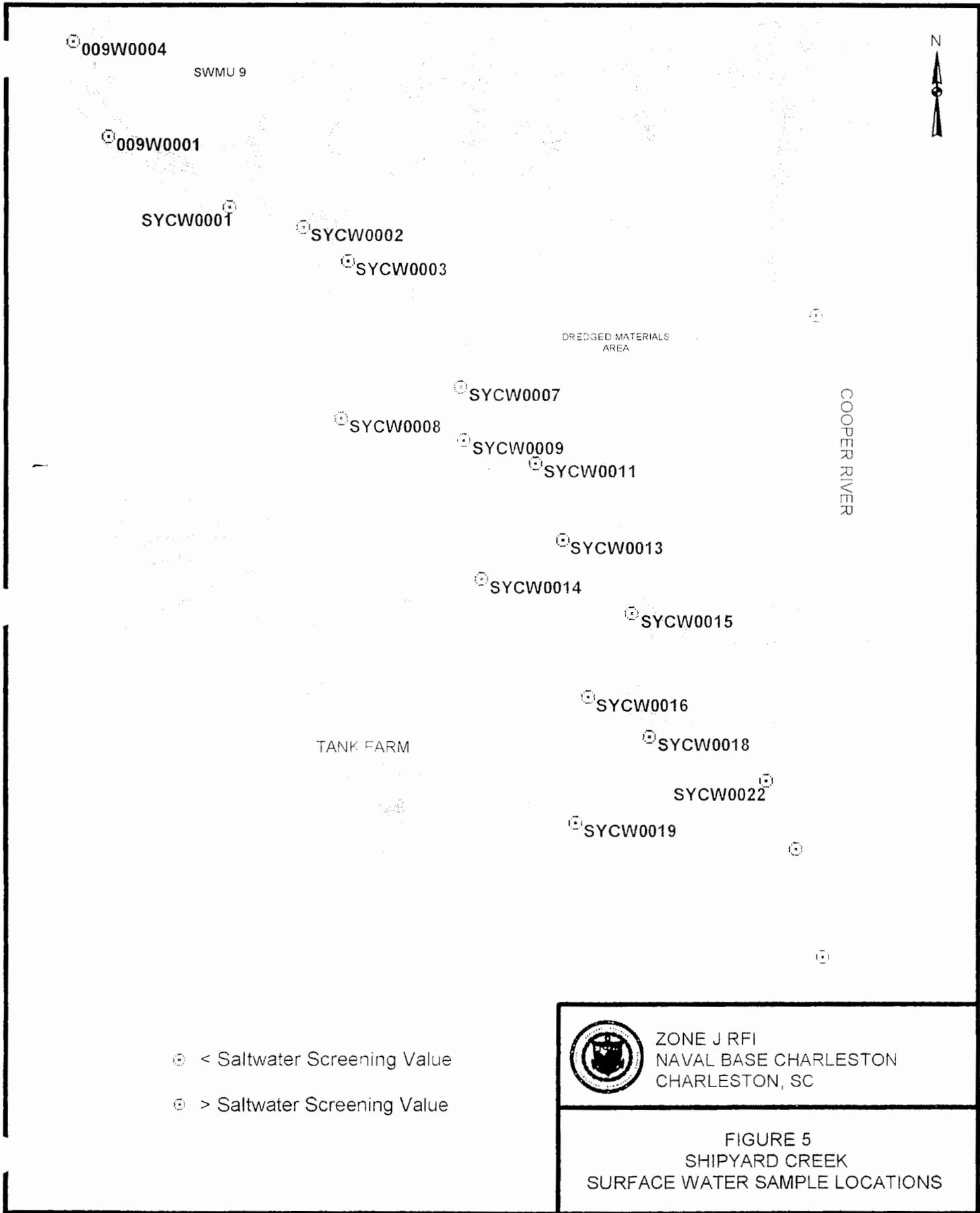
Shipyard Creek

Twenty-one surface water samples were collected in Shipyard Creek. Fourteen were Zone J grid-based locations. Due to shallow water at sample locations near known NAVBASE outfalls, no mid-depth samples were warranted. Two surface water samples from the Zone H investigation of SWMU 9 are also included in this data set. In addition to standard Zone J chemical analyses, Shipyard Creek water samples collected for Zone J were also analyzed for hexavalent chromium and dioxins, since these were both identified as possible constituents of concern during previous investigations (see Zone J Work Plan for more details). The surface water sampling locations for Shipyard Creek are presented on Figure 5, and Table 5 presents a summary of the results of water analyses conducted to date in Shipyard Creek.

Volatile Organic Compounds — Acetone, the only VOC detected in Shipyard Creek surface water, was present in three samples (maximum concentration of 6.0 $\mu\text{g/L}$). No SSWSV exists for acetone.

Semivolatile Organic Compounds — Three SVOCs were detected in the surface water of Shipyard Creek — 2-nitrophenol, benzoic acid, and BEHP — however no SSWSVs exist for these compounds.

Inorganics — Six metals — chromium, copper, lead, nickel, silver, and zinc — were detected in surface water at concentrations above their respective SSWSVs. The detected concentrations for these metals are as follows: chromium, 443 $\mu\text{g/L}$ at SYC-22 with a mean of 95 $\mu\text{g/L}$; lead, 55.5 $\mu\text{g/L}$ at 009-01 with a mean of 3.6 $\mu\text{g/L}$; and nickel, 24.6 $\mu\text{g/L}$ at SYC-16 with a mean of 17.4 $\mu\text{g/L}$. The respective SSWSVs for these metals are 103/50 $\mu\text{g/L}$ chromium (III/VI), 8.5 $\mu\text{g/L}$ lead, and 8.3 $\mu\text{g/L}$ nickel. Copper exceedances were reported in samples collected both in the headwaters and in the central portion of the creek with a maximum concentration of



- ⊙ < Saltwater Screening Value
- ⊗ > Saltwater Screening Value


 ZONE J RFI
 NAVAL BASE CHARLESTON
 CHARLESTON, SC

FIGURE 5
 SHIPYARD CREEK
 SURFACE WATER SAMPLE LOCATIONS

Table 5
Shipyard Creek Surface Water Summary
Zone J - NAVBASE Charleston, Charleston, SC
(Also includes Zone H results)

	Number of Detections	Range	Mean Concentration	SSWSV	Units	No. Exceeding SSWSV
Volatile Organics N=16						
Acetone	3	4 - 6	5.00	NA	ug/L	—
Semivolatile Organics N=16						
2-Nitrophenol	1	20 - 20	20.00	NA	ug/L	—
Benzoic acid	1	1 - 1	1.00	NA	ug/L	—
bis(2-Ethylhexyl)phthalate (BEHP)	9	1 - 23	4.56	NA	ug/L	—
Inorganics N=16						
Aluminum (Al)	14	70.2 - 6,210	1,191.84	NA	ug/L	—
Antimony (Sb)	1	21.6 - 21.6	21.60	NA	ug/L	—
Arsenic (As)	9	3.15 - 8	5.12	36	ug/L	0
Barium (Ba)	16	10.7 - 93.2	22.91	NA	ug/L	—
Beryllium (Be)	11	1.2 - 10.1	3.67	NA	ug/L	—
Cadmium (Ca)	1	2.4 - 2.4	2.40	9.3	ug/L	0
Chromium (Cr)	7	7.7 - 443	195.21	103/50	ug/L	4
Cobalt (Co)	1	14.8 - 14.8	14.80	NA	ug/L	—
Copper (Cu)	4	10.3 - 50.8	31.53	2.9	ug/L	4
Lead (Pb)	4	3.3 - 55.5	33.63	8.5	ug/L	3
Manganese (Mn)	16	6.2 - 260	54.23	NA	ug/L	—
Nickel (Ni)	3	12.7 - 24.6	17.43	8.3	ug/L	3
Selenium (Se)	3	3.6 - 39.7	15.87	NA	ug/L	—
Silver (Ag)	5	2.45 - 76.7	17.55	0.23	ug/L	5
Tin (Sn)	6	65.3 - 802	330.78	NA	ug/L	—
Vanadium (V)	16	2.4 - 24	6.29	NA	ug/L	—
Zinc (Zn)	7	3.4 - 229	67.41	86	ug/L	2
Dioxins N=14						
1234678-HpCDD	11	3.69 - 6.9	4.99	NA	pg/L	—
1234678-HpCDF	1	5.62 - 5.62	5.62	NA	pg/L	—
OCDD	13	23.9 - 68.75	46.55	NA	pg/L	—
OCDF	6	2.04 - 12.4	4.61	NA	pg/L	—
Total Hepta-Dioxins	13	7.31 - 30.1	15.54	NA	pg/L	—
Physicochemical Parameters N=14						
Chloride	14	7,740 - 16,700	11,831	NA	mg/L	—
Chemical Oxygen Demand	14	32.6 - 444	186.83	NA	mg/L	—
pH	14	6.91 - 7.67	7.37	6.5 - 8.5	SU	0
Total Alkalinity	14	63 - 101	83.00	NA	mg/L	—
Total Kjeldahl Nitrogen (TKN)	4	0.41 - 1.3	0.89	NA	mg/L	—
Total Organic Carbon (TOC)	6	2.1 - 8.9	4.32	NA	mg/L	—
Total Suspended Solids (TSS)	3	20 - 154	78.67	NA	mg/L	—

Notes:

Results from primary sample and its duplicate are presented as an average.

N = Number of samples collected

SSWSV = Saltwater Surface Water Screening Value (Chronic) for Hazardous Waste Sites (USEPA, 1995)

NA = Not available

— = Number of exceedances can not be calculated

ug/L = micrograms/liter

pg/L = picograms/liter

mg/L = milligrams/liter

SU = standard units

50.8 $\mu\text{g/L}$ at 009-04, a mean concentration of 31.5 $\mu\text{g/L}$, and a SSWSV of 2.9 $\mu\text{g/L}$. Silver was present in surface water collected at five locations along the NAVBASE shoreline in the creek's upper, central, and lower portions. The maximum concentration for silver was 76.7 $\mu\text{g/L}$ at SYC-16 and a mean concentration of 17.5 $\mu\text{g/L}$. The SSWSV for silver is 0.23 $\mu\text{g/L}$. Zinc also exceeded its SSWSV of 86 $\mu\text{g/L}$ at two locations (229 $\mu\text{g/L}$ at 009-01 and 196 $\mu\text{g/L}$ at 009-04) in the SWMU 9 headwater samples. No other inorganic constituents were detected at concentrations above SSWSVs. Refer to Attachment D for inorganic SSWSV exceedances in Shipyard Creek.

Noisette Creek

Ten surface water samples were collected in Noisette Creek. Due to shallow water at sample locations near known outfalls, no mid-depth samples were warranted. In addition to six Zone J samples, four surface water samples were collected as part of the Zone C RFI of SWMU 44 (Coal Storage Area). The surface water sample locations for Noisette Creek are presented on Figure 6. Table 6 presents a summary of the results of both Zone J and Zone C water analyses conducted to date in Noisette Creek.

Volatile Organic Compounds — The only VOC detected was acrolein, reported at 044-19, the Zone C surface water sample collected at the outfall from SWMU 44. Its concentration of 1.0 $\mu\text{g/L}$ exceeded its SSWSV of 0.55 $\mu\text{g/L}$.

Semivolatile Organic Compounds — Three SVOCs were detected in Noisette Creek — benzoic acid, BEHP, and di-n-butylphthalate. Only di-n-butylphthalate has a corresponding SSWSV (3.4 $\mu\text{g/L}$), and the highest detected concentration in the creek was 2.0 $\mu\text{g/L}$ at location 044-19.



OFFSITE MARSH

COOPER RIVER



⊖ < Saltwater Screening Value

⊕ > Saltwater Screening Value



ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 6
NOISSETTE CREEK
SURFACE WATER SAMPLE LOCATIONS

Table 6
Noisette Creek Surface Water Summary
Zone J - NAVBASE Charleston, Charleston, SC
(Also includes Zone C Results)

Parameter	Number of Detections	Range	Mean Concentration	SSWSV	Units	No. Exceeding SSWSV
Volatile Organics	N=10					
Acrolein	1	1.00 - 1.00	1.00	0.55	ug/L	1
Semivolatile Organics	N=10					
Benzoic acid	1	1.00 - 1.00	1.00	NA	ug/L	—
BEHP	2	2.00 - 4.00	3.00	NA	ug/L	—
Di-n-butylphthalate	1	2.00 - 2.00	2.00	3.4	ug/L	0
Inorganics	N=10					
Aluminum (Al)	2	292 - 980	636	NA	ug/L	—
Arsenic (As)	1	2.40 - 2.40	2.40	36	ug/L	0
Barium (Ba)	10	16.20 - 23.25	20.48	NA	ug/L	—
Beryllium (Be)	1	1.50 - 1.50	1.50	NA	ug/L	—
Cadmium (Cd)	1	0.31 - 0.31	0.31	9.3	ug/L	0
Chromium (Cr)	5	2.10 - 3.65	2.87	103/50	ug/L	0
Cobalt (Co)	1	0.93 - 0.93	0.93	NA	ug/L	—
Copper (Cu)	2	4.90 - 8.60	6.75	2.9	ug/L	2
Iron (Fe)	9	213 - 2,610	660.39	NA	ug/L	—
Lead (Pb)	1	3.50 - 3.50	3.50	8.5	ug/L	0
Manganese (Mn)	10	23.20 - 92.95	61.95	NA	ug/L	—
Nickel (Ni)	2	1.50 - 10.20	5.85	8.3	ug/L	1
Silver (Ag)	1	2.20 - 2.20	2.20	0.23	ug/L	1
Tin (Sn)	2	67.70 - 259	163.35	NA	ug/L	—
Vanadium (V)	6	1.40 - 9.70	3.47	NA	ug/L	—
Zinc (Zn)	5	13.20 - 21.90	17.28	86	ug/L	0
Organotins	N=10					
Dibutyltin	1	0.12 - 0.12	0.12	0.01	ug/L	1
Monobutyltin	1	0.17 - 0.17	0.17	0.01	ug/L	1
Physicochemical Parameters	N=6					
Total Alkalinity	6	56.00 - 81.00	69.17	NA	mg/L	—
Chloride	6	2,670 - 6,800	4,340	NA	mg/L	—
TKN	5	0.43 - 0.84	0.61	NA	mg/L	—
TOC	4	3.00 - 32.50	12.98	NA	mg/L	—
TSS	1	36.00 - 36.00	36.00	NA	mg/L	—
Chemical Oxygen Demand	6	68.50 - 93.60	83.92	NA	mg/L	—
Nitrate-Nitrite-N	4	0.07 - 0.11	0.08	NA	mg/L	—
pH	6	6.81 - 7.06	6.89	6.5 - 8.5	SU	0

Notes:

Results from primary sample and its duplicate are presented as an average.

N = Number of samples collected

SSWSV = Saltwater Surface Water Screening Value (Chronic) for Hazardous Waste Sites (USEPA, 1995)

NA = Not available

— = Number of exceedances cannot be calculated.

ug/L = micrograms/liter

mg/L = milligrams/liter

SU = standard units

Inorganics — Three metals — copper, nickel, and silver — were detected at concentrations above their SSWSVs at three surface water locations. Copper's exceedances occurred in samples collected at two biased sample locations; 4.9 $\mu\text{g/L}$ detected in 044-19 collected at an NPDES outfall located immediately west of the railroad trestle crossing Noisette Creek and 8.6 $\mu\text{g/L}$ in NOI-03 collected at an NPDES outfall approximately 400 feet farther east. The SSWSV for copper is 2.9 $\mu\text{g/L}$. A slightly elevated concentration of nickel (10.2 $\mu\text{g/L}$; SSWSV = 8.3 $\mu\text{g/L}$) was detected in 044-20 collected west of the Avenue D bridge. In addition to an elevated concentration of copper, 2.2 $\mu\text{g/L}$ silver was also detected in NOI-03, exceeding silver's SSWSV of 0.23 $\mu\text{g/L}$.

Organotins — Concentrations of two organotins — dibutyltin and monobutyltin — were also detected in Noisette Creek surface water at concentrations above their advisory SSWSV of 0.01 $\mu\text{g/L}$. The Zone C surface water sample 044-20 collected near the Avenue D bridge had 0.12 $\mu\text{g/L}$ dibutyltin and 0.17 $\mu\text{g/L}$ monobutyltin. The figures in Attachment D represent the spatial distribution of SSWSV exceedances in Noisette Creek.

4.3 Conclusion

As performed, the sampling of the Zone J water bodies met its objective of determining what contaminants are present in the sediment and surface water surrounding NAVBASE.

Cooper River

In the Cooper River, primarily around the Zone E drydocks and other piers, high concentrations of SVOCs and metals were detected in fine-grained sediments. Surface waters at upriver locations in the Cooper exhibited higher concentrations of both SVOCs and metals while downriver locations had higher pesticide concentrations. Dioxins were also present in the surface water

sample collected near Drydock 1 and organotins were present in the water sample taken near Drydock 4.

Shipyards Creek

Sediments in Shipyards Creek had elevated concentrations of metals, pesticides, and SVOCs, with higher concentrations primarily in the sediments collected in the creek's headwaters. Dioxins were also detected in the central and lower portion of the creek. Shipyards Creek's surface water samples containing elevated concentrations of metals were present throughout but higher concentrations were found at the creek's headwaters and mouth.

Noisette Creek

Sediment in Noisette Creek contained elevated concentrations of SVOCs and metals which were detected in the fine-grained sediments from the upgradient, offsite marsh and also from the central and lower portions of the creek. Analysis of surface waters in the creek found a single VOC, three metals, and two organotins at concentrations above their respective SSWSVs.

Data Gaps

Lacking suitable background concentrations, it is impossible to identify COPCs attributable to NAVBASE, which are critical for assessing the need to conduct additional phases of Zone J sampling.

While there are some areas in Zone J where the need for further sampling is likely, such as around the Zone E drydocks, this decision will also depend largely on the activities planned for these areas. If future uses for the potentially impacted NAVBASE waterfronts involve extensive dredging, then coordination between SOUTHDIV, future tenants, and/or the dredge activity sponsor(s) would be necessary before collecting additional RFI samples of those sediments designated for removal.

Attachment A

**SAMPLE-SPECIFIC
ANALYTICAL RESULTS**

COOPER RIVER SEDIMENT RESULTS - ZONE J ONLY

Sample ID	Cation Exchange Capacity meq/kg	Tributyltin mg/kg	REDOX mV	Acenaphthene ug/kg	Anthracene ug/kg	Benzo(a)anthracene ug/kg	Benzo(a)pyrene ug/kg	Benzo(b)fluoranthene ug/kg	Benzo(k)fluoranthene ug/kg
CPRM000101	58.7		274						
CPRM000201	11.1		233						
CPRM000401	32.7		473						
CPRM000501	41.6								
CPRM000601	59.6								
CPRM000701	12		277						
CPRM000801	11		423						
CPRM000901	56.8	52	248		840	210	140	170	
CPRM001001	6		284						
CPRM001101	48.45								
CPRM001201	19								
CPRM001301	69.9		268			160			
CPRM001401	48.3		281		86	120			
CPRM001501	51.6		288						
CPRM001601	80.1								
CPRM001701	92.1		259						
CPRM001801	35.4								
CPRM001901	2.3		249						
CPRM002001	11.2		369			220	220	270	210
CPRM002101	65.3		241	730	880	840	420	450	530
CPRM002201	56.8		253		230	170			
CPRM002301	18.3		304						
CPRM002401	62.7								
CPRM002501	68.7		243		210				
CPRM002601	6.7		300						
CPRM002701	55.5		247						
CPRM002801	10.9		319						
CPRM002901	45.1				220	140			
CPRM003001	61.3			300	190	1100	350	560	210
CPRM003101	37.55		287.00						
CPRM003201	53.7					180			
CPRM003301	37.6		157						
CPRM003401	14.1		84						
CPRM003501	6.7		253						
CPRM003601	55.6								
CPRM003701	19.6		235						
CPRM003801	21.4		143		120	150			
CPRM003901	22.6								
CPRM004001	65.8		217						
CPRM004101	26.1		230						
CPRM004201	63		238						
CPRM004301	34.3		251						
CPRM004501	12.5								
CPRM004601	10		208						
CPRM004701	11.8		292				53	83	
CPRM004801	23.8		215						
CPRM004901	8.6		177						
CPRM005001	19.6		177						

COOPER RIVER SEDIMENT RESULTS - ZONE J ONLY

Sample ID	BEHP ug/kg	Carbazole ug/kg	Chrysene ug/kg	Di-n-butylphthalate ug/kg	Dibenzofuran ug/kg	Diethylphthalate ug/kg	Fluoranthene ug/kg	Fluorene ug/kg	Indeno(1,2,3-cd)pyrene ug/kg	Phenanthrene ug/kg	Pyrene ug/kg
CPRM000101	150						140				
CPRM000201	1100										
CPRM000401											
CPRM000501											
CPRM000601											
CPRM000701						120					
CPRM000801											
CPRM000901	140		185				255				260
CPRM001001											
CPRM001101			99				145				130
CPRM001201											
CPRM001301			200				330				370
CPRM001401			110			150	290				140
CPRM001501						1200					84
CPRM001601											
CPRM001701											
CPRM001801											
CPRM001901						110					
CPRM002001			310				320		100		160
CPRM002101			800		390		2600	680		1900	1900
CPRM002201			200				460				250
CPRM002301						1500					
CPRM002401							340				290
CPRM002501			270				440				330
CPRM002601						860					
CPRM002701											
CPRM002801											
CPRM002901			150				220				170
CPRM003001			720				2600			580	2100
CPRM003101						2,100.00					
CPRM003201			190								150
CPRM003301						280					
CPRM003401											
CPRM003501					98		54				
CPRM003601											
CPRM003701											
CPRM003801	55		140				610				320
CPRM003901											
CPRM004001	87										
CPRM004101						770	93				650
CPRM004201						800					
CPRM004301											
CPRM004501											
CPRM004601											
CPRM004701											
CPRM004801											
CPRM004901					68		54				54
CPRM005001											

COOPER RIVER SEDIMENT RESULTS - ZONE J ONLY

Sample ID	Aluminum (Al) mg/kg	Antimony (Sb) mg/kg	Arsenic (As) mg/kg	Barium (Ba) mg/kg	Beryllium (Be) mg/kg	Cadmium (Cd) mg/kg	Chromium (Cr) mg/kg	Cobalt (Co) mg/kg	Copper (Cu) mg/kg	Lead (Pb) mg/kg	Manganese (Mn) mg/kg
CPRM000101	35000		21.3	42.1	1.5	0.28	60.9	8.7	23.7	23.5	654
CPRM000201	5310		6.7	9.6	0.56		28.8	0.67	7.8	3.7	112
CPRM000401	8270		9	12.1	0.51	0.38	22.2	3.6	12.1	8.9	123
CPRM000501	19200		10	22	0.69	0.37	37.2	4.1	16.7	11.4	223
CPRM000601	18400		19.4	24.9	0.87	0.55	41.1	6.6	19.4	20.9	554
CPRM000701	1830		2.7	4.6	0.19		5.1	1.7	1.9	3.4	64.9
CPRM000801	3020		2.4	6	0.09	0.21	6.9	1.3	3.7	4.4	60
CPRM000901	18450		16.2	24.55	1.15	0.38	43.25	5.25	22.45	19.25	495
CPRM001001	1680		2.4	5.3	0.18		4.7	1.2	1.4	2.7	63.9
CPRM001101	14650		13.2	20.9	0.61	0.52	34.2	4.35	17.4	15.7	364
CPRM001201	10500		5.3	14.4	0.51	0.26	23.5	2.6	4.2	7.4	136
CPRM001301	25900		18.2	33.2	1.4	0.93	51.5	8	26.1	32.3	716
CPRM001401	9990		8.7	14.7	0.49	0.13	19	3.1	8.7	11.5	174
CPRM001501	14600		10.7	37.1	0.69	0.61	28	4.3	23.2	17	157
CPRM001601	23000		21.5	30.6	0.99	1.1	53.5	8	32.4	28.8	728
CPRM001701	28800		16.6	30.3	1.1	1.4	51.2	6.5	8.5	21	329
CPRM001801	30100		21.6	35.6	1	0.74	55.4	7.7	26.1	25.7	721
CPRM001901	1750		9.1	12.2	0.81	0.29	13.7	1.1	4	5.6	137
CPRM002001	3660	0.53	4.8	8.3	0.11	0.2	8.8	0.91	330	24.6	77.7
CPRM002101	13400		19.1	21.7	1.2	0.79	36.2	5.1	21	27.8	607
CPRM002201	27300		20.1	33.4	1.3	0.47	52.2	7.4	22.2	27.9	666
CPRM002301	1420		5.2	4.1	0.25	0.11	5.1	1.2	7.6	2.9	115
CPRM002401	23900		22.2	30.6	0.85	0.66	50.2	6.8	25.6	24.7	789
CPRM002501	29600		21.9	34.6	1.4		53.8	7.6	20.9	25.2	663
CPRM002601	1700		1.4	12.9	0.25	0.27	6	0.76	30.7	5.1	31.7
CPRM002701	15600		10.1	18.8	0.57	0.57	30	4.3	13	10.6	216
CPRM002801	1700		2	4.3		0.09	4.4	0.55	2.3	3.2	23.2
CPRM002901	32000		21.7	35.6	1.1	0.65	55.6	7.7	21.2	23.1	649
CPRM003001	28900		17.9	33.7	1.1	0.69	53.1	8.6	22.1	26.3	590
CPRM003101	7,135.00		6.75	8.95	0.39	0.38	34.65	1.20	9.30	7.86	196.50
CPRM003201	19600		17.4	25.3	0.84	0.62	44.8	7.9	23.6	22.8	460
CPRM003301	2980		5	5.5	0.31	0.4	35.5		8.2	0.75	128
CPRM003401	5090		3.1	9.1	0.05	0.21	10.4	0.87	3.2	6.9	49.3
CPRM003501	3750		4.1	9.7	0.32		14.5	0.77	3.8	3.4	41.8
CPRM003601	26500		15.8	30.1	0.95	0.7	47.9	5.1	28.4	24.6	383
CPRM003701	13100		12.8	21.9	0.92	0.57	40.6	1.7	10.3	9.3	157
CPRM003801	9360		7	14.5	0.46	0.3	25.3	1.9	9	7	144
CPRM003901	17500		10.9	24.7	0.66	0.84	47	2.2	11.4	10.9	191
CPRM004001	24600		9	24.7	1.2	0.76	49.1	6.6	7.1	15.2	279
CPRM004101	10600		7.2	13.2	0.45	0.24	25	2.2	17.7	8.9	88.3
CPRM004201	15100		13.9	19.9	0.85	0.39	36.9	3.8	17.5	23.9	135
CPRM004301	20500		9.7	25	0.87	0.42	35	2.8	11.6	14.2	207
CPRM004501	8260		8.9	14.3	0.48	0.51	33.6	1.4	6.9	5.6	97.3
CPRM004601	4210		3.8	11	0.41		12.5	0.85	3.6	5	50.3
CPRM004701	2580		2.4	5.3	0.08	0.16	8.4	0.48	3	2.7	48.3
CPRM004801	17500		7.8	23.7	0.56		28.6	1.7		10	51.8
CPRM004901	1160		1.5	18.2	0.11		17.5	0.64	5	2.8	36.2
CPRM005001	3910		4.8	7	0.29	0.09	15.5	1.7	4.3	4	70.7

COOPER RIVER SEDIMENT RESULTS - ZONE J ONLY

Sample ID	Mercury (Hg) mg/kg	Nickel (Ni) mg/kg	Selenium (Se) mg/kg	Silver (Ag) mg/kg	Thallium (Tl) mg/kg	Tin (Sn) mg/kg	Vanadium (V) mg/kg	Zinc (Zn) mg/kg	TOC mg/kg	2-Butanone (MEK) ug/kg	Acetone ug/kg	Carbon disulfide ug/kg
CPRM000101		18.7					82.4	95.9	4.6	61	2400	9
CPRM000201		9.1	1.1				17.2	30.4	1.4	5		3
CPRM000401		9.8				19.8	20.4	55.9	2.3		39	5
CPRM000501		11.1					38.8	59.3	3.1	13	77	
CPRM000601		11.3					61.5	82.3	4.7	50	670	8
CPRM000701		1.1					7	13.1	0.62		20	
CPRM000801		1.9				13	7.7	21.9	0.9		11	3
CPRM000901		13.25					48.75	127.45	4.75	33.5		12
CPRM001001		0.94					5.1	10.8	0.27		29	
CPRM001101		9.45					41.6	69.35	5.5	51	420	
CPRM001201		5.8					20.6	31.6	1.1			
CPRM001301		15.5					62.1	130	4.6	53	2200	
CPRM001401		5.2					27	36	6.5		31	
CPRM001501		7.9				20.3	32.5	54.1	2.2	10	190	18
CPRM001601		15.6					70.5	116	4.9	58	320	10
CPRM001701		14.1				30	57.3	63	4.7	7	68	7
CPRM001801		15.6					73	106	4.9	82	430	12
CPRM001901		3.8					13.6	21.9	0.17		28	
CPRM002001	0.12	2.5					7.6	40.1	0.52		14	
CPRM002101		9.7					55	96.5	5.2	76	4100	9
CPRM002201		15.2					73.1	97.9	5.1	58	2700	9
CPRM002301		2.3		0.19			9	17	0.7		390	
CPRM002401		14.9					73.5	146	2	100	400	
CPRM002501		16.2					74.2	92.5	5.3	58	1300	10
CPRM002601		1.2		0.85	0.85		4.4	6.1	0.2		250	
CPRM002701		7.4				21	31.6	49.2	2.7	6	130	22
CPRM002801		1.4				15.9	5.2	11.9	0.64		13	
CPRM002901		15.8					78.3	104	4.6	85	610	10
CPRM003001		15.2					70.3	99.5	5.2	70	450	
CPRM003101		12.65			1.30		24.20	36.45	0.85		173.00	
CPRM003201		13.4					60.6	102	4.7	130	710	21
CPRM003301		11.8			2		21.7	33.4	1.3		55	
CPRM003401		2.6				9.8	10.6	18.4	0.95		24	
CPRM003501		4.4					8.8		0.68	3		5
CPRM003601		13.5	2.2				58.8	92.2	3.5	21	160	23
CPRM003701		12.5					27.2	50.8	1.7	9		10
CPRM003801		7.2					22	36.2	1		90	5
CPRM003901		15.3					36	60.2	1.7	10	120	4
CPRM004001		13.1					40.6	57.7	3		47	24
CPRM004101		6.9					22.6	52.1	1.3	40	870	5
CPRM004201	0.09	11.4					53.6	91.4	4			
CPRM004301		12.8					35.9	50.3	1.3			
CPRM004501		13.1	1.6		1.5		18.3	35.7	0.65	20	240	
CPRM004601		3.7					11.6	32	0.76			
CPRM004701		2.4				12.7	6.9	16	0.57		77	
CPRM004801		4.6					39.7	27.4	0.77			6
CPRM004901		3.6		0.26	0.97		5.7	12.2	0.53		690	
CPRM005001		5.3		0.49			9.3	27	0.49		280	

COOPER RIVER SEDIMENT RESULTS -- ZONES A, E, K, L ONLY

Sample ID	Cation Exchange Capacity meq/kg	Cyanide (CN) mg/kg	1234678-HpCDD ng/kg	1234678-HpCDF ng/kg	123678-HxCDD ng/kg	123678-HxCDF ng/kg	123789-HxCDD ng/kg	123789-HxCDF ng/kg	OCDD ng/kg
002M000101									
002M000201									
S02M000901									
S02M000501									
S02M000601									
S02M000701									
S02M000801									
S02M001001									
S02M001101									
054M000101									
054M000201			37.78	3.23	1.89	1.16	2.54	0.94	723.95
054M000301									
054M000401									
081M000101									
081M000201									
555M000101									
555M000201									
556M000101									
556M000201									
556M000301									
556M000401									
556M000501									
556M000601									
556M000701									
556M000801			70.7	7.86	2.76		3.06		970
556M000901									
695M000101	83.4								
695M000201	92								
699M0001E1		0.16							
699M0002E1		0.13							
699M0004E1		0.16							
699M0007E1		0.4							

COOPER RIVER SEDIMENT RESULTS -- ZONES A, E, K, L ONLY

Sample ID	OCDF ng/kg	Total Hepta-Dioxins ng/kg	Total Hepta-Furans ng/kg	Total Hexa-Dioxins ng/kg	Total Hexa-Furans ng/kg	Total Penta-Dioxins ng/kg	Total Tetra-Dioxins ng/kg	4,4'-DDE ug/kg	Endrin ketone ug/kg
002M000101									
002M000201									
S02M000901									
S02M000501									
S02M000601									
S02M000701									
S02M000801									
S02M001001									
S02M001101									
054M000101									
054M000201	6.23	156.05		95.97	2.1	8.16	5.18		
054M000301									
054M000401									
081M000101									
081M000201									
555M000101									
555M000201									
556M000101									
556M000201									
556M000301									
556M000401									14
556M000501								7.6	
556M000601									7.8
556M000701									
556M000801	22.4	377	7.86	68.9	3.07				11
556M000901									
695M000101									
695M000201									
699M0001E1									
699M0002E1									
699M0004E1									
699M0007E1									

COOPER RIVER SEDIMENT RESULTS -- ZONES A, E, K, L ONLY

Sample ID	Methoxychlor ug/kg	REDOX mV	2-Methylnaphthalene ug/kg	Acenaphthene ug/kg	Acenaphthylene ug/kg	Anthracene ug/kg	Benzo(a)anthracene ug/kg	Benzo(a)pyrene ug/kg	Benzo(b)fluoranthene ug/kg
002M000101									
002M000201									
S02M000901									
S02M000501									
S02M000601									
S02M000701									
S02M000801									
S02M001001									
S02M001101									
054M000101			220	640		1400	2600	2200	
054M000201							220	240	230
054M000301							210	210	170
054M000401									
081M000101							550	320	320
081M000201							370	300	300
555M000101									
555M000201									
556M000101									
556M000201									
556M000301						410	1600	1500	
556M000401				520	350	2500	6400	5500	
556M000501	45			260		1200	4300	3600	4300
556M000601						1000	2800	2400	2800
556M000701				690		1200	1800	1500	
556M000801				1100		1150	1400	1085	1130
556M000901									
695M000101		157							
695M000201		232							
699M0001E1									
699M0002E1									
699M0004E1									
699M0007E1									

COOPER RIVER SEDIMENT RESULTS -- ZONES A, E, K, L ONLY

Sample ID	Benzo(g,h,i)perylene ug/kg	Benzo(k)fluoranthene ug/kg	BEHP ug/kg	Carbazole ug/kg	Chrysene ug/kg	Di-n-butylphthalate ug/kg	Di-n-octyl phthalate ug/kg	Dibenz(a,h)anthracene ug/kg	Dibenzofuran ug/kg
002M000101									
002M000201									
S02M000901									
S02M000501									
S02M000601									
S02M000701									
S02M000801									
S02M001001									
S02M001101									
054M000101	1200	3600			2900			720	590
054M000201	170	250			160			90	
054M000301	120	210			260				
054M000401									
081M000101		460			940				
081M000201		320			430				
555M000101									
555M000201									
556M000101					350				
556M000201									
556M000301	430	2600			2000				
556M000401	3300	11000			10000			1500	150
556M000501	1800	3200			5600			820	
556M000601	1100	3000			4700			540	
556M000701	710	2200			1900		290	360	
556M000801	450	1100		220	1900			250	390
556M000901									
695M000101						200			
695M000201			170			120			
699M0001E1									
699M0002E1									
699M0004E1									
699M0007E1									

COOPER RIVER SEDIMENT RESULTS -- ZONES A, E, K, L ONLY

Sample ID	Diethylphthalate ug/kg	Fluoranthene ug/kg	Fluorene ug/kg	Indeno(1,2,3-cd)pyrene ug/kg	Naphthalene ug/kg	Phenanthrene ug/kg	Pyrene ug/kg	Aluminum (Al) mg/kg	Antimony (Sb) mg/kg	Arsenic (As) mg/kg
002M000101								13400		4.4
002M000201								14700		7.8
S02M000901								629		
S02M000501								2600		5.1
S02M000601								1,000.00		2.00
S02M000701								1300		
S02M000801								560		
S02M001001								1400		
S02M001101								4600		4.7
054M000101		6700	760	1100	590	6900	5600	2140	1.8	3.7
054M000201		255		140			635	15250	1.1	21.5
054M000301		500		110		260	480	2470	3.2	5.9
054M000401							130	2230	23.2	4.2
081M000101		1300					1200	12700		18.7
081M000201		780					840	9540		15.6
555M000101								5050	1.4	9
555M000201								5910	0.86	7.9
556M000101		810					690	15500		19.4
556M000201								16000		20.4
556M000301		2100		480			1600	12300		18.7
556M000401		18000	320	3000		3200	10000	6780	0.75	10.9
556M000501		14000		1800		5700	10000	2770	1.7	5.4
556M000601		8000		1100		760	4600	11500		9.7
556M000701		4600	520	690		2400	4400	8770		9.1
556M000801		3750	730	430	250	1800	3500	13300		17.4
556M000901							470	13300		21.2
695M000101	580							33300		17.7
695M000201	420							29900		15.5
699M0001E1								23000	0.65	20.8
699M0002E1								2450	4.4	5.3
699M0004E1								4380	7	9.7
699M0007E1								23400		20.3

COOPER RIVER SEDIMENT RESULTS -- ZONES A, E, K, L ONLY

Sample ID	Barium (Ba) mg/kg	Beryllium (Be) mg/kg	Cadmium (Cd) mg/kg	Chromium (Cr) mg/kg	Cobalt (Co) mg/kg	Copper (Cu) mg/kg	Lead (Pb) mg/kg	Manganese (Mn) mg/kg	Mercury (Hg) mg/kg	Nickel (Ni) mg/kg	Selenium (Se) mg/kg
002M000101	19.6			22.7		7.4	15.2	35.8		8.3	
002M000201	27.8			33.5		44.5	26.4	165		13.6	
S02M000901	4.5			2.95		4.55	16.55	13			
S02M000501	5.4			6.6	1.5		3.7	24			
S02M000601	16.00			4.20		14.00	14.00	23.00			
S02M000701	55			5.4		4.1	47	19			
S02M000801	20			2.2		3.4	6.4	9.2			
S02M001001	3.2			5.6		4.2	7.9	33			
S02M001101	10			15		22	17	41	0.04		
054M000101	19.5	0.26	0.3	28.4	2.9	83.1	87	47.1	0.52	19.7	
054M000201	26.1	1.15	0.27	35	6.45	36.5	57.45	298.5	0.635	14.4	1.85
054M000301	45.5	1.1	0.38	34.4	18.3	427	196	135	0.06	42.4	0.8
054M000401	56.8	2.5	0.45	40.4	15.8	355	482	140	0.06	35.7	0.81
081M000101	21.2	1.1		36.7	8	25.6	24.2	551		11.4	
081M000201	18.4	1		31.9	7.4	27.5	23.1	412		10.5	
555M000101	51.5	0.47	3.6	177	4	220	155	194	0.26	28.7	1.2
555M000201	17.5	0.45	0.67	64.6	3.6	61.8	180	104	0.15	11.4	
556M000101	25.8	1.2		41.4	9.1	24.6	28.2	736		12.4	
556M000201	25.4	1.2		42.3	9.7	39.1	26.7	865		14.6	
556M000301	20.6	1.1		35.6	8.2	27.7	22.3	407		11	
556M000401	20.5	0.49	0.67	23.6	4.1	156	47.1	204	0.09	9	10.5
556M000501	27.4	0.49	0.29	36.7	6.8	1930	220	162	0.05	32.6	0.6
556M000601	14.1	0.6		25.7	4.6	25.5	41.4	173		7.8	
556M000701	15	0.59		20.9	4.4	26.9	13.4	230	0.09	7.3	
556M000801	29.6	1.04		38.55	7.7	75.2	28.15	568.5	0.09	18.3	
556M000901	45	1.2		39.3	9.4	25.6	26.3	824		12.2	
695M000101	33	1.6	0.25	60.3	7.3	9.6	14.8	255		17	
695M000201	30.1	1.5	0.16	57.7	7.2	9.1	13.9	301		17.4	
699M0001E1	40.7	1.3	0.17	45	7.3	41.1	77.5	224	0.35	16.4	1.2
699M0002E1	90.8	0.19	0.4	230	3.7	146	515	148	0.11	102	0.63
699M0004E1	19	0.48	0.48	151	3.4	164	996	85.4	0.12	25.2	0.54
699M0007E1	36.4	1.4		50.3	8.4	51.1	26.2	583	0.15	15.7	1.6

COOPER RIVER SEDIMENT RESULTS -- ZONES A, E, K, L ONLY

Sample ID	Silver (Ag) mg/kg	Thallium (Tl) mg/kg	Tin (Sn) mg/kg	Vanadium (V) mg/kg	Zinc (Zn) mg/kg	TOC %	2-Butanone (MEK) ug/kg	Acetone ug/kg	Carbon disulfide ug/kg	Chloroform ug/kg	Methylene chloride ug/kg
002M000101				23.8	34.3						
002M000201				29.7	57.1						
S02M000901				2.45	15.15						
S02M000501				10	5.8						
S02M000601				3.90	14.00						
S02M000701				12	17						
S02M000801				2	7.5						
S02M001001				4.5	21						
S02M001101				13	37						
054M000101				7.4	211						
054M000201				53.35	118						
054M000301	0.75		43.6	6.6	1180						
054M000401	0.71		55.7	5.4	1390						
081M000101				50.7	77.5		24		21		
081M000201				40.2	73.5		27		18		
555M000101	0.67		15.8	20.7	277						
555M000201	0.68			20	177						
556M000101				53.5	91.5		32				
556M000201			12.8	54.5	76.9		17				
556M000301			12.3	53.3	71.8		26		12		
556M000401				21.8	443		18	2000			
556M000501			35	6.3	774		4	600			
556M000601				28.9	70.6			300			
556M000701				25.3	55.4		33	350	18		
556M000801				45.05	114.95		20.5	570	10		
556M000901			13.6	52	79.6		42		6		
695M000101	0.67	1.9		66.2	64.5	6		83			
695M000201	0.66	3.3		61.4	53.5	5		60			
699M0001E1		1.1	4.8	68.6	189			38		5	9
699M0002E1			546	12.1	1250			37		3	6
699M0004E1	0.37		12	21.3	341			10		3	5
699M0007E1			5.6	71.2	98.8			130		9	22

SHIPYARD CREEK SEDIMENT RESULTS

Sample ID	Cation Exchange Capacity meq/kg	REDOX mV	2-Butanone (MEK) ug/kg	Acetone ug/kg	Carbon disulfide ug/kg	1234678-HpCDD ug/kg	1234678-HpCDF ng/kg	123478-HxCDD ng/kg
SYCM000101	55.7	273			13	46.8	5.15	
SYCM000201	53.6	278			23	14.2	1.7	
SYCM000301	66	248		380	8	0.89		
SYCM000401	29.7	268				27	2.05	
SYCM000501	46.1	230			11	11.2	0.99	
SYCM000601	24.1	240				4.49	0.2	
SYCM000701	69.8	209	8	99	17	26	1.86	0.83
SYCM000801	154	245	13		12	91.2	5.34	
SYCM000901	66.8	299	8		14	56.5		
SYCM001001	51	197	17	120	7	34.1	0.46	0.57
SYCM001101	41.8	185	5			4.56		
SYCM001201	41.5	170				2.45	0.42	
SYCM001301	62.6	185				20	1.96	
SYCM001401	149	268	47			267	11.1	
SYCM001501	66.6	191	6		19	58.4	1.38	0.92
SYCM001601	120.87	148	52	1000	18	84.5	5.34	
SYCM001701	71.9	233.5	10	1010	20	13.88		
SYCM001801	22.03	224	7.5		8.5	23.89	2.92	
SYCM001901	120	112	47	420	11	67.3	3.93	
SYCM002001	7.8	256	12	7600		80.5		
SYCM002101	8.7	247.5		1300	5	16.85		
SYCM002201	83.7	132	21		8	40.9	2.81	
009M000101								
009M000201								
009M000301					150			
009M000401					64			
009M000501					11			

SHIPYARD CREEK SEDIMENT RESULTS

Sample ID	123478-HxCDF	1234789-HpCDF	123678-HxCDD	123678-HxCDF	123789-HxCDD	OCDD	OCDF	Total Hepta-Dioxins
	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg
SYCM000101	0.75		1.64		2.21	566	6.76	181
SYCM000201						153	2.17	57.2
SYCM000301						17.1	0.49	0.09
SYCM000401			1.11		2.53	415	2.98	126
SYCM000501						183	0.91	45.4
SYCM000601						46.1	0.34	25.1
SYCM000701	0.35		0.93		1.56	389	3.23	106
SYCM000801					3.13	995	15.9	435
SYCM000901			1.47		3.7	893		245
SYCM001001			1.51		2.62	366	0.49	148
SYCM001101						35.3	0.72	20.1
SYCM001201						21.7	0.51	8.46
SYCM001301						212	5.05	66.1
SYCM001401	1.79		3.39		8.75	2540	55.3	1990
SYCM001501	0.31		1.53		3.94	828	4.84	272
SYCM001601			2.495		5.165	882.67	16.57	424.33
SYCM001701					1.53	177.5		53.2
SYCM001801	0.77	0.49	0.57	0.53	1.33	232.67	9.43	100.87
SYCM001901	3.33		1.95		3.99	734	12.1	313
SYCM002001						1060	10	430
SYCM002101						289.5		73.75
SYCM002201					2.24	444	10.3	176
009M000101								
009M000201								
009M000301								
009M000401								
009M000501								

SHIPYARD CREEK SEDIMENT RESULTS

Sample ID	Total Hepta-Furans ng/kg	Total Hexa-Dioxins ng/kg	Total Hexa-Furans ng/kg	Total Penta-Dioxins ng/kg	Total Penta-Furans ng/kg	Total Tetra-Dioxins ng/kg	Total Tetra-Furans ng/kg
SYCM000101	5.5	81.3	4.34	8.71	3.14	9.09	1.03
SYCM000201	1.81	25.4	1.58	4.23		9.27	
SYCM000301						0.88	
SYCM000401	2.05	74.1	5.15	8.82		16.8	
SYCM000501	1.06	21.4	0.7	3.4		7.46	
SYCM000601	0.47	19.7	0.2	2.22		5.2	
SYCM000701	5.04	45.4	2.71	3.56	1.34	2.51	
SYCM000801	5.7	97.3	1.82	8.6		4.72	
SYCM000901	1.09	126		15.6		7.32	
SYCM001001	1.17	119		12.4		5.79	
SYCM001101	0.68	8.81		1.41		1.39	
SYCM001201	0.82	2.38					
SYCM001301	2.09	23	2.09	1.41			
SYCM001401		201	13.4	5.62		5.56	
SYCM001501	1.48	112	1.9	8.14		3.92	0.42
SYCM001601	7.69	88.33	4.69	5.22		3.98	
SYCM001701		46		7.17		3.15	
SYCM001801	3.36	27.28	1.31	2.41	2.72	2.12	
SYCM001901	4.2	74.2		7.42		3.37	
SYCM002001	8.89	151					
SYCM002101		47.15				2.26	
SYCM002201		50.4	2.63	3.78		2.76	
009M000101							
009M000201							
009M000301							
009M000401							
009M000501							

SHIPYARD CREEK SEDIMENT RESULTS

Sample ID	Aluminum (Al)	Antimony (Sb)	Arsenic (As)	Barium (Ba)	Beryllium (Be)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
SYCM000101	16900	0.99	13.1	21.8	0.91	1	132	3.4	20.1
SYCM000201	15100		12.9	18.6	0.93	0.77	97.7	3.4	18.6
SYCM000301	14300		13.2	19.9	0.97	0.97	53.7	3.3	14
SYCM000401	9640	0.96	9.4	14.7	0.68	0.66	79.4	2.2	10.7
SYCM000501	17300	0.77	12.8	20.3	0.82	0.8	63.4	3.3	11.9
SYCM000601	7350	0.78	9.1	15.5	0.63	0.64	50	1.2	13.5
SYCM000701	13700		12.8	21.7	0.77	0.68	76.5	3.4	23.4
SYCM000801	20200		21.6	27.5	0.72	0.84	63.2	6.3	20.8
SYCM000901	10800	0.66	13.9	18.3	0.43	0.76	60.5	3.9	41.9
SYCM001001	16900		13.4	27.1	1.2	0.73	73.1	5.2	21
SYCM001101	5720		6.9	15.1	0.49	0.15	26	2.6	11.4
SYCM001201	13400	0.7	8.1	27.7	0.68	0.56	59.2	2.5	24.1
SYCM001301	14900		7.3	23.4	0.84	0.28	104	4.2	36.5
SYCM001401	33800		18.8	37.4	0.82	0.87	57.7	7.3	24.4
SYCM001501	27300		21.7	32.6	1.3	0.35	58.2	7.1	17.3
SYCM001601	26,366.67		20.43	31.33	0.81	0.98	50.27	6.4	20.53
SYCM001701	20550		24.2	24.65	1.35	0.32	43.8	6.9	12.2
SYCM001801	15,826.67	0.56	11.63	28.47	0.78	0.73	40.4	2.35	30.93
SYCM001901	25100		21.7	31.4	0.93	0.84	52.4	6.7	21.3
SYCM002001	26300		20.6	30.4	1.2		53.4	7.1	18.3
SYCM002101	24200		14.8	30.55	1.1	0.185	43.3	3.8	12.6
SYCM002201	16300		13.8	21.3	0.78	0.72	37	5.1	16.1
009M000101	21400		14.1	17.7	0.93		132	5	31.4
009M000201	5160		3.3	18.6	0.57		17.8	2.3	228
009M000301	17600		15.6	21.4	1	0.23	48.3	5.6	28.7
009M000401	20600	2.7	11.9	29.1	0.94	0.64	291	5.7	141
009M000501	9870	2.9	7.3	19.2	0.55	0.61	168	3.3	90

SHIPYARD CREEK SEDIMENT RESULTS

Sample ID	Lead (Pb) mg/kg	Manganese (Mn) mg/kg	Mercury (Hg) mg/kg	Nickel (Ni) mg/kg	Selenium (Se) mg/kg	Silver (Ag) mg/kg	Thallium (Tl) mg/kg	Tin (Sn) mg/kg	Vanadium (V) mg/kg	Zinc (Zn) mg/kg
SYCM000101	22.9	192		27.8					45.4	115
SYCM000201	18	179		25.4	1.7	0.44			40.9	89.3
SYCM000301	11.5	202		21.5	2.5	0.49			42.7	67
SYCM000401	10.9	98.1		22	1.2	0.38			25.7	67.5
SYCM000501	10	142		22.3	1.9				40.5	56.5
SYCM000601	3.8	74.7		20.9	2		1.3		22.4	41.4
SYCM000701	23	197		24.3					40.7	76.4
SYCM000801	27.7	626		13.7					72.4	99.3
SYCM000901	28.1	118		10.2					30.6	94.9
SYCM001001	21.5	145		20		1.1			36.6	87.4
SYCM001101	10.6	128		6.5		0.7			19.4	39.2
SYCM001201	17.3	367		16.5	1.2		3.3		30.4	74.8
SYCM001301	36.9	67.7	0.09	19.9		1.4			42.3	87.5
SYCM001401	27	532		17					83.9	102
SYCM001501	20.9	383		17.7		0.78			61.8	60.5
SYCM001601	25.77	707		14.1					66.53	90.77
SYCM001701	19.6	183		13.9	2.2	0.87			59.9	46.85
SYCM001801	14.13	142.27		11.77	1.7		1.65		28.53	49.17
SYCM001901	28.6	763		14.4					70	103
SYCM002001	22.5	838		14.4	2.9			27.1	63.6	76.5
SYCM002101	17.7	166.5		15.25	0.86				43.9	51.05
SYCM002201	19.7	434		10.8					48	69.2
009M000101	44.8	161	0.16	24.3	1.5				47.7	115
009M000201	102	25.7	0.02	14.2	0.82				17.4	133
009M000301	74.5	274	0.51	18.3	1.5				49.6	121
009M000401	107	274	0.69	37.3	0.56				52.2	387
009M000501	74.8	118	0.33	21.2	0.9				28.7	261

SHIPYARD CREEK SEDIMENT RESULTS

Sample ID	Benzo(a)anthracene ug/kg	Benzo(a)pyrene ug/kg	Benzo(b)fluoranthene ug/kg	Benzo(g,h,i)perylene ug/kg	Benzo(k)fluoranthene ug/kg	BEHP ug/kg	Chrysene ug/kg
SYCM000101							
SYCM000201							
SYCM000301						1600	
SYCM000401							
SYCM000501							
SYCM000601							
SYCM000701	110						170
SYCM000801							
SYCM000901	100	110	140				120
SYCM001001							
SYCM001101							
SYCM001201							
SYCM001301						150	
SYCM001401							
SYCM001501							
SYCM001601							
SYCM001701							
SYCM001801	114	147.5	139	41	87	51	122
SYCM001901							
SYCM002001							180
SYCM002101	68.5	60				630	70
SYCM002201							
009M000101	87						
009M000201						160	
009M000301							
009M000401							
009M000501	140					830	

SHIPYARD CREEK SEDIMENT RESULTS

Sample ID	Di-n-butylphthalate ug/kg	Di-n-octyl phthalate ug/kg	Diethylphthalate ug/kg	Fluoranthene ug/kg	Indeno(1,2,3-cd)pyrene ug/kg	Phenanthrene ug/kg	Pyrene ug/kg
SYCM000101							
SYCM000201							
SYCM000301			830				
SYCM000401							
SYCM000501							
SYCM000601							
SYCM000701	160			99			100
SYCM000801	200			210			
SYCM000901	81			190		74	180
SYCM001001							
SYCM001101							
SYCM001201							
SYCM001301	130						
SYCM001401			1400				
SYCM001501	89						
SYCM001601				180			
SYCM001701							
SYCM001801	45			203.33	100	96.5	206.67
SYCM001901							
SYCM002001				350		170	250
SYCM002101		110		115.5		69	170
SYCM002201							
009M000101				230			280
009M000201							
009M000301							
009M000401				9500			6400
009M000501				350			340

SHIPYARD CREEK SEDIMENT RESULTS

Sample ID	Total Organic Carbon (TOC) mg/kg	4,4'-DDD ug/kg	4,4'-DDE ug/kg	4,4'-DDT ug/kg	Aldrin ug/kg	Aroclor-1248 ug/kg	Aroclor-1254 ug/kg	Aroclor-1260 ug/kg	beta-BHC ug/kg
SYCM000101	2.1								
SYCM000201	2.6								
SYCM000301	2.4								
SYCM000401	0.98								
SYCM000501	3.4								
SYCM000601	0.71								
SYCM000701	5.1								
SYCM000801	4.7								
SYCM000901	2.7								
SYCM001001	3.2								
SYCM001101	1.9								
SYCM001201	2.2								
SYCM001301	6.4								
SYCM001401	4.6								
SYCM001501	2.4								
SYCM001601	4.87								
SYCM001701	5.1								
SYCM001801	1.12								
SYCM001901	4.7								
SYCM002001	2.8								
SYCM002101	2.6								
SYCM002201	3.5								
009M000101	34000		4				110		
009M000201	22000	4	4	15				130	7
009M000301	26000		21						
009M000401	46000	41	110		18	3000	690	770	
009M000501	26000	91	150	140	12		510	380	

NOISETTE CREEK SEDIMENT RESULTS

Sample ID	TOC	2-Butanone (MEK)	Acetone	Carbon disulfide	Aroclor-1260	2,4-Dimethylphenol	2-Methylnaphthalene	2-Methylphenol (o-Cresol)
	mg/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
NOIM000101	10400	9	91	28				
NOIM000201	4600		48	24		1200	1000	4300
NOIM000301	1000				123			
NOIM000401	2100	5		10				
NOIM000501	8600	5		13				
NOIM000601	570							
NOIM000701	3500		33	27				
NOIM000801	12200	13	130	31				
NOIM000901	19600	19	190	52				
NOIM001001	2600		350					
044M001801	14000							
044M001901	15200							
044M002001	12400							
044M002101	10200							

NOISETTE CREEK SEDIMENT RESULTS

Sample ID	Anthracene ug/kg	Benzo(a)anthracene ug/kg	Benzo(a)pyrene ug/kg	Benzo(b)fluoranthene ug/kg	Benzo(g,h,i)perylene ug/kg	Benzo(k)fluoranthene ug/kg	Chrysene ug/kg
NOIM000101							
NOIM000201							
NOIM000301		61	65	110			70
NOIM000401	610	1000	990	1200	210	760	1500
NOIM000501		170	230	250		190	190
NOIM000601		100	65	96			72
NOIM000701							
NOIM000801							
NOIM000901							
NOIM001001							
044M001801							
044M001901							
044M002001							
044M002101							

NOISETTE CREEK SEDIMENT RESULTS

Sample ID	Dibenz(a,h)anthracene ug/kg	Diethylphthalate ug/kg	Fluoranthene ug/kg	Indeno(1,2,3-cd)pyrene ug/kg	Naphthalene ug/kg	Phenanthrene ug/kg	Pyrene ug/kg	BEHP ug/kg
NOIM000101		1400						
NOIM000201		960			630	160	100	170
NOIM000301			120				170	1800
NOIM000401	150		1500	270		83	950	
NOIM000501			750				660	
NOIM000601			180			110	150	
NOIM000701								
NOIM000801								
NOIM000901								
NOIM001001		500	100				65	
044M001801								
044M001901								
044M002001								
044M002101								

NOISETTE CREEK SEDIMENT RESULTS

Sample ID	Aluminum (Al)	Antimony (Sb)	Arsenic (As)	Barium (Ba)	Beryllium (Be)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
NOIM000101	9760		14.6	24.5	0.94	0.29	26.3	4.2	14.7
NOIM000201	28900		19.9	32.7	1.3	0.82	54.9	7.5	36.3
NOIM000301	1870		4.5	7.9			7	1.3	15.6
NOIM000401	7830	1.1	10.7	44.4	1.9	0.45	25.3	10.6	127
NOIM000501	20600		14.5	23.7	0.84	0.51	32.3	5.3	23.2
NOIM000601	1550		1.8	3.2			4.1	0.69	4.1
NOIM000701	8450		14.7	14.4	0.69	0.26	21	4.3	16.3
NOIM000801	24300		19.9	27.9	1.1	0.4	47.4	5.8	27.9
NOIM000901	12800		7.5	18.6	0.26	0.36	22.8	2.2	31
NOIM001001	3510		5.3	5.1	0.18	0.1	9.2	1.2	7.5
044M001801									
044M001901									
044M002001									
044M002101									

NOISETTE CREEK SEDIMENT RESULTS

Sample ID	Lead (Pb)	Manganese (Mn)	Mercury (Hg)	Nickel (Ni)	Tin (Sn)	Vanadium (V)	Zinc (Zn)
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
NOIM000101	18.5	202		7.7		34.1	117
NOIM000201	39.9	181	1.2	16.4		76	151
NOIM000301	16.3	18.5		6.3		7.2	41.1
NOIM000401	126	140	0.16	20.5	48.1	22.2	718
NOIM000501	32.3	233	0.24	10.8		44.9	106
NOIM000601	6.8	11.3	0.14	1.4		3.7	26.8
NOIM000701	21.5	167	0.13	6.1		28.1	61.9
NOIM000801	59.1	194	0.28	12.5		81.2	124
NOIM000901	62.6	113		6.4		38.2	156
NOIM001001	9.4	32.4		4.7		10.5	36.4
044M001801							
044M001901							
044M002001							
044M002101							

COOPER RIVER SURFACE WATER RESULTS

Sample ID	Total Alkalinity mg/L	Acenaphthene mg/L	BEHP mg/L	Pyrene mg/L	Chloride mg/L	Chemical Oxygen Demand mg/L	Nitrate-Nitrite-N mg/L	Tributyltin ug/L	pH SU
556W000103									
556W000203									
556W000303									
556W000603								28.00	
556W000703									
556W000803									
556W000903		1.00	2.00	1.00					
CPRW000103	81.00				11,100.00	98.50	0.07		7.43
CPRW000903	83.00				11,400.00	57.40	0.08		7.61
CPRW001303	82.50				11,600.00	77.90	0.07		7.64
CPRW001503	60.50				7,250.00	45.10	0.09		7.38
CPRW002103	90.00				12,400.00	86.20	0.05		7.73
CPRW002503	92.50				12,800.00				7.70
CPRW002803	82.50				11,100.00	154.00	0.06		7.35
CPRW003203	84.50				11,700.00	78.00			7.53
CPRW003703	72.50				9,200.00	101.00	0.12		7.45
CPRW004603	70.00				9,370.00	183.00	0.07		7.52
CPRW004703	74.00				10,600.00	109.00	0.09		7.57
CPRW004803	73.00				8,320.00	155.00	0.18		7.24
CPRW004903	77.00				10,700.00	212.00			7.43
CPRW005003	85.00				13,500.00	153.00			6.58

COOPER RIVER SURFACE WATER RESULTS

Sample ID	Total phosphorus mg/L	Acetone ug/L	Carbon disulfide ug/L	Methylene chloride ug/L	1234678-HpCDF pg/L	OCDD pg/L	Total Hepta-Dioxins pg/L	Aluminum (Al) ug/L
556W000103								743.00
556W000203								199.00
556W000303								165.00
556W000603								87.50
556W000703								182.00
556W000803								218.00
556W000903					7.52	46.40	7.59	1,007.00
CPRW000103	0.15			3.00				730.00
CPRW000903	3.40	4.00						996.00
CPRW001303		3.00						694.00
CPRW001503		4.00						582.00
CPRW002103								4,790.00
CPRW002503	0.11	3.00						5,430.00
CPRW002803								5,320.00
CPRW003203	0.10							1,060.00
CPRW003703			2.00					55.40
CPRW004603								572.00
CPRW004703	0.31							2,420.00
CPRW004803	0.20	2.00	2.00					324.00
CPRW004903		7.00						198.50
CPRW005003		4.00						189.00

COOPER RIVER SURFACE WATER RESULTS

Sample ID	Arsenic (As) ug/L	Barium (Ba) ug/L	Beryllium (Be) ug/L	Cadmium (Cd) ug/L	Chromium (Cr) ug/L	Copper (Cu) ug/L	Lead (Pb) ug/L	Manganese (Mn) ug/L	Mercury (Hg) ug/L
556W000103		11.00						11.50	
556W000203		10.50							
556W000303		11.40							
556W000603		11.90							
556W000703		13.70						6.00	
556W000803		12.00					6.50	4.30	
556W000903		11.20				2.40		17.35	
CPRW000103		12.60			41.20			30.90	
CPRW000903		14.90	3.60		37.10			42.40	
CPRW001303		14.40			31.10			20.40	
CPRW001503		11.80			16.20			20.30	
CPRW002103									
CPRW002503									
CPRW002803								55.60	
CPRW003203		19.40							
CPRW003703		11.00	0.43					12.00	
CPRW004603		12.60	0.47					10.30	
CPRW004703	5.30	14.60	0.86				3.30	124.00	
CPRW004803		13.00						21.20	
CPRW004903		9.85	2.10	0.38		13.10		21.40	
CPRW005003		9.60	2.10					20.30	1.10

COOPER RIVER SURFACE WATER RESULTS

Sample ID	Nickel (Ni) ug/L	Silver (Ag) ug/L	Thallium (Tl) ug/L	Tin (Sn) ug/L	Vanadium (V) ug/L	Zinc (Zn) ug/L	alpha-BHC ug/L	BEHP ug/L	Di-n-butylphthalate ug/L
556W000103	1.30		6.70		3.00				
556W000203			6.10		1.20				
556W000303			5.00		1.30				
556W000603			5.30		1.40			3.00	
556W000703	1.40		5.50		1.60				
556W000803	1.10		5.10		1.70			14.00	
556W000903	2.35		5.80		3.80				
CPRW000103		15.40		385.00		68.20			1.00
CPRW000903		11.20		383.00	5.70	57.00		1.00	
CPRW001303				386.00		60.20		1.00	
CPRW001503				289.00		52.90			
CPRW002103				385.00		357.00		4.00	4.00
CPRW002503				385.00		349.00			
CPRW002803				372.00		340.00			
CPRW003203						182.00			
CPRW003703				458.00	2.10	25.70			
CPRW004603				416.00	1.80	29.30	1.12		
CPRW004703				409.00	8.90	48.20			
CPRW004803				368.00		61.30	0.07		
CPRW004903				117.00	2.60	34.50			8.00
CPRW005003				50.20	2.70	55.30		2.00	3.00

COOPER RIVER SURFACE WATER RESULTS

Sample ID	Diethylphthalate ug/L	Xylene (Total) ug/L	TKN mg/L	Total Organic Carbon (TOC) mg/L	Total phosphorus mg/L	Total Suspended Solids (TSS) mg/L
556W000103						
556W000203						
556W000303						
556W000603		2.00				
556W000703						
556W000803						
556W000903						
CPRW000103	83.00		0.61			
CPRW000903	23.00		0.73			86.00
CPRW001303	24.00		0.35			
CPRW001503	33.00		0.47			
CPRW002103	66.00		0.44			50.00
CPRW002503	12.00		0.51			
CPRW002803	14.00		0.52			32.00
CPRW003203			0.52			32.00
CPRW003703	5.00		0.49			
CPRW004603	5.00		0.42	14.10		
CPRW004703	5.00		0.30	10.30		66.00
CPRW004803	5.00		0.49			
CPRW004903	32.00		0.82		0.15	
CPRW005003			0.79		2.00	

SHIPYARD CREEK SURFACE WATER RESULTS

Sample ID	Total Alkalinity mg/L	Chloride mg/L	Chemical Oxygen Demand mg/L	pH SU	Acetone ug/L	1234678-HpCDD pg/L	1234678-HpCDF pg/L	OCDD pg/L	OCDF pg/L
SYCW000103	67.5	7820	116	7.07				34	
SYCW000203	69	7740	32.6	6.91				23.9	
SYCW000303	77	10250	207	7.2		5.125		68.75	2.98
SYCW000703	71	8060	172	7.47		5.77		52.8	
SYCW000803	98	15600	444	7.67		5.75	5.62	51.3	12.4
SYCW000903	85	12300	106	7.35		3.99		39.2	2.04
SYCW001103	80.5	10100	152	7.19	4	4.12		54.4	2.65
SYCW001303	63	7960	126	7.49		6.9		53.1	
SYCW001403	94.5	14900	402	7.63	5	4.3		48.2	4.71
SYCW001503	77.5	10300	197	7.22		5.01		53.2	
SYCW001603	101	16700	194	7.54					
SYCW001803	82	11900	129	7.36	6	5.27		44.4	
SYCW001903	96	15700	207	7.53		4.97		45.4	2.89
SYCW002203	100	16300	131	7.59		3.69		36.5	
009W000101									
009W000401									

SHIPYARD CREEK SURFACE WATER RESULTS

Sample ID	Total Hepta-Dioxins pg/L	Aluminum (Al) ug/L	Antimony (Sb) ug/L	Arsenic (As) ug/L	Barium (Ba) ug/L	Beryllium (Be) ug/L	Cadmium (Ca) ug/L	Chromium (Cr) ug/L
SYCW000103	10.7	346			16.6			29.7
SYCW000203	8.13				15.1			
SYCW000303	14.95	73.6		3.15	13.9	2.65		
SYCW000703	28.6	402			16.3			7.7
SYCW000803	15.7	949		5.2	12.8	3.4		
SYCW000903	7.31	99.9		3.5	13.4	2.7		
SYCW001103	12.2	70.2		3.6	16	2.7		
SYCW001303	30.1				13	1.2		
SYCW001403	16.8	1750		6	13.3	3.8		
SYCW001503	19.9	84			13.7	2.6		
SYCW001603		2010	21.6		13.7	10.1		36.1
SYCW001803	14.2	234		5	13.2	3.3		
SYCW001903	15.6	146			11.9	3.5		429
SYCW002203	7.81	211		4.4	10.7	4.4		443
009W000101		6210		8	93.2		2.4	221
009W000401		4100		7.2	79.8			200

SHIPYARD CREEK SURFACE WATER RESULTS

Sample ID	Cobalt (Co) ug/L	Copper (Cu) ug/L	Lead (Pb) ug/L	Manganese (Mn) ug/L	Nickel (Ni) ug/L	Selenium (Se) ug/L	Silver (Ag) ug/L	Tin (Sn) ug/L	Vanadium (V) ug/L	Zinc (Zn) ug/L
SYCW000103				32.1					3.7	
SYCW000203				23.3					2.6	
SYCW000303				10.9		3.6	2.45		2.6	
SYCW000703				28.1					5.3	
SYCW000803				41.6				68.4	5.1	9
SYCW000903				9				802	2.8	
SYCW001103				13.3		4.3	2.6		2.5	
SYCW001303		10.3		19.7					2.7	
SYCW001403			3.3	96.9					8.6	7.6
SYCW001503				12				798	2.4	8
SYCW001603	14.8	24.3	24.4	81.9	24.6	39.7	76.7	119	5.3	18.9
SYCW001803				15			3.4	65.3	3.3	
SYCW001903				6.2					2.8	3.4
SYCW002203				9.7			2.6	132	3	
009W000101		40.7	55.5	208	12.7				24	229
009W000401		50.8	51.3	260	15				24	196

SHIPYARD CREEK SURFACE WATER RESULTS

Sample ID	2-Nitrophenol ug/L	Benzoic acid ug/L	BEHP ug/L	TKN mg/L	TOC mg/L	TSS mg/L
SYCW000103				0.41	5	
SYCW000203				0.99	3.4	
SYCW000303	20				2.1	
SYCW000703				1.3	4	
SYCW000803			3			
SYCW000903			2		2.5	
SYCW001103			3			
SYCW001303				0.84		
SYCW001403			6			
SYCW001503			23			
SYCW001603		1	1		8.9	62
SYCW001803			1			
SYCW001903			1			154
SYCW002203			1			20
009W000101						
009W000401						

NOISETTE CREEK SURFACE WATER RESULTS

Sample ID	Acrolein ug/L	Total Alkalinity mg/L	Chloride mg/L	TKN mg/L	TOC mg/L	TSS mg/L	Chemical Oxygen Demand mg/L	Nitrate-Nitrite-N mg/L	pH SU	Aluminum (Al) ug/L
NOIW000103		72.5	3630	0.84	5.9		89.6	0.07	6.81	
NOIW000203		81	2670	0.5		36	93.6		6.92	
NOIW000303		67	6800		3		91		6.83	292
NOIW000403		68.5	4020	0.61	32.5		81.4	0.065	6.82	
NOIW000603		70	3770	0.65	10.5		68.5	0.11	6.89	
NOIW001003		56	5150	0.43			79.4	0.09	7.06	
044W001801										
044W001901	1.00									980.00
044W002001										
044W002101										

NOISETTE CREEK SURFACE WATER RESULTS

Sample ID	Arsenic (As) ug/L	Barium (Ba) ug/L	Beryllium (Be) ug/L	Cadmium (Cd) ug/L	Chromium (Cr) ug/L	Cobalt (Co) ug/L	Copper (Cu) ug/L	Iron (Fe) ug/L	Lead (Pb) ug/L	Manganese (Mn) ug/L
NOIW000103		22.8						213		64.4
NOIW000203		21.8						2610		74.9
NOIW000303	2.4	17.3	1.5	0.31	3.2		8.6	451	3.5	40.6
NOIW000403		22						237.5		54.1
NOIW000603		18.7						283		47.7
NOIW001003		16.2								23.2
044W001801		20.40			2.30			362.00		82.60
044W001901		23.25			3.65	0.93	4.90	1,066.00		92.95
044W002001		20.80			3.10			359.00		80.30
044W002101		21.50			2.10			362.00		58.70

NOISETTE CREEK SURFACE WATER RESULTS

Sample ID	Nickel (Ni) ug/L	Silver (Ag) ug/L	Tin (Sn) ug/L	Vanadium (V) ug/L	Zinc (Zn) ug/L	Benzoic acid ug/L	BEHP ug/L	Di-n-butylphthalate ug/L	Dibutyltin ug/L	Monobutyltin ug/L
NOIW000103										
NOIW000203				9.7						
NOIW000303	1.5	2.2	67.7	3.2	21.9	1	2			
NOIW000403										
NOIW000603							4			
NOIW001003			259							
044W001801				1.50	15.20					
044W001901				3.50	17.30			2.00		
044W002001	10.20			1.50	13.20				0.12	0.17
044W002101				1.40	18.80					

ZONE J SEDIMENT PARTICLE SIZE					
Cooper River		Shipyard Creek		Noisette Creek	
Sample ID	Particle Size	Sample ID	Particle Size	Sample ID	Particle Size
CPRM0018	100	SYCM0019	100	NOIM0002	98
CPRM0022	98	SYCM0016	98	NOIM0008	84
CPRM0017	98	SYCM0008	97	NOIM0007	66
CPRM0024	98	SYCM0014	93	NOIM0001	65
CPRM0029	97	SYCM0022	82	NOIM0009	58
CPRM0025	97	SYCM0007	80	NOIM0006	39
CPRM0020	97	SYCM0017	79	NOIM0010	14
CPRM0021	94	SYCM0003	72	NOIM0004	14
CPRM0013	93	SYCM0001	71	NOIM0003	5
CPRM0030	87	SYCM0013	70		
CPRM0042	86	SYCM0009	60		
CPRM0038	83	SYCM0011	57		
CPRM0001	79	SYCM0012	53		
CPRM0016	69	SYCM0002	51		
CPRM0011	65	SYCM0015	50		
CPRM0032	64	SYCM0005	44		
CPRM0040	61	SYCM0010	41		
CPRM0009	60	SYCM0004	31		
CPRM0005	52	SYCM0021	29		
CPRM0048	50	SYCM0006	23		
CPRM0033	48	SYCM0018	4		
CPRM0031	47	SYCM0020	4		
CPRM0006	39				
CPRM0004	39				
CPRM0027	37				
CPRM0043	33				
CPRM0036	31				
CPRM0014	27				
CPRM0039	27				
CPRM0041	24				
CPRM0012	22				
CPRM0026	20				
CPRM0045	19				
CPRM0034	16				
CPRM0002	13				
CPRM0035	13				
CPRM0015	13				
CPRM0008	9				
CPRM0049	8				
CPRM0023	8				
CPRM0050	7				
CPRM0047	7				
CPRM0010	7				
CPRM0037	6				
CPRM0007	5				
CPRM0028	5				
CPRM0019	3				
CPRM0046	2				

Notes:

Particle Size = Percentage of sample passing through a 0.075mm sieve.

Attachment B

WATER QUALITY READINGS

ZONE J WATER QUALITY READINGS

Sample Location	Date	Time	Water Depth ft	Temp C	Cond mS/cm	Salinity ng/kg	pH units	Turbidity NTU	SpC mS/cm	TDS mg/L	DO mg/L	Redox mV
Cooper River												
<i>No YSI data collected due to severe drift</i>												
CPR-01-03	06/24/97	1445	46									
CPR-09-03	06/25/97	1430	47.5	81.54	29.45	999.99	7.77	1.9	2813	1828	150.6	142.2
CPR-13-02	06/25/97	1537	28.8	81.64	20.69	999.99	7.6	0.1	1969	1278	330.4	106.4
CPR-13-03	06/25/97	1541	28.8	81.46	27.3	999.99	7.73	53.8	2623	1706	654.8	106.1
CPR-15-03	06/26/97	1512	5.1	82.9	47.77	29.5	11.5	14.6	45.81	29.53	199.8	151.1
CPR-21-02	06/26/97	1613	28	82.27	73.1	45.4	13.36	10.7	64.96	42.09	248.5	170.3
CPR-21-03	06/26/97	1617	28	82.06	77.25	50.68	13.73	17.3	73.97	48.18	244.9	151.7
CPR-25-03	06/27/97	1557	23.1	82.24	80.33	52.64	7.78	22.7	76.36	49.7	389.7	134.1
CPR-28-03	06/27/97	1520	12	82.92	70.44	44.46	7.63	18.3	65.74	42.78	288.9	150
CPR-32-01	06/10/97	1600	16.5	72.66	43.87	29.9	7.71	104.6	45.16	29.49	100	171.7
CPR-32-02	06/10/97	1602	16.5	71.84	47.98	33.39	7.7	104.4	50.89	33.48	111.2	162.4
CPR-32-03	06/10/97	1604	16.5	70.47	66.87	49.44	7.77	102.7	71.55	46.21	278.9	158.8
CPR-37-03	06/30/97	1055	7	81.69	61.93	39.38	7.68	13.3	59.01	38.34	351.5	102.8
CPR-46-03	06/30/97	947	4	81.11	62.03	39.43	7.57	9.7	58.86	38.05	983.99	77.1
CPR-47-03	06/30/97	1025	10	81.11	66.92	43.06	7.48	84.6	64.3	41.8	999.99	92
CPR-48-03	06/30/97	915	3	80.9	60.52	38.74	6.68	10.8	58.16	37.94	999.99	103.3
CPR-49-03	07/11/97	1210	17.4	83.48	59.8	37.52	27.65	0.1	59.28	38.45	149.4	192.4
CPR-50-03	07/11/97	1240	49	85.53	51.62	24.31	28.89	0.3	48.6	31.83	145.4	153.1
Shipyard Creek												
SYC-01-03	07/08/97	1245	2.5	85.48	59.11	35.69	7.4	10.5	54.2	35.25	77.4	191
SYC-02-03	07/08/97	1318	2	86.59	60.01	35.97	7.67	19.2	54.42	35.43	82.2	109.7
SYC-03-03	07/08/97	1400	1	87.16	59.43	35.25	7.71	10.1	53.63	34.05	88.1	105
SYC-03-03	09/17/97	936	1	80.78	28.64	16.87	7.05	—	27541	6.017	3.35	370.8
SYC-04-03	07/08/97	1328	4.5	85.9	59.78	36.74	7.87	8.6	54.68	35.5	86.4	104.6
SYC-05-03	07/08/97	1436	0.5	89.49	60.07	34.75	7.76	49.5	53.04	34.47	103.3	87
SYC-06-03	07/08/97	1420	1	89.61	60.55	35.04	7.71	24.1	53.38	34.7	97.6	100.2
SYC-07-03	07/09/97	1240	7	85.1	818.4	999.99	7.69	15.3	753.2	490.6	311.4	101.2
SYC-08-03	09/16/97	1320	30	81.37	35.97	21.43	7.36	—	33808	0.022	0.39	121.5
SYC-09-03	09/17/97	1108	8	81.52	36.24	21.67	7.64	—	34530	0.022	4.1	151.7
SYC-10-03	07/09/97	1257	2.75	82.88	781.8	999.99	7.64	119.5	735.8	478.4	191.3	58.3
SYC-11-03	09/17/97	1030	1.5	81.5	29.04	16.98	7.34	—	27719	0.018	3.64	238.5
SYC-13-03	07/09/97	1400	3.5	88.31	846.2	999.99	8.23	89.8	754.2	490.4	222.9	104.4
SYC-14-03	09/16/97	1355	30	81.16	42.8	26	7.79	—	40655	0.026	5.17	158.5
SYC-15-03	07/09/97	1415	3	85.23	857.2	999.99	8.12	19.2	786.3	511.2	200.1	109
SYC-15-03	09/17/97	1040	2	81.45	32.81	19.41	7.49	—	31331	0.02	3.87	140.4
SYC-16-03	09/17/97	1136	36	81.32	38.8	23.47	7.65	—	36960	0.024	3.49	174.7
SYC-17-03	07/08/97	1510	0.5	87.19	61.14	36.42	8.52	12	55.1	35.8	121.5	82
SYC-18-03	07/09/97	1434	3	86.57	831.5	999.99	8.17	17.4	758.9	494.4	197.8	125.3
SYC-18-03	09/17/97	1150	2	82.38	32.91	19.29	7.6	—	31347	0.02	8.12	188.9
SYC-19-03	09/16/97	1429	30	81.19	36.66	22.11	7.65	—	34618	0.0226	0.98	-32
SYC-22-03	09/17/97	1215	4	81.3	40.8	24.72	7.49	—	38977	0.025	7.45	191.3
Noisette Creek												
NOI-01-03	07/01/97	1106	3	81.24	29.62	17.4	6.88	117.1	28.3	18.38	35.1	79
NOI-02-03	07/01/97	1045	1.5	80.71	23.78	13.75	6.78	114.4	22.73	14.73	35.8	47.7
NOI-03-03	09/16/97	1225	3	80.69	20.66	11.81	6.99	—	19860	0.013	3.91	200.1
NOI-04-03	07/01/97	1135	5	81.58	32.56	19.25	6.91	117.10	31.04	20.16	37.60	74.60
NOI-06-03	06/30/97	1127	2	81.02	29.91	17.64	7.49	18	28.71	18.71	223.5	34.1
NOI-10-03	07/01/97	1005	4.5									
<i>No YSI data collected</i>												

Notes:

Boxed cells indicate a possible meter malfunction and/or reading error

Bolded locations indicate second reading on later date.

SpC = Specific Conductivity

TDS = Total Dissolved Solids

DO = Dissolved Oxygen

Redox = Oxidation/Reduction Potential

C = degrees Celcius

mS/cm = milliSeimer/centimeter

mg/L = milligrams/liter

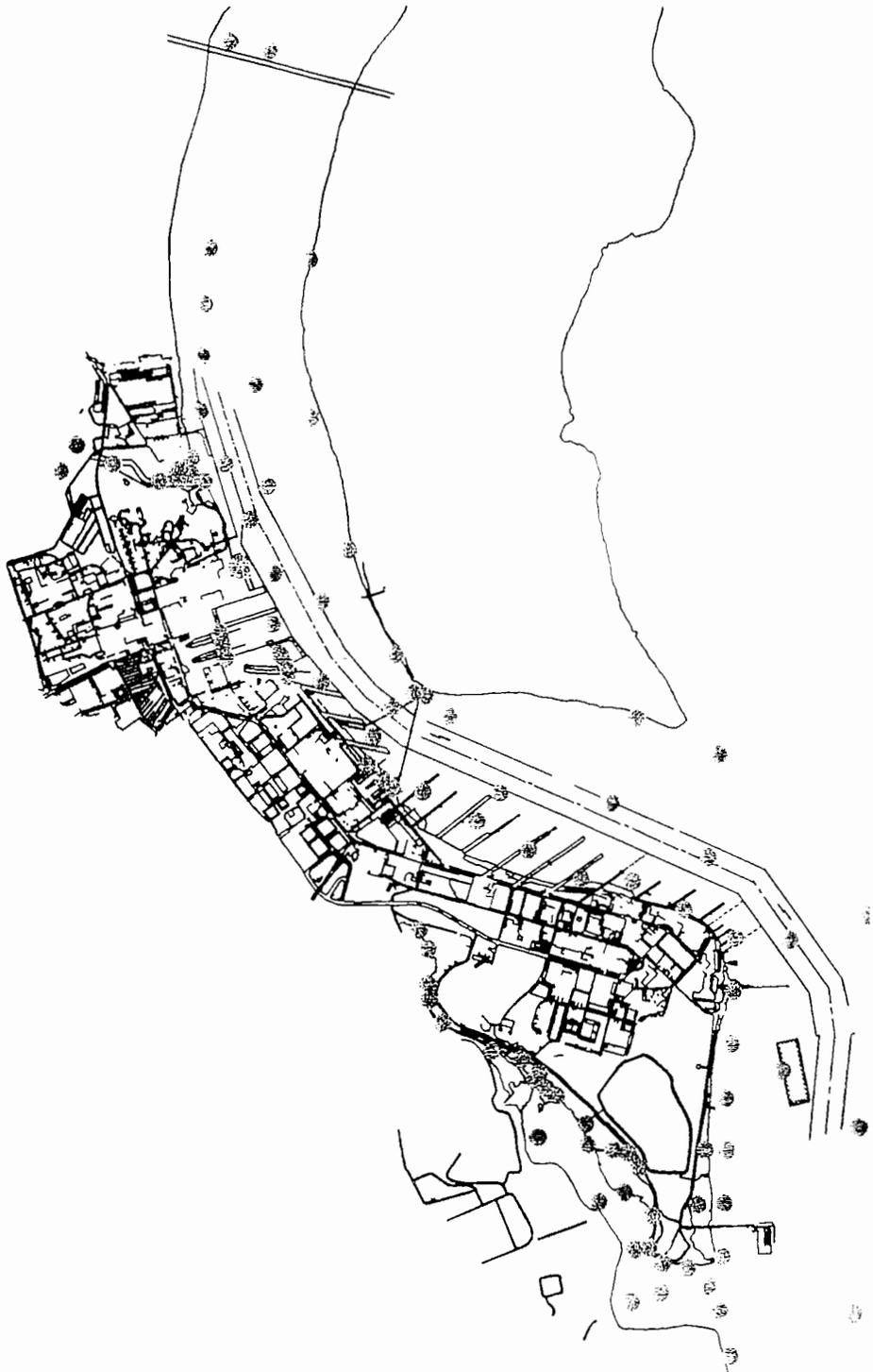
mV = millivolts

ng/L = nanograms/liter

NTU - nephelometric turbidity units

Attachment C

**DISTRIBUTION OF ZONE J
SEDIMENT CONSTITUENTS**



-  < Screening Value
-  > Screening Value
-  > 2x Screening Value



ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

2-METHLYNAPHTHALENE
IN SEDIMENT

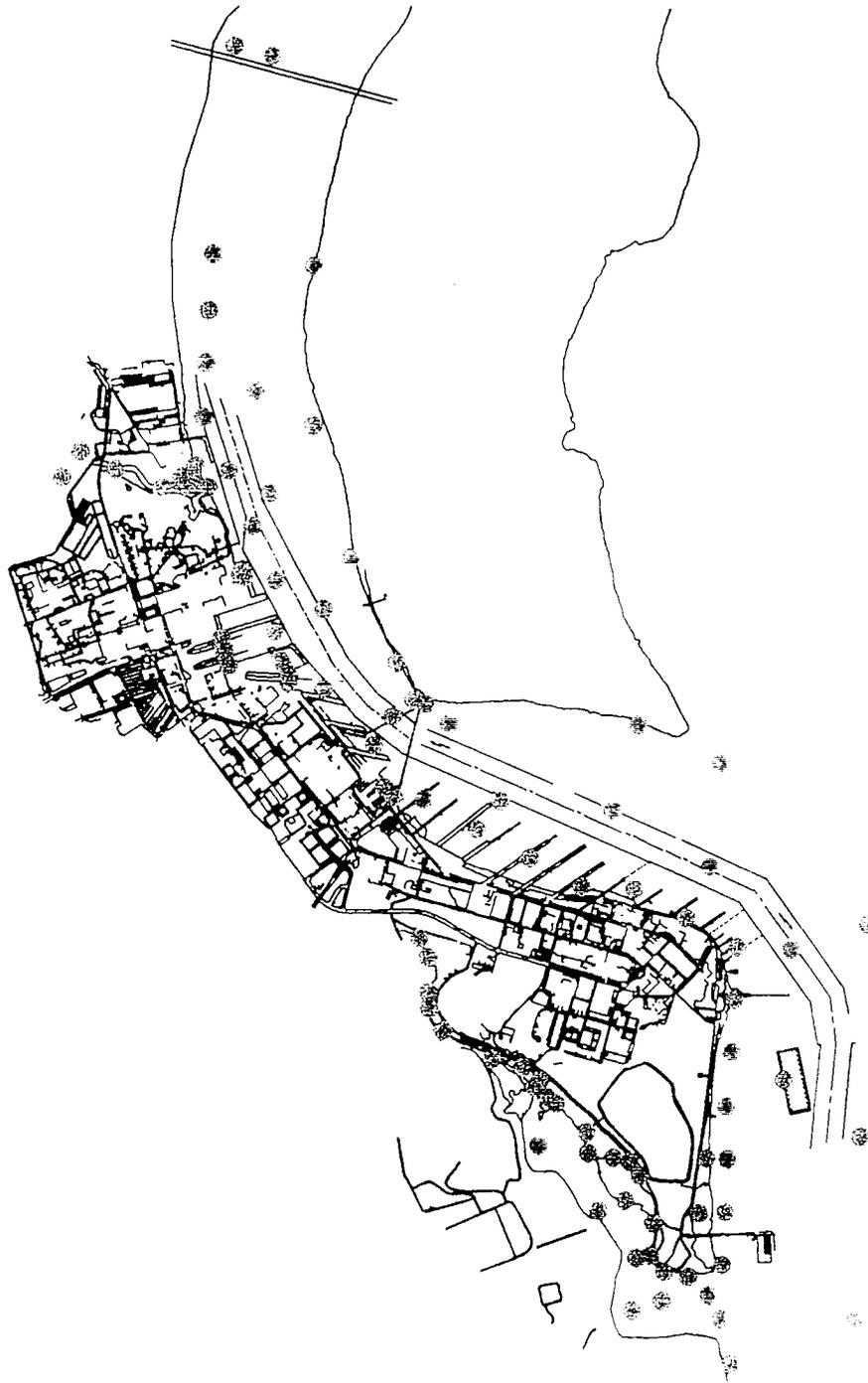


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- > 2x Screening Value



ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

ACENAPHTHENE
IN SEDIMENT

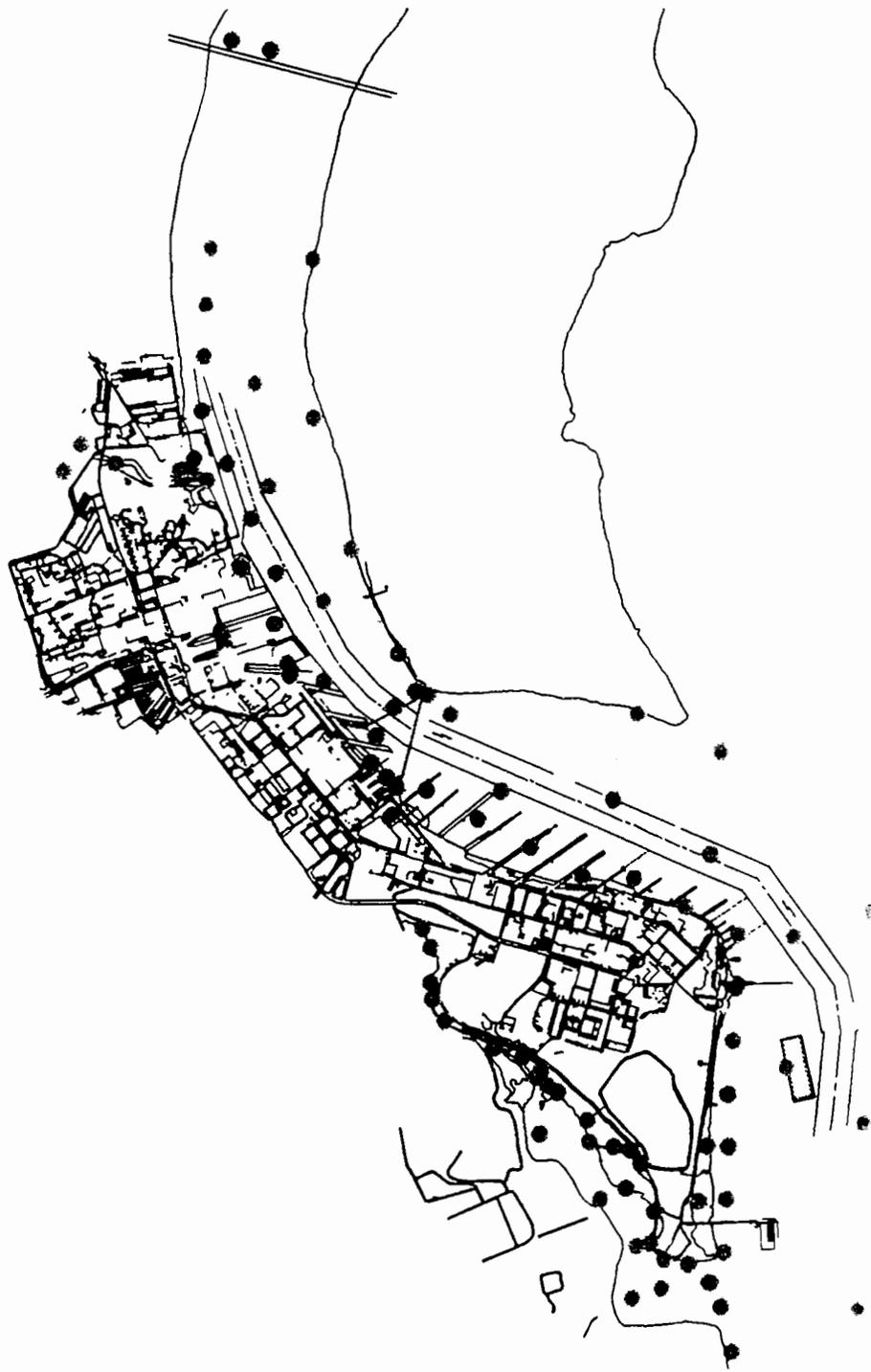


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ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

ACENAPHTHYLENE
IN SEDIMENT

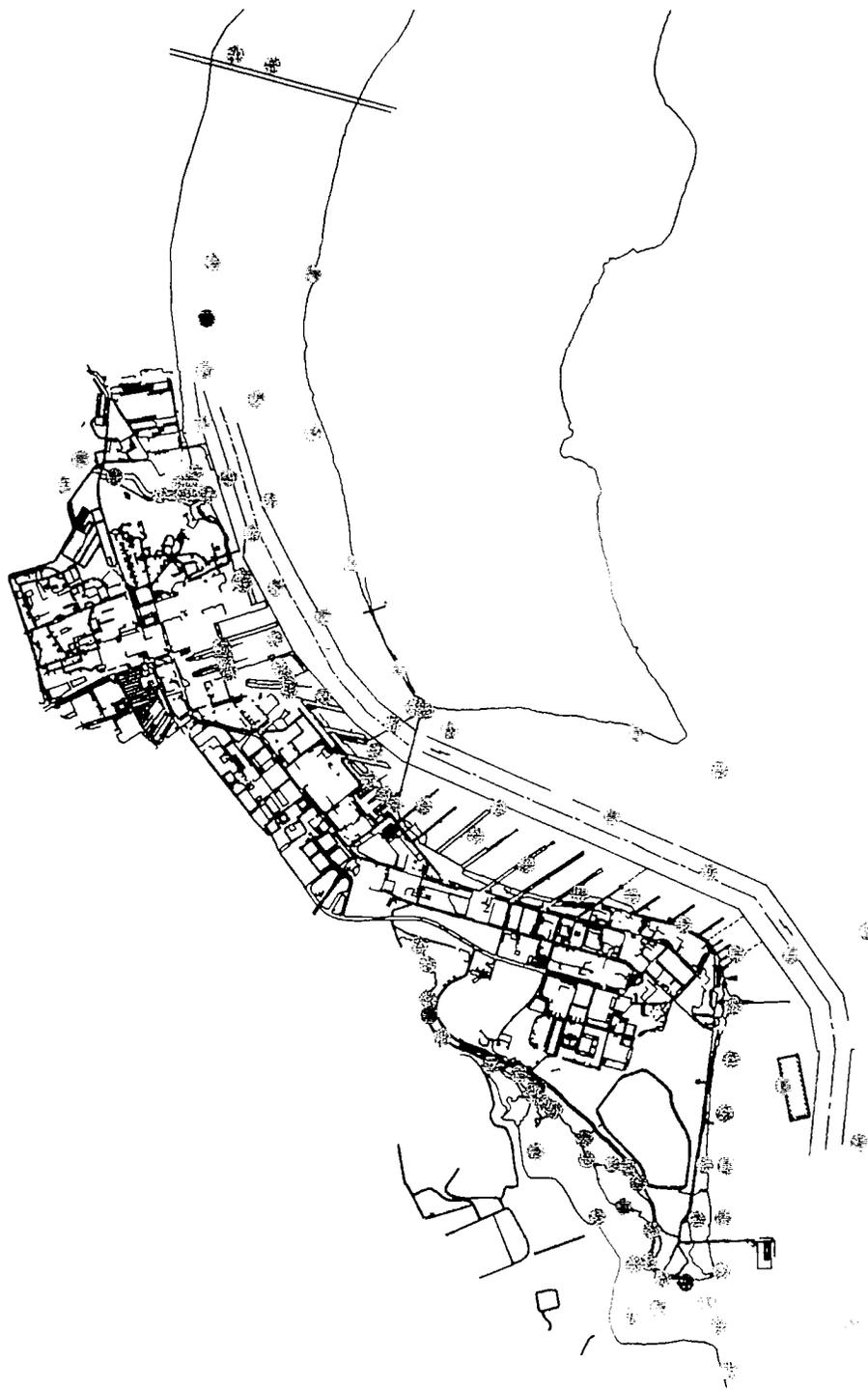


- < Screening Value
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ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

ANTHRACENE
IN SEDIMENT

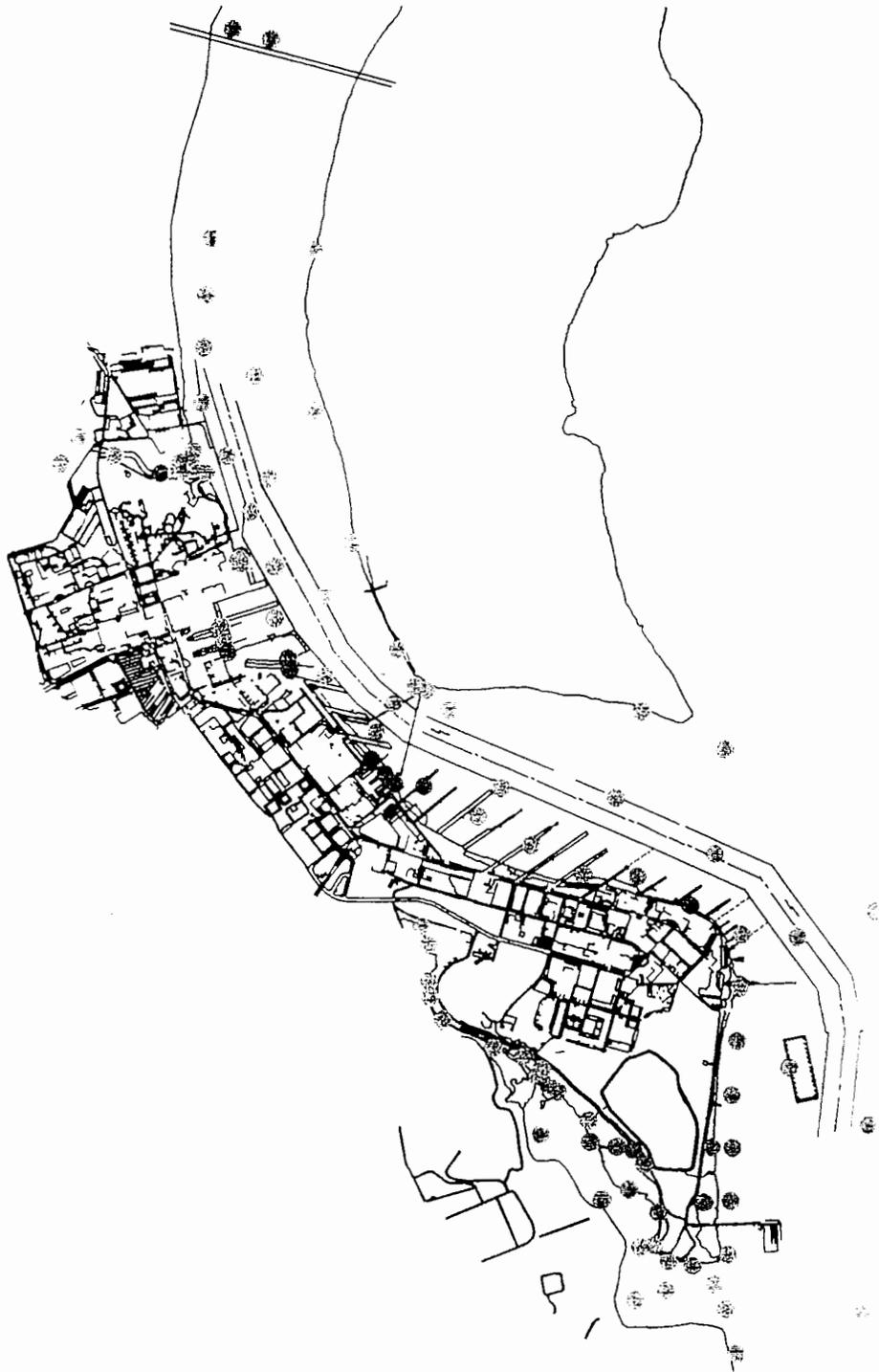


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-  > 2x Screening Value



ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

BEHP
IN SEDIMENT

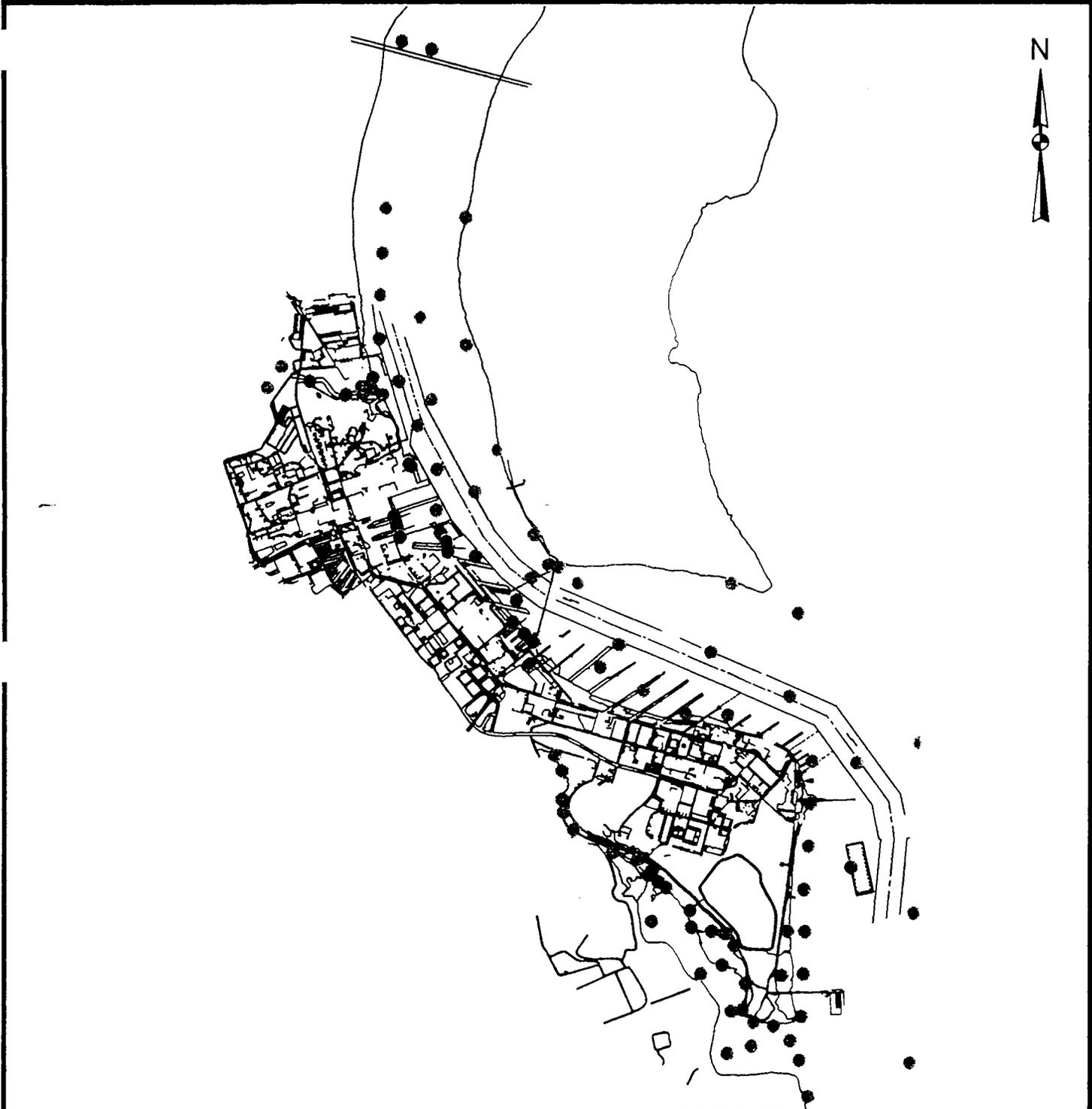


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-  > 2x Screening Value



ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

BENZO(A)ANTHRACENE
IN SEDIMENT



 ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

BENZO(A)PYRENE
IN SEDIMENT

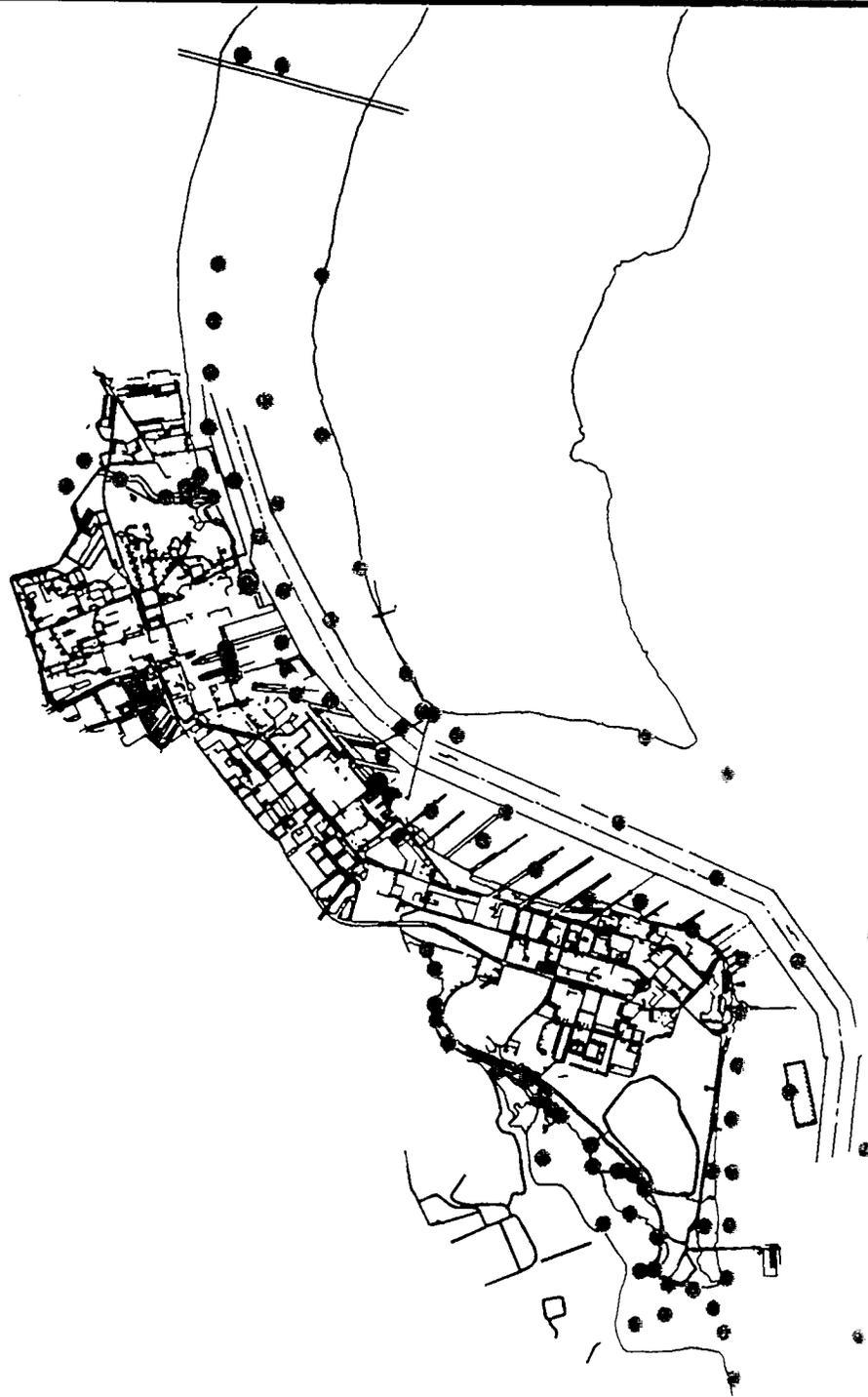


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-  > 2x Screening Value



ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

CHRYSENE
IN SEDIMENT



- < Screening Value
- > Screening Value
- > 2x Screening Value



ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

DIBENZ(A,H)ANTHRACENE
IN SEDIMENT

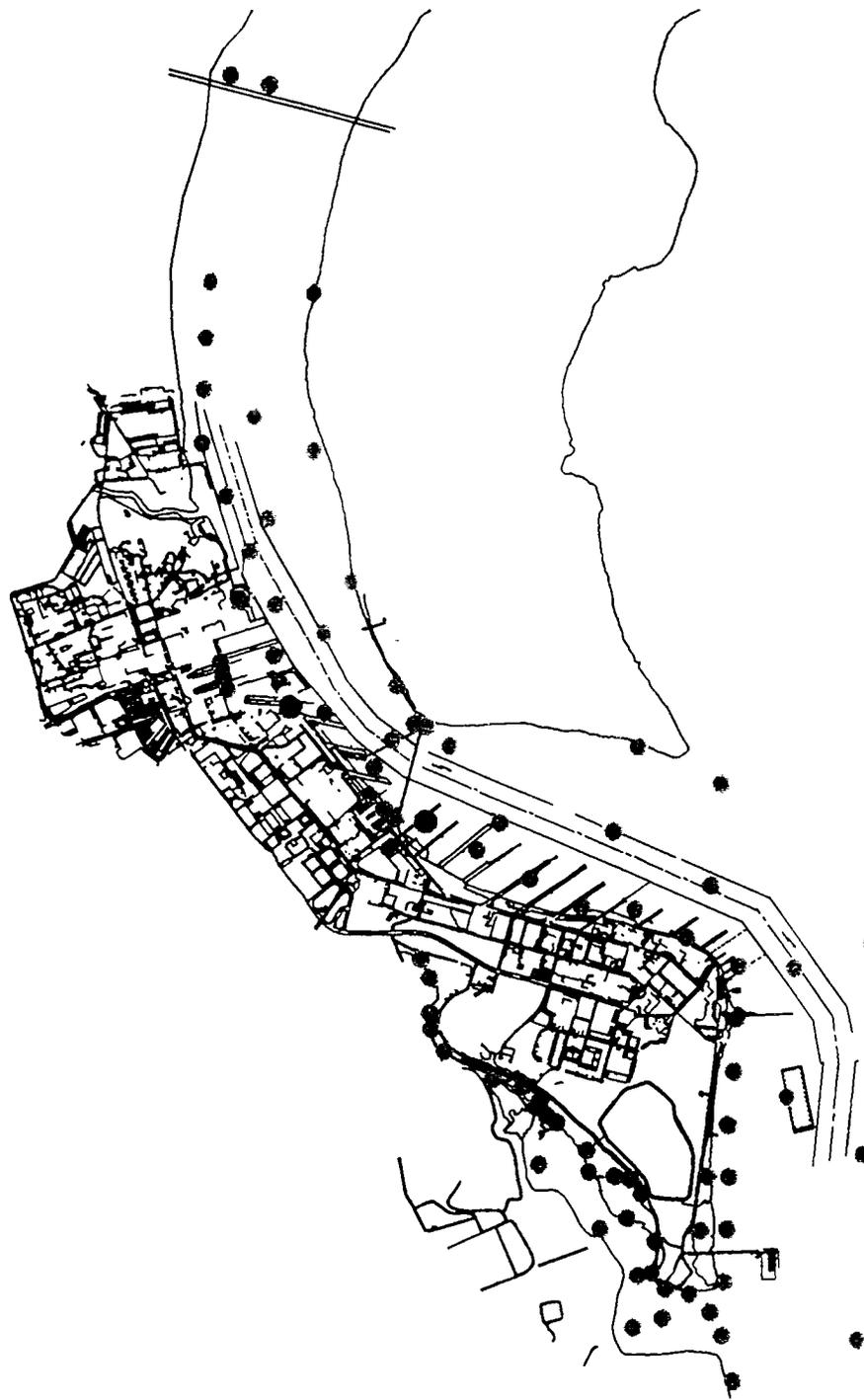


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-  > Screening Value
-  > 2x Screening Value



ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

FLUORANTHENE
IN SEDIMENT



- < Screening Value
- > Screening Value
- > 2x Screening Value



ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

FLUORENE
IN SEDIMENT

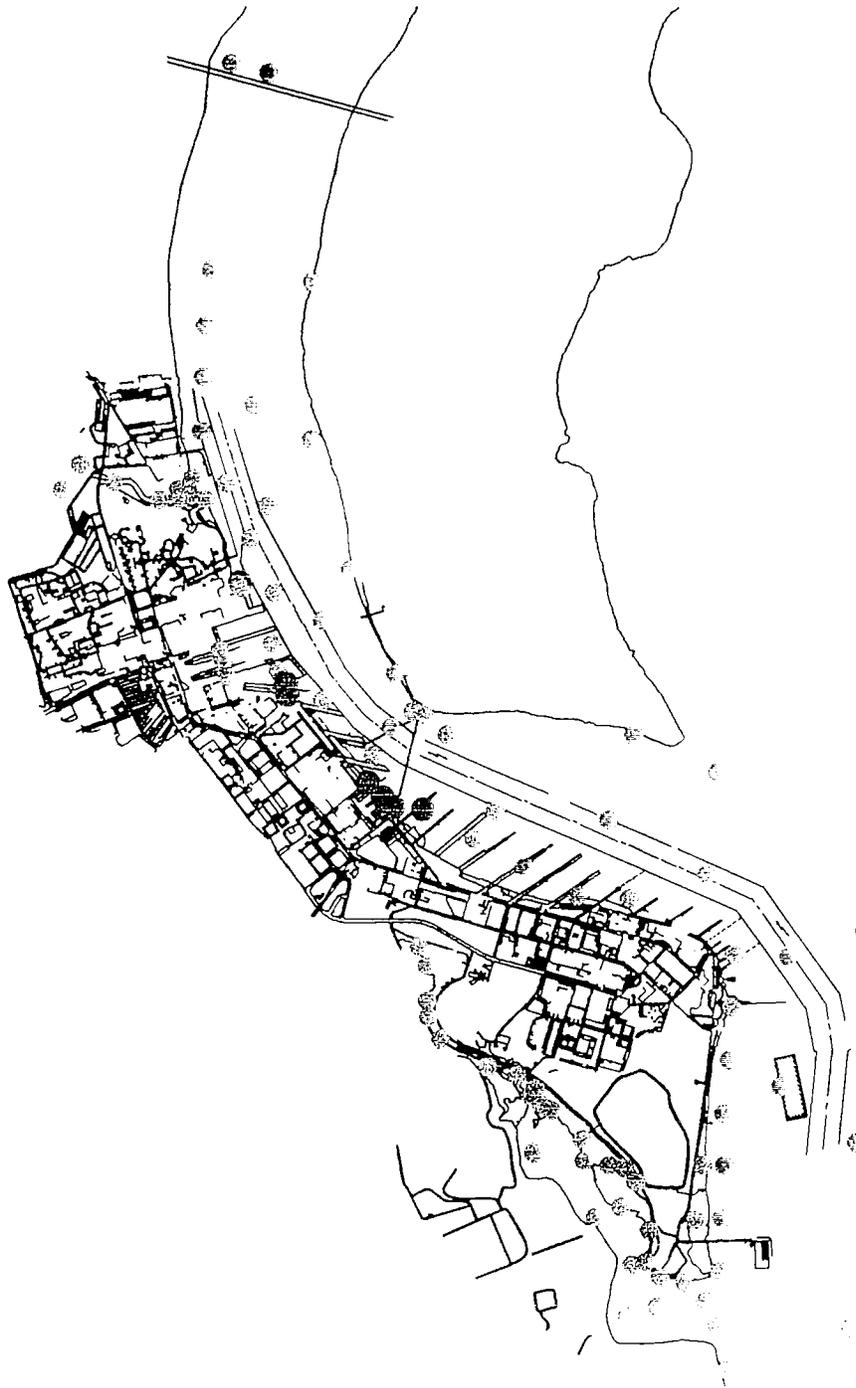


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ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

NAPHTHALENE
IN SEDIMENT

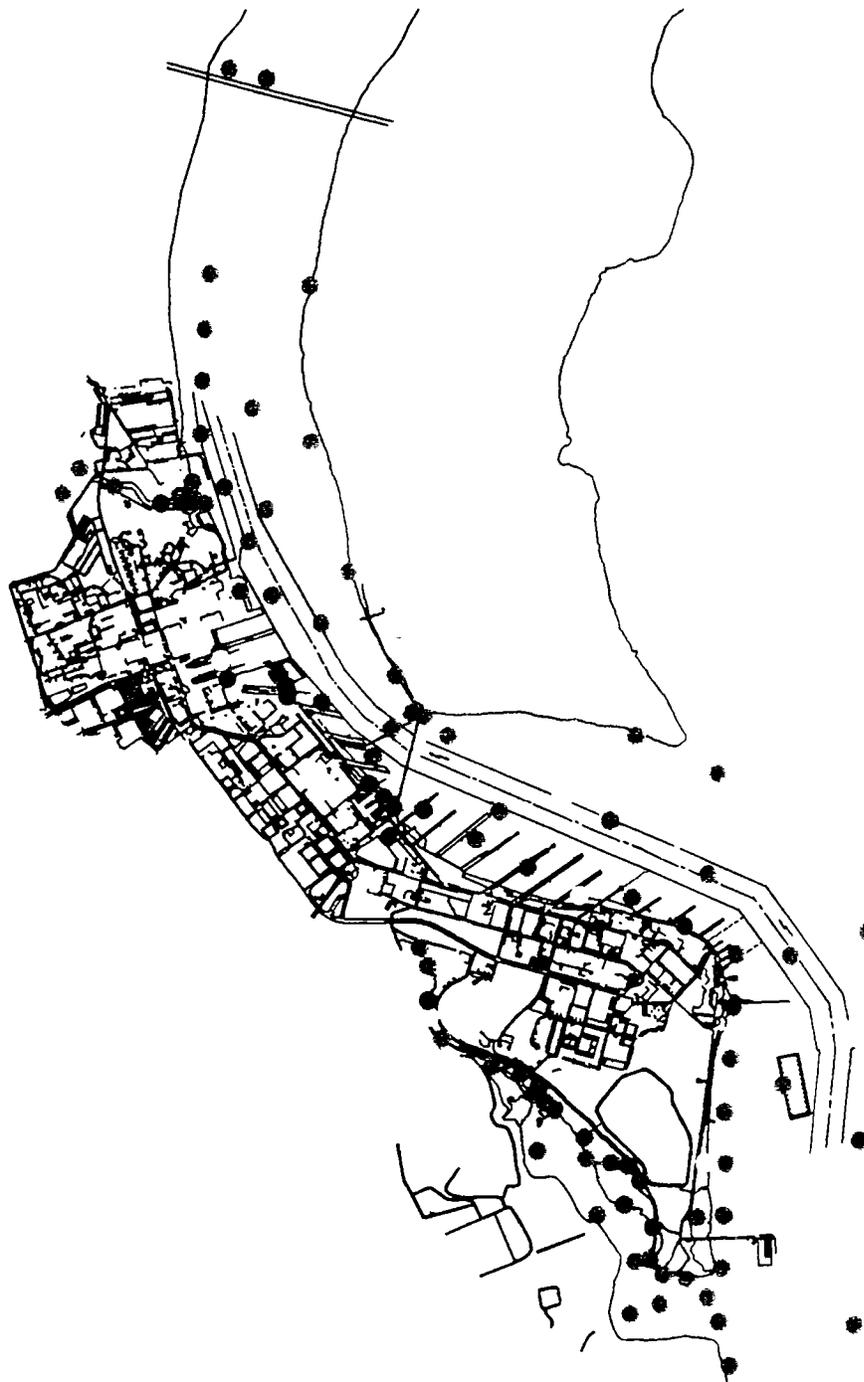


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-  > 2x Screening Value



ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

PHENANTHRENE
IN SEDIMENT



- < Screening Value
- > Screening Value
- > 2x Screening Value



ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

PYRENE
IN SEDIMENT



-  < Screening Value
-  > Screening Value
-  > 2x Screening Value



ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

DDD
IN SEDIMENT

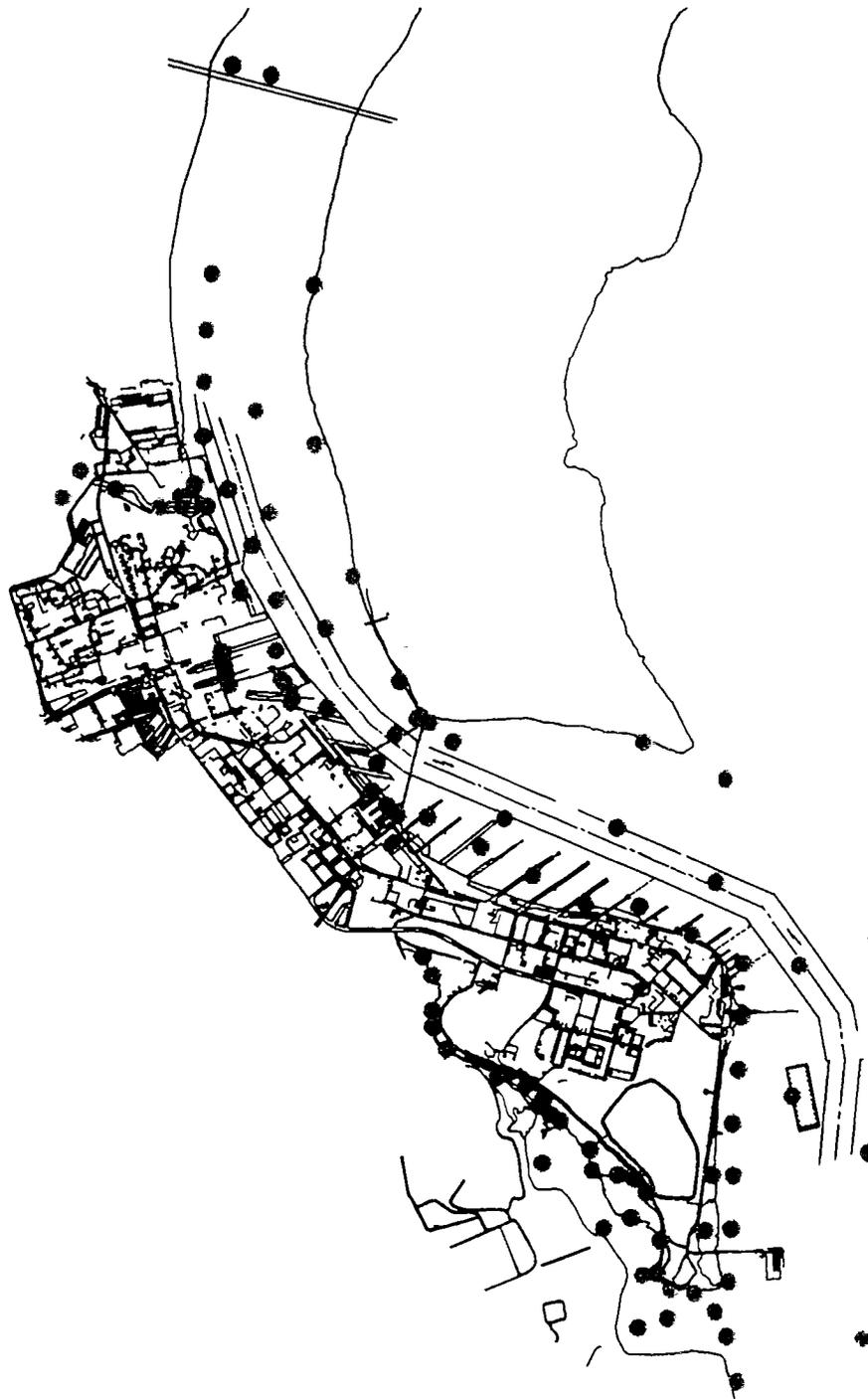


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ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

DDE
IN SEDIMENT

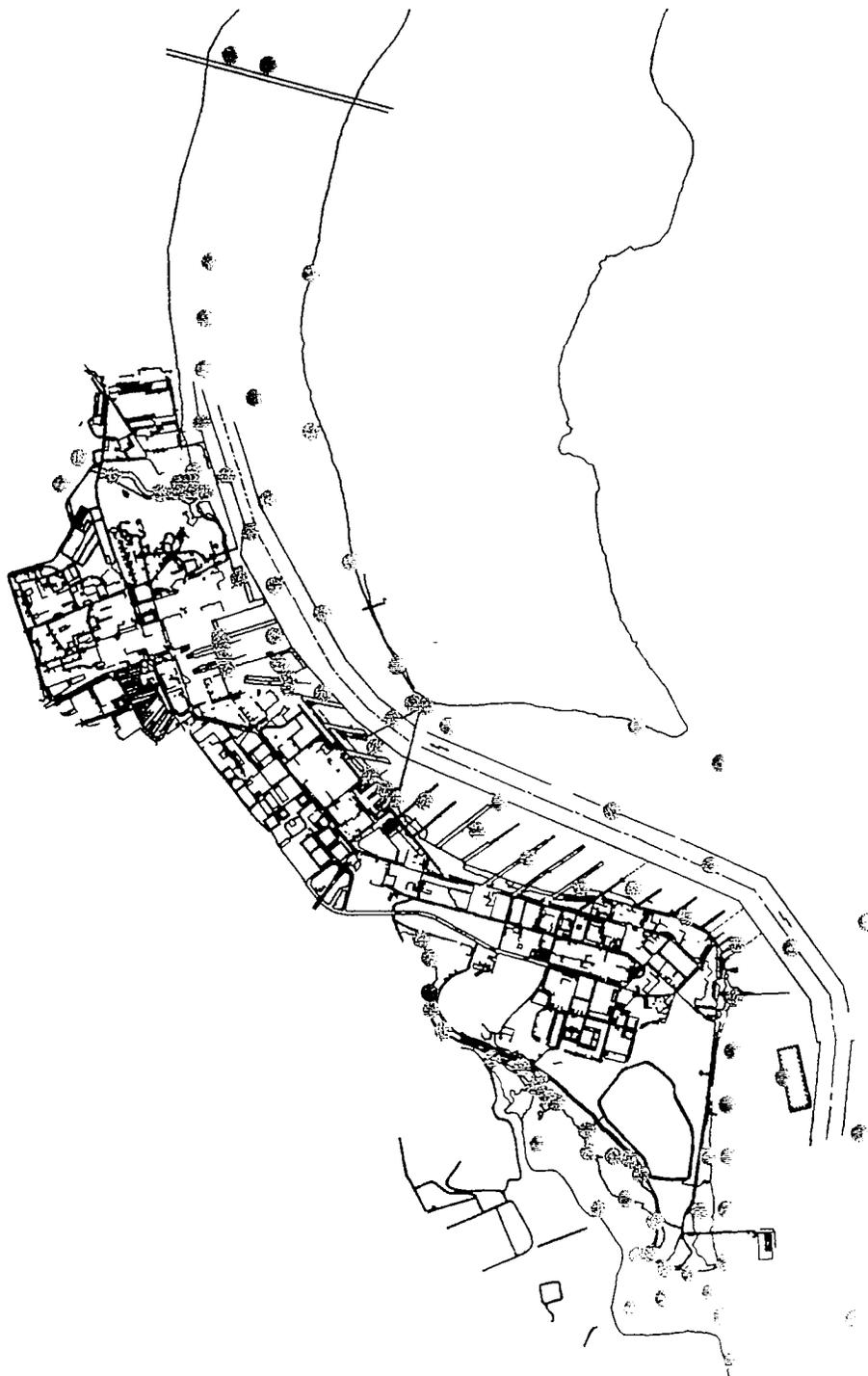


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ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

DDT
IN SEDIMENT

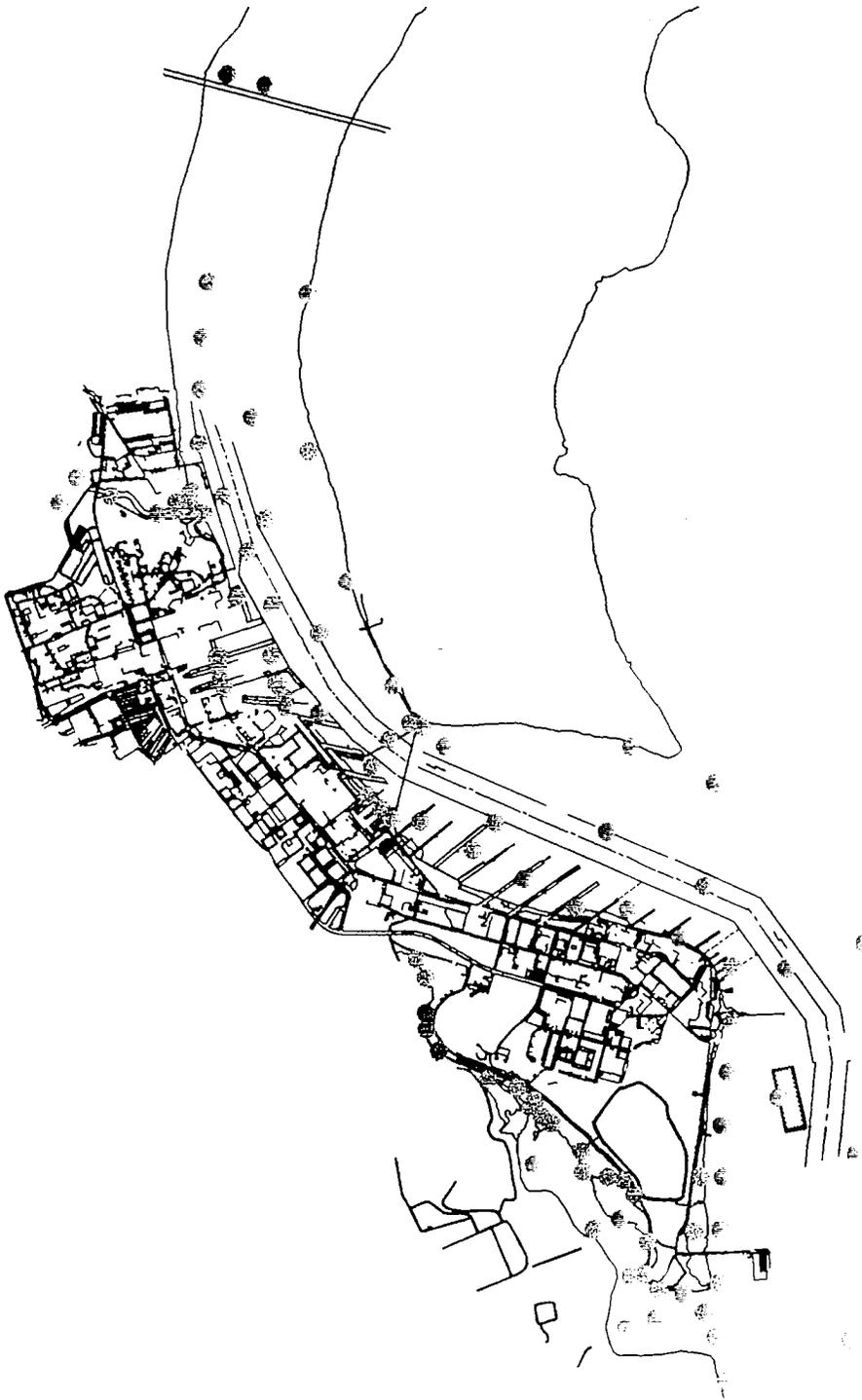


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ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

AROCOR-1248
IN SEDIMENT



-  < Screening Value
-  > Screening Value
-  > 2x Screening Value



ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

AROCOR-1254
IN SEDIMENT

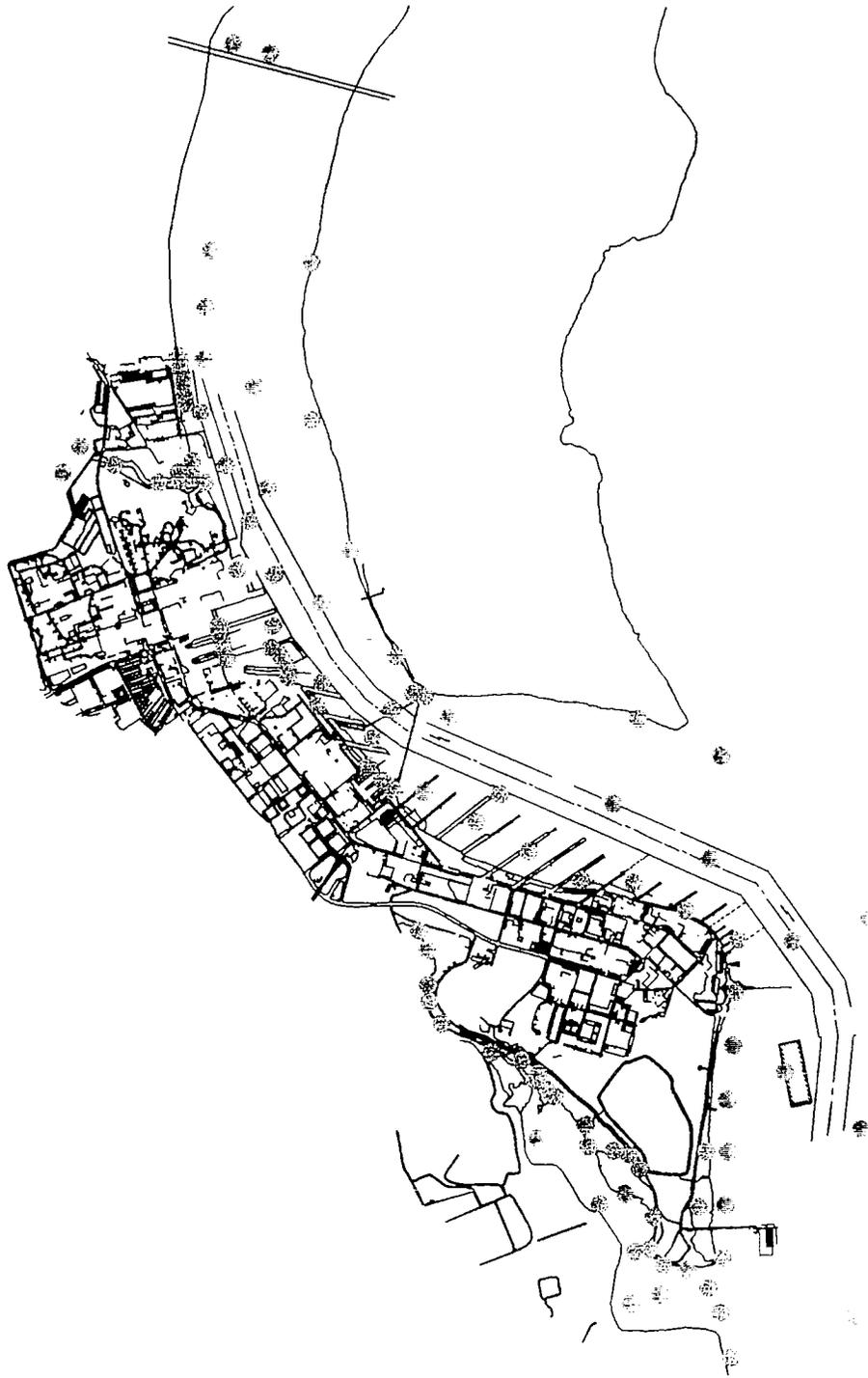


- < Screening Value
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- > 2x Screening Value



ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

AROCLOR 1260
IN SEDIMENT



-  < Screening Value
-  > Screening Value
-  > 2x Screening Value



ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

ANTIMONY
IN SEDIMENT

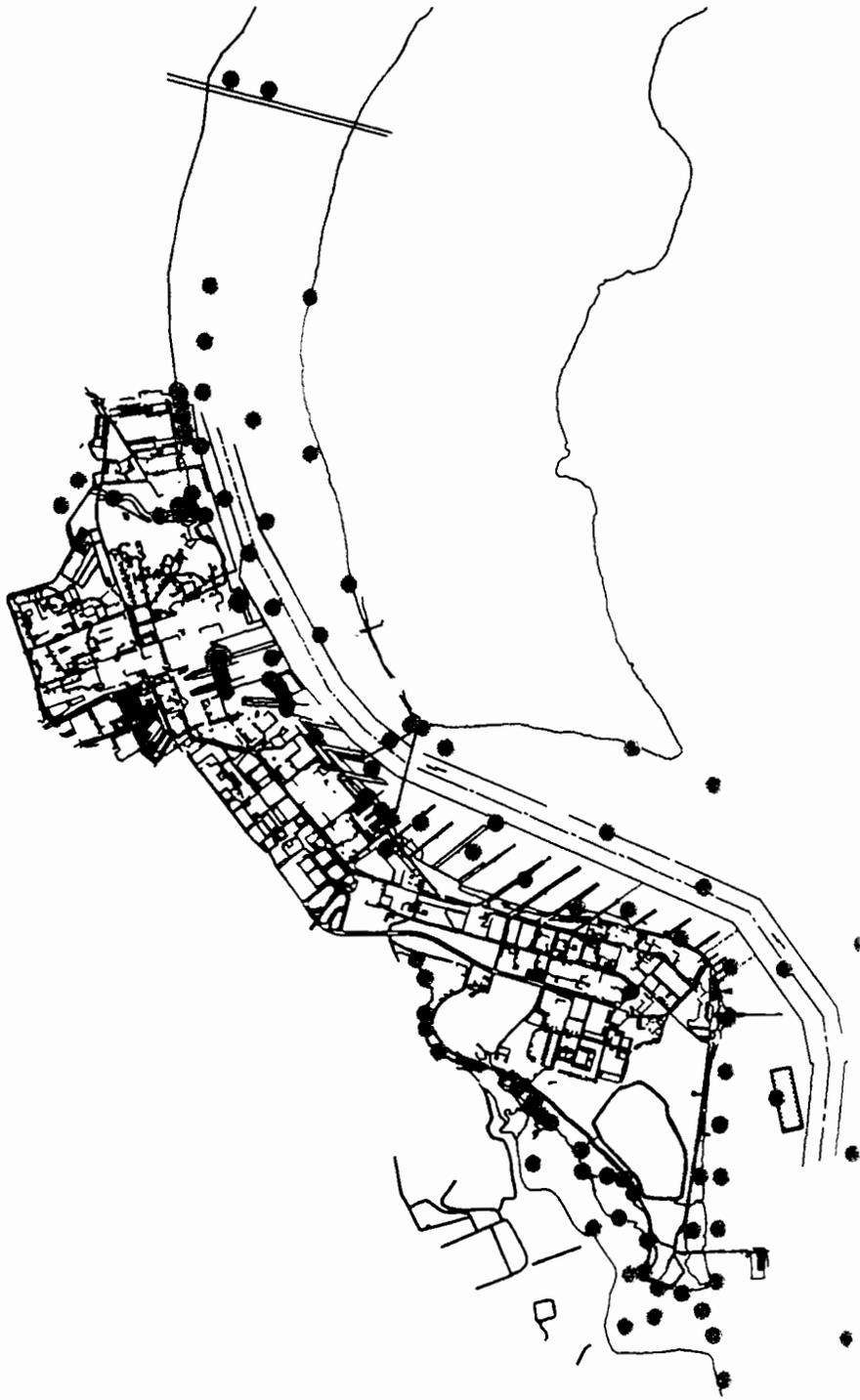


-  < Screening Value
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-  > 2x Screening Value



ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

ARSENIC
IN SEDIMENT



- < Screening Value
- > Screening Value
- > 2x Screening Value

	ZONE J RFI NAVAL BASE CHARLESTON CHARLESTON, SC
	CADMIUM IN SEDIMENT

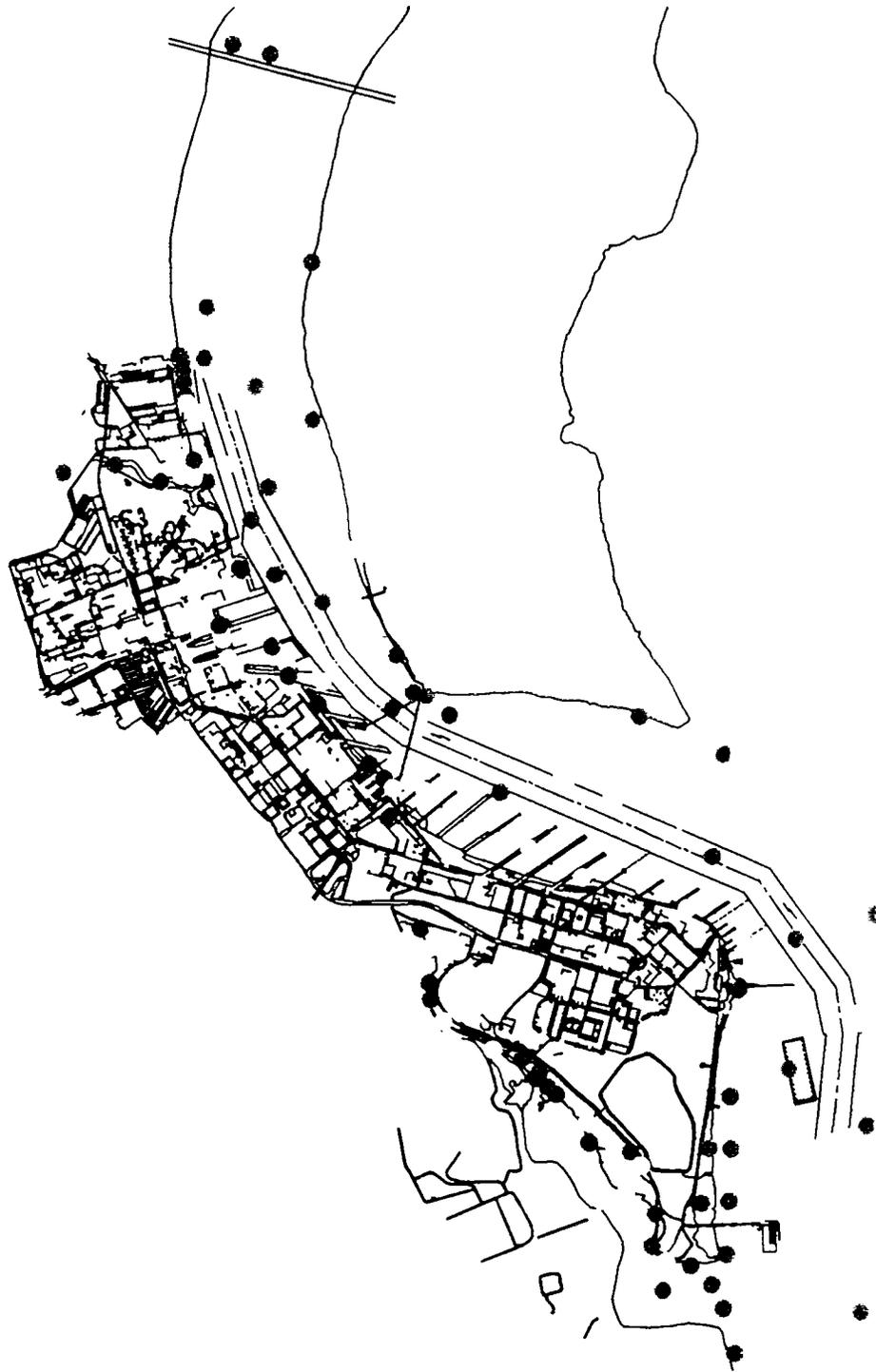


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-  > 2x Screening Value



ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

CHROMIUM
IN SEDIMENT

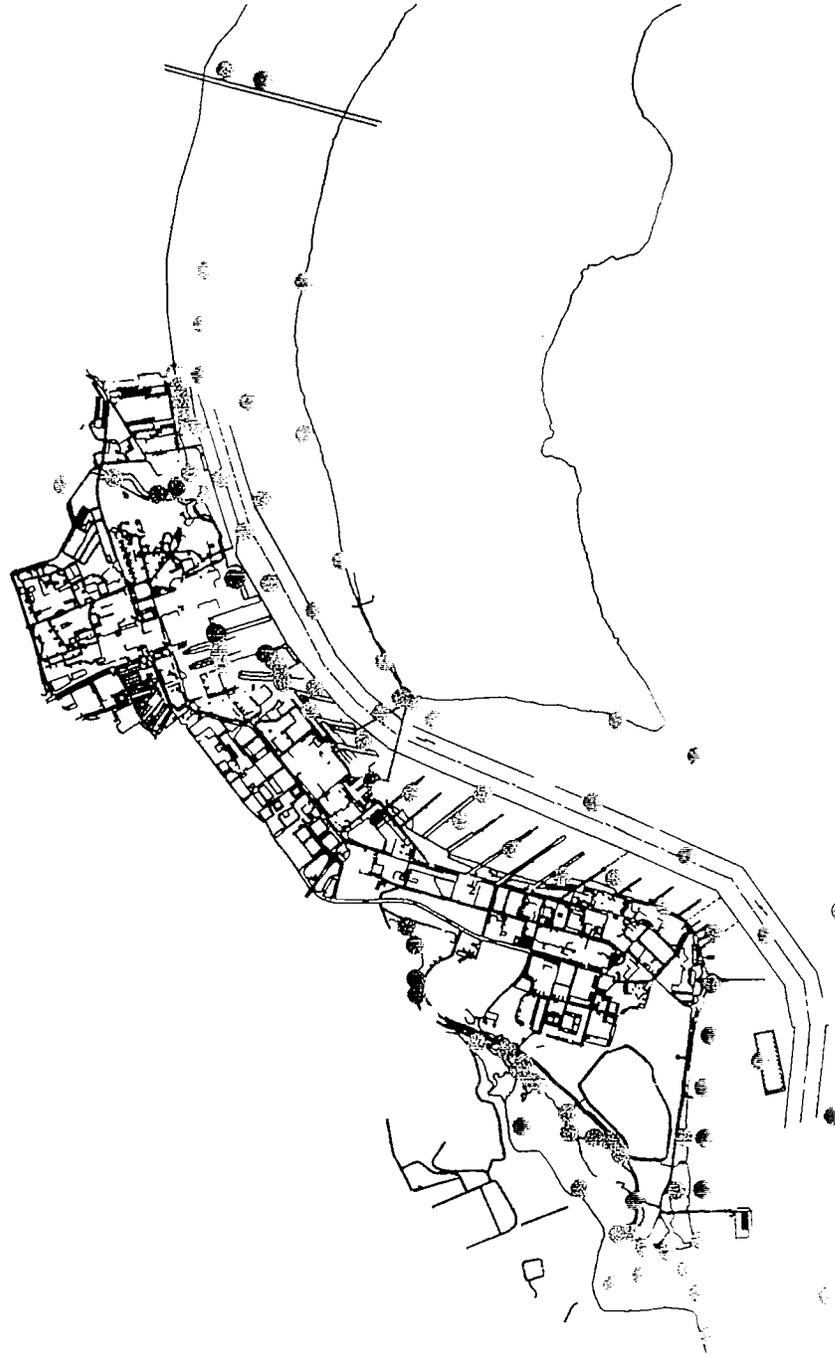


- < Screening Value
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ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

COPPER
IN SEDIMENT

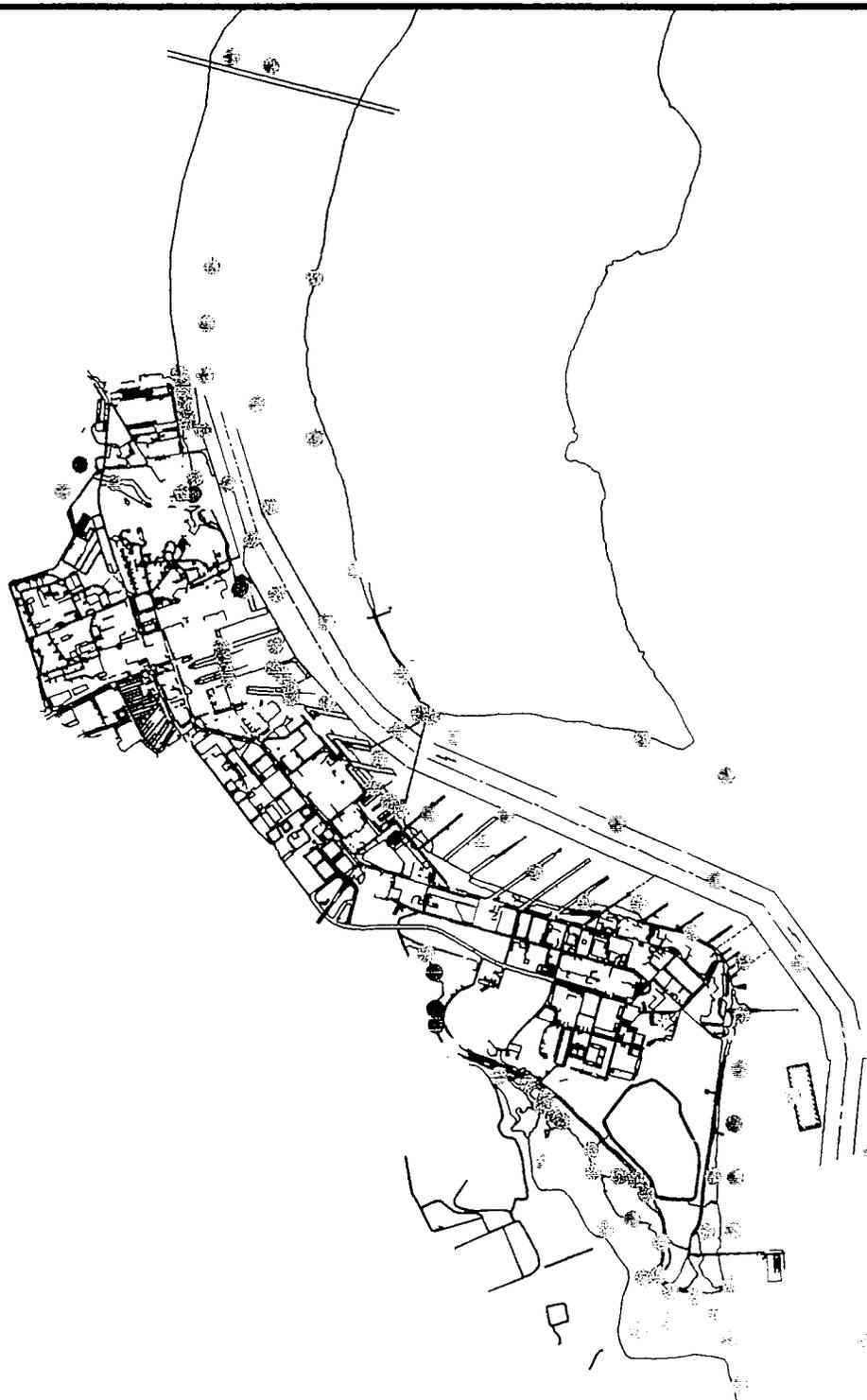


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-  > 2x Screening Value



ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

LEAD
IN SEDIMENT

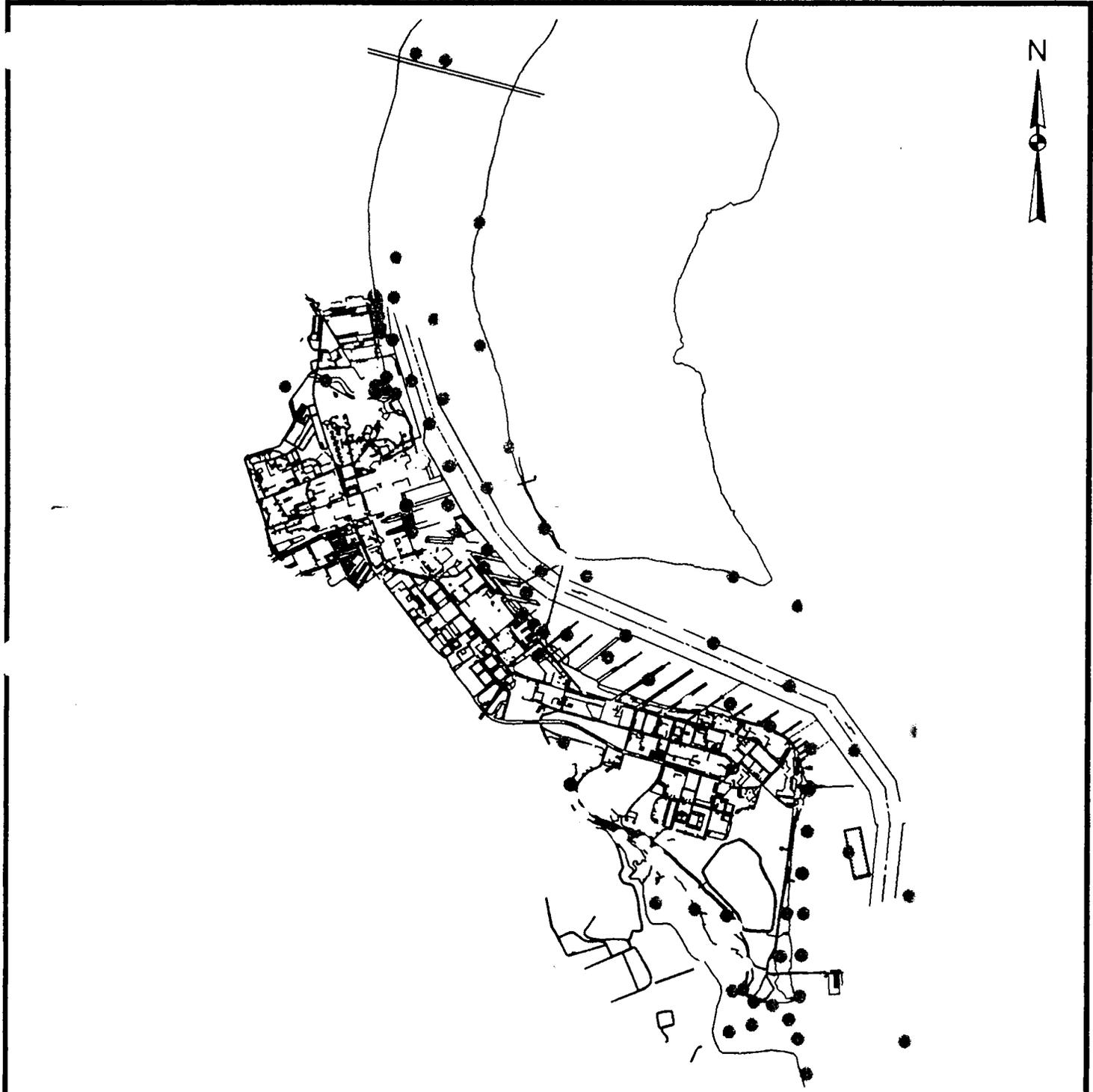


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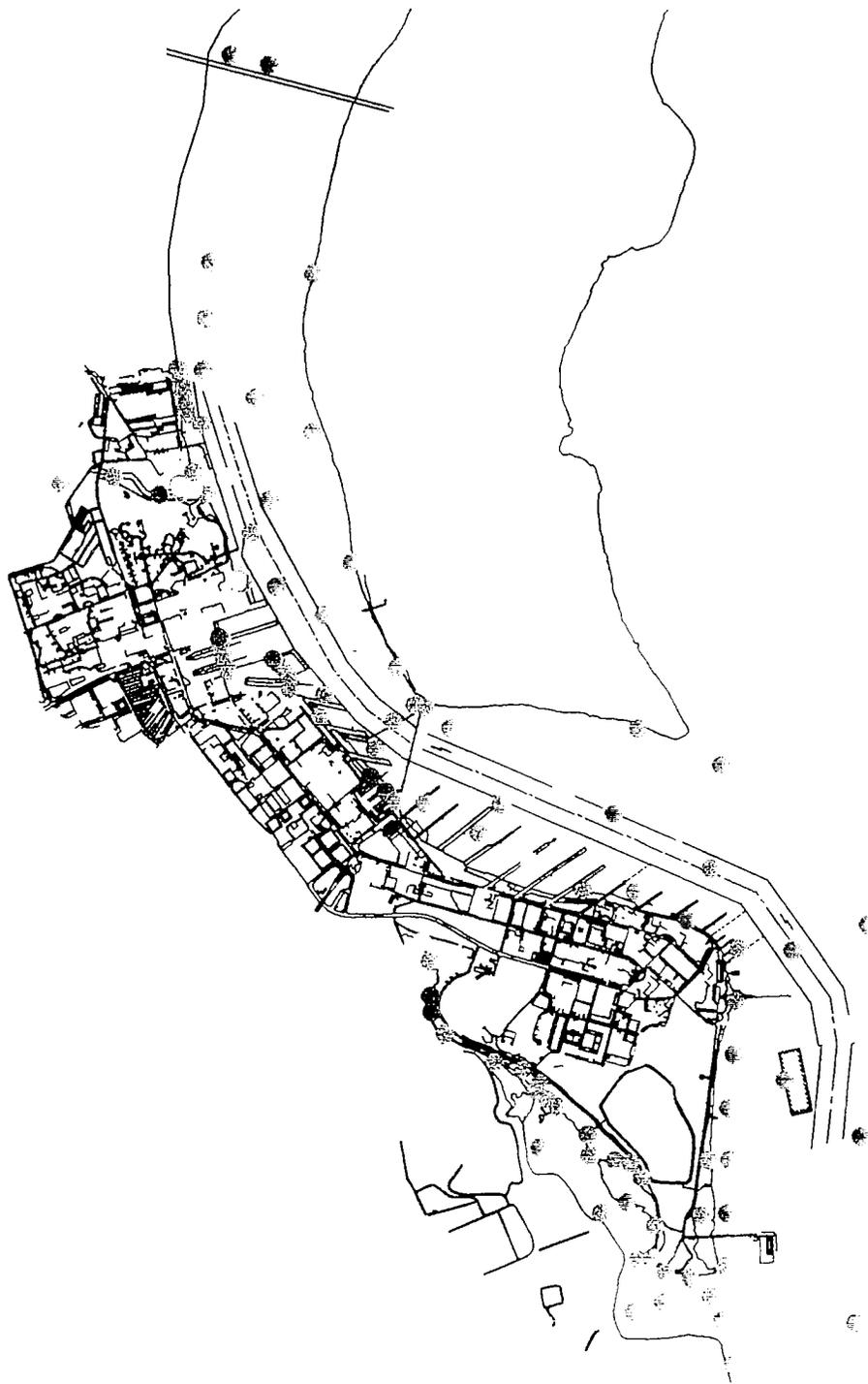
ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

MERCURY
IN SEDIMENT



- < Screening Value
- > Screening Value
- > 2x Screening Value

	ZONE J RFI NAVAL BASE CHARLESTON CHARLESTON, SC
NICKEL IN SEDIMENT	

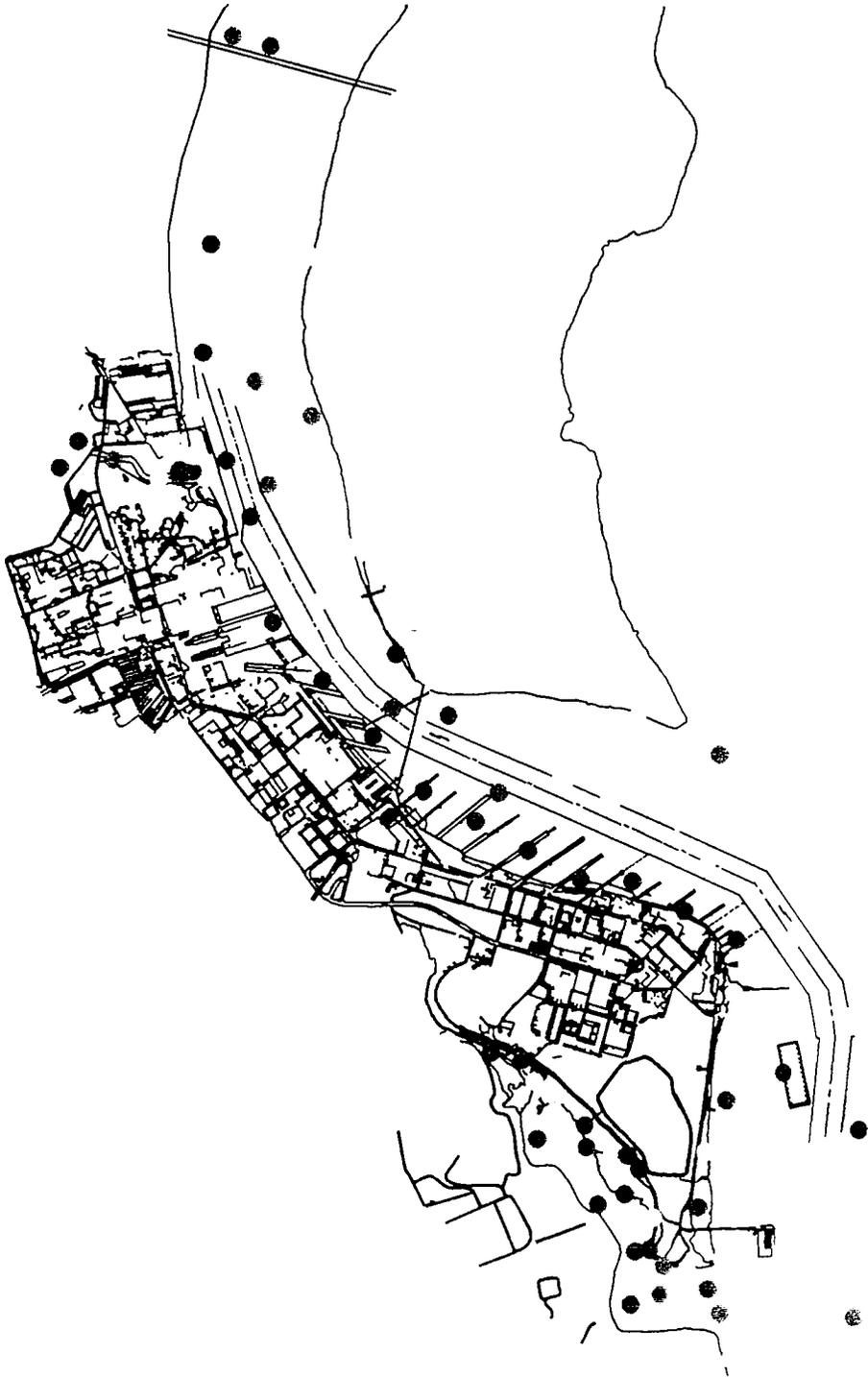


-  < Screening Value
-  > Screening Value
-  > 2x Screening Value



ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

ZINC
IN SEDIMENT



- = Course-grain Sediment
- = Medium-grain Sediment
- = Fine-grain Sediment

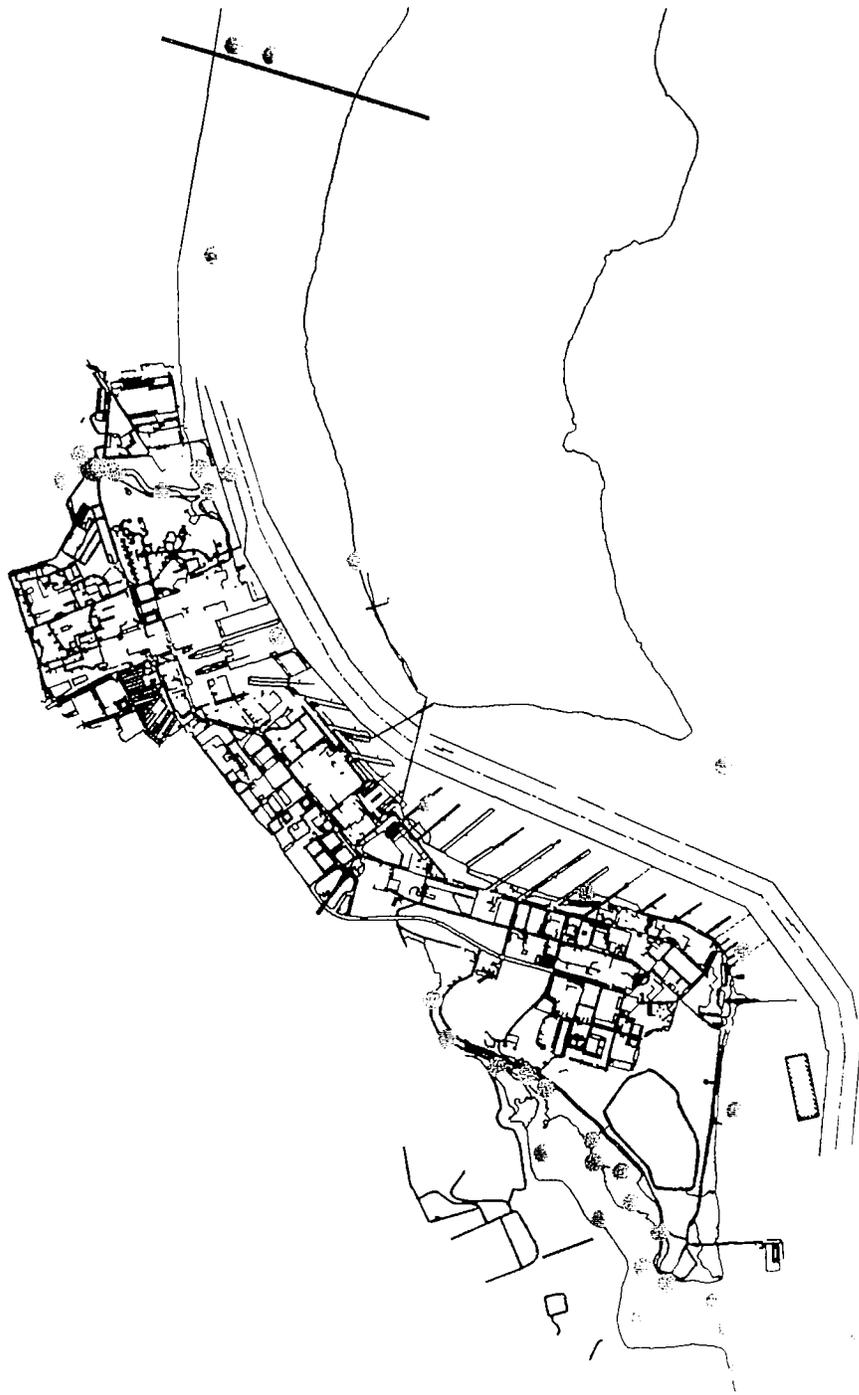


ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

PARTICLE SIZE
IN SEDIMENT

Attachment D

**DISTRIBUTION OF ZONE J
SURFACE WATER CONSTITUENTS**



- < Screening Value
- > Screening Value
- > 2x Screening Value



ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

ACROLIN
IN SURFACE WATER



- < Screening Value
- > Screening Value
- > 2x Screening Value



ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

DIETHYLPHTHALATE
IN SURFACE WATER

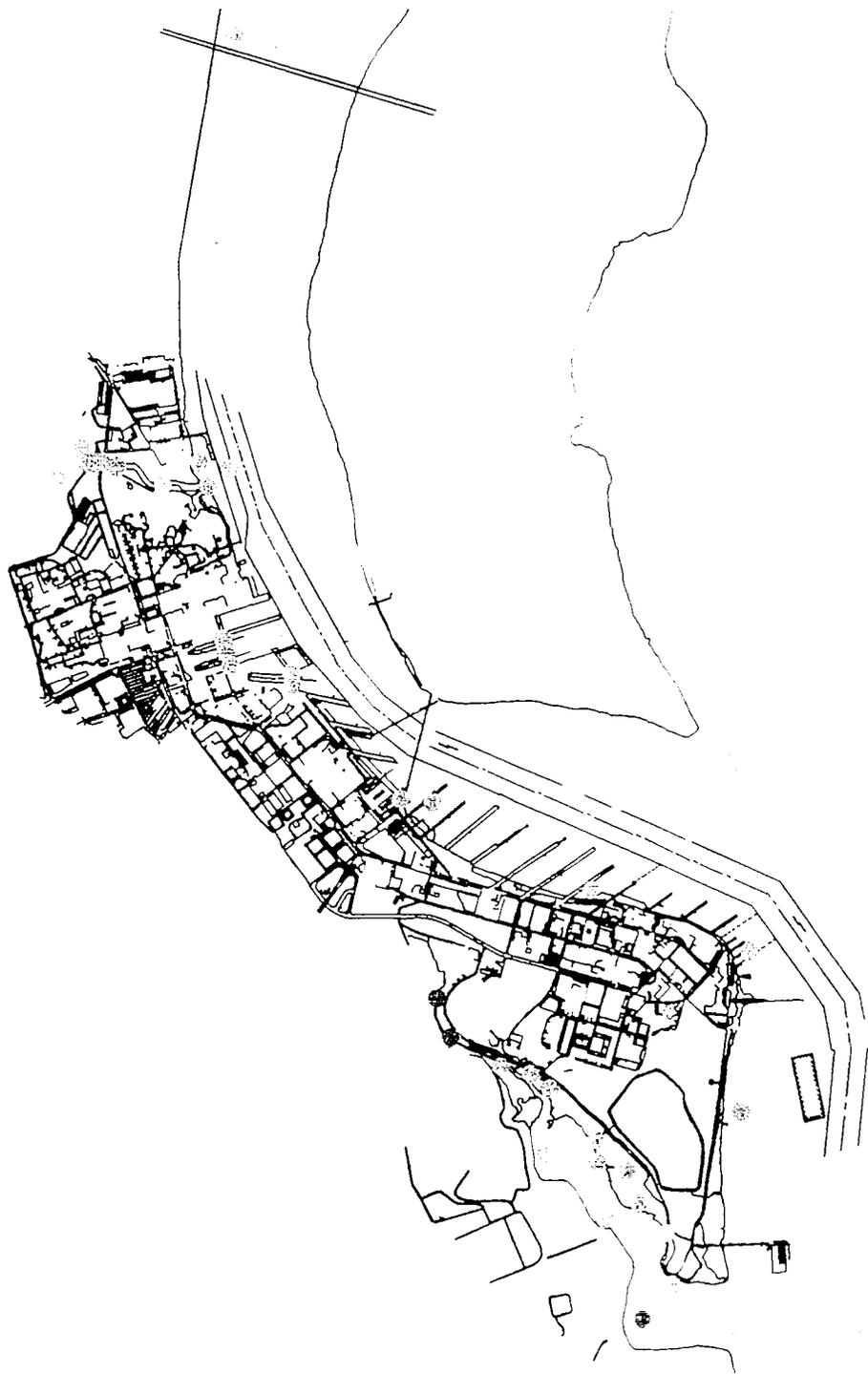


- < Screening Value
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ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

DI-N-BUTYLPHTHALATE
IN SURFACE WATER

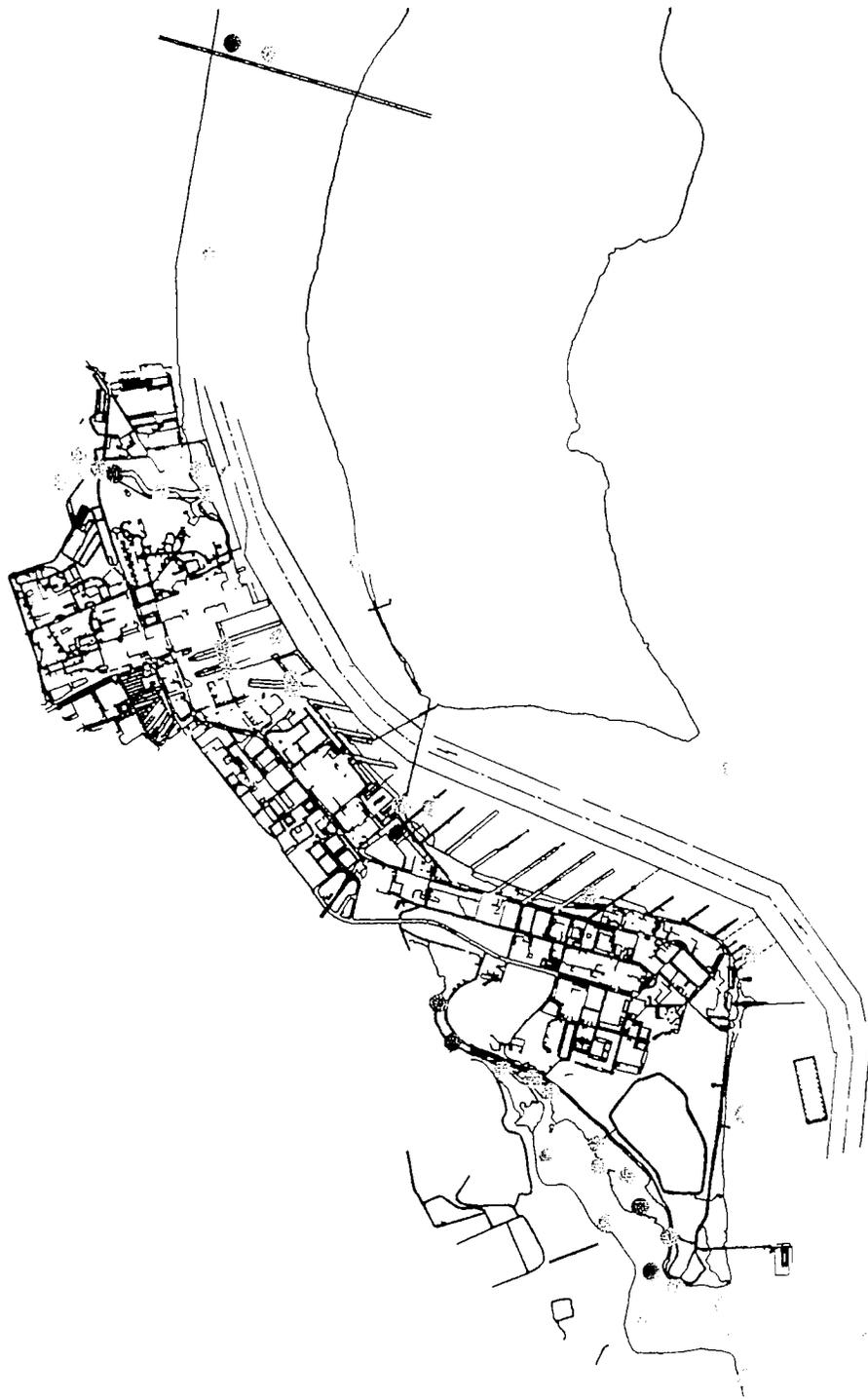


-  < Screening Value
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-  > 2x Screening Value



ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

CHROMIUM
IN SURFACE WATER



○ < Screening Value

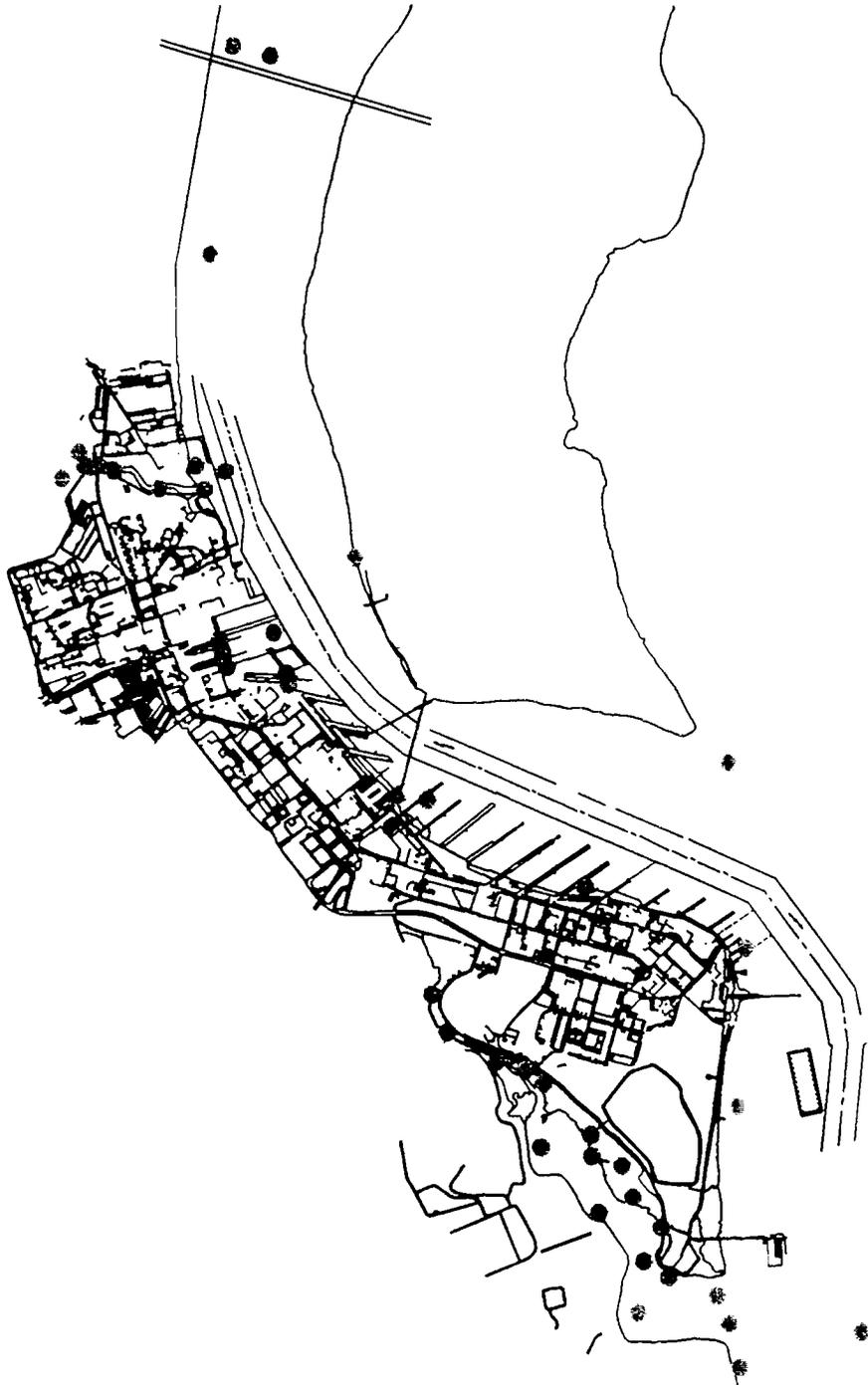
○ > Screening Value

● > 2x Screening Value



ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

COPPER
IN SURFACE WATER



- < Screening Value
- > Screening Value
- > 2x Screening Value



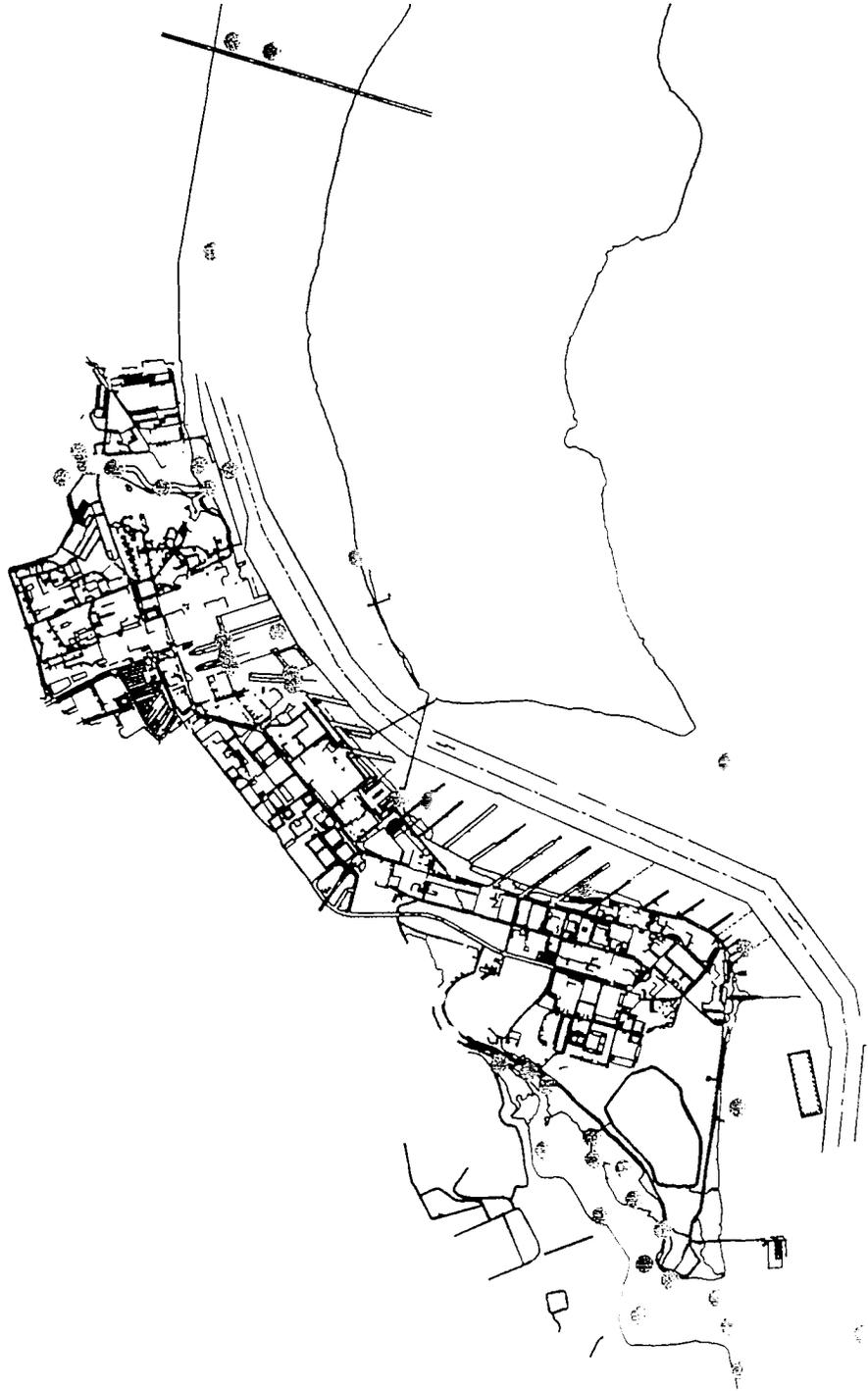
ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

LEAD
IN SURFACE WATER



- < Screening Value
- > Screening Value
- > 2x Screening Value

	ZONE J RFI NAVAL BASE CHARLESTON CHARLESTON, SC
	MERCURY IN SURFACE WATER



-  < Screening Value
-  > Screening Value
-  > 2x Screening Value



ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

NICKEL
IN SURFACE WATER

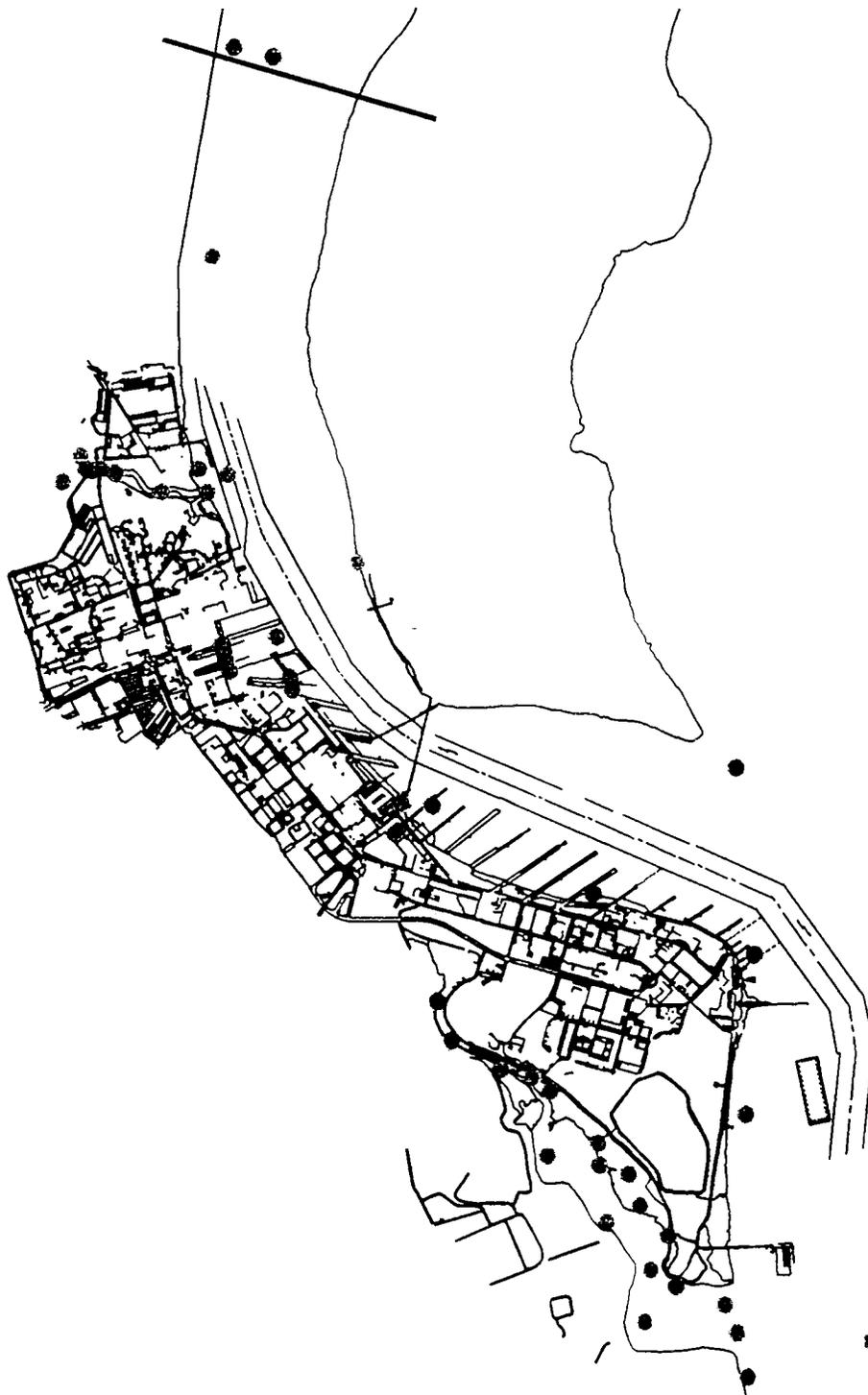


-  < Screening Value
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ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

SILVER
IN SURFACE WATER



- < Screening Value
- > Screening Value
- > 2x Screening Value



ZONE J RFI
NAVAL BASE CHARLESTON
CHARLESTON, SC

ZINC
IN SURFACE WATER