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PRIVATE SCOPE REPORT: AN EVALUATION OF TISSUE AND SEDIMENT CONCENTRATIONS OF SELECTED COMPOUNDS IN THE HACKENSACK MEADOWLANDS

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1.0 INTRODUCTION

1.1 PROJECT OVERVIEW AND GOALS

A previously reported Ecological Assessment (EA) at the Kearny, New Jersey Site (ECKENFELDER INC., 1992) was conducted as part of the continuing remediation and environmental evaluation efforts required by the New Jersey Department of Environmental Protection and Energy (NJDEPE) under an April 1990 Administrative Consent Order (ACO). This report presents the results of a study conducted voluntarily by Maxus Energy Corporation (Maxus) to determine whether selected constituents have had any ecological effects on the site (Study Site). The "constituents of concern" evaluated in this study include mercury, polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), and total petroleum hydrocarbons, as well as target compound list (TCL) pesticides, Aroclors (PCBs), and volatile and semivolatile compounds. The concentrations of these constituents in biotic and abiotic media at the Study Site were compared to those of the same media collected from the adjacent Hackensack River. The general physical and chemical characteristics of the two sites were also evaluated.

ECKENFELDER INC. was retained by Maxus Energy Corporation (Maxus) on behalf of Occidental Chemical Corporation (as successor to Diamond Shamrock Chemicals Company) to prepare this report. Sample collection and analysis for the study were performed by others. Conduct of the initial phases of the study had been essentially completed when ECKENFELDER INC. was retained to synthesize and interpret the data collected.

The goals of this study were to:

- Characterize the general physical and chemical settings in the Study Site and the Hackensack River Site.

- Identify specific physical and chemical characteristics of the two sites which may affect the bioavailability of the constituents evaluated.

- Determine the concentrations of the constituents of concern in abiotic and biotic media of the Study Site and the Hackensack River Site.

- Compare sediment and biota concentrations of the constituents of concern to published concentrations for comparable estuarine systems.

- Compare concentrations of the constituents of concern in tissues of blue crabs collected from each site to concentrations present in blue crabs obtained from the consumer marketplace.

1.2 SITE DESCRIPTIONS

Three areas in the Hackensack Meadowlands were the subjects of this assessment. These were the Maxus Study Site, a site in the Hackensack River adjacent to the Study Site, and another river site approximately 1,300 feet downstream and adjacent to the Standard Chlorine Chemical Company. The Hackensack River Site was selected for evaluation due to its proximity to the Study Site. The general location of the three sites is depicted in Figure 1-1.

1.2.1 Study Site Description

1.2.1.1 Physical Layout. The Study Site is located in Hudson County, New Jersey in the Hackensack Meadowlands. The area studied is a wetlands area adjacent to the Hackensack River (Figure 1-2). The Study Site is located in a highly urbanized area and is bordered to the east by the Hackensack River, to the west by the Belleville Turnpike, to the north by the New Jersey Turnpike, and to the south by an AmTrak railway. The general area serves as a transportation corridor for motor vehicles and railcars, as well as water traffic on the Hackensack River. Tidal exchange at the Study Site is highly restricted by Cayuga Dike.

A nearby inactive dump (previously operated by the Hackensack Meadowlands Development Commission) and an adjoining marshy area are located just across the Belleville Turnpike from the Study Site and may also influence water quality in the Study Site from surface runoff and/or leachate or groundwater migration. Runoff from the adjacent New Jersey Turnpike as well as the highly developed urban surroundings also probably affects water quality and physical habitat in the Study Site.

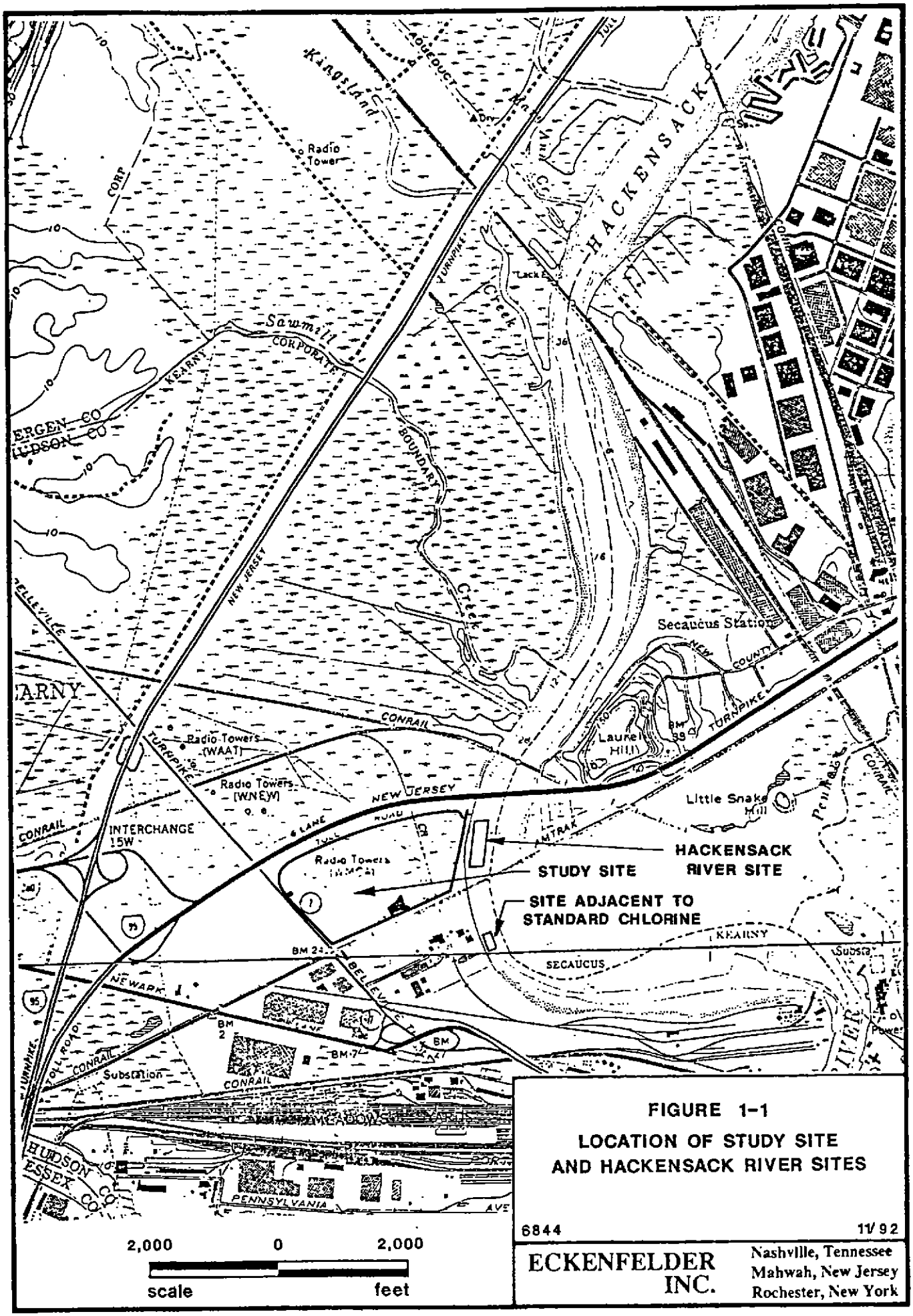


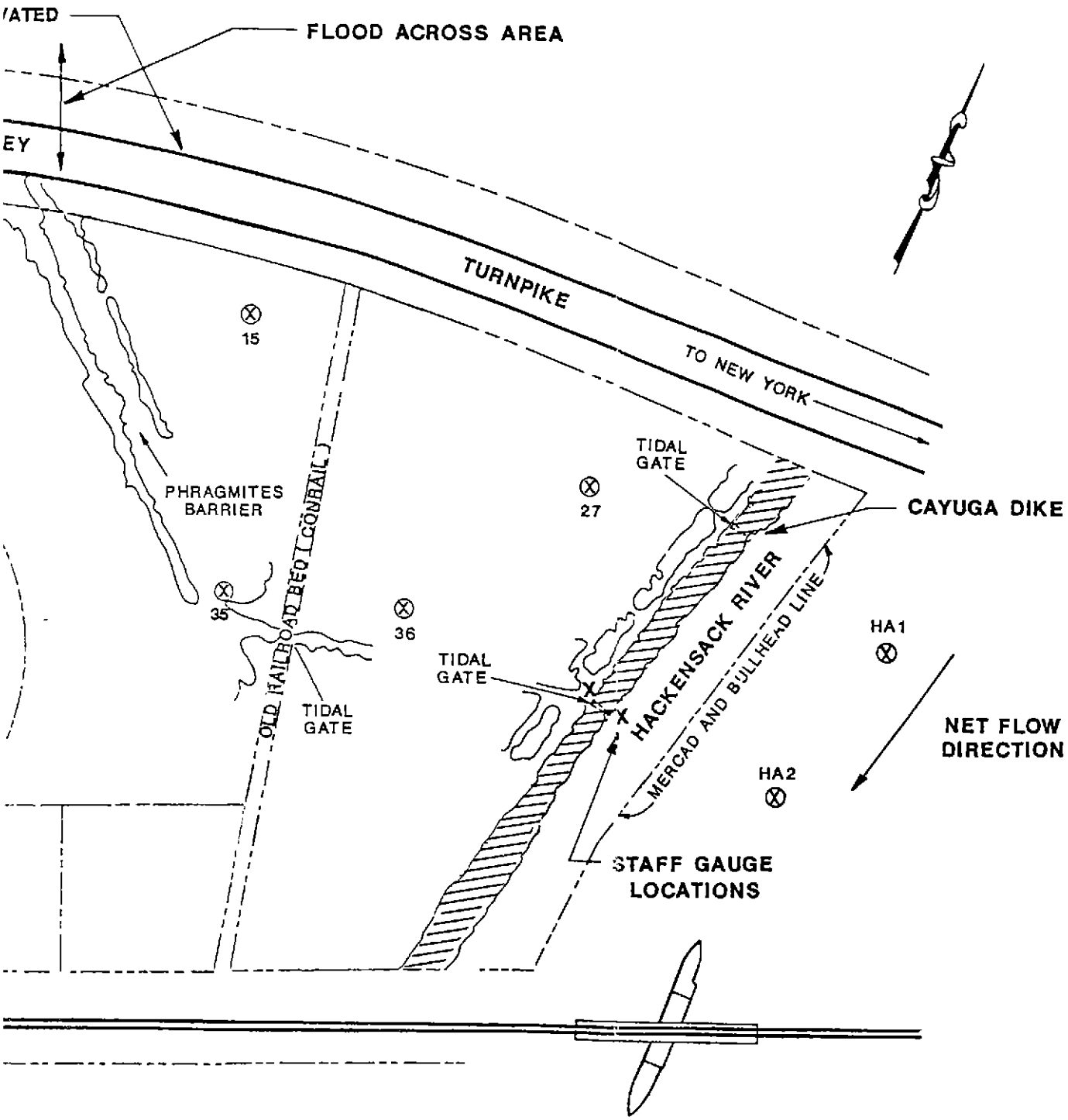
FIGURE 1-1

LOCATION OF STUDY SITE AND HACKENSACK RIVER SITES

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ECKENFELDER INC.

Nashville, Tennessee
Mahwah, New Jersey
Rochester, New York



SCALE

140 0 140 280 FEET

FIGURE 1-2
STUDY SITE AND HACKENSACK RIVER SITE CONFIGURATION AND SAMPLE LOCATIONS

(Adapted from: McLaren-Hart, 1991)

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Nashville, Tennessee
Mahwah, New Jersey
Rochester, New York

The Study Site covers approximately 100 acres, and its approximate dimensions are 3,000 feet by 1,500 feet. The Study Site is subject to tidal water level variations and is largely inundated at high tide. Approximately 30 percent of the area is typically exposed during low tide. Tidal interchange is "controlled" by two tidal gates connecting the Study Site with the Hackensack River. These two tidal gates are located in the Cayuga Dike, between the AmTrak rail line and the New Jersey Turnpike.

Freshwater runoff enters the Study Site from the south (drainage area of approximately 30 acres) and the north (drainage area of approximately 50 acres). A large area to the west of the site (estimated at 75 acres) also drains into the Study Site. Ground surface elevations range from zero to 10 feet, with most areas being less than 5 feet above sea level (Sipple, 1971).

The northern boundary of the Study Site is the raised New Jersey Turnpike and adjacent access road. The runoff from this side of the Study Site is dominated by stormwater from the Turnpike, but it has historically included some runoff from the access road area. Runoff from Belleville Turnpike, a heavily trafficked local thoroughfare, enters the Study Site from the south and along the western perimeter. To the east, the Cayuga Dike separates the Study Site from the Hackensack River.

1.2.1.2 Ecological Setting. The Study Site is a tidal marsh having expanses of open water interspersed with emergent wetlands vegetation dominated by *Phragmites* (*Phragmites australis*). The site was drained by the Hackensack Meadowlands Development Commission for a short period to perform tidal gate maintenance activities approximately three weeks prior to the start of this study. The general ecological setting of the Study Site is typical of temperate estuarine marshes. The plant community of the marsh is dominated by the emergent macrophyte *Phragmites*. Aquatic fauna typical of such areas include killifish (e.g., *Fundulus heteroclitus* and the sheepshead minnow, *Cyprinodon variagatus*), blue crabs (*Callinectes sapidus*), and grass shrimp (*Palaemonetes pugio*). Avian species typical of such areas include herons, various ducks and migratory waterfowl, and kingfishers.

1.2.2 Hackensack River Site

1.2.2.1 Physical Layout. The physical layout of the Hackensack River Site is different from that of the Study Site. Tidal exchange at the Hackensack River Site is unrestricted, and water depth is greater than that at the Study Site. Additionally, the Hackensack River Site is an open expanse of water and does not contain *Phragmites* beyond the immediate shoreline. The sampling locations of the Hackensack River Site are illustrated in Figure 1-2.

1.2.2.2 Ecological Setting. The general ecological setting of the Hackensack River Site is different from that of the Study Site. Unlike the Study Site, the Hackensack River Site is not dominated by *Phragmites*. The tidal exchange and open water nature of the Hackensack River Site, and the lack of a physical barrier such as Cayuga Dike, provide for higher levels of exchange and colonization by aquatic biota. Also, wading birds and small mammals (e.g., raccoons, muskrats) are not likely to use the Hackensack River Site to the extent that they use the Study Site.

1.2.3 Hackensack River Site Adjacent to Standard Chlorine

Standard Chlorine Chemical Company (Standard Chlorine) is an industrial facility approximately 1,300 feet downstream of the Study and Hackensack River Sites. Chlorinated products were formerly produced at the site, which is presently used only for warehousing operations. In a study that was conducted subsequent to the study documented in this report, sediment and blue crab samples were collected from the Hackensack River in the vicinity of Standard Chlorine and were analyzed for PCDDs and PCDFs. For comparison purposes, results from the Standard Chlorine study are included in some of the data presentations in Section 3.0 (Results and Discussion) of this report.

1.3 CHEMICAL FACTORS INFLUENCING THE FATE AND BIOAVAILABILITY OF THE CONSTITUENTS OF CONCERN

1.3.1 General

Many physical and chemical factors influence the form and subsequent fate and effects of chemicals in aquatic environments. For example, pH, suspended solids, organic carbon, and temperature can alter the form and toxicity of chemicals. Biological factors such as methylation play an important role in the form and subsequent fate and bioavailability of mercury. The "bioavailable" form of a constituent is considered to be any form of a constituent which can exert toxicity or bioaccumulate.

The form of a chemical and its bioavailability are closely linked. It is generally accepted that the biologically available forms of chemicals are present in the aqueous (dissolved) phase (e.g., Hamelink, 1980; Schuytema et al., 1983; Hall et al., 1986). Insoluble precipitates, chelates, and adsorbed forms of chemicals are not only of lower bioavailability than dissolved forms, but they typically are removed from the water column and accumulate in sediments. In sediments, organic carbon and nearly neutral pH conditions tend to reduce the bioavailability of most chemicals.

Brief overviews of the environmental and toxicological characteristics of some of the constituents evaluated in this study are presented below. The potential for biological effects due to these is documented in the literature.

1.3.2 Mercury

Mercury is a known mutagen, teratogen, and carcinogen (Eisler, 1987). It has a high potential for bioaccumulation and biomagnification and is slow to depurate. Organomercury compounds are more effective in producing adverse effects on aquatic biota than are inorganic mercury compounds (USEPA, 1985). Mercury at relatively low concentrations adversely affects the reproduction, growth, behavior, metabolism, blood chemistry, osmoregulation, and oxygen exchange of marine and freshwater organisms.

The significance of elevated mercury residues in tissues of aquatic organisms is not fully understood. Concentrations greater than 1 mg/kg wet weight can occur in various tissues of selected species of fish and aquatic mammals (USEPA, 1985). However, it would be incorrect to assume that aquatic food chains, especially marine food chains, incorporate mercury exclusively from anthropogenic activities (Barber et al., 1980).

Mercury concentrations of >1.0 mg/kg wet weight as methylmercury in biological samples are often associated with proximity to human use of mercury (Eisler, 1987). Elevated levels of mercury in biota may persist in contaminated areas long after the source of mercury has been discontinued (Rada et al., 1986).

Chemical speciation is probably the most important variable influencing the ecotoxicology of mercury. Mercury compounds in an aqueous solution are chemically complex. Depending on pH, alkalinity, redox, and other variables, a wide variety of chemical species may be formed, having different electrical charges and solubilities. For example, $HgCl_2$ in solution can speciate into $Hg(OH)_2$, Hg^{2+}, $HgCl^+$, $Hg(OH)^-$, $HgCl_3$, and $HgCl_4^{2-}$ (Eisler, 1987). In the aquatic environment under naturally occurring conditions of pH and temperature, mercury may become methylated by biological or chemical processes, or both. Mercury discharged into rivers, bays, or estuaries as elemental mercury, inorganic divalent mercury, phenylmercury, or alkoxyalkyl mercury can be converted into methylmercury compounds by natural processes. Mercury methylation in ecosystems depends on mercury loadings, microbial activity, nutrient content, pH and redox condition, suspended sediment load, sedimentation rates, and other variables. Methylmercury is the most hazardous mercury species due to its high stability, its lipid solubility, and its ionic properties that lead to a high ability to penetrate the membranes of living organisms (USEPA, 1985).

1.3.3 PCBs/Aroclors

Polychlorinated biphenyls (PCBs) constitute a group of over 200 synthetic, halogenated aromatic compounds which have been used primarily in the electric generating industry as insulating materials. Specific Aroclor PCBs constitute the most important chemicals of the collective group of chemicals known as PCBs. Due to their wide use and persistence, PCBs are now distributed throughout the world.

PCBs elicit a variety of biological responses depending on their individual toxicity. PCBs are highly persistent and readily bioaccumulate (e.g., Olafsson et al., 1983).

The toxicological properties of PCBs depend primarily on two factors: the octanol/water partition coefficient (K_{ow}) and the distribution of chlorine on the molecule (e.g., Eisler, 1986a). PCBs with high K_{ow} values and a high degree of chlorine substitution are of the highest environmental concern. Historically, PCBs were assessed on a "total" PCB basis. However, with improved analytical methodologies and an improved understanding of the toxicity of Aroclor PCBs, individual Aroclors can now be measured and the toxicological relevance of those measurements interpreted. Today, there is a great deal of interest in analysis of specific PCB congeners, but regulatory guidance has not yet been developed in this area (USEPA, 1992). Acutely toxic concentrations of some Aroclor PCBs have been reported to be in the range of 1 μg/L (e.g., USEPA, 1980).

Due to the toxicity, high K_{ow} values, and highly persistent nature of many PCBs, they possess a high potential to bioaccumulate and exert reproductive effects in higher trophic level organisms. The potential for bioaccumulation and subsequent effects constitutes the largest environmental concern over PCBs. Due to their hydrophobic nature, PCBs tend to partition to organic materials and accumulate in the sediments of aquatic systems, which may also limit their bioavailability to some aquatic organisms.

1.3.4 PCDDs and PCDFs

PCDDs consist of a class of compounds which includes 75 different polychlorinated dibenzo-p-dioxins (Clement, 1991). The framework of the PCDD structure is two benzene rings joined by two oxygen atoms. PCDDs are commonly associated with a class of compounds called PCDFs which have a very similar structure. However, the two benzene rings of PCDFs are joined by one oxygen atom rather than two (Paddock, 1989). PCDDs have been found as impurities during the manufacture of certain herbicides and germicides, in sludges from the bleached pulp and paper industry, in exhaust from vehicles not equipped with catalytic converters, during the incineration of certain industrial and municipal wastes, and as a result of wood burning (ATSDR, 1989; Paddock, 1989).

Some PCDDs and PCDFs have high octanol-water partition coefficient (K_{ow}) values and are highly persistent in the environment. The high K_{ow} values of these PCDDs and PCDFs also limit their mobility in the environment. The log K_{ow} for 2,3,7,8-TCDD is reported with a range of 6.15 to 7.28 (ATSDR, 1989; Montgomery and Welkom, 1990), indicating that it is very hydrophobic (Lyman et al., 1990). In addition, the range of log K_{oc} (sediment-water equilibrium distribution coefficient referenced to organic content) values reported for 2,3,7,8-TCDD of 6.0 to 7.39 (ATSDR, 1989; Montgomery and Welkom, 1990) indicates that it sorbs strongly to soil or sediment, binding strongly to organic carbon (Paddock, 1989).

The environmental fate of 2,3,7,8-TCDD is not clearly understood. In the air, particulate-bound 2,3,7,8-TCDD may undergo photolysis or it may be removed via wet or dry deposition. The ultimate sink of airborne 2,3,7,8-TCDD is either sediments or surface water, and the ultimate sink of aquatic 2,3,7,8-TCDD is sediments (ATSDR, 1989). In sediments, 2,3,7,8-TCDD has been suggested to have a half-life of approximately 10 years (Paddock, 1989).

1.4 BIOLOGICAL FACTORS INFLUENCING BIOACCUMULATION AND TOXICITY

Biological factors influencing the bioaccumulation and toxicity of a chemical relate primarily to the organism exposed (e.g., life stage). Another biological factor of potential importance is microbial methylation. Methylation can be very important in altering the bioaccumulative potential and toxicity of mercury. Methyl mercury is much more toxic and bioaccumulates to a much higher degree than the inorganic forms of mercury (USEPA, 1985).

Biological factors of importance to the bioaccumulation of chemicals include the organism's mode of exposure (e.g., direct body uptake or gill uptake versus ingestion), life stage, percent lipid content, metabolism (e.g., depuration), and life history characteristics (e.g., proximity to sediments). Routes of uptake vary from species to species. However, direct body uptake of chemicals by fish appears to be of less importance than uptake through gills. Uptake of chemicals by invertebrates is highly dependent on the mode of exposure. The uptake of chemicals by invertebrates such as blue crabs (*Callinectes sapidus*) is heavily influenced by their proximity to sediments and mode of uptake. Although blue crabs are excellent

swimmers, they do spend an appreciable amount of time in close proximity to bottom sediments. As such, the level of biologically available chemicals present in the sediment-water interface plays an important role in influencing the effects of the chemicals of concern on blue crabs. The amount of a given chemical present in biologically available forms at this interface depends on the physical and chemical factors influencing the form of that chemical.

1.5 GENERAL CONSIDERATIONS AND CONCERNS IN DETERMINING ECOLOGICAL EFFECTS

The toxicological and subsequent ecological effects of chemicals in aquatic environments are highly site-specific. The numerous variables which influence the bioavailability of chemicals (Section 1.4) play a critical role in determining toxicological and ecological effects at the Study Site. However, other variables not directly related to toxicological effects are also important in interpreting those effects. For example, the physical and chemical conditions at a site (pH, dissolved oxygen, salinity, sediment characteristics, tidal flushing, nutrient levels, etc.) dictate the site's ecological composition absent the presence of anthropogenic constituents. The interrelationship of site-specific variables can make the interpretation of ecological data, and especially the assigning of causality to any observed "effects," quite difficult in some cases. Additionally, determining ecological risk and ecological effects may be constrained by the limited amount of quantitative data on the transport, accumulation, and toxicity of many chemicals (Bartell et al., 1992). Interpretation of the results of any ecological assessment should be conducted with the answers to the following questions in mind:

- What levels of which chemicals are present in the ecosystems being studied?
- What media are these chemicals in?
- Are these chemicals in biologically available forms?
- What physical and chemical factors control the effects of the chemicals of concern?

- What species or ecosystems are potentially exposed?
- What is a suitable site for comparison?
- What factors other than the chemicals of concern may be present which could also deleteriously affect the biota?
- What levels of these chemicals have been shown to be detrimental to site biota? Under what conditions?
- Can the chemicals of concern be correlated with observed effects and distinguished between sites?
- Are exposure pathways available?
- What trophic levels of the ecosystem are potentially affected and need to be evaluated?

Ecological assessments (EAs) can be quantitative or qualitative in nature. However, EAs should consider, if not actually address, each of the above and other questions as relevant.

2.0 MATERIALS AND METHODS

2.1 INTRODUCTION

This study was designed to evaluate the potential for effects, if any, from the selected chemicals of concern on the aquatic and wetlands ecosystems present in the Study Site. The chemicals of concern are mercury, Aroclors (PCBs), PCDDs, PCDFs, total petroleum hydrocarbons (TPH), TCL pesticides, and TCL volatile and semivolatile compounds.

This study was designed using guidance published in the *Risk Assessment Guidance for Superfund Sites Volume II Environmental Evaluation Manual* (USEPA, 1989a) and in *Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference* (USEPA, 1989b). Additional guidance on the scope of some aspects of this assessment was provided by the NJDEPE in written comments to the Draft RI Work Plan, dated December 21, 1990.

The field work for this study was conducted during the period August 30 to November 20, 1991. The following description of the procedures utilized was taken largely from the Work Plan for this study (McLaren-Hart, 1991).

2.2 GENERAL APPROACH

This study evaluated the levels of the chemicals of concern in selected fauna of the studied ecosystems. The assessment also characterized the levels of these constituents in sediments associated with the Study Site and Hackensack River Site. Tissue analyses of biota from the Study and Hackensack River Sites allowed a preliminary evaluation of (i) the levels of the constituents of concern in selected organisms and (ii) the potential adverse effects on the species evaluated.

This study included sampling of biota and sediments in the Study Site and the Hackensack River Site. Sampling was conducted only when the salinity of the surface water was in excess of five parts per thousand and the water temperature was no higher than 80°F (Chesapeake Executive Council, 1989). Biota samples were obtained from indicator species chosen by NJDEPE. These species included the blue crab (*Callinectes sapidus*) and a killifish (*Fundulus heteroclitus*). Blue crabs

Blue crabs and killifish were sampled from six locations in the Study Site and from two locations in the Hackensack River Site adjacent to the Study Site. Sediment samples were collected at seven locations within the Study Site and from two locations in the Hackensack River Site. At each location the sample was collected from the top 0 to 6-inch interval of the sediment.

Crab tissue analyses for the selected constituents included analysis of the hepatopancreas and claw and body muscle ("edible tissue"). Laboratory analyses of killifish samples were performed using the whole organism. Sediment analyses were conducted on a whole sediment basis.

All biological sample dissections were conducted in a field laboratory setting established at a location near the Study Site. Organisms collected on a given day were placed in coolers or temporary storage containers and taken to the field laboratory for dissection and sample tissue preparation. The analytical procedures used to assess the concentrations of the constituents of concern in sediments and biota are presented in Table 2-1. Table 2-2 presents the analytical procedures used to assess the general physical and chemical characteristics of sediments.

The results of this study were used for comparison with data available from other studies to determine whether the levels of chemicals of concern in the Study Site and Hackensack River Site biota were similar to those reported in the literature. Selected ecological parameters were also evaluated (e.g., blue crab carapace size, avian species composition, etc.) in order to assess the general condition of Study Site biota.

2.3 BIOTIC SAMPLING

2.3.1 Blue Crabs

2.3.1.1 Field Sampling. Blue crabs were collected at each of six sampling locations in the Study Site (Stations 15, 23, 27, 35, 36, and 43) and two sampling locations in the Hackensack River Site adjacent to the Study Site, adjacent to Cayuga Dike (Stations HA1 and HA2). The approximate locations of these stations were previously identified in Figure 1-2. The size and apparent health of the organisms in the population were also assessed.

TABLE 2-1

SUMMARY OF ANALYTICAL METHODOLOGIES FOR SEDIMENT AND BIOTA ANALYSES FOR THE CONSTITUENTS OF CONCERN

Constituent	Analytical Method
PCDDs	USEPA 1613 A
PCDFs	USEPA 1613 A
TCL Pesticides	CLP 3/90[a]
TCL Aroclors	CLP 3/90[a]
TCL Volatiles and Semivolatiles	CLP 3/90
Mercury (total)	CLP 3/90[a]
Total Petroleum Hydrocarbons	USEPA 418.1

[a]Biota method had modifications in the preparation steps as approved by NJDEPE.

TABLE 2-2

SUMMARY OF METHODS UTILIZED TO EVALUATE GENERAL SEDIMENT PARAMETERS

Sediment Parameter	Method
Dissolved Oxygen	USEPA 360.1
Nutrients (P, K, Ca, Mg, Na, TKN, NH_3-N)	USEPA CLP SOW 3/90 and 4500-P, 4500-N
Grain size	ASTM D422
pH	USEPA 9045
Total Organic Carbon	Modified USEPA 415.1 or USEPA 9060
Salinity	Standard Methods (17th Ed.) 2520
Percent Water	USEPA CLP SOW 3/90

Although the work plan had been developed to collect male and female specimens, female blue crabs had already departed from near-shore waters as part of the seasonal migration. Thus, as agreed upon by NJDEPE, only male blue crabs were collected in this study. Crabs were collected using crab traps baited with fresh chicken. Fresh bait was placed in each trap when that trap was checked. Three traps were placed at each sampling location. At each sample station the blue crabs collected from each trap were tagged for identification, placed in ice chests in separate containers, and transported to a temporary shore-based storage facility at the end of each day's operations. Each crab collected was measured across the carapace from the points and identified as to sex. Each crab was visually searched for apparent physiological abnormalities. Crabs that had just molted were not sampled but were recorded.

2.3.1.2 Preparation of Tissues for Analysis. Each crab was separated into edible tissue and hepatopancreas fractions. Only one-half of each tissue fraction (edible and hepatopancreas tissue) was composited to provide a total of four samples of each tissue fraction for analysis from each sample location. The remainder was archived by individual crab. The extraction and preparation of blue crab tissues were performed in accordance with procedures described by Tetra Tech (1986). Samples were dissected under controlled, clean room conditions to the maximum extent possible.

Each crab was first washed with distilled/deionized water to remove surface contaminants and then dried using a paper towel. The claws were removed at the body suture, and the body was then placed on a pre-cleaned glass surface. The hepatopancreas was extracted from the body cavity using pre-cleaned plastic or brass forceps and placed on a pre-cleaned glass surface. Body muscle tissue was removed using pre-cleaned plastic or brass forceps and placed on a pre-cleaned glass surface. The end of each claw was cut with scissors and the muscle tissue removed by squeezing the muscle tissue. Extracted claw muscle tissue was placed on a pre-cleaned glass surface.

After the body and claw muscle tissues and the hepatopancreas of each crab were extracted, each of these samples was diced into small pieces using a pre-cleaned plastic or brass scalpel. One-half of the tissue from each crab was mixed thoroughly

and divided into two equal fractions. One-half of the tissue fractions from the crabs collected at each sampling location was composited for analysis. The remaining one-half of the tissue from each crab was packaged separately, labeled, and archived in frozen storage. Samples containing edible tissue and hepatopancreas were labeled, sealed with custody tape, and stored chilled in zip-lock bags. Samples were stored in a freezer at the site prior to shipment under chain-of-custody to the project laboratory (Accutest Laboratories of Dayton, New Jersey, a NJDEPE certified laboratory) for analysis. Several parameters were analyzed at Accutest Laboratories in Marlborough, Massachusetts. At the laboratory, the samples were maintained under refrigerated conditions prior to analysis. All sample handling and analysis procedures followed those specified in the Quality Assurance Project Plan (QAPP) which was a companion document to the Remedial Investigation Work Plan (McLaren-Hart, 1991) for the previously reported Environmental Assessment (ECKENFELDER INC., 1992).

2.3.2 Killifish

2.3.2.1 Field Sampling. Approximately 60 grams (wet weight) of killifish were collected from each of six sampling locations in the Study Site (Stations 15, 23, 27, 35, 36, and 43) and two sampling locations in the Hackensack River Site (Stations HA1 and HA2). Sampling locations were previously noted on Figure 1-2. Killifish were collected in the approximate area of the crab collection locations.

Killifish were collected with either thrownets or minnow traps. Killifish were placed in a pre-cleaned and pre-measured container for weighing. If an adequate quantity of killifish was not collected in the designated sampling locations, then the sampling area was expanded to obtain the necessary quantity of killifish.

2.3.2.2 Preparation of Tissue for Analysis. After collection at each sampling location, the killifish were cleaned thoroughly using distilled/deionized water to remove surface contaminants.

Killifish were analyzed on a whole body tissue basis. The killifish from each sampling location were divided into two composite samples of approximately 30 grams each. Each composite sample was placed in a plastic zip-lock bag. Each container was sealed, labeled, and chilled to 4°C until shipment under chain-of-

custody to the project laboratory. Upon receipt at the laboratory, the samples were homogenized and analyzed according to the NJDEPE-approved laboratory SOP.

2.3.3 Decontamination Procedures

All dissection instruments were pre-cleaned prior to use according to the USEPA Region II decontamination procedures (USEPA, 1988) and procedures described in the Equipment Decontamination Plan (EDP). All plastic or glass troughs, glass plates, spoons, spatulas, and homogenizing bowls were cleaned and wrapped in aluminum foil prior to tissue extraction and preparation. Cleaning included (sequentially) washing with a non-phosphate detergent solution while scrubbing with a natural bristle brush, potable water rinse, deionized water rinse, 10 percent nitric acid solution rinse, and deionized water rinse. Work surfaces were washed with a mild non-phosphate detergent, dilute nitric acid, deionized water and air dried. Each sample was handled with only pre-cleaned Teflon®, plastic or nickel-plated instruments and contacted only pre-cleaned glass.

All brass instruments and samplers were cleaned using the following procedures:

1. non-phosphate detergent wash and scrub;
2. potable water rinse;
3. deionized water rinse.

2.3.4 Sample Handling

All biotic specimens from each collection site were stored at 4°C and dissected as a group to ensure that specimens from different sampling stations were not mixed. Following dissection, crabs were frozen as a group until analyses were performed. To maintain the integrity of each composite crab and killifish sample, each specimen was processed to completion before a second sample was undertaken. Specimen processing consisted of removing identifying labels that accompanied each specimen, labeling the final tissue sample jars, and processing the entire group of specimens before beginning the next set. All biotic samples were handled and shipped according to procedures for the general management of laboratory samples as defined in Section 7.0 of the Standard Investigative Procedures Plan (SIPP), which was a companion document to the Remedial Investigation Work Plan

(McLaren-Hart, 1991). No trip blanks were required for the biotic samples. Field blanks were prepared in accordance with the frequency requirements in the QAPP.

2.4 SEDIMENT SAMPLING

Sediment samples were collected at six locations in the Study Site (15, 23, 27, 35, 36, and 43) and at each of the two biotic sampling locations in the Hackensack River Site (Stations HA1 and HA2). Sediment samples were collected according to procedures outlined in Section 5.4 of the SIPP from the 0 to 6-inch interval.

Sediment samples in the Study Site were collected using a Lamont dredge, in some cases using a long implement to push the dredge down to ensure adequate recovery of material. The gravel/cobble nature of the river bottom at the Hackensack River Site stations HA-1 and HA-2 necessitated the hand collection of depositional silt at low tide at positions located closer to the bank than originally anticipated. Sample quantities of at least 200 grams were collected at each station.

2.5 SURFACE WATER SAMPLING

Surface water samples were collected at each of six locations in the Study Site (Stations 15, 23, 27, 35, 36, and 43) and at the two biotic sampling locations in the Hackensack River Site (Stations HA1 and HA2) in order to assess general surface water parameters at the two sites. These sample locations are the same as those previously shown on Figure 1-2. Surface water samples were collected approximately two-thirds of the distance from the surface to the bottom using a sub-surface grab sampler according to procedures outlined in SIPP Section 5.3. Because of the shallow water in the Study Site (less than 2 feet), three samples were collected by hand submersion of the sample jar. Table 2-3 summarizes the analytical methods utilized to evaluate general surface water parameters.

Surface water sampling was synchronized, to the extent possible, to a pre-determined tidal stage. Sampling was synchronized to occur at as low a tidal stage as was consistent with boat access, synchronization requirements, and field constraints. Atypical conditions such as extreme rainfall or extreme drought were cause for postponing the sampling until typical conditions were prevalent.

TABLE 2-3

SUMMARY OF METHODS USED TO EVALUATE GENERAL SURFACE WATER PARAMETERS

Constituent	Analytical Methods
Salinity	*
pH	*
Temperature	*
Conductivity	*
Dissolved Oxygen	*
TOC	USEPA 415.1
BOD	Standard Methods (17th Ed.) 5210
Sulfides	USEPA 376.1
TKN	USEPA 351.4
Fecal Coliforms	Standard Methods (17th Ed.) 9221
Hardness	USEPA 130.2
TSS	USEPA 160.3

*Field measurements.

2.6 TIDAL FLUX STUDIES

Tidal marshes, such as the Study Site, are typically influenced by the rise and fall of daily tides, as well as by runoff from surrounding areas. The water currents associated with the tidal flux allow for continuous cyclical inflow and outflow of water from a marsh and a resulting mixing of the water. Mixing in the Study Site is limited by Cayuga Dike, which acts to isolate the Study Site from the Hackensack River Site. Passage of water as a result of tidal influences is controlled through a series of tidal gates located in the dike. Staff gauges were set up on the Hackensack River Site side and the Study Site side of a tidal gate in the Cayuga Dike to measure the water levels on both sides of the dike over a tidal cycle. The locations of these gauges were previously presented in Figure 1-2. The gauges were monitored on a continuous basis over a 12-hour period on two separate occasions during the course of the field work. This provided a comparison of tidal ranges in the Study Site to tidal ranges in the Hackensack River Site. The resulting data were used in assessing the hydraulic similarities between the two areas and the potential for tidal influence on the Study Site.

2.7 COMMUNITY STRUCTURE

A cursory evaluation of community structure in the Study Site was conducted. Inventories of the species present from major taxonomic groups not specifically addressed in other portions of this project were conducted. Procedures for these evaluations are presented below.

2.7.1 Avian Species Richness Inventory

Avian surveys were conducted during the course of the field work. Birds seen or heard during the various field activities were noted as residing in the Study Site. Birds flying overhead were not considered unless observed flying from the wetlands. Spotting devices were utilized for species identification. Cruises through the swamp by small boat were also used to identify species.

2.7.2 Vegetation Species Richness Inventory

Vegetative species inhabiting the Study Site were identified during various field activities. The observer walked or took a boat along shoreline areas, noting the species present.

2.8 QUALITY ASSURANCE PROGRAM

The QAPP was followed for all investigative activities conducted during this study. All biota, sediment, and surface water sampling, as well as laboratory protocols for analysis, are described in the QAPP. The QAPP describes requirements for chemical measurement, sample handling, analytical methods and procedures, calibration procedures and frequency, internal quality control checks, performance audits, corrective actions, and data reduction and validation.

2.8.1 Sample Site Selection

The locations of the Study Site sediment and surface water sampling locations were chosen using a rectangular grid. The locations were selected to be representative of the geographic variations of the abiotic components in the Study Site. As such, these locations provided a cross-section of information on the presence of constituents of interest across the ecological areas studied. Biota sampling locations were selectively chosen to provide broad geographic coverage for assessment of the Study Site.

2.8.2 Measures of Quality Assurance and Quality Control (QA/QC)

QA/QC samples were included to provide quality control over the collection of environmental measurements and subsequent review, interpretation, and validation of the analytical data generated by the project laboratory. QA/QC samples included field blanks and duplicates as specified in the QAPP for sediment samples and surface water samples. Field blanks alone were used for biota samples. The number of blanks, their collection, handling, preparation, and management are also outlined in the QAPP.

2.8.3 Sample Management

The procedures by which samples were handled and stored, including chain-of-custody procedures, labeling, and documentation, were specified in the QAPP.

2.8.4 Project Documentation

The field work for the Private Scope Study was documented to provide a concise, permanent record of the activities performed. A daily field logbook was kept as the primary record for documenting all investigative activities. Field logbooks were bound and contained numbered, water-resistant pages. Pertinent information regarding the site and sampling procedures were documented, including the time and date of entries in the logbooks. Information recorded in the logbooks included, but was not limited to, the following material:

- Date and time of on-site arrival/departure
- Name of person keeping logbook
- Name of on-site personnel associated with the field activities
- Daily objective
- Sketch of sampling points in relation to important landmarks
- Number of samples taken
- Methods used in sample collection
- Media sampled and parameters to be analyzed
- Organisms collected
- Detailed measurements and descriptions of organisms
- Weather conditions
- Description of photographs taken

2.8.5 Analytical Methods

Analytical methods were specified in the QAPP. The QAPP also specified the laboratory QA/QC requirements which were followed in the laboratory analysis of the samples collected. In summary, both biotic and sediment samples were analyzed for the constituents of concern (i.e., mercury, PCDDs, PCDFs, TPH, TCL pesticides, TCL volatile and semivolatile compounds, and TCL Aroclors). Surface water samples were analyzed for dissolved oxygen, BOD, TOC, TKN, fecal coliform,

salinity, pH, hardness, temperature, sulfides, total suspended solids, and conductivity (Table 2-3). Sediment samples were analyzed for dissolved oxygen, soil nutrients (TKN, ammonia-nitrogen, phosphorous, potassium, calcium, magnesium and sodium), grain size, pH, TOC, salinity, and percent water (Table 2-2).

2.8.6 Data Utilization

The data presented in this report have undergone QA/QC evaluations by an external consultant specializing in data quality assessment. The data generally meet NJDEPE requirements for acceptability in areas such as spike recovery, contaminant-free blanks, replication of duplicates, etc.

2.9 DATA ANALYSIS

Data from this study included concentrations of various analytes in the tissues of indicator species and in surface waters and sediments from both the Study Site and the Hackensack River Site. In addition, general physical and chemical parameters of the sediments in both sites and water quality conditions of surface waters in both sites were documented. General water chemistry and sediment characteristics were used to assess the similarity of the Study Site and Hackensack River Site to determine if factors other than the constituents of concern likely play a role in any biological or ecological differences observed between the two sites. Tissue samples served as a screening mechanism for the levels of analytes in the organisms evaluated. A comparison of tissue concentrations to values in the scientific literature was also used to determine whether similar results had been obtained in other studies. The data developed on relative abundance of the organisms, apparent vigor, and the description of community structure allowed for a qualitative assessment of the health of the Study Site ecosystem.

At Maxus' request, toxicity equivalents (TEs) were calculated for PCDDs and PCDFs for all media evaluated for these parameters. Standard toxicity equivalent factors (TEFs) for each PCDD and PCDF congener were used to calculate the TEs associated with the concentration of each congener in each sample. The TEs were then totaled for each sample. The TEFs used for the PCDD and PCDF congeners were those provided in USEPA's 1989 document entitled "Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated

Dibenzo-p-Dioxins and Dibenzofurans (CDDs and CDFs) and 1989 Update" (USEPA, 1989c). Values of one-half of the detection limit were used for congeners not detected in a sample.

2.10 HEALTH AND SAFETY

Activities conducted during the field investigative phase of the ecological assessment were conducted in accordance with the Health & Safety Plan (HASP) which was a companion document to the Remedial Investigation Work Plan (McLaren-Hart, 1991).

3.0 RESULTS AND DISCUSSION

The results of this study are presented below. Data on the physical and chemical characteristics of the surface waters and sediments at each site are presented first to provide a context in which to interpret subsequent data on constituents of concern in these same media. The data on constituents of concern in biota and the data on ecological endpoints are then presented as a means of interpreting actual and potential ecological effects. Data on residuals concentrations and biological differences between the Study Site and Hackensack River Site must be interpreted in light of the basic physical and chemical attributes of each site. Data not presented in their entirety in the text of this report are summarized in the appendices to this report.

3.1 PHYSICAL AND CHEMICAL SITE CHARACTERISTICS

3.1.1 Tidal Fluctuation Studies

Table 3-1 presents the results of one of the two tidal fluctuation studies conducted to determine if differences exist in the extent of tidal flushing in the Hackensack River and Study Sites (the results of the second study were essentially identical). From the Table 3-1 data, the bottom and peak of the tidal cycles at the Study Site and the Hackensack River Site occurred at roughly the same time, as would be expected, with some delay at the Study Site attributable to the tidal gates in Cayuga Dike. However, the degree of flushing in the two sites was quite different as evidenced by the difference in water level fluctuations. The differences in peak and bottom levels of the tidal cycle were 5.34 feet (5 feet 4 inches) in the Hackensack River Site and 0.54 feet (6-1/2 inches) in the Study Site. The results of the second tidal study (Appendix A) indicated a 6-foot tidal fluctuation in the Hackensack River Site and a 6-inch fluctuation in the Study Site. The results from both tidal fluctuation studies indicate that flushing in the Study Site is highly restricted as a result of Cayuga Dike.

3.1.2 Basic Surface Water Chemistry

Presented below are the results of basic water chemistry parameters ("field parameters") measured at each site. These data were previously reported in

TABLE 3-1

RESULTS OF TIDAL MONITORING CONDUCTED OCTOBER 31, 1991[a]

Time of Day	Study Site (feet)	Hackensack River (feet)
0800	1.12	1.44
0830	1.08	1.36 (bottom of tidal cycle)
0900	1.06	1.54
0930	1.06 (bottom of tidal cycle)	2.04
1000	1.10	2.70
1030	1.14	3.26
1100	1.18	3.86
1130	1.20	4.30
1200	1.22	4.90
1230	1.26	5.20
1300	1.28	5.50
1330	1.30	5.90
1400	1.30	6.24
1430	1.34	6.52
1500	1.40	6.70 (peak of tidal cycle)
1530	1.44	6.70
1600	1.56	6.50
1630	1.60 (peak of tidal cycle)	6.20
1700	1.58	5.86
1730	1.54	5.46
1800	1.50	5.02
1830	1.48	4.54
1900	1.46	4.06
1930	1.46	3.64
2000		
Range	0.54 feet	5.34 feet

[a]Measured from tidal gauges placed in the Study Site and Hackensack River. A second study produced very similar results (Appendix A).

ECKENFELDER INC. (1992). Data for each parameter were combined for all sampling locations at each site. The data were organized temporally (by month) to account for seasonal changes which would have introduced additional variability.

The data for "bottom" and "surface" field parameters (Table 3-2) were combined because the "bottom" depths were often shallow (did not exceed 2 feet) and because the data were very similar for samples collected from each depth in the Study Site. Hackensack River Site data were available for the October sampling period only. These data indicate that similar water chemistry conditions existed at the two sites in October. The data for other surface water parameters (Table 3-3) indicate that the concentrations of sulfides, hardness, TKN, and TSS were similar at the two sites. BOD and TOC concentrations were higher and fecal coliform counts were lower at the Study Site.

3.2 PHYSICAL AND CHEMICAL CHARACTERISTICS OF SEDIMENTS

3.2.1 General Sediment Characteristics

The results of the physical and chemical analyses of sediments collected from each site are summarized in Tables 3-4 and 3-5. Data from Study Site sampling locations on each side of the former railroad bed were combined after evaluations showed no statistically significant differences between the two sample locations (analysis not presented). The sediment field parameters (Table 3-4) indicated that similar pH and dissolved oxygen conditions exist at the two sites, and that salinity and conductivity are higher at the Study Site. Specific gravity, percent sand, and percent silt/clay are similar between the two sites (Table 3-5). However, percent organic carbon and percent water were higher at the Study Site, while percent gravel and percent solids were higher at the Hackensack River Site.

Results of sediment hydrogen sulfide, acid volatile sulfide (AVS), total sulfide, and mercaptan analyses (Table 3-6) indicate that reducing conditions predominate in the sediments of the Study Site. Much higher levels of hydrogen sulfide and mercaptans were present in Study Site sediments than Hackensack River Site sediments. Total sulfide and acid volatile sulfide were consistently detected in Study Site sediments and averaged 12,400 and 5,580 mg/kg, respectively.

TABLE 3-2

SUMMARY OF SEPTEMBER, OCTOBER, AND NOVEMBER SURFACE WATER CHEMISTRY FOR DATA MEASURED BY DEPTH (Depths Combined)

Parameter	Study Site				Hackensack River			
	Mean	Range	Std. Dev.	N	Mean	Range	Std. Dev.	N
September								
Dissolved Oxygen (mg/L)	5.6	1.4 to 11.5	2.3	60	--	--	--	--
Salinity (parts per thousand)	15.6	13.1 to 26.0	2.5	58	--	--	--	--
pH (s.u.)	--	6.3 to 8.9	--	6	--	--	--	--
Temperature (°C)	24.1	22.0 to 27.0	1.2	59	--	--	--	--
October								
Dissolved Oxygen (mg/L)	5.7	3.1 to 7.2	1.3	12	4.1	3.4 to 5.1	0.6	7
Salinity (parts per thousand)	14.9	14.0 to 17.5	0.9	12	14.9	11.4 to 18.0	3.0	7
pH (s.u.)	--	7.9 to 8.0	--	5	--	7.6 to 7.8	--	7
Temperature (°C)	13.5	11.5 to 18.0	2.1	11	16.6	15.7 to 18	0.9	5
November								
Dissolved Oxygen (mg/L)	8.7	5.7 to 12.5	2.3	16	2.0	--	--	1
Salinity (parts per thousand)	14.5	11.2 to 16.6	1.3	23	7.0	--	--	1
pH (s.u.)	--	6.5 to 8.0	--	32	--	--	--	1
Temperature (°C)	9.4	5.2 to 16.5	2.8	23	11.1	--	--	1

Dashes (--) indicate that no data were collected, or that means and standard deviations were not calculated for pH values due to the logarithmic nature of the parameter.

N = Number of values in the statistical analysis.

TABLE 3-3

SURFACE WATER DATA FOR OTHER PARAMETERS

Parameter[a]	Study Site				Hackensack River			
	Mean	Range	Std. Dev.	N	Mean	Range	Std. Dev.	N
Sulfides	2.3	1.0 to 3.6	1.1	11	3.7	1.0 to 8.2	2.7	6
BOD	8.3	1.0 to 21.5	5.7	21	1.2	1.0 to 1.65	0.3	6
Hardness	2,790	2,652 to 3,010	88	12	2,930	2,200 to 3,450	542	5
TKN	2.6	0.6 to 3.6	0.8	12	2.5	0.2 to 6.4	2.4	6
TOC	9.2	1.8 to 20.8	6.5	13	3.9	2.5 to 6.5	2.2	6
Fecal Coliforms (col./100 mL)	71[b]	0 to 1,500	379	21	298[b]	0 to 2,500	982	6
TSS	15.8	2.0 to 39	9.4	21	19	2.0 to 38.0	15	6

[a]mg/L unless otherwise noted.
[b]Geometric means.
N = Number of values in the statistical analysis.

TABLE 3-4

SUMMARY OF SEDIMENT FIELD PARAMETERS
(November 1991)

Parameter	Study Site		Hackensack River	
	Mean	Range	Mean	Range
pH (s.u.)	--	6.5 to 7.4	--	6.5 to 6.8
Temperature (°C)	9.5	7.2 to 12.0	11.1	11 to 11.1
Dissolved Oxygen (mg/L)	0.3	0.1 to 0.6	0.2	0.1 to 0.2
Salinity (parts per thousand)	12.7	9.9 to 14.6	7.9	7.0 to 8.7
Conductivity (μmhos/cm)	15,071	11,500 to 18,000	9,650	8,500 to 10,800

TABLE 3-5

SUMMARY OF SEDIMENT PHYSICAL AND CHEMICAL CHARACTERISTICS[a]

Parameter	Study Site				Hackensack River			
	Mean	Range	Std. Dev.	N	Mean	Range	Std. Dev.	N
Specific Gravity	2.00	1.71 to 2.30	0.2	14	2.6	2.46 to 2.63	0.08	2
Organic Carbon (%)	42.4	18.5 to 62.6	10.5	23	6.8	6.1 to 7.4	0.6	2
Gravel (%)	7.1	0 to 25.0	6.8	27	20.0	5.0 to 35.0	15.0	2
Sand (%)	42.9	21.0 to 57.0	9.2	27	35.5	21.0 to 50.0	14.5	2
Silt/Clay (%)	49.7	33.0 to 79.0	10.9	27	44.5	15.0 to 74.0	29.5	2
Solids (%)	9.4	4.7 to 18.8	3.9	27	49.0	41.8 to 56.2	7.2	2
Water (%)	90.2	74.9 to 95.3	4.8	27	51.0	43.8 to 58.2	7.2	2

[a]Original data generated by French, Parrello, and Associates.
N = Number of values in the statistical analysis.

TABLE 3-6

SEDIMENT SULFIDE AND MERCAPTAN CONCENTRATIONS

Station	Total Sulfide[a] (mg/kg dry weight)	Acid Volatile Sulfide[b] (mg/kg dry weight)	Hydrogen Sulfide[c] (ppm gas phase)	Mercaptans[d] (ppm gas phase)
Study Site				
	12,100	10,500	>1,600	>120
	6,500	6,500	ND	ND
	7,610	7,590	>1,600	>120
	5,250	4,180	160	ND
	11,900	750	ND	ND
	4,580	2,120	>1,600	>120
	3,020	498	700	ND
	12,200	4,440	300	ND
	40,400	11,200	2,600	>120
	19,400	6,100	40,000	>120
	13,100	7,490	ND	ND
			10	ND
			10	ND
			ND	ND
			ND	ND
			5	--
			ND	ND
			ND	ND
			1,400	ND
			2,000	ND
			10	ND
Mean	12,400	5,580	CC	CC
Range	3,020 to 40,400	498 to 11,200	<1 to 40,000	ND to >120
Hackensack River				
	--	--	ND	ND
	--	--	ND	ND
Mean	--	--	ND	ND
Range	--	--	ND	ND

[a]Total sulfide detection limit was 4 mg/kg.
[b]Acid volatile sulfide detection limit was 15 mg/kg.
[c]A hydrogen sulfide detection limit of 1 ppm was assumed based on the data received. Values reflect concentrations of H_2S in the gas phase as determined by the Sensidyne tube technique.
[d]Detection limit for mercaptans was 5 ppm. Values reflect concentrations of mercaptans in the gas phase as determined by the Sensidyne tube technique.
ND = Not detected.
CC = Cannot calculate due to unquantified values.

Table 3-7 presents the results of other sediment chemical analyses. The higher levels of sodium in Study Site sediments support the previously reported higher levels of salinity and conductivity in the Study Site sediments (Table 3-4) and again indicate that restricted flushing in the Study Site contributes to the accumulation of inorganic materials in these sediments. Due to the restricted flushing, the Study Site functions as a settling pond for insoluble inputs to it, including organic materials from biological production at the site. Total organic carbon (TOC), total Kjehldahl nitrogen, and ammonia-nitrogen values were ten times greater in the Study Site sediments than in the Hackensack River sediments. These data indicate basic differences in the sediment characteristics of the Study Site and Hackensack River Site.

The sediments at the two sites are quite different in terms of percent organic carbon, percent solids, reducing environment products (e.g., sulfides), salinity, and nutrient status. The sediments of the Study Site can be characterized as being "mucky" and loose and of high organic carbon content relative to the Hackensack River Site sediments which are firmer and contain more gravel. These characteristics likely reflect the lower degree of flushing in the Study Site. The high organic carbon content and fine grain size (high specific surface area) of Study Site sediments likely enhance the sorption of chemicals in these sediments.

3.3 SEDIMENT CONCENTRATIONS OF CONSTITUENTS OF CONCERN

3.3.1 Pesticides and Aroclors (PCBs)

Sediment pesticide and Aroclor concentrations are summarized in Table 3-8. Lindane was detected in five of the six Study Site samples, but it was not present at detectable levels in the two Hackensack River Site sediment samples. Aroclor 1254 was detected at approximately 0.04 to 0.05 mg/kg (dry weight) in both Hackensack River Site sediment samples. Aroclor 1254 was not detected in any of the Study Site sediment samples. Aroclor 1260 was not detected in either of the Hackensack River Site sediment samples and was detected at 0.37 mg/kg (dry weight) in only one of the Study Site samples. DDE and DDD were detected in both Hackensack River Site sediment samples at 0.003 to 0.008 mg/kg (dry weight) and in two of the six Study Site samples at 0.015 to 0.036 mg/kg (dry weight). The primary factor contributing to this finding is considered to be the restricted flushing of the Study

TABLE 3-7

SEDIMENT SUMMARY DATA - GENERAL PARAMETERS

Parameter[a]	Study Site				Hackensack River			
	Mean	Range	Std. Dev.	N	Mean	Range	Std. Dev.	N
Calcium	5,340	2,830 to 8,470	1,290	26	9,140	7,090 to 11,200	NA	2
Magnesium	9,070	4,820 to 12,500	1,920	28	8,250	7,800 to 8,700	NA	2
Potassium	3,280	1,720 to 4,820	610	27	3,740	3,640 to 3,840	NA	2
Sodium	49,400	5,100 to 93,500	21,900	27	6,410	4,490 to 8,330	NA	2
PO_4-P	630	239 to 1,170	256	27	951	612 to 1,290	NA	2
TKN	26,000	11,100 to 47,800	10,200	27	2,710	1,850 to 3,570	NA	2
NH_3-N	352	120 to 620	127	28	32.1	28.7 to 45.5	NA	2
TOC (%)	45.0	13.5 to 83.9	18.9	27	3.9	3.0 to 4.7	NA	2
Solids (%)	8.0	4.6 to 18	3.1	43	49	37 to 60	NA	2
pH (s.u.)[b]	--	7.10 to 7.80	0.15	43	--	7.36 to 7.38	NA	2

[a]All values are mg/kg dry weight unless otherwise noted.
[b]Laboratory measured value.
N = Number of values in the statistical analysis.
NA = Not applicable due to small sample size.

TABLE 3-8

SUMMARY OF SEDIMENT PESTICIDE AND AROCLOR CONCENTRATIONS
(mg/kg dry weight)

Sediment	Compound				
	Lindane	Aroclor 1260	Aroclor 1254	4,4'-DDE	4,4'-DDD
Study Site					
15	0.026	ND	ND	ND	ND
23	0.040	ND	ND	ND	ND
27	ND	ND	ND	0.021	0.015
35	0.011	ND	ND	0.020	0.036
36	0.017	ND	ND	ND	ND
43	0.022	0.370	ND	ND	ND
Hackensack River					
HA1	ND	ND	0.052	0.008	0.005
HA2	ND	ND	0.043	0.005	0.003

ND = Not detected.

Site, due to Cayuga Dike, and the associated accumulation of organic carbon in the Study Site sediments. Both the Study Site and the Hackensack River Site have been subjected to similar urban and industrial impacts, icnluding PCB Aroclors and pesticides. Consequently, differences in urban or industrial inputs were not considered to play a role in the higher concentrations of these hydrophobic organics in the Study Site sediments.

Concentrations of sediment pesticides and PCBs reported in the literature (Table 3-9) cover a wide range and generally encompass the concentrations observed in Study Site sediments. The values listed in Table 3-9 represent data for urbanized settings that have had no known specific releases of PCBs to them. The settings are therefore considered comparable to that of the Study Site. DDE sediment concentrations in the Study Site ranged from not detected to 0.021 mg/kg, compared to a range of not detected to 0.015 mg/kg for other estuarine sediments. Similar Study Site and literature concentrations were also observed for DDD. Literature data on lindane were unavailable for comparison. Literature-reported values for PCBs ranged from not detected to 3.910 mg/kg (excluding Barry's Creek data reported in Squibb et al., 1991, which represent a site where known releases of PCBs have occurred) compared to the maximum value of 0.370 mg/kg for Aroclor 1260 in one Study Site sediment sample. It is concluded from this comparison that chlorinated pesticides and PCBs are present in Study Site sediments at concentrations within the ranges reported in the literature.

3.3.2 TCL Volatile and Semivolatile Compounds

Volatile TCL target compounds and semivolatile non-target compounds were consistently present at higher concentrations in Study Site sediments as compared to Hackensack River Site sediments (Table 3-10). The sediment concentrations of semivolatile target compounds and volatile nontarget compounds were comparable (i.e., same order of magnitude) between the two sites. These data indicate that volatile and semivolatile compounds are consistently present in Study Site sediments at detectable concentrations, and that nontarget semivolatile compounds are typically present at concentrations above 100 mg/kg in these sediments. Many of the target and nontarget compounds detected at the two sites were those not routinely reported (e.g., cholestans, ergosts, sterol).

TABLE 3-9

COMPARISON OF ESTUARINE SEDIMENT PESTICIDE AND PCB CONCENTRATIONS REPORTED IN THE LITERATURE TO THOSE OBSERVED IN STUDY SITE SEDIMENTS

Parameter Reported - Location	Concentration (mg/kg dry weight)	Reference
PCBs - NY/NJ	0.001 to 2.79[a]	Squibb et al., 1991[c]
PCBs - NY/NJ	0.001 to 103[b]	Squibb et al., 1991[c]
PCBs - Hudson/Raritan	0.126 to 1.150	NOAA, 1990
PCBs - Baltimore Harbor	0.300 to 1.900	NOAA, 1990
PCBs - Masachusetts Bay	0.001 to 0.01	NOAA, 1990
PCBs - Southern California	ND to 3.910	NOAA, 1990
PCBs - San Diego Bay	0.025	NOAA, 1990
PCBs - San Francisco Bay	ND to 0.595	NOAA, 1990
PCBs - Commencement Bay	0.001 to 1.063	NOAA, 1990
PCBs - Puget Sound	ND to 0.641	NOAA, 1990
Aroclor 1260 - This Study	ND to 0.370	This Study
Aroclor 1254 - This Study	ND	This Study
Total Chlorinated Pesticides - NY/NJ	0.00002 to 0.236	Squibb et al., 1991[c]
Total DDT - NY/NJ	0.0046 to 164	Squibb et al., 1991[c]
4,4'-DDE - San Francisco Bay	ND to 0.0086	NOAA, 1990
4,4'-DDE - Puget Sound	0.015	NOAA, 1990
4,4'-DDE - This Study	ND to 0.021	This Study
4,4'-DDD - San Francisco Bay	ND to 0.0393	NOAA, 1990
4,4'-DDD - This Study	ND to 0.036	This Study
Dieldrin - San Francisco Bay	0.007 to 0.0199	NOAA, 1990

[a]Range excludes data for Barry's Creek, where specific releases of PCBs were known to have occurred.
[b]Range includes Barry's Creek data.
[c]All data for Squibb et al., 1991 are for the New York/New Jersey Harbor Estuary System.
ND = Not detected.

TABLE 3-10

SUMMARY OF SEDIMENT TCL COMPOUNDS[a]
(mg/kg dry weight)

Sediment	Target Compounds		Non-Target Compounds	
	Volatiles	Semivolatiles	Volatiles	Semivolatiles
Study Site				
15	0.18	13.7	ND	NM
23	0.37	2.44	ND	544
27	0.31	14.5	ND	198
35	0.07	1.76	ND	76.6
36	0.08	3.01	0.37	58.3
43	0.14	NM	0.37	NM
Hackensack River				
HA1	0.024	6.16	0.04	8.4
HA2	0.022	6.20	0.034	20.8

[a]Values are cumulative concentrations of all chemicals measured at concentrations above detection limits.

ND = Not detected.

NM = Results were not meaningful.

3.3.3 Mercury and TPH

Higher concentrations of mercury and total petroleum hydrocarbons (TPH) were generally observed in Study Site sediments as compared to Hackensack River Site sediments (Table 3-11). These findings may reflect (i) the reducing conditions and elevated AVS concentrations in the Study Site sediments favoring the precipitation of mercury, (ii) the higher levels of organic carbon in Study Site sediments favoring the sorption and accumulation of mercury and TPH, and (iii) the restricted tidal flushing of the Study Site. Literature-reported dry weight concentrations of mercury range from not detected to 34 mg/kg as reported by NOAA (1990). In the NOAA study, sediment mercury concentrations of 0.0014 to 0.0146 mg/kg were reported for Hudson-Raritan sediments. The highest concentrations were reported for sites in Puget Sound (19.8 mg/kg) and Commencement Bay (34 mg/kg). The values observed in Study Site sediments (<0.77 to 2.90 mg/kg) exceed the range of values reported for Hudson-Raritan sediments, but are within the range for all literature-reported sediments.

No literature-reported TPH data were available for comparison to the data generated in this study.

3.3.4 PCDFs and PCDDs

Concentrations of PCDFs (dry weight) in Study Site sediments (Table 3-12) were highly variable, ranging from non-detectable to 8,980 nanograms per kilogram (ng/kg) . The most toxic of the PCDFs (i.e., 2,3,7,8 TCDF) was present in all of the Study Site samples evaluated, but was not detected in sediment samples from the Hackensack River Site or the Standard Chlorine Site. Concentrations of PCDDs in Study Site and Hackensack River Site sediments were highly variable. The highest concentrations and most frequently observed of the PCDDs detected were from the HpCDD and OCDD groups. The 2,3,7,8-TCDD congener was detected in four of seven Study Site and both Hackensack River Site sediment samples. Overall, concentrations of PCDDs and PCDFs in Study Site sediments were higher than those in sediments from the Hackensack River and Standard Chlorine Site. This finding may again reflect the higher concentrations of organic carbon in Study Site sediments and the restricted tidal flushing of the Study Site. Total toxicity equivalents for PCDDs and PCDFs were also highest in Study Site sediments.

TABLE 3-11

SUMMARY OF SEDIMENT MERCURY AND TOTAL PETROLEUM HYDROCARBON CONCENTRATIONS
(mg/kg dry weight)

	Mercury	Total Petroleum Hydrocarbons
Study Site		
15	2.50	<941
23	<1.90	1,540
27	2.90	1,780
35	0.97	<645
36	2.10	1,120
43	<1.90	6,060
Hackensack River Site		
HA1	0.72	150
HA2	0.71	325

TABLE 3-12

PCDFs AND PCDDs IN STUDY SITE AND HACKENSACK RIVER SEDIMENTS
(ng/kg dry weight)

Constituent	Study Site						Hackensack River		
	Site 43	Site 23	Site 35	Site 15	Site 36	Site 27	Site HA 1	Site HA 2	Adjacent to Standard Chlorine
PCDFs									
Total TCDFs	6,060[a]	1,310[a]	913[a]	943[a]	1,750	1,150	106	115	4.34
2,3,7,8-TCDF	187[a]	86.5[a]	60.1[a]	81.0[a]	99.6	55.3	ND	ND	ND
Total PeCDFs	6,880[a]	690[a]	593[a]	919[a]	1,260[a]	897[a]	84.7[a]	111[a]	8.55
1,2,3,7,8-PeCDF	219[a]	ND	31.6[a]	ND	ND	43.9[a]	4.54[a]	ND	ND
2,3,4,7,8-PeCDF	1,050[a]	124[a]	75.1[a]	95.2[a]	240[a]	139[a]	7.37[a]	12.6[a]	ND
Total HxCDFs	8,980	944	751	942	1,890[a]	1,290[a]	119	133	52.9
1,2,3,4,7,8-HxCDF	2,530	224	196	277	624	429	44.1	43.5	25.0
1,2,3,6,7,8-HxCDF	487	ND	44.6	ND	100	72.6	9.30	8.87	ND
2,3,4,6,7,8-HxCDF	173	ND	46.2	65.2	102	65.2	6.13	6.27	ND
1,2,3,7,8,9-HxCDF	374	ND	ND	ND	ND	ND	ND	ND	ND
Total HpCDFs	7,930	986	887	1,350	2,150[a]	2,070[a]	209	181	7.71
1,2,3,4,6,7,8-HpCDF	5,910	751	670	933	1,770	1,520	155	133	ND
1,2,3,4,7,8,9-HpCDF	159	ND	ND	ND	ND	ND	ND	ND	ND
OCDFs	4,540	1,030	851	1,380	1,730	2,210	364	186	104
PCDDs									
Total TCDDs	457	130	202	140	260	254	44.0	34.7	ND
2,3,7,8-TCDD	ND	ND	89.6	ND	82.0	141	26.9	20.0	ND
Total PeCDDs	433[a]	ND	84[a]	171[a]	159	70.9	10.5	ND	ND
1,2,3,7,8-PeCDD	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total HxCDDs	708	358	247	263	103	476[a]	27.3	22.6	7.40
1,2,3,4,7,8-HxCDD	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,3,6,7,8-HxCDD	ND	ND	ND	ND	ND	44.6	ND	ND	ND
1,2,3,7,8,9-HxCDD	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total HpCDDs	2,120	1,560	577	984	931	1,680	129	147	9.45
1,2,3,4,6,7,8-HpCDD	988	867	267	441	411	760	48.4	3.2	ND
OCDDs	6,910[a]	5,540	2,190	3,770	3,910[a]	7,130[a]	499[a]	662[a]	324
Total TEs[b]	**1030**	**155**	**182**	**148**	**331**	**319**	**41.3**	**38.3**	**4.87**

[a]Estimated values.

[b]Sum of the toxicity equivalents for all listed compounds.

ND = Not detected.

A comparison of data from this study to literature-reported sediment PCDD and PCDF concentrations for New York and New Jersey estuarine sediments is presented in Table 3-13. The concentrations of total PCDDs in Study Site sediments are within the ranges reported for other regional estuarine sediments. The upper range of concentrations of total PCDFs in Study Site sediments is greater than literature-reported values for each group available for comparison.

3.4 BIOTA CONCENTRATIONS OF CONSTITUENTS OF CONCERN

3.4.1 Pesticides and Aroclors (PCBs)

Biota pesticide and Aroclor concentrations (dry weight) are summarized in Table 3-14. Killifish were not available from the Hackensack River Site sampling locations. Of the nine pesticide and Aroclor compounds detected, only DDE, DDD, and Aroclor 1254 were detected in Killifish collected from the Study Site. Compounds other than DDE and DDD were infrequently detected in blue crabs. DDE and DDD in the edible tissues of blue crabs were generally present at similar or lower concentrations in crabs collected from the Study Site as compared to the Hackensack River Site. Store bought crabs had the highest concentrations of DDD and DDE in edible tissues. Concentrations of DDE and DDD were lower in blue crab hepatopancreas tissues for organisms collected from the Study Site as compared to the Hackensack River Site. The concentrations of DDD and DDE in the hepatopancreas tissues of store bought blue crabs were lower than the edible tissue concentrations of these same organisms.

Table 3-15 compares the Study Site biota pesticide and PCB concentrations (dry weight) to those reported by Squibb et al. (1991) for other estuarine organisms in the New York/New Jersey Harbor system. Only data for identical species were used if such a comparison was available. Dieldrin was generally not detected in Study Site blue crab edible tissues or killifish whole body tissues or in other organisms reported in the literature for the New York/New Jersey harbor system. Dieldrin in killifish collected from the Study Site was always below detectable concentrations, compared to not detected to 0.020 mg/kg for killifish muscle tissue for organisms reported by Squibb et al. (1991). Cumulative DDT, DDE, and DDD literature concentrations for killifish were similar to cumulative DDE and DDD concentrations

TABLE 3-13

COMPARISON OF ESTUARINE SEDIMENT CONCENTRATIONS OF PCDDs AND PCDFs FOR NEW YORK AND NEW JERSEY SITES TO THOSE OBSERVED IN STUDY SITE SEDIMENTS

(all values are ng/kg dry weight)

Constituent	Range of Sediment Concentrations	
	Study Site	Literature Reported[a]
PCDDs		
Total TCDDs	130 to 457	20 to 1,800[b] ND to 590
Total PeCDDs	ND to 433	ND to 630
Total HxCDDs	103 to 708	ND to 1,700
Total HpCDDs	577 to 2,120	5.4 to 4,100
OCDDs	2,190 to 7,130	31 to 17,000
PCDFs		
Total TCDFs	913 to 6,060	0.32 to 1,500
Total PeCDFs	593 to 6,880	ND to 2,300
Total HxCDFs	751 to 8,980	ND to 990
Total HpCDFs	887 to 7,930	ND to 2,200
OCDFs	851 to 4,540	ND to 2,400

[a]Except as noted, all data are from Finley et al., 1990.
[b]Squibb et al., 1991.
ND = Not detected.

TABLE 3-14

SUMMARY OF BIOTA
PESTICIDE AND AROCLOR CONCENTRATIONS
(mg/kg dry weight)

Sample[a]	Compound								
	4,4'DDE	4,4'DDD	Aroclor 1254	Aroclor 1260	alpha BHC	gamma BHC	Aldrin	Dieldrin	Heptachlor Epoxide
KILLIFISH									
Study Site 23/43	0.084	0.120	0.630	ND	ND	ND	ND	ND	ND
Study Site 15/35	0.070	0.110	0.580	ND	ND	ND	ND	ND	ND
Study Site 27/36	0.096	0.150	0.840	ND	ND	ND	ND	ND	ND
BLUE CRABS									
Edible Tissue									
Study Site 23/43	ND	ND	ND	ND	ND	ND	0.017	0.082	ND
Study Site 15/35	0.025	0.022	ND	ND	ND	ND	ND	ND	ND
Study Site 27/36	0.024	NM	ND	ND	ND	ND	ND	ND	ND
HA -Cayuga Dike	0.045	0.024	ND	ND	ND	ND	ND	ND	ND
HA - Standard Chlorine	0.098	0.038	ND	ND	ND	ND	ND	ND	0.008
Store Bought[c]	0.057	0.024	ND	ND	ND	ND	ND	ND	ND
Hepatopancreas Tissue									
Study Site 23/43	0.010	0.012	0.130	ND	ND	ND	ND	ND	ND
Study Site 15/35	0.550	0.420	ND	3.9	ND	ND	ND	ND	ND
Study Site 27/36	0.530	0.360	ND	3.9	ND	ND	ND	ND	ND
HA - Cayuga Dike	1.700	0.940	ND	5.6	ND	ND	ND	ND	ND
HA - Standard Chlorine	2.100	1.200	ND	ND	ND	ND	ND	ND	ND
Store Bought[c]	1.400	0.440	ND	1.8	ND	ND	ND	0.120	0.069

[a] HA = Hackensack River.
[b] Suspected sample identification reversal between the Edible Tissue and the Hepatopancreas Tissue for the Store Bought samples. Consequently, the values reported in the table for the Store Bought Edible Tissue and Hepatopancreas Tissue analytical results have been reversed from those reported in the laboratory's analytical report.
ND = Not detected.
NM = Results were not meaningful.

TABLE 3-15

COMPARISON OF STUDY SITE BIOTA PESTICIDE AND PCB CONCENTRATIONS TO LITERATURE-REPORTED VALUES FOR ESTUARINE ORGANISMS (mg/kg dry weight)

Constituent	Organism	Tissue	Range of Concentrations	Reference
Aldrin	Blue Crab	Muscle (edible)	ND to 0.017	This Study
	Blue Crab	Hepatopancreas	ND	This Study
	Killifish	Whole Body	ND	This Study
	Striped Bass	Various Tissues	ND	Squibb et al., 1991
	Lobster	Various Tissues	ND	Squibb et al., 1991
	Grass Shrimp	Various Tissues	ND	Squibb et al., 1991
Dieldrin	Blue Crab	Muscle (edible)	ND to 0.082	This Study
	Blue Crab	Hepatopancreas	ND to 0.120	This Study
	Killifish	Whole Body	ND	This Study
	Killifish	Muscle	ND to 0.020	Squibb et al., 1991
	Striped Bass	Muscle	ND to 0.340	Squibb et al., 1991
DDT + DDD + DDE	Blue Crab	Muscle (edible)	ND to 0.047[a]	This Study
	Blue Crab	Muscle	0.006 to 0.012	Squibb et al., 1991
	Blue Crab	Hepatopancreas	0.022 to 0.970[a]	This Study
	Killifish	Whole Body	0.180 to 0.246[a]	This Study
	Killifish	Muscle	0.040 to 0.540	Squibb et al., 1991
Total PCBs or Aroclors	Blue Crab	Muscle (edible)	ND	This Study
	Blue Crab	Muscle	<0.240 to 0.390[b]	Squibb et al., 1991
	Blue Crab	Hepatopancreas	0.130 to 3.9[c]	This Study
	Killifish	Whole Body	ND to 0.840[c]	This Study
	Killifish	Whole Body	0.190 to 2.43[b]	Squibb et al., 1991

[a]Value is for DDE + DDD only.
[b]As total PCBs.
[c]For Aroclors 1254 and 1260.
ND = Not detected.

for killifish collected from the Study Site. Values in the upper end of the range of DDE plus DDD concentrations for Study Site blue crabs were greater than those reported by Squibb et al. (1991). Aroclor 1254 and 1260 concentrations for Study Site blue crabs and killifish were less than total PCB concentrations for the same organisms reported by Squibb et al. (1991) for the New York/New Jersey harbor system.

3.4.2 TCL Semivolatile Compounds and Mercury

The biota concentrations (dry weight) of TCL semivolatile compounds and mercury are summarized in Table 3-16 (TCL volatile compounds were not assessed in biota). No target semivolatile compounds were detected in any biota tissue samples. Study Site killifish contained whole body concentrations of non-target semivolatile compounds ranging from 6,124 to 11,283 mg/kg. The concentrations of non-target semivolatile compounds in edible tissues of blue crabs collected from the Study Site were generally higher than those for organisms collected from the Hackensack River Site. The highest edible tissue concentrations of semivolatile non-target compounds were observed for store bought blue crabs. The highest concentrations of these compounds in blue crab hepatopancreas tissues were observed in organisms collected from the Study Site. The implications of these findings are uncertain due to the types of specific compounds present, because non-target compounds are, by definition, of less concern than target compounds. Some of the more commonly detected compounds and/or those present at higher concentrations were those not routinely reported and/or are naturally occurring compounds (e.g., organic acids).

Mercury concentrations in biota were generally in the range of 0.35 to 0.65 mg/kg. The one notable exception to this was the edible blue crab tissue sample from the Cayuga Dike location at the Hackensack River Site which contained 1 mg/kg of mercury. The mercury concentrations observed in this study are within the range of 0.05 to 2.9 mg/kg reported by Eisler (1987) for marine fish and crustaceans.

3.4.3 PCDFs and PCDDs

Table 3-17 presents the results (dry weight) of blue crab edible tissue analyses for PCDFs and PCDDs. Total TCDFs and TCDDs were always detected in blue crab edible tissues collected from the Study, Standard Chlorine, and Hackensack River

TABLE 3-16

SUMMARY OF BIOTA
TCL SEMIVOLATILE COMPOUNDS
AND MERCURY CONCENTRATIONS
(mg/kg dry weight)

Sample[a]	TCL Semivolatile Compounds		Mercury
	Non-Target Compounds[b]	Target Compounds	
KILLIFISH			
Study Site 23/43	7,808	ND	ND
Study Site 15/35	11,283	ND	ND
Study Site 27/36	6,124	ND	ND
BLUE CRABS			
Edible Tissues			
Study Site 23/43[c]	1,096	ND	ND
Study Site 15/35	1,596	ND	ND
Study Site 27/36	1,067	ND	ND
HA - Cayuga Dike	754	ND	1.0
HA - Standard Chlorine	1,656	ND	1.4
Store Bought[c]	1,257	ND	ND
Hepatopancreas Tissues			
Study Site 23/43[c]	7,574	ND	ND
Study Site 15/35	55,000	ND	ND
Study Site 27/36	50,000	ND	ND
HA - Cayuga Dike	10,422	ND	0.39
HA - Standard Chlorine	6,738	ND	ND
Store Bought[c]	8,130	ND	ND

[a] HA = Hackensack River.

[b] Values are cumulative concentrations of all semivolatile non-target chemicals present at concentrations above detection limits.

[c] Suspected sample identification reversal between the Edible Tissue and the Hepatopancreas Tissue samples submitted for TCL Semivolatile Compunds analyses. Consequently, the values reported in the table for the Edible Tissue and Hepatopancreas Tissue analytical results for these samples have been been reversed from those reported in the laboratory's analytical report.

ND = Not detected.

TABLE 3-17

PCDFs AND PCDDs IN BLUE CRAB EDIBLE TISSUES
(ng/kg dry weight)

Constituent	Study Site			Hackensack River		Store Bought Crabs
	Site 23/43[a]	Site 15/35	Site 27/36	Cayuga Dike	Standard Chlorine	
PCDFs						
Total TCDF	ND	5.80	9.89	45.1	43.8	4.04
2,3,7,8-TCDF	ND	1.29	1.40	3.39	5.38	ND
Total PeCDF	ND	ND	ND	19.1	19.5[b]	ND
1,2,3,7,8-PeCDF	ND	ND	ND	ND	ND	ND
2,3,4,7,8-PeCDF	ND	ND	ND	ND	3.49[b]	ND
Total HxCDF	ND	ND	ND	5.47	9.52[b]	ND
1,2,3,4,7,8-HxCDF	ND	ND	ND	ND	4.27[b]	ND
1,2,3,6,7,8-HxCDF	ND	ND	ND	ND	ND	ND
2,3,4,6,7,8-HxCDF	ND	ND	ND	ND	ND	ND
1,2,3,7,8,9-HxCDF	ND	ND	ND	ND	ND	ND
Total HpCDF	ND	ND	ND	ND	ND	ND
1,2,3,4,6,7,8-HpCDF	ND	ND	ND	ND	ND	ND
1,2,3,4,7,8,9-HpCDF	ND	ND	ND	ND	ND	ND
OCDF	ND	ND	ND	ND	ND	ND
PCDDs						
Total TCDD	0.870	2.28	3.20	26.0	27.9	ND
2,3,7,8-TCDD	0.870	2.28	3.20	20.0	23.1	ND
Total PeCDD	ND	ND	ND	ND	3.49[b]	ND
1,2,3,7,8-PeCDD	ND	ND	ND	ND	ND	ND
Total HxCDD	ND	ND	ND	ND	ND	ND
1,2,3,4,7,8-HxCDD	ND	ND	ND	ND	ND	ND
1,2,3,6,7,8-HxCDD	ND	ND	ND	ND	ND	ND
1,2,3,7,8,9-HxCDD	ND	ND	ND	ND	ND	ND
Total HpCDD	ND	ND	ND	ND	ND	ND
1,2,3,4,6,7,8-HpCDD	ND	ND	ND	ND	ND	ND
OCDD	ND	ND	27.8[b]	ND	ND	ND
Total TEs[c]	**1.3**	**3.0**	**3.9**	**22**	**26**	**0.65**

[a] Suspected sample identification reversal between the Edible Tissue and the Hepatopancreas Tissue samples from Site 23/43. Consequently, the analytical results reported for the Edible Tissue (in this table) and Hepatopancreas Tissue (in Table 3-18) for these samples have been been reversed from those reported in the laboratory's analytical report.

[b] Estimated values.

[c] Sum of the toxicity equivalents for all listed compounds.

ND = Not detected.

Sites. The 2,3,7,8-TCDD congener accounted for the majority of the TCDDs in all samples in which total TCDDs were present. The highest concentrations of total TCDFs and total TCDDs, as well as the highest total TE values, were found in blue crabs collected from the Hackensack River Site. Analyses of PCDDs and PCDFs in blue crab hepatopancreas tissue samples (Table 3-18) indicate that many of the congeners not detected in edible tissues were present in the hepatopancreas tissues. Order of magnitude differences in concentrations existed for some congeners in edible versus hepatopancreas tissues. The highest concentrations of PCDDs and PCDFs and the highest TE values for the hepatopancreas tissues were also found in blue crabs collected from the Hackensack River Site.

The only PCDDs or PCDFs detected in Study Site killifish (Table 3-19) were total TCDFs, 2,3,7,8-TCDF, total TCDDs, and 2,3,7,8-TCDD. All of these compounds were present at dry weight concentrations less than 13 ng/kg and resulted in total TE values less than 15 ng/kg.

Table 3-20 compares the tissue concentrations of PCDDs and PCDFs reported for other studies to those observed in Study Site organisms. The concentrations of PCDDs and PCDFs in the edible (muscle) tissues of blue crabs collected from the Study Site are similar to or less than those reported in the literature for crustaceans (e.g., crabs, lobster, shrimp). The concentrations of PCDDs and PCDFs in whole body tissues of killifish collected from the Study Site are less than or near the lower end of the range of the literature-reported concentrations for other fishes. This finding could reflect the lower trophic status of killifish as opposed to the other fishes reported (e.g., striped bass).

It is concluded from these comparisons that PCDDs and PCDFs are present in Study Site biota at concentrations that are less than in biota from the Hackensack River Site and that are generally lower than some of those reported in the literature.

3.5 ECOLOGICAL PARAMETERS

3.5.1 Blue Crab Carapace Size

Table 3-21 presents the results of evaluations of blue crab carapace sizes for organisms collected from the Study Site and Hackensack River Site. Average blue

TABLE 3-18

PCDFs AND PCDDs IN BLUE CRAB HEPATOPANCREAS TISSUE
(ng/kg dry weight)

Constituent	Study Site			Hackensack River		Store Bought Crabs
	Site 23/43[a]	Site 15/35	Site 27/36	Cayuga Dike	Standard Chlorine	
PCDFs						
Total TCDF	250	328	537	1,700	1,201	154
2,3,7,8-TCDF	67.3	53.2	85.5	204	196	39.7
Total PeCDF	80.0[b]	95.1[b]	180[b]	726[b]	589[b]	62.5[b]
1,2,3,7,8-PeCDF	8.0[b]	5.64[b]	10.4[b]	32.5[b]	30.8[b]	5.75[b]
2,3,4,7,8-PeCDF	20.1[b]	15.8[b]	33.7[b]	106[b]	94.2[b]	12.7[b]
Total HxCDF	35.0[b]	29.4[b]	65.8[b]	222[b]	189[b]	4.00
1,2,3,4,7,8-HxCDF	11.6[b]	8.96[b]	22.5[b]	93.8[b]	109[b]	ND
1,2,3,6,7,8-HxCDF	6.6[b]	ND	5.18[b]	17.0[b]	14.6[b]	ND
2,3,4,6,7,8-HxCDF	ND	ND	ND	7.91	8.10	ND
1,2,3,7,8,9-HxCDF	ND	ND	ND	ND	ND	ND
Total HpCDF	7.8[b]	ND	15.6[b]	30.1[b]	37.9[b]	ND
1,2,3,4,6,7,8-HpCDF	7.8[b]	ND	15.6[b]	28.4[b]	40.3[b]	ND
1,2,3,4,7,8,9-HpCDF	ND	ND	ND	ND	ND	ND
OCDF	ND	ND	ND	ND	ND	ND
PCDDs						
Total TCDD	53.1	62.2	169	896	639	15.2
2,3,7,8-TCDD	39.3	30.1	112	665	507	2.48
Total PeCDD	22.4	16.4[b]	35.1[b]	90.4[b]	52.1[b]	24.6[b]
1,2,3,7,8-PeCDD	ND	ND	5.18[b]	17.8[b]	13.1[b]	4.86[b]
Total HxCDD	34.4[b]	8.35	23.2[b]	67.8[b]	75.5[b]	59.6[b]
1,2,3,4,7,8-HxCDD	ND	ND	ND	3.68[b]	ND	ND
1,2,3,6,7,8-HxCDD	6.93[b]	ND	3.96[b]	12.5[b]	14.5[b]	4.16[b]
1,2,3,7,8,9-HxCDD	3.75	ND	ND	3.20[b]	ND	2.06[b]
Total HpCDD	14.4[b]	4.28	14.0[b]	12.6[b]	18.9[b]	15.9[b]
1,2,3,4,6,7,8-HpCDD	7.23[b]	ND	4.65[b]	5.15[b]	6.92[b]	4.88[b]
OCDD	ND	8.60[b]	9.10[b]	8.16[b]	8.21[b]	23.6[b]
Total TEs[c]	**60.6**	**45.5**	**144**	**763**	**597**	**16.6**

[a] Suspected sample identification reversal between the Edible Tissue and the Hepatopancreas Tissue samples from Site 23/43. Consequently, the analytical results reported for the Edible Tissue (Table 3-17) and Hepatopancreas Tissue (in this table) for these samples have been been reversed from those reported in the laboratory's analytical report.

[b] Estimated values.

[c] Sum of the toxicity equivalents for all listed compounds.

ND = Not detected.

TABLE 3-19

PCDFs AND PCDDs IN STUDY SITE KILLIFISH WHOLE BODY TISSUES
(ng/kg dry weight)

Constituent	Site 23/43	Site 15/35	Site 27/36
PCDFs			
Total TCDF	3.15	3.38	6.78
2,3,7,8-TCDF	3.15	3.38	4.83
Total PeCDF	ND	ND	ND
1,2,3,7,8-PeCDF	ND	ND	ND
2,3,4,7,8-PeCDF	ND	ND	ND
Total HxCDF	ND	ND	ND
1,2,3,4,7,8-HxCDF	ND	ND	ND
1,2,3,6,7,8-HxCDF	ND	ND	ND
2,3,4,6,7,8-HxCDF	ND	ND	ND
1,2,3,7,8,9-HxCDF	ND	ND	ND
Total HpCDF	ND	ND	ND
1,2,3,4,6,7,8-HpCDF	ND	ND	ND
1,2,3,4,7,8,9-HpCDF	ND	ND	ND
OCDF	ND	ND	ND
PCDDs			
Total TCDD	4.20	3.69	12.5
2,3,7,8-TCDD	4.20	3.69	12.5
Total PeCDD	ND	ND	ND
1,2,3,7,8-PeCDD	ND	ND	ND
Total HxCDD	ND	ND	ND
1,2,3,4,7,8-HxCDD	ND	ND	ND
1,2,3,6,7,8-HxCDD	ND	ND	ND
1,2,3,7,8,9-HxCDD	ND	ND	ND
Total HpCDD	ND	ND	ND
1,2,3,4,6,7,8-HpCDD	ND	ND	ND
OCDD	ND	ND	ND
TOTAL TEs[a]	**5.3**	**4.9**	**14**

[a]Sum of the toxicity equivalents for all listed compounds.
ND = Not detected.

TABLE 3-20

COMPARISON OF STUDY SITE AND LITERATURE-REPORTED TISSUE CONCENTRATIONS OF SELECTED PCDFs AND PCDDs IN SALTWATER AND ESTUARINE ORGANISMS[a]

Compound	Organism	Tissue[b]	Range of Concentrations	Weight Basis[c]	Reference
PCDFs					
2,3,7,8-TCDF	Blue Crab	M	ND to 1.40	ng/kg, Dry	This Study
	Blue Crab	M	11.0 to 15.5	ppt, Wet	USEPA, 1992
	Lobster	M	3.5 to 4.1	ppt, Wet	USEPA, 1992
	Shrimp	M	6.1 to 37	ppt, Fresh	USEPA, 1992
	Killifish	WB	3.15 to 4.83	ng/kg, Dry	This Study
	Striped Bass	M	7 to 93	ppt, NR & Wet	USEPA, 1992
Total TCDFs	Blue Crab	M	ND to 9.89	ng/kg, Dry	This Study
	Blue Crab	M	132.9 to 164.5	ppt, Wet	USEPA, 1992
	Lobster	M	23.0 to 31.2	ppt, Wet	USEPA, 1992
	Killifish	WB	3.15 to 6.78	ng/kg, Dry	This Study
	Striped Bass	M	77.2 to 107.7	ppt, Wet	USEPA, 1992
Total PeCDFs	Blue Crab	M	ND	ng/kg, Dry	This Study
	Blue Crab	M	89.7 to 94.1	ppt, Wet	USEPA, 1992
	Lobster	M	29.8 to 37.3	ppt, Wet	USEPA, 1992
	Killifish	WB	ND	ng/kg, Dry	This Study
	Striped Bass	M	34.3 to 82.6	ppt, Wet	USEPA, 1992
PCDDs					
2,3,7,8-TCDD	Blue Crab	M	0.87 to 3.20	ng/kg, Dry	This Study
	Blue Crab	M	105.7 to 116.1	ppt, Wet	USEPA, 1992
	Lobster	M	4.7 to 6.8	ppt, Wet	USEPA, 1992
	Shrimp	M	<2.0	ppt, Fresh	USEPA, 1992
	Killifish	WB	3.69 to 12.5	ng/kg, Dry	This Study
	Striped Bass	M	83.9 to 733.9	ppt, Wet	USEPA, 1992
Total TCDDs	Blue Crab	M	0.87 to 3.20	ng/kg, Dry	This Study
	Blue Crab	M	117.6 to 149.5	ppt, Wet	USEPA, 1992
	Lobster	M	6.6 to 8.3	ppt, Wet	USEPA, 1992
	Killifish	WB	3.69 to 12.5	ng/kg, Dry	This Study
	Striped Bass	M	85.4 to 733.9	ppt, Wet	USEPA, 1992
Total PeCDDs	Blue Crab	M	ND	ng/kg, Dry	This Study
	Blue Crab	M	17.2 to 18.0	ppt, Wet	USEPA, 1992
	Lobster	M	10.0 to 11.0	ppt, Wet	USEPA, 1992
	Killifish	WB	ND	ng/kg, Dry	This Study
	Striped Bass	M	5.2 to 10.6	ppt, Wet	USEPA, 1992

[a]Comparisons are made only for congeners or groups of congeners (e.g., TCDDs) for which data were available both from this study and in USEPA, 1992.

[b]M = Muscle; WB = Whole Body.

[c]ng/kg = nanograms per kilogram; ppt = parts per trillion; NR = not reported.

ND = Not detected.

TABLE 3-21

BLUE CRAB CARAPACE DATA

	Study Site	Hackensack River
Mean (inches)	5.46	5.70
Range (inches)	4.19 to 6.63	5.0 to 6.63
Standard Deviation (inches)	0.55	0.41
N	127	40

N = Number of values in the statistical analysis.

crab carapace sizes for organisms from these sites were similar (5.46 and 5.70 inches). The ranges of carapace sizes for organisms collected from the two sites were also similar.

3.5.2 Qualitative Assessment of Blue Crab and Killifish Condition

The results of the Ecological Assessment (ECKENFELDER INC., 1992) indicated that blue crabs and killifish in the Study Site are occasionally subjected to stress as a result of low concentrations of dissolved oxygen and fouling of gills by high levels of suspended matter. The low dissolved oxygen concentrations in the Study Site are likely a result of the accumulation of organic debris in the sediments due to restricted tidal flushing at the site. Lethargy in blue crabs was observed in the Study Site during periods of low dissolved oxygen concentrations. Fouling of blue crab gill membranes by suspended matter was also observed and may have compounded the deleterious effects of low concentrations of dissolved oxygen (ECKENFELDER INC., 1992). These conditions indicate that, at least occasionally, organisms at the Study Site are subjected to stress and are deleteriously impacted by conditions unrelated to the chemical constituents evaluated in this study.

3.5.3 Avian and Vegetation Surveys

Tables 3-22 and 3-23 present the results of the avian and vegetation surveys conducted in the Study Site. The results of the avian surveys indicate that a wide variety of birds inhabit and/or use the Study Site. For example, waterfowl (e.g., Canada goose, mallard duck), predatory birds (e.g., belted kingfisher), and various songbirds and small birds typical of temperate estuaries were observed. The vegetative surveys also revealed that a wide variety of trees and shrubs typical of temperate estuaries are present in the Study Site. It is concluded from this that the avian fauna and the flora of the Study Site are similar to those typically found in temperate estuarine ecosystems, and that no obvious deleterious effects to these components of the ecosystem exist in the Study Site. This conclusion is constrained, because only qualitative parameters were assessed and only the Study Site was considered (i.e., there was no reference or baseline site with which to compare the Study Site).

The presence of the reported compounds in biota indicates that the organisms evaluated are exposed to a wide variety of chemical compounds. No effects of these compounds on Study Site biota were ascertained from the data collected.

Subjective evaluations of Study Site biota indicated that killifish and blue crabs were occasionally deleteriously affected by low dissolved oxygen concentrations and the physical stress associated with fouling of gills by suspended matter. Evaluations of Study Site avian and plant communities indicated that no gross deleterious effects to these components of the ecosystem were evident.

In conclusion, many chemical constituents are present in Study Site sediments and biota. These chemicals are likely related to the high degree of urbanization in the area. The effects of these constituents on the site's ecosystem (if any) are unknown. At times, low dissolved oxygen concentrations and high concentrations of suspended matter at the Study Site are known to be detrimental to at least some of the aquatic organisms at the site. Since biota and sediment concentrations of most constituents measured in this study are similar to literature-reported values, the site does not appear to be a candidate for cleanup measures. Additionally, since no deleterious ecological effects were identified at the site in this study, some cleanup measures (e.g., dredging) could, in fact, be detrimental to site's ecology.

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APPENDIX A

SECOND TIDAL STUDY

TIDAL MONITORING 10/4/91

Time (hrs)	Study Area		Hackensack River	
0700	4.90		3.00	
0730	4.94		2.74	
0800	4.96		2.28	
0830	4.98	- Peak of tidal cycle	1.72	
0900	4.96		1.10	
0930	4.94		0.44	
1000	4.86		- 0.28	
1030	4.80		- 0.78	
1100	4.74		- 1.30	
1130	4.68	tide falling	- 2.78	- bottom of tidal cycle
1200				
1230				
1300				
1330	4.54			Turn of Tide
1400	4.50			
1430	4.48	bottom of tidal cycle	- 1.22	
1500	4.48		- 0.32	
1530	4.50		+ 0.46	
1600	4.58		1.30	
1630	4.66		2.00	
1700	4.74		2.58	
1730	4.78		2.92	
1800	4.84		3.14	
1830	4.88		3.24	peak high tide
1900	4.92		3.18	

Range = 6"

Range 6'0"

Measured in ~~tenth~~ 1/100 of foot from tidal gauges placed in Study Area and Hackensack River

TIDAL MONITORING 10/4/91

Time (hrs)	Study Area		Hackensack River	
0700	4.90		3.00	
0730	4.94		2.74	
0800	4.96		2.28	
0830	4.98	- Peak of tidal cycle	1.72	
0900	4.96		1.10	
0930	4.94		0.44	
1000	4.86		- 0.28	
1030	4.80		- 0.78	
1100	4.74		- 1.30	
1130	4.68	tide falling	- 2.78	- bottom of tidal cycle
1200				
1230				
1300			Turn of Tide	
1330	4.54			
1400	4.50			
1430	4.48	bottom of tidal cycle	- 1.22	
1500	4.48		- 0.32	
1530	4.50		+ 0.46	
1600	4.58		1.30	
1630	4.66		2.00	
1700	4.74		2.58	
1730	4.78		2.92	
1800	4.84		3.14	
1830	4.88		3.24	peak high tide
1900	4.92		3.18	

Range = 6" Range 6'0"

Measured in ~~tenth~~ 1/10ø of foot from tidal gauges placed in Study Area and Hackensack River

APPENDIX B

SURFACE WATER
FIELD PARAMETERS

FIELD WATER CHEMS. FOR DATA WITH DEPTHS RECORDED.
DEPTHS COMBINEDNOTE:HACK RIVER DATA NOT
USED DUE TO VERY SMALL DATA SET

STUDY AREA	SEPTEMBER		
DO	SALINITY	PH	TEMP
11.00	15.40		25
9.10	13.10	8.90	24.9
8.40	15.50	7.50	23.8
8.70	14.90	7.10	23.5
6.20	16.90	7.70	26
4.80	14.50	6.30	25
4.00	19.00	8.10	26
3.50	20.00		25
6.30	19.00		25
5.20	19.00		25
11.50	15.50		25
7.80	15.10		24.9
6.70	16.00		24
6.20	16.50		24
11.00	13.90		24.5
10.90	16.50		24
6.10	17.00		27
4.20	18.00		25
8.20	17.00		25
7.80	15.20		23.2
5.50	15.00		23
4.50	15.10		22.1
2.30	14.90		22
2.10	15.00		24
4.00	15.00		23.5
4.50	15.50		27
7.00	15.00		25
3.80	15.00		25
6.20	15.00		25
5.40	15.20		24
11.20	15.10		23.2
6.10	14.00		22.1
4.70	14.90		22.1
4.30	14.50		23.5
4.40	16.00		23
3.20	16.00		25
5.20	16.00		25
4.40	16.00		24
5.70			24
4.50	25.00		22.5
4.50	26.00		22
4.30	14.90		23
1.60	14.30		22
1.40	14.92		23.5
4.10	15.00		23.5
5.20	15.00		25.5
6.70	15.00		25
4.40	15.00		25
4.10	15.00		24.5
3.20	14.50		23.5
5.60	15.00		23
5.70	15.20		22.9
5.80	15.20		22.8
5.7	14.5		24
4.8	15		23
4.1	16		24
5.8	16		24
3.3	16.5		25
6.8	16.5		25
4.5			

STUDY	DO	SALIN	PH	TEMP
AREA,	6.6	14.5	8	14.5
OCTOB	7.22	14.5	7.9	12
	5.5	15	8	15
	6.2	15	8	11.5
	5.7	17.5		18
	6.5	15		12.5
	7	14.8		12
	3.4	14		14.5
	5.7	14.2		11.5
	3.1	14.2		15
	5.9	15		12

STUDY	DO	SALIN	PH	TEMP
AREA, NOV	7.9	12.8	6.8	9.4
	11.6	15.2	7	10.2
	12.3	16.5	7	12
	8.4	13.2	6.8	11.4
	10.8	14	7.5	6
	7	15.9	8	16
	8.5	14.5	6.8	5.5
	7.1	14.1	7.7	10.2
	5.9	15.9	6.8	10.7
	10.8	14.9	7	8.1
	9.3	15	7.5	16.5
	5.7	14.5	7.5	7.5
	8.5	13.1	7.1	5.2
	5.9	14.4	7	6
	6.9	16.6	7.4	10.8
	12.5	15	7.1	10
		15.6	6.8	11
		15.3	7	10
		12.4	6.8	8.1
		14.1	7	8.5
		14.5	6.5	10.4
		14.9	7	10.4
		11.2	6.5	9.9
			7	
			7.1	
			7	
			6.8	
			7	
			7.1	
			6.8	
			6.8	
			7	

HACK. RIVER	DO	SALINITY	PH	TEMP
	5.10	18.00	7.60	18
	4.00	17.00	7.60	17.8
	4.40	13.50	7.60	15.7
	3.50	18.50	7.70	15.7
	3.70	11.40	7.70	15.8
	3.40	12.50	7.80	
	3.40	12.50	7.80	

APPENDIX C

SURFACE WATER CHEMISTRY

```
 9
10  SURF WATER TSS , HACK
 2
38
19
34
```

SURF WATER TOC, STUDY

8.7
13.4
17.8
14.6
20.8
12
1.8
7.4
2.5
2.5
2.5
6.4

6.9
6.5 SURFSCE WATER TOC, HACK
2.5
2.5
2.5
2.5

```
  1
3.6  SURF WATER SULFIDES, STUDY
  1
  1
  1
3.2
2.6
3.4
  3
2.4
3.4
```

2820
2779 SURF WATER HDSS. STUDY
2760
2759
2652
2720
2740
2779
2880
3010
2800
2780

41
4 SURF WATER FECALS STUDY
8
6
36
10
0
24
38
310
100
260
70
120
150
340
450
1000
1500
410
330

```
    1  SURFACE WATER BOD STUDY SITE
 18.5
 11.3
   15
 21.5
    1
    1
  6.9
    1
    8
  5.4
  4.8
   10
  8.6
   11
    6
   12
  8.4
  2.2
   11
    9
```

APPENDIX D

SEDIMENT PHYSICAL CHARACTERISTICS AND FIELD PARAMETERS

SEDIMENT FIELD PARAMETERS
(Samples Collected 11/5/91 through 11/18/91)

Station	pH (s.u.)	Temperature (°C)	Dissolved Oxygen (mg/L)	Salinity (ppth)	Conductivity (μmhos/cm)
Study Areas					
	7.1	8.9	0.6	11.6	13,700
	6.8	7.5	0.5	13.5	14,800
	7.1	9.8	0.3	11.6	13,800
	6.8	9.9	0.4	11.2	13,200
	6.8	8.4	0.4	14.6	16,400
	6.8	11	0.3	12	15,300
	7.1	9.3	0.4	13	15,000
	6.8	9.5	0.4	13	15,000
	7.1	9.2	0.2	14	15,900
	7.1	10.5	0.1	15	17,900
	6.8	10.0	0.2	14.1	16,500
	6.8	12	0.6	9	11,500
	7.1	10.1	0.2	14	16,000
	6.5	11.2	0.3	13.8	16,500
	6.8	11.0	0.3	14.1	17,200
	6.8	10.8	0.1	11.2	13,900
	6.8	9	0.1	12.3	18,000
	7.4	8.5	0.1	14	16,000
	7.1	9.0	0.1	11.8	13,500
	7.1	7.5	0.1	11.8	13,200
	7.1	7.2	0.1	12.0	13,200
Mean	--	9.5	0.3	12.7	15,070
Range	6.5 to 7.4	7.2 to 12.0	0.1 to 0.6	9.9 to 14.6	11,500 to 18,000
Hackensack River					
	6.5	11.0	0.1	8.7	10,800
	6.8	11.1	0.2	7.0	8,500
Mean	--	11.1	0.2	7.9	9,650
Range	6.5 to 6.8	11.0 to 11.1	0.1 to 0.2	7.0 to 8.7	8,500 to 10,800

PHYSICAL AND CHEMICAL CHARACTERISTICS OF SEDIMENTS

Station	Specific Gravity	Organic Content (%)	Gravel (%)	Sand (%)	Silt/Clay (%)	Solids (%)	Water (%)
Study Areas							
	1.88	–	3	53	44	7.9	92.1
	–	46	17	45	38	5.9	94.1
	–	50	10	43	47	4.7	95.3
	1.89	36.3	3	50	47	8.9	91.1
	–	34.0	3	40	57	8.0	92.0
	–	49	25	42	33	6.5	93.5
	–	–	10	48	42	6.2	93.8
	1.8	58	8	57	35	5.9[a]	94.1
	–	52	5	51	44	6.3[a]	93.7
	2.00	40	4	54	42	9.3[a]	90.7
	2.08	33	3	35	62	11.3	88.7
	2.30	18.5	0	21	79	17.4	82.6
	2.07	38.5[a]	3	44	53	11.8	88.2
	1.71	–	6	54	40	5.9	94.1
	–	54	13	40	47	5.4	94.6
	–	55	3	47	50	6.1	93.9
	2.02	28.1	2	49	49	11.8	88.2
	–	33.4	0	35	65	17.4	82.6
	2.18	62.6	1	27	72	18.8	81.2
	2.01[a]	45	4	53	43	8.2[a]	91.8
	1.82	48	10	34	56	6.5[a]	93.5
	–	47.5	19	28	53	8.1[a]	91.9
	2.08	44	23	32	45	8.5[a]	91.5
	–	35.1	1	45	54	9.8	90.1
	–	–	9	46	37	8.8	91.2
	2.14	30.2	3	35	62	15.1	74.9
	–	37.5	3	50	47	12.6	87.4
Mean	2.00	42.4	7.1	42.9	42.7	9.4	90.2
Range	1.71 to 2.30	18.5 to 62.6	0 to 25	21 to 57	33 to 79	4.7 to 17.4	74.9 to 94.6
Hackensack River							
	2.63	6.1	35	50	15	56.2	43.8
	2.46	7.4	5	21	74	41.8	58.2
Mean	2.55	6.75	20	35.5	44.5	49.0	51.0
Range	2.46 to 2.63	6.1 to 7.4	5 to 35	21 to 50	15 to 74	41.8 to 56.2	43.8 to 58.2

[a]Values are means of duplicate samples.

APPENDIX E

SEDIMENT NUTRIENTS AND MAJOR IONS

```
SED, CA, HACK
   11200
    7090
```

4920
6660 sed. ca., study
5030
5910
7050
4960
7700
6910
4420
5280
4710
6100
5160
5180
3870
3730
4040
5210
5650
3910
6020
5030
8470
5600
4400
2830

7800 sed. magn. hack
8700

3840 sed potassium, hack
3640

47200 sed. tkn., study
33400
35300
36300
24700
47800
41500
33600
26900
12600
21200
18724
23900
23500
16100
15100
11100
16900
16100
20600
16700
27400
38300
23000
17400
27100
29000

28.7 sed. ammonia hack
45.5

SED.	AMMON.	STUDY	SITE
	291		
	352		
	298		
	268		
	507		
	460		
	620		
	407		
	471		
	226		
	418		
	370		
	483		
	352		
	384		
	167		
	286		
	277		
	120		
	321		
	254		
	494		
	404		
	409		
	476		
	426		
	272		

3 SED TOC HACK
4.7

57.1 SED TOC STUDY
45.3
45.2
57
54.2
35.1
51.1
59.3
58.5
19.9
33.4
15.7
29.7
19.5
36.2
31.4
13.5
30
25.4
54.1
83.9
39.4
74.2
65.9
44
62.2
73.5

SED. SOLIDS, HACK
60
37

5.6 SED SOLIDS STUDY
9.7
7.7
8.7
6.4
8.3
6.4
6.6
6.3
13
8.2
6.3
6.7
5.4
4.6
6.5
7.1
7.1
9.2
4.6
5.4
5.4
6.6
5.4
5.7
7.7
8.8
12
9.1
7.4
9.9
15
17
11
18
6
7.4
5.2
5.7
8.9
9.8
6.9
5.8

APPENDIX F

CRAB CARAPACE DATA

CRAB CARAPACE INCHES

study area

5.5	4.88		6.63
4.88			4.94
4.88			4.19
5.5			6
4.75	4.88		5.5
5.88	5		6
4.63	5.5		6.25
6.5	6.5		
5.75	6		
5	6.25		
5.19	6		5.88
5.5	5.5		5
5.56	5		6.13
4.75	5.75		6.63
5.56	5		4.88
4.38	6		5.75
5.44	5.31		6.38
4.63	6		5.5
4.88	6.13		5.88
5.38	6		5.25
4.75	5.13		5.25
4.63	6.5		6
4.88	6		5.63
5.31	4.88		5.75
5.5	6.06		6.38
4.5	5.38		5.88
5.5	4.63		4.88
6	4.75		
5.25	6		
5	6.25		
5.38	5.25		
5.5	5.5		
5.5	5.13		
5.5	5.38		
5.63	5.25		
5.44	4.94		
5.75	5		
4.75	5.38		
6.25	6		
5.25	5.63		
5.81	5		
6.25	4.38		
4.88	6.25		
6.13	5.13		
5.25	5		
5.25	5.63		
5.75	5.13		
5.13	6.25		
5.63	5.75		
5.75	4.75		
5.38	6.5		
5.19	4.75		
5.25	5.5		

MEAN	5.462834
MIN	4.19
MAX	6.63
STDDEV	0.548086
N	127

CRAB CARAPACE INCHES	
hack.	5.75
river	5
	5.5
	6
	5.5
	6
	5.5
	6.5
	5.25
	5.5
	6.25
	5.75
	5.25
	5.5
	5.25
	5.5
	5.25
	6.25
	6
	6.25
	5.75
	6
	5
	5.5
	6
	6
	5.63
	6.25
	5.5
	5.75
	5.75
	6.5
	6.63
	5.5
	5.25
	5.5
	5.5
	5.25
	5.5
	5.5

MEAN	5.70025
MIN	5
MAX	6.63
STDDEV	0.407041
N	40

APPENDIX G

TOXICITY EQUIVALENTS CALCULATIONS

TABLE G-1

TOXICITY EQUIVALENTS IN STUDY SITE AND HACKENSACK RIVER SEDIMENTS FOR SAMPLE SITES 43, 23, 35, 65, AND 15

(using 1/2 of detection limit for non-detect data)

(parts per trillion, wet weight)

Constituent	[a] I-TEFs/89	[b] Site 43 Conc.	[c] Site 43 Tox. Equiv.	[b] Site 23 Conc.	[c] Site 23 Tox. Equiv.	[b] Site 35 Conc.	[c] Site 35 Tox. Equiv.	[b] Site 65 Conc.	[c] Site 65 Tox. Equiv.	[b] Site 15 Conc.	[c] Site 15 Tox. Equiv.
Furans											
Total TCDF		6060		1310		913		944		943	
2,3,7,8-TCDF	0.1	187	18.7	86.5	8.65	60.1	6.01	62.5	6.25	81	8.1
Other TCDF	0	5873	0	1223.5	0	852.9	0	881.5	0	862	0
Total PCDF		6880		690		593		988		919	
1,2,3,7,8-PCDF	0.05	219	10.95	19.6 *	0.98	31.6	1.58	16.3 *	0.815	24.1 *	1.21
2,3,4,7,8-PCDF	0.5	1050	525	124	62	75.1	37.6	79.9	40.0	95.2	47.6
Other PCDF	0	5611	0	546.4	0	486.3	0	891.8	0	799.7	0
Total HxCDF		8980		944		751		753		912	
1,2,3,4,7,8-HxCDF	0.1	2530	253	224	22.4	196	19.6	227	22.7	277	27.7
1,2,3,6,7,8-HxCDF	0.1	487	48.7	28.5 *	2.85	44.6	4.46	51.9	5.19	25.9 *	2.59
2,3,4,6,7,8-HxCDF	0.1	173	17.3	30.4 *	3.04	46.2	4.62	43.8	4.38	65.2	6.52
1,2,3,7,8,9-HxCDF	0.1	374	37.4	9.8 *	0.98	5.3 *	0.53	5.5 *	0.55	6.6 *	0.66
Other HxCDF	0	5416	0	651.3	0	458.9	0	424.8	0	567.3	0
Total HpCDF		7930		986		887		1050		1350	
1,2,3,4,6,7,8-HpCDF	0.01	5910	59.1	751	7.51	670	6.7	733	7.33	933	9.33
1,2,3,4,7,8,9-HpCDF	0.01	159	1.59	19.6 *	0.196	11.3 *	0.113	10.6 *	0.106	16.3 *	0.163
Other HpCDF	0	1861	0	216.4	0	205.7	0	306.4	0	400.7	0
OCDF	0.001	4540	4.54	1030	1.03	851	0.851	1090	1.09	1380	1.38
Dioxins											
Total TCDD		457		130		202		152		140	
2,3,7,8-TCDD	1	17.9 *	17.9	19.6 *	19.6	89.6	89.6	35.1	35.1	25.1 *	25.1
Other TCDD	0	439.1	0	110.4	0	112.4	0	116.9	0	114.9	0

TABLE G-1 (Continued)

TOXICITY EQUIVALENTS IN STUDY SITE AND HACKENSACK RIVER SEDIMENTS FOR SAMPLE SITES 43, 23, 35, 65, AND 15

(using 1/2 of detection limit for non-detect data)

(parts per trillion, wet weight)

Constituent	[a] I-TEFs/89	[b] Site 43 Conc.	[c] Site 43 Tox. Equiv.	[b] Site 23 Conc.	[c] Site 23 Tox. Equiv.	[b] Site 35 Conc.	[c] Site 35 Tox. Equiv.	[b] Site 65 Conc.	[c] Site 65 Tox. Equiv.	[b] Site 15 Conc	[c] Site 15 Tox. Equiv.
Dioxins (Continued)											
Total PCDD		433		196 *		84		94.6		171	
1,2,3,7,8-PCDD	0.5	20.8 *	10.4	9.4 *	4.7	4.4 *	2.2	8.2 *	4.1	7.9 *	3.95
Other PCDD	0	412.2	0	186.6	0	79.6	0	86.3	0	163.1	0
Total HxCDD		708		358		247		156		263	
1,2,3,4,7,8-HxCDD	0.1	53 *	5.3	0.7 *	0.07	7.2 *	0.72	7.5 *	0.75	15.1 *	1.51
1,2,3,6,7,8-HxCDD	0.1	31.0 *	3.1	36.3 *	3.63	13.5 *	1.35	14.0 *	1.4	24.1 *	2.41
1,2,3,7,8,9-HxCDD	0.1	29.3 *	2.93	22.6 *	2.26	11.3 *	1.13	13.6 *	1.36	16.3 *	1.63
Other HxCDD	0	591.7	0	289.4	0	215	0	120.9	0	207.5	0
Total HpCDD		2120		1560		577		627		984	
1,2,3,4,6,7,8-HpCDD	0.01	988	9.88	867	8.67	267	2.67	270	2.7	441	4.41
Other HpCDD	0	1132	0	693	0	310	0	357	0	543	0
OCDD	0.001	6910	6.91	5540	5.54	2190	2.19	2360	2.36	3770	3.77
Total Toxicity Equivalents			1033.0		155.0		181.9		136.2		148.0

[a] Weighting factors from USEPA's "Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-Dioxins and -Dibenzo furans (CDDs and CDFs) and 1989 Update".

[b] Concentrations from Maxus report summary table 3-12 as updated by final summary data tables received from Environmental Standards Inc. (not from raw data sheets).

[c] Toxicity Equivalents are calculated by multiplying the associated weighting factor (I-TEFs/89 column) by the appropriate concentration.

[*] Constituent not detected in this sample per Maxus report summary table 3-12 as updated by final data summary tables received from Environmental Standards Inc. Value given is 1/2 the detection limit.

TABLE G-2

TOXICITY EQUIVALENTS IN STUDY SITE AND HACKENSACK RIVER SEDIMENTS FOR SAMPLE SITES 36, 27, HA1, AND HA2 AND STANDARD CHLORINE

(using 1/2 of detection limit for non-detect data)

(parts per trillion, wet weight)

Constituent	[a] I-TEFs/89	[b] Site 36 Conc.	[c] Site 36 Tox. Equiv.	[b] Site 27 Conc.	[c] Site 27 Tox. Equiv.	[b] Site HA 1 Conc.	[c] Site HA 1 Tox. Equiv.	[b] Site HA 2 Conc.	[c] Site HA 2 Tox. Equiv.	[b] Standard Chlorine Conc.	[c] Standard Chlorine Tox. Equiv.
Furans											
Total TCDF		1750		1150		106		115		4.34	
2,3,7,8-TCDF	0.1	99.6	9.96	55 3	5.53	2.6 *	0.26	5.6 *	0 56	0.24 *	0.024
Other TCDF	0	1650.4	0	1094.7	0	103.4	0	109.4	0	4.10	0
Total PCDF		1260		897		84.7		111		8 55	
1,2,3,7,8-PCDF	0.05	32.4 *	1 62	43.9	2.20	4.54	0.227	1.7 *	0.085	0 60 *	0 03
2,3,4,7,8-PCDF	0.5	240	120	139	69.5	7.37	3 685	12.6	6.3	1.20 *	0.6
Other PCDF	0	987.6	0	714.1	0	72.79	0	96 7	0	6.75	0
Total HxCDF		1890		1290		119		133		52.9	
1,2,3,4,7,8-HxCDF	0.1	624	62.4	429	42 9	44.1	4.41	43.5	4.35	25 0	2 5
1,2,3,6,7,8-HxCDF	0.1	100	10	72.6	7.26	9.3	0 93	8.87	0.887	1 75 *	0 175
2,3,4,6,7,8-HxCDF	0.1	102	10.2	65 2	6.52	6.13	0.613	6.27	0.627	1.40 *	0 14
1,2,3,7,8,9-HxCDF	0.1	17.9 *	1.79	9.7 *	0.97	0.8 *	0.08	1 2 *	0.12	0.34 *	0.034
Other HxCDF	0	1046.1	0	713 5	0	58.67	0	73.16	0	24 4	0
Total HpCDF		2150		2070		209		181		7.71	
1,2,3,4,6,7,8-HpCDF	0.01	1770	17.7	1520	15.2	165	1.65	133	1.33	35 5 *	0.355
1,2,3,4,7,8,9-HpCDF	0.01	14.9 *	0.149	18 *	0.18	1.9 *	0.019	6.3 *	0.063	1.3 *	0.013
Other HpCDF	0	365.1	0	532	0	52.1	0	41.7	0	29.1 [d]	0
OCDF	0.001	1730	1.73	2210	2 21	364	0.364	186	0.186	104	
Dioxins											
Total TCDD		260		254		44		34.7		0.60 *	
2,3,7,8-TCDD	1	82	82	141	141	26.9	26.9	20	20	0 38 *	0.38
Other TCDD	0	178	0	113	0	17.1	0	14 7	0	0.22	0

TABLE G-2 (Continued)

TOXICITY EQUIVALENTS IN STUDY SITE AND HACKENSACK RIVER SEDIMENTS FOR SAMPLE SITES 36, 27, HA1, AND HA2 AND STANDARD CHLORINE

(using 1/2 of detection limit for non-detect data)

(parts per trillion, wet weight)

Constituent	[a] I-TEFs/89	[b] Site 36 Conc.	[c] Site 36 Tox. Equiv.	[b] Site 27 Conc.	[c] Site 27 Tox. Equiv.	[b] Site HA 1 Conc.	[c] Site HA 1 Tox. Equiv.	[b] Site HA 2 Conc.	[c] Site HA 2 Tox. Equiv.	[b] Standard Chlorine Conc.	[c] Standard Chlorine Tox. Equiv.
Dioxins (Continued)											
Total PCDD		159		70.9		10.5		3.2 *		2.25 *	
1,2,3,7,8-PCDD	0.5	7.2 *	3.6	8.4 *	4.2	1.5 *	0.75	3.2 *	1.6	0.19 *	0.095
Other PCDD	0	151.8	0	62.5	0	9	0	0	0	2.06	0
Total HxCDD		103		476		27.3		22.6		7.40	
1,2,3,4,7,8-HxCDD	0.1	15.7 *	1.57	8.4 *	0.84	1.8 *	0.18	5 *	0.5	0.55 *	0.055
1,2,3,6,7,8-HxCDD	0.1	13.5 *	1.35	44.6	4.46	1.7 *	0.17	4.8 *	0.48	0.60 *	0.06
1,2,3,7,8,9-HxCDD	0.1	9.7 *	0.97	11 *	1.1	2.0 *	0.2	5 *	0.5	0.55 *	0.055
Other HxCDD	0	64.1	0	412	0	21.8	0	7.8	0	5.70	0
Total HpCDD		931		1680		120		147		9.45	
1,2,3,4,6,7,8-HpCDD	0.01	411	4.11	760	7.6	48.4	0.484	3.2	0.032	2.75 *	0.0275
Other HpCDD	0	520	0	920	0	80.6	0	143.8	0	6.70	0
OCDD	0.001	3910	3.91	7130	7.13	499	0.499	662	0.662	324	0.324
Total Toxicity Equivalents			333.1		318.8		41.3		38.3		4.87

[a] Weighting factors from USEPA's "Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-Dioxins and -Dibenzo furans (CDDs and CDFs) and 1989 Update".

[b] Concentrations from Maxus report summary table 3-12 as updated by final summary data tables received from Environmental Standards Inc (not from raw data sheets).

[c] Toxicity Equivalents are calculated by multiplying the associated weighting factor (I-TEFs/89 column) by the appropriate concentration

[d] Negative concentration results when the sum of individual isomer concentrations exceeds the total concentration (due to using 1/2 the detection limit for non-detect data).

* Constituent not detected in this sample per Maxus report summary table 3-12 as updated by final data summary tables received from Environmental Standards Inc. Value given is 1/2 the detection limit.

TABLE G-3

TOXICITY EQUIVALENTS IN BLUE CRAB EDIBLE TISSUES FOR SAMPLE SITES 23/43, 15/35, 27/36, AND CAYUGA DIKE

(using 1/2 of detection limit for non-detect data)

(parts per trillion, wet weight)

Constituent	[a] I-TEFs/89	[b] Site 23/43 Conc.	[c] Site 23/43 Tox. Equiv.	[b] Site 15/35 Conc.	[c] Site 15/35 Tox. Equiv.	[b] Site 27/36 Conc.	[c] Site 27/36 Tox. Equiv.	[b] Cayuga Dike Conc.	[c] Cayuga Dike Tox. Equiv.
Furans									
Total TCDF		0.22 *		5.8		9.89		45.1	
2,3,7,8-TCDF	0.1	0.22 *	0.022	1.29	0.129	1.40	0.14	3.39	0.339
Other TCDF	0	0	0	4.51	0	8.49	0	41.71	0
Total PCDF		0.185 *		0.915 *		0.615 *		19.1	
1,2,3,7,8-PCDF	0.05	0.185 *	0.00925	0.183 *	0.00915	0.179 *	0.00895	0.59 *	0.0295
2,3,4,7,8-PCDF	0.5	0.14 *	0.07	0.293 *	0.1465	0.278 *	0.139	1.41 *	0.705
Other PCDF	0	-0.14 d	0	0.439	0	0.158	0	17.1	0
Total HxCDF		0.49 *		0.73 *		0.555 *		5.47	
1,2,3,4,7,8-HxCDF	0.1	0.44 *	0.044	0.269 *	0.0269	0.383 *	0.0383	1.23 *	0.123
1,2,3,6,7,8-HxCDF	0.1	0.49 *	0.049	0.287 *	0.0287	0.42 *	0.042	0.483 *	0.0483
2,3,4,6,7,8-HxCDF	0.1	0.195 *	0.0195	0.171 *	0.0171	0.414 *	0.0414	0.395 *	0.0395
1,2,3,7,8,9-HxCDF	0.1	0.085 *	0.0085	0.73 *	0.073	0.377 *	0.0377	0.474 *	0.0474
Other HxCDF	0	-0.72 d	0	-0.727 d	0	-1.039 d	0	2.89	0
Total HpCDF		0.615 *		0.79 *		0.615 *		0.63 *	
1,2,3,4,6,7,8-HpCDF	0.01	0.20 *	0.002	0.402 *	0.00402	0.401 *	0.00401	0.63 *	0.0063
1,2,3,4,7,8,9-HpCDF	0.01	0.10 *	0.001	0.377 *	0.00377	0.352 *	0.00352	0.334 *	0.00334
Other HpCDF	0	0.315	0	0.011	0	-0.138 d	0	-0.334 d	0
OCDF	0.001	0.21 *	0.00021	0.427 *	0.000427	1.05 *	0.00105	0.965 *	0.000965
Dioxins									
Total TCDD		0.870		2.28		3.2		26.0	
2,3,7,8-TCDD	1	0.870	0.870	2.28	2.28	3.2	3.2	20.0	20
Other TCDD	0	0	0	0	0	0	0	6.0	0

TABLE G-3 (Continued)

TOXICITY EQUIVALENTS IN BLUE CRAB EDIBLE TISSUES
FOR SAMPLE SITES 23/43, 15/35, 27/36, AND CAYUGA DIKE
(using 1/2 of detection limit for non-detect data)
(parts per trillion, wet weight)

Constituent	[a] I-TEFs/89	[b] Site 23/43 Conc.	[c] Site 23/43 Tox. Equiv.	[b] Site 15/35 Conc.	[c] Site 15/35 Tox. Equiv.	[b] Site 27/36 Conc.	[c] Site 27/36 Tox. Equiv.	[b] Cayuga Dike Conc.	[c] Cayuga Dike Tox. Equiv.
Dioxins (Continued)									
Total PCDD		0.27 *		0.73 *		0.432 *		0 905 *	
1,2,3,7,8-PCDD	0.5	0.27 *	0.135	0.256 *	0.128	0.253 *	0.127	0.59 *	0.295
Other PCDD	0	0	0	0.474	0	0.179	0	0.315	0
Total HxCDD		0.30 *		1.035 *		0.432 *		0.905 *	
1,2,3,4,7,8-HxCDD	0.1	0.25 *	0.025	0.36 *	0.036	0.334 *	0.0334	0.595 *	0.0595
1,2,3,6,7,8-HxCDD	0.1	0.30 *	0.03	0.421 *	0.0421	0.408 *	0.0408	0.55 *	0.055
1,2,3,7,8,9-HxCDD	0.1	0.29 *	0.029	0.415 *	0.0415	0.401 *	0.0401	0.57 *	0.057
Other HxCDD	0	-0.54 [d]	0	-0.161 [d]	0	-0.711 [d]	0	-0.81 [d]	0
Total HpCDD		0.30 *		0.366 *		0.865 *		0.66 *	
1,2,3,4,6,7,8-HpCDD	0.01	0.30 *	0.003	0.36 *	0.0036	0.865 *	0.00865	0.66 *	0.0066
Other HpCDD	0	0	0	0.006	0	0	0	0	0
OCDD	0.001	0.76 *	0.00076	1.47 *	0.00147	27.8	0.0278	2.90 *	0.0029
Total Toxicity Equivalents			1.3		3.0		3.9		21.8

[a] Weighting factors from USEPA's "Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-Dioxins and -Dibenzo furans (CDDs and CDFs) and 1989 Update".

[b] Concentrations from Maxus report summary table 3-17 as updated by final summary data tables received from Environmental Standards Inc. (not from raw data sheets).

[c] Toxicity Equivalents are calculated by multiplying the associated weighting factor (I-TEFs/89 column) by the appropriate concentration.

[d] Negative concentration results when the sum of individual isomer concentrations exceeds the total concentration (due to using 1/2 the detection limit for non-detect data).

* Constituent not detected in this sample per Maxus report summary table 3-17 as updated by final data summary tables received from Environmental Standards Inc. Value given is 1/2 the detection limit.

TABLE G-4

TOXICITY EQUIVALENTS IN BLUE CRAB EDIBLE TISSUES FOR STANDARD CHLORINE AND STORE BOUGHT CRABS

(using 1/2 of detection limit for non-detect data)

(parts per trillion, wet weight)

Constituent	[a] I-TEFs/89	[b] Standard Chlorine Conc.	[c] Standard Chlorine Tox. Equiv.	[b] Store Bought Crabs Conc.	[c] Store Bought Crabs Tox. Equiv.
Furans					
Total TCDF		43.8		4.04	
2,3,7,8-TCDF	0.1	5.38	0.538	0.58 *	0.058
Other TCDF	0	38.42	0	3.46	0
Total PCDF		19.5		0.163 *	
1,2,3,7,8-PCDF	0.05	0.545 *	0.0273	0.163 *	0.00815
2,3,4,7,8-PCDF	0.5	3.49	1.745	0.163 *	0.0815
Other PCDF	0	15.5	0	-0.163 d	0
Total HxCDF		9.52		0.25 *	
1,2,3,4,7,8-HxCDF	0.1	4.27	0.427	0.15 *	0.015
1,2,3,6,7,8-HxCDF	0.1	0.5 *	0.05	0.156 *	0.0156
2,3,4,6,7,8-HxCDF	0.1	0.314 *	0.0314	0.219 *	0.0219
1,2,3,7,8,9-HxCDF	0.1	0.225 *	0.0225	0.25 *	0.025
Other HxCDF	0	4.21	0	-0.525 d	0
Total HpCDF		0.835 *		0.314 *	
1,2,3,4,6,7,8-HpCDF	0.01	0.835 *	0.00835	0.276 *	0.00276
1,2,3,4,7,8,9-HpCDF	0.01	0.231 *	0.00231	0.319 *	0.00319
Other HpCDF	0	-0.231 d	0	-0.28 d	0
OCDF	0.001	0.449 *	0.000449	0.75 *	0.00075
Dioxins					
Total TCDD		27.9		0.488 *	
2,3,7,8-TCDD	1	23.1	23.1	0.2 *	0.2
Other TCDD	0	4.8	0	0.288	0

TABLE G-4 (Continued)

TOXICITY EQUIVALENTS IN BLUE CRAB EDIBLE TISSUES FOR STANDARD CHLORINE AND STORE BOUGHT CRABS

(using 1/2 of detection limit for non-detect data)

(parts per trillion, wet weight)

Constituent	[a] I-TEFs/89	[b] Standard Chlorine Conc.	[c] Standard Chlorine Tox. Equiv.	[b] Store Bought Crabs Conc.	[c] Store Bought Crabs Tox. Equiv.
Dioxins (Continued)					
Total PCDD		3.49		0.219 *	
1,2,3,7,8-PCDD	0.5	0.353 *	0.177	0.219 *	0.110
Other PCDD	0	3.137	0	0	0
Total HxCDD		0.705 *		0.626 *	
1,2,3,4,7,8-HxCDD	0.1	0.164 *	0.0164	0.444 *	0 0444
1,2,3,6,7,8-HxCDD	0.1	0 314 *	0.0314	0 0555 *	0 00555
1,2,3,7,8,9-HxCDD	0.1	0.16 *	0.016	0.575 *	0.0575
Other HxCDD	0	0.077	0	-0.450 [d]	0
Total HpCDD		0 321 *		0.363 *	
1,2,3,4,6,7,8-HpCDD	0.01	0.314 *	0.00314	0.363 *	0.00363
Other HpCDD	0	0.007	0	0	0
OCDD	0.001	1.35 *	0.00135	1.5 *	0 0015
Total Toxicity Equivalents			26.2		0.65

[a] Weighting factors from USEPA's "Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-Dioxins and -Dibenzo furans (CDDs and CDFs) and 1989 Update".

[b] Concentrations from Maxus report summary table 3-17 as updated by final summary data tables received from Environmental Standards Inc. (not from raw data sheets).

[c] Toxicity Equivalents are calculated by multiplying the associated weighting factor (I-TEFs/89 column) by the appropriate concentration.

[d] Negative concentration results when the sum of individual isomer concentrations exceeds the total concentration (due to using 1/2 the detection limit for non-detect data).

TABLE G-5

TOXICITY EQUIVALENTS IN BLUE CRAB HEPATOPANCREAS TISSUES FOR SAMPLE SITES 23/43, 15/35, 27/36, AND CAYUGA DIKE

(using 1/2 of detection limit for non-detect data)

(parts per trillion, wet weight)

Constituent	[a] I-TEFs/89	[b] Site 23/43 Conc.	[c] Site 23/43 Tox. Equiv.	[b] Site 15/35 Conc.	[c] Site 15/35 Tox. Equiv.	[b] Site 27/36 Conc.	[c] Site 27/36 Tox. Equiv.	[b] Cayuga Dike Conc.	[c] Cayuga Dike Tox. Equiv.
Furans									
Total TCDF		250		328		537		1700	
2,3,7,8-TCDF	0.1	67.3	6.73	53.2	5.32	85.5	8.55	204	20.4
Other TCDF	0	182.7	0	274.8	0	451.5	0	1496	0
Total PCDF		80.0		95.1		180		726	
1,2,3,7,8-PCDF	0.05	8.0	0.4	5.64	0.282	10.4	0.52	32.5	1.625
2,3,4,7,8-PCDF	0.5	20.1	10.05	15.8	7.9	33.7	16.85	106	53
Other PCDF	0	51.9	0	73.66	0	135.9	0	587.5	0
Total HxCDF		35.0		29.4		65.8		222	
1,2,3,4,7,8-HxCDF	0.1	11.6	1.16	8.96	0.896	22.5	2.25	93 8	9.38
1,2,3,6,7,8-HxCDF	0.1	6.6	0.66	1.04 *	0.104	5.18	0.518	17	1.7
2,3,4,6,7,8-HxCDF	0.1	0.775 *	0.0775	0.56 *	0.056	1.27 *	0.127	7.91	0.791
1,2,3,7,8,9-HxCDF	0.1	0.16 *	0.016	0.62 *	0.062	0.219 *	0.0219	0.655 *	0.0655
Other HxCDF	0	15.87	0	18.2	0	36.6	0	102.6	0
Total HpCDF		7.80		1.53 *		15.6		30.1	
1,2,3,4,6,7,8-HpCDF	0.01	7.80	0.078	2.85 *	0.0285	15.6	0.156	28.4	0.284
1,2,3,4,7,8,9-HpCDF	0.01	0.20 *	0.002	0.188 *	0.00188	0.176 *	0.00176	0.449 *	0.00449
Other HpCDF	0	-0.20 d	0	-1.51 d	0	-0.176 d	0	1.25	0
OCDF	0.001	0.38 *	0.00038	0.347 *	0.000347	0.54 *	0.00054	0.81 *	0.00081
Dioxins									
Total TCDD		53.1		62.2		169		896	
2,3,7,8-TCDD	1	39.3	39.3	30.1	30.1	112	112	665	665
Other TCDD	0	13.8	0	32.1	0	57	0	231	0

TABLE G-6

TOXICITY EQUIVALENTS IN BLUE CRAB HEPATOPANCREAS TISSUES FOR STANDARD CHLORINE AND STORE BOUGHT CRABS

(using 1/2 of detection limit for non-detect data)

(parts per trillion, wet weight)

Constituent	[a] I-TEFs/89	[b] Standard Chlorine Conc.	[c] Standard Chlorine Tox. Equiv.	[b] Store Bought Crabs Conc.	[c] Store Bought Crabs Tox. Equiv.
Furans					
Total TCDF		1201		164	
2,3,7,8-TCDF	0.1	196	19.6	39.7	3.97
Other TCDF	0	1005	0	114.3	0
Total PCDF		589		62.5	
1,2,3,7,8-PCDF	0.05	30.8	1.54	5 75	0.2875
2,3,4,7,8-PCDF	0.5	94.2	47.1	12 7	6.35
Other PCDF	0	464	0	44 05	0
Total HxCDF		189		4.0	
1,2,3,4,7,8-HxCDF	0.1	109	10.9	1.09 *	0.109
1,2,3,6,7,8-HxCDF	0.1	14.6	1.46	0.585 *	0.0585
2,3,4,6,7,8-HxCDF	0.1	8.1	0.81	0.795 *	0.0795
1,2,3,7,8,9-HxCDF	0.1	0 605 *	0.0605	0.63 *	0.063
Other HxCDF	0	56.696	0	0.9	0
Total HpCDF		37 9		0.795 *	
1,2,3,4,6,7,8-HpCDF	0.01	40.3	0.403	0.63 *	0.0063
1,2,3,4,7,8,9-HpCDF	0.01	0.493 *	0.00493	0.795 *	0 00795
Other HpCDF	0	-2.893 d	0	-0.63 e	0
OCDF	0 001	0.62 *	0 00062	0.67 *	0.00067
Dioxins					
Total TCDD		639		15 2	
2,3,7,8-TCDD	1	507	507	2.48	2.48
Other TCDD	0	132	0	12.7	0

TABLE G-6 (Continued)

TOXICITY EQUIVALENTS IN BLUE CRAB HEPATOPANCREAS TISSUES FOR STANDARD CHLORINE AND STORE BOUGHT CRABS

(using 1/2 of detection limit for non-detect data)

(parts per trillion, wet weight)

Constituent	[a] I-TEFs/89	[b] Standard Chlorine Conc.	[c] Standard Chlorine Tox. Equiv.	[b] Store Bought Crabs Conc.	[c] Store Bought Crabs Tox. Equiv.
Dioxins (Continued)					
Total PCDD		52.1		24.6	
1,2,3,7,8-PCDD	0.5	13.1	6.55	4.86	2.43
Other PCDD	0	39	0	19.7	0
Total HxCDD		76.5		69.6	
1,2,3,4,7,8-HxCDD	0.1	1.55 *	0.155	1.02 *	0.102
1,2,3,6,7,8-HxCDD	0.1	14.5	1.45	4.16	0.416
1,2,3,7,8,9-HxCDD	0.1	1.9 *	0.19	2.06	0.206
Other HxCDD	0	57.55	0	52.4	0
Total HpCDD		18.9		15 9	
1,2,3,4,6,7,8-HpCDD	0.01	6.92	0.0692	4 88	0.0488
Other HpCDD	0	11.98	0	11.02	0
OCDD	0.001	8.21	0.00821	23.6	0.0236
Total Toxicity Equivalents			597.3		16.6

[a] Weighting factors from USEPA's "Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-Dioxins and -Dibenzo furans (CDDs and CDFs) and 1989 Update".

[b] Concentrations from Maxus report summary table 3-18 as updated by final summary data tables received from Environmental Standards Inc. (not from raw data sheets).

[c] Toxicity Equivalents are calculated by multiplying the associated weighting factor (I-TEFs/89 column) by the appropriate concentration.

[d] Negative concentration results from individual isomer concentration exceeding the total concentration. While not reasonable, these values were reported in the final data summary tables received from Environmental Standards Inc.

TABLE G-6 (Continued)

TOXICITY EQUIVALENTS IN BLUE CRAB HEPATOPANCREAS TISSUES FOR STANDARD CHLORINE AND STORE BOUGHT CRABS

(using 1/2 of detection limit for non-detect data)

(parts per trillion, wet weight)

Constituent	[a] I-TEFs/89	[b] Standard Chlorine Conc.	[c] Standard Chlorine Tox. Equiv.	[b] Store Bought Crabs Conc.	[c] Store Bought Crabs Tox. Equiv.

[e] Negative concentration results when the sum of individual isomer concentrations exceeds the total concentration (due to using 1/2 the detection limit for non-detect data).

[*] Constituent not detected in this sample per Maxus report summary table 3-18 as updated by final data summary tables received from Environmental Standards Inc. Value given is 1/2 the detection limit.

TABLE G-7

TOXICITY EQUIVALENTS IN STUDY SITE KILLIFISH WHOLE BODY TISSUES FOR SAMPLE SITES 23/43, 15/35, AND 27/36

(using 1/2 of detection limit for non-detect data)

(parts per trillion, wet weight)

Constituent	[a] I-TEFs/89	[b] Site 23/43 Conc.	[c] Site 23/43 Tox. Equiv.	[b] Site 15/35 Conc.	[c] Site 15/35 Tox. Equiv.	[b] Site 27/36 Conc.	[c] Site 27/36 Tox. Equiv.
Furans							
Total TCDF		3.15		3.38		6.78	
2,3,7,8-TCDF	0.1	3.15	0.315	3.38	0.338	4.83	0.483
Other TCDF	0	0	0	0	0	1.95	0
Total PCDF		1.14 *		0.75 *		1.67 *	
1,2,3,7,8-PCDF	0.05	0.16 *	0.008	0.28 *	0.014	0.25 *	0.0125
2,3,4,7,8-TCDF	0.5	0.995 *	0.4975	0.75 *	0.38	1.32 *	0.66
Other PCDF	0	-0.015 d	0	-0.28 d	0	0.1	0
Total HxCDF		0.43 *		0.57 *		1.46 *	
1,2,3,4,7,8-HxCDF	0.1	0.41 *	0.041	0.55 *	0.055	0.222 *	0.0222
1,2,3,6,7,8-HxCDF	0.1	0.43 *	0.043	0.57 *	0.057	0.243 *	0.0243
2,3,4,6,7,8-HxCDF	0.1	0.23 *	0.023	0.24 *	0.024	0.299 *	0.0299
1,2,3,7,8,9-HxCDF	0.1	0.10 *	0.01	0.085 *	0.0085	1.46 *	0.146
Other HxCDF	0	-0.74 d	0	-0.875 d	0	-0.764 d	0
Total HpCDF		0.60 *		0.37 *		0.459 *	
1,2,3,4,6,7,8-HpCDF	0.01	0.20 *	0.002	0.12 *	0.0012	0.459 *	0.00459
1,2,3,4,7,8,9-HpCDF	0.01	0.10 *	0.001	0.047 *	0.00047	0.347 *	0.00347
Other HpCDF	0	0.30	0	0.203	0	-0.347 d	0
OCDF	0.001	0.18 *	0.00018	0.20 *	0.0002	1.04 *	0.00104
Dioxins							
Total TCDD		4.20		3.69		12.5	
2,3,7,8-TCDD	1	4.20	4.2	3.69	3.69	12.5	12.5
Other TCDD	0	0	0	0	0	0	0

TABLE G-7 (Continued)

TOXICITY EQUIVALENTS IN STUDY SITE KILLIFISH WHOLE BODY TISSUES FOR SAMPLE SITES 23/43, 15/35, AND 27/36
(using 1/2 of detection limit for non-detect data)
(parts per trillion, wet weight)

Constituent	[a] I-TEFs/89	[b] Site 23/43 Conc.	[c] Site 23/43 Tox. Equiv.	[b] Site 15/35 Conc.	[c] Site 15/35 Tox. Equiv.	[b] Site 27/36 Conc.	[c] Site 27/36 Tox. Equiv.
Dioxins (Continued)							
Total PCDD		0.20 *		0.39 *		2.02 *	
1,2,3,7,8-PCDD	0.5	0.20 *	0.1	0.39 *	0.195	0.396 *	0.198
Other PCDD	0	0	0	0	0	1.62	0
Total HxCDD		0.26 *		0.35 *		0.361 *	
1,2,3,4,7,8-HxCDD	0.1	0.13 *	0.013	0.29 *	0.029	0.278 *	0.0278
1,2,3,6,7,8-HxCDD	0.1	0.18 *	0.018	0.29 *	0.029	0.354 *	0.0354
1,2,3,7,8,9-HxCDD	0.1	0.17 *	0.017	0.33 *	0.033	0.361 *	0.0361
Other HxCDD	0	-0.22 [d]	0	-0.56 [d]	0	-0.632 [d]	0
Total HpCDD		0.34 *		0.21 *		0.57 *	
1,2,3,4,6,7,8-HpCDD	0.01	0.34 *	0.0034	0.21 *	0.0021	0.57 *	0.0057
Other HpCDD	0	0	0	0	0	0	0
OCDD	0.001	1.62 *	0.00162	1.48 *	0.00148	1.88 *	0.00188
Total Toxicity Equivalents			5.3		4.9		14.2

[a] Weighting factors from USEPA's "Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-Dioxins and -Dibenzo furans (CDDs and CDFs) and 1989 Update".

[b] Concentrations from Maxus report summary table 3-19 as updated by final summary data tables received from Environmental Standards Inc. (not from raw data sheets).

[c] Toxicity Equivalents are calculated by multiplying the associated weighting factor (I-TEFs/89 column) by the appropriate concentration.

[d] Negative concentration results when the sum of individual isomer concentrations exceeds the total concentration (due to using 1/2 the detection limit for non-detect data).

TABLE G-7 (Continued)

TOXICITY EQUIVALENTS IN STUDY SITE KILLIFISH WHOLE BODY TISSUES FOR SAMPLE SITES 23/43, 15/35, AND 27/36
(using 1/2 of detection limit for non-detect data)
(parts per trillion, wet weight)

Constituent	a I-TEFs/89	b Site 23/43 Conc.	c Site 23/43 Tox. Equiv.	b Site 15/35 Conc.	c Site 15/35 Tox. Equiv.	b Site 27/36 Conc.	c Site 27/36 Tox. Equiv.

* Constituent not detected in this sample per Maxus report summary table 3-19 as updated by final data summary tables received from Environmental Standards Inc. Value given is 1/2 the detection limit.