Executive Summary

Passaic River Study Area
Preliminary Findings

Tierra Solutions, Inc.
East Brunswick, New Jersey

January 2003

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Introduction

Purpose

This Executive Summary presents preliminary findings and interpretations for Passaic River Study Area (Study Area) data collected to date. It is presented in response to the September 20, 2002 letter from Mr. George Pavlou (United States Environmental Protection Agency [USEPA]) to Mr. David Rabbe (Tierra Solutions, Inc. [Tierra]). Because the Study Area data are in the early stages of being assembled and evaluated as part of the site-specific Remedial Investigation (RI) Report, the preliminary findings and interpretations presented herein are considered "work in progress," and will continue to undergo rigorous assessment/refinement as the Study Area RI Report evolves.

The RI Report is being prepared pursuant to the Administrative Order on Consent (AOC), Index Number II – Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) 0117, dated April 20, 1994, between the USEPA and Occidental Chemical Corporation (OCC), in the matter of the Diamond Alkali Superfund Site. OCC undertook a remedial investigation/feasibility study (RI/FS) of the Study Area in accordance with the terms and provisions of the AOC. On behalf of OCC, as successor to Diamond Shamrock Chemicals Company, Tierra (formerly Chemical Land Holdings, Inc. [CLH]) is conducting this RI.

As indicated in the AOC Statement of Work (SOW), the RI is meant to fulfill the following three objectives:

- determine the horizontal and vertical distribution and concentration of polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), polychlorinated biphenyls (PCBs), polynuclear aromatic hydrocarbons (PAHs), pesticides, and metals in sediments from the Passaic River Study Area;
- determine the primary human and ecological receptors (endpoints) of PCDDs, PCDFs, PCBs, PAHs, pesticides, and metals-contaminated sediments in the Passaic River Study Area; and
- determine contaminated sediment transport within the boundaries of the Passaic River Study Area.

Consistent with these objectives, this Executive Summary contains a discussion of results for Study Area investigations since 1990, including:

- sediments;
- biota (tissue);
- biotic/ecological communities; and
- hydrodynamics/sediment transport.

The data assessed through this preliminary analysis have been generated by numerous investigatory programs, including those conducted by Tierra and various agencies. A complete listing of these programs is provided in Table 1.

The key preliminary findings are listed in the summary below. The remainder of this Executive Summary provides information to support such findings, and, in certain instances, provides more detailed observations where appropriate.

Summary of Key Preliminary Findings

Following are the key preliminary findings for each of the three AOC objectives listed above:

Objective 1: Determine horizontal and vertical distribution and concentration of PCDDs, PCDFs, PCBs, PAHs, pesticides, and metals in Study Area sediments

- Multiple chemicals were detected with high frequency in both surface and subsurface sediments throughout the Study Area.
- Multiple chemicals were detected at elevated concentrations in surface and subsurface sediments throughout the Study Area.
- For most chemicals, average River-wide subsurface (i.e., deeper than 0.5 feet [ft]) concentrations were greater than average surface concentrations.

Objective 2: Determine the primary human and ecological receptors of PCDDs, PCDFs, PCBs, PAHs, pesticides, and metals from contaminated sediments in the Study Area

- Human use (i.e., exposure) of the River is low.
- Primary human receptors include visitors to the River, scullers and boaters, anglers, industrial and construction workers, community volunteers, and homeless people.
- Primary ecological receptors include benthic invertebrates, fish/crab, and aquatic birds.
- Habitats and ecological communities in the Study Area are substantially limited due to historical physical alteration.
- Ecological communities in the Study Area are dominated by pollution-tolerant species.
- Multiple chemicals were detected at elevated concentrations in fish and crab tissue throughout the Study Area.

Objective 3: Determine contaminated sediment transport within the boundaries of the Study Area

- Higher chemical concentrations generally occur in subsurface sediments and were deposited during early industrial time periods.
- Bathymetric evidence (1949 through 1995) indicates continuing sedimentation in the Study Area.
- Since the mid-1950s, the Study Area has experienced an average net sedimentation rate of approximately 2 inches/year.
- Generally higher rates of deposition are evident in the lower reaches of the Study Area.
- Resuspension is limited and is generally confined to near-bottom water.

Site Setting/Background

Physical Setting

The Study Area consists of a 6-mile stretch of the lower Passaic River, and is primarily located in Newark, New Jersey (Figure 1). The Study Area spans five navigation reaches, as defined by the United States Army Corps of Engineers (USACE), including (upriver from mouth) Point No Point Reach, Harrison Reach, Newark Reach, Kearny Reach, and Arlington Reach.

A tributary to Newark Bay, the Passaic River drains a 935-square-mile watershed. The tidal portion of the Passaic River is part of the larger New York/New Jersey (NY/NJ) Harbor Estuary, one of the most densely populated coastal areas in the world.

Land use along the lower Passaic River, including within the Study Area, is dominated by high-density commercial and industrial/commercial development resulting in little or no public access to the River. The west/south bank of the Study Area is almost fully developed, consisting of active or abandoned commercial and industrial/commercial properties. Active or abandoned industrial properties and rail lines dominate the east/north bank of the Study Area for approximately 5 miles upstream from the Passaic River's confluence with Newark Bay. The final upstream mile of the Study Area is a mixture of industrial and commercial properties. A highly developed network of highways, combined sewer

overflows (CSOs), stormwater outfalls, and publicly owned treatment works (POTWs) also exist within the Study Area (Mueller et al., 1982). Riverbank parks located in Newark and Kearny are examples of the limited "green space" available within the Study Area.

Hydrology

The Passaic River consists of a freshwater regime upstream of Dundee Dam, and a saline tidal regime from Dundee Dam south to the River's confluence with Newark Bay that includes the Study Area. Based on data from the United States Geological Survey (USGS, 1989) and USACE (1987), the upstream Passaic River contributes the majority of freshwater inflow (approximately 1,200 cubic feet per second [cfs] on average) to the lower tidal portion of the River. Several tributaries (Third River, Saddle River, Second River, Frank's Creek, and Lawyers Creek) provide lesser amounts of freshwater inflow. In addition, urban runoff, including storm sewers and CSOs, provide flow to the River. According to Suszkowski (1978), the ungaged flow between Dundee Dam and Newark Bay is less than 10% of the total flow at the mouth of the Passaic River.

The lower Passaic River is influenced by semidiurnal tides. The mean tidal range at the New Jersey Turnpike Bridge (approximately 1.5 miles upstream from Newark Bay and within the Study Area) is 5.1 ft (National Oceanic and Atmospheric Administration [NOAA], 1972). Within the Study Area, the cross-sectional average river velocity due to freshwater flow is approximately 1 ft per second (fps), with a typical maximum tidal velocity of approximately 3 fps (USACE, 1987).

Hydrodynamics within portions of the Study Area are complex. Density stratification and estuarine nontidal residual circulation are characteristic of the lower Passaic River, causing currents near the bed to occasionally flow in the opposite direction of currents near the water surface for portions of the tidal cycle. Sediment inputs to the Study Area come from the upstream watershed and river system, CSOs and stormwater outfalls, as well as from Newark Bay. Differential flood tide and ebb tide velocities tend to result in net landward movement of bottom sediments in the downstream portion of the Study Area, contributing to long-term deposition. The lower Passaic River is dominated by sediment deposition as evidenced by historical bathymetric records and the historical need for periodic maintenance dredging of the navigational channel.

Geomorphology

In assessing the geomorphology of the Study Area, the impacts of natural and human actions are inseparable. A chronicle of many of the human alterations of the River basin and estuary by Iannuzzi et al. (2002) found that although human activity has drastically altered the River, the effects of these changes on depositional behavior have been offsetting in some cases and varied in time. The dominant geomorphic processes yield long-term net sedimentation in the Study Area. The most important of the human alterations are the extensive channel deepening by dredging (which enhances sedimentation) and the extensive filling and armoring of the channel shoreline (limiting both the further meander of the River and tidal mudflat formation).

Considering this, there are several important geomorphic processes in the Study Area, including:

- Enhanced deposition of suspended material occurs in the zone of minimum flow velocities where channel widening and deepening from dredging have slowed natural flow velocities.
- Net landward tidal transport of near-bottom suspended sediments at the river mouth during flood tide enhances long-term sediment accumulation and estuarine infilling.
- Enhanced deposition of fine suspended material occurs along the shore in the intertidal zone, leading to mudflat formation.
- Enhanced deposition of sediments occurs in secondary circulation areas, such as downstream and upstream of bridge piers and abutments (due to tidally reversing flows) and in nearshore areas

protected by variations in the shoreline. Flow velocities in these areas tend to be lower than in the main channel.

- Cohesive bed consolidation and bonding processes are important to long-term stability of fine-grained sediment beds and mudflats in the Study Area.

In general, the geomorphology of the Study Area fits the classical model of Atlantic coastal plain estuaries, which tend to experience long-term, permanent infilling due to retention of sediments from both fluvial and marine sources (see Meade, 1969).

Site History

During the past two centuries, the Study Area has been subject to multiple influences and changes, mainly due to rapidly expanding urban and industrial development in the region. These influences — in the form of habitat destruction, wetlands drainage, land alteration, garbage and sewage disposal, and releases of hazardous substances into the environment — have resulted in the dramatic degradation of the Passaic River and the Newark Bay area (Iannuzzi et al., 2002).

Degradation of water quality in the lower Passaic River, including the Study Area, first became apparent during the Civil War, and became a substantial problem during the period of increasing industrialization that followed (Brydon, 1974; Cunningham, 1966b). By the early twentieth century, Newark was the largest industrial-based city in the United States, with well-established industries such as petroleum refining, shipping, tanneries, creosote wood preservers, metal recyclers, and manufacturing of materials such as rubber, rope, textiles, paints and dyes, pharmaceuticals, raw chemicals, leather, and paper products (Meyers, 1945; Cunningham, 1954, 1966a; Brydon, 1974; Halle, 1984; MacRae's, 1986; Galishoff, 1988).

Hundreds of chemicals were released into the Passaic River during the latter half of the nineteenth century and throughout the twentieth century. In 1970, the USEPA declared the Passaic River the "second most polluted river in America," behind only the Cuyahoga, which actually caught fire in 1969 (Peet and Johnson, 1996). The growing population of Newark during the first half of the twentieth century also facilitated the generation of increasing volumes of human wastes, resulting in a characterization of the lower Passaic River as an "open sewer" (Suszkowski et al., 1990).

Considering this history, and in common with numerous industrialized waterways in the United States, sediments within the Study Area contain elevated concentrations of various hazardous substances including, but not limited to, arsenic, cadmium, copper, lead, mercury, nickel, zinc, bis(2-ethylhexyl)phthalate, PAHs, PCBs, dichlorodiphenyltrichloroethane (DDT), petroleum hydrocarbons, PCDDs/PCDFs, pesticides, and chlorinated herbicides and phenols (Bonnevie et al., 1992; Bonnevie et al., 1993; Gillis et al., 1993; Huntley et al., 1993; Wenning et al., 1993; Bonnevie et al., 1994; Wenning et al., 1994; Gillis et al., 1995; Huntley et al., 1995; Iannuzzi et al., 1995; Iannuzzi and Wenning, 1995; NOAA, 1995; Shear et al., 1996; Iannuzzi et al., 1997; Huntley et al., 1997).

The expansion of industry and population surrounding the Study Area also resulted in a severe loss of natural habitat for indigenous and migratory biota (Squires and Barclay, 1990; Crawford et al., 1994). Almost all of the wetlands adjoining the lower Passaic River (including those within the Study Area) have been eliminated, with more than 7,500 acres of wetlands lost since 1940. In total, more than 21,800 acres (or approximately 88%) of wetlands have been eliminated from the area covering the lower Passaic and Hackensack Rivers, and Newark Bay watersheds (Iannuzzi et al., 2002).

A decline in bird diversity in the area is attributed to the destruction of marshlands and other natural habitats from encroachment of human development and industrial activities on nesting and breeding grounds (Burger et al., 1993). Habitat for birds along the Study Area is currently limited to several mudflats with little or no associated vegetation and areas of narrow riparian weedlots. The majority of the

shoreline is unsuitable for birds and is dominated by bulkheads, rip-rap, buildings, parking lots, roads, and other structures (Ludwig and Iannuzzi, 2002).

Populations of fish and shellfish within the Study Area and surrounding area have been substantially reduced by over-harvesting, loss of habitat, and pollution (Mytelka et al., 1981; Esser, 1982; Franz, 1982). Tidal creeks and marshes provide vital habitat for resident and migratory fish (Kneib, 1997), and it is likely that wetland and tributary losses contributed greatly to the severe loss of fish in the latter half of the nineteenth century and the first half of the twentieth century (Iannuzzi et al., 2002).

Data Collection Activities

AOC Programs

Since 1995, Tierra has undertaken several data collection programs to meet the three AOC objectives (see Introduction), including those outlined in the Investigation Work Plan (IWP; CLH, 1995) and the Ecological Sampling Plan (ESP; CLH, 1999a).

The IWP was implemented between 1995 and 1996, and focused on obtaining field data to achieve Objectives 1 and 3. The program consisted of the following:

- sediment characterization (chemical);
- sediment characterization (radiochemical);
- sediment characterization (geotechnical); and
- sediment mobility modeling (consisting of several discrete activities, one of which included surface-water characterization).

An additional task of the IWP included preparation of a Screening Level Human and Ecological Risk Assessment (SLHERA; CLH, 1995), which represented an initial investigation into the adequacy of data available to achieve Objective 2. Upon completion of the SLHERA, it was determined that sufficient information was not available. Therefore, the ESP was designed to collect data to be used for the Human and Ecological Risk Assessment (HERA).

The ESP program was conducted between 1999 and 2001, and included:

- surface-water characterization (physicochemical parameters only);
- surface sediment sampling (chemistry and toxicity);
- caged bivalve investigation;
- biological tissue-residue sampling; and
- ecological habitat/community surveys.

The ESP Work Plan (CLH, 1999a) also required a Creel/Angler Survey. However, after the Creel/Angler Survey Work Plan (CLH, 1999b) was submitted, the USEPA disapproved it on April 27, 2000 (USEPA, 2000), declaring it was "...impossible to conduct a survey which will produce representative data..." (USEPA, 2000). Tierra met with the USEPA on May 23, 2000 to discuss the disapproval of the Creel/Angler Survey Work Plan. The USEPA would not reverse its determination, and Tierra notified the USEPA at the May 23, 2000 meeting, and again in a letter dated June 16, 2000, that due to the importance of obtaining site-specific angler and consumption data from the Study Area, Tierra was proceeding with the study on its own.

In the absence of the USEPA's approval of the Creel/Angler Survey and its oversight of the investigation, Tierra engaged an independent panel of experts in human health, creel and angler surveys, population statistics, and community health issues to ensure that the Creel/Angler Survey was conducted to the highest scientific standards. Under the oversight of this expert panel, Tierra conducted the Creel/Angler Survey as a supplemental investigation (see Supplemental Programs) to meet the objectives of:

- quantifying angling activity in the Study Area, including the size of the angler population, angling frequency, angling seasonality, and fish and crab consumption rates;
- characterizing the Study Area angler population that may be at risk by investigating angler characteristics and demographics, the potential for subsistence angling populations, and the potential for suppression of angling due to bans or advisories; and
- characterizing angling practices among persons living in the vicinity of the Study Area.

As a result of additional discussions, USEPA decided to "...consider a creel/angler survey report submitted by October 2001 as part of any risk assessment drafted for the Passaic River" (USEPA, 2001).

In addition, the ESP Work Plan (CLH, 1999a) included a CSO Investigation which has yet to be implemented on a full-scale basis. Given the potential nature and scope of this program, a dedicated work plan was developed following the implementation of a Trial Run Program, and submitted to the USEPA in May 2002. Because of this, the CSO Investigation is discussed separately (i.e., not as part of the ESP). The CSO sampling will be performed upon approval of the associated work plan, and will address the goals of:

- identifying the types and concentrations of chemicals that are discharged to the Study Area from active CSOs; and
- estimating CSO contributions of contamination in the Study Area under current and future conditions.

All of the IWP, ESP, Creel/Angler Survey, and CSO activities presented above are discussed further herein.

IWP

The IWP consisted of sediment coring within the Study Area along 26 transects spaced approximately 1,200 ft apart. Three core locations were established per transect (for a total of 78 cores), and were located along each transect at the left channel bed, right channel bed, and in the middle section (thalweg). Due to field obstructions, however, three of the 78 cores were collected as surface grabs.

To supplement the 78 core locations described above, 18 additional cores were obtained, producing a total of 96 cores (see Figure 2). Three of the additional cores were collected at Transect (-1) (approximately 2,500 ft downstream of the Study Area) for geotechnical purposes only, while the 15 remaining cores were collected within the Study Area (10 located by the USEPA [per the SOW], and five at the discretion of Tierra) for additional characterization of chemical, radiochemical, and geotechnical parameters (EA, 1995).

These cores were used as input for two major IWP components: sediment characterization (chemical, radiochemical, and geotechnical) and sediment mobility modeling. Other activities, including the collection of total suspended solids (TSS) samples, a bathymetric survey, erosion testing, and hydrodynamic characterization, were also used to support the sediment transport model.

Sediment Chemical Characterization

The objective of this phase was to chemically characterize sediments from the surface to the depth corresponding to the year 1940, the year the Diamond Alkali Facility began operation (CLH, 1995). The depth interval associated with each decade from 1940 to 1990 (along with others) was subsampled to chemically characterize the sediment within these decades. The maximum time-stratigraphic depth sampled was determined by reviewing historical radiochemical geochronology or historical bathymetric data. One sample representing the biologically active zone (BAZ) was also collected from each core at the sediment surface (i.e., to a depth of 0.5 ft).

As part of the chemical characterization activities, 552 samples (not including duplicates) were collected from 93 cores, and submitted for the following analyses: volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), including PAHs; pesticides/PCBs; herbicides; total petroleum hydrocarbons (TPH); total organic carbon (TOC); PCDDs/PCDFs; coplanar PCBs; metals; and cyanide.

Sediment Radiochemical Characterization

To support the determination of time-stratigraphic intervals and historical sedimentation rates, the radioisotopes for lead (^{210}Pb), cesium (^{137}Cs), and beryllium (^{7}Be) were measured in 90 sediment cores (for a total of 1,038 sediment samples) collected within the Study Area. For this study, transverse sections (0.1-ft thick) of each core were cut at intervals throughout their lengths.

Sediment Geotechnical Characterization

The IWP (CLH, 1995) specifies that the primary reason for collecting geotechnical data is to support the hydraulic and sediment mobility model analysis. Given this objective, the description of activities for sediment mobility modeling (below) provides the pertinent information related to all geotechnical data collection activities.

Sediment Mobility Modeling

The objective of the sediment mobility model is to determine contaminated sediment transport within the Study Area (USEPA, 1994). To meet this goal, the USEPA selected the TABS-2 (STUDH) modeling package as specified in the SOW. To verify and calibrate the model, several data collection activities were implemented, including those associated with sediment geotechnical and physical parameter analyses, sediment erodibility measurements, bathymetric measurements, and surface-water characterization. Each is briefly discussed below.

Geotechnical and Physical Analyses

Forty-five geotechnical cores were collected to characterize sediments for hydraulic and sediment mobility modeling. From the cores collected within the Study Area and at Transect (-1), 117 individual samples were analyzed for grain size, specific gravity, bulk (wet) density/dry density, Atterberg limits, water content, and consolidation. In addition, the following physical tests were performed, where possible: piezocone penetration tests (CPTs), vane shear tests, and pocket penetration tests. For these tests, 163 physical tests were conducted.

Erodibility Measurements

As part of the modeling effort, two types of erosion test apparatuses were used to estimate the erosion-related properties (i.e., critical shear stress with depth) of PRSA sediments: a rotating cylinder apparatus and the Sedflume testing apparatus. Due to problems with the rotating cylinder tests (shallow sediments could not be used), model inputs were generated through the Sedflume testing process.

Bathymetric Survey

A bathymetric survey was also performed to provide current bathymetric information, and to compare the current bathymetric data with previous bathymetric surveys. The 1995 survey covered the entire PRSA, and also extended approximately 2,100 ft downstream and approximately 6,600 ft upstream of the PRSA. Water-depth soundings were performed along 395 survey lines perpendicular to the riverbanks, spaced at approximately 100-ft intervals. Soundings were taken continuously along each survey line and recorded at approximately 2-ft intervals.

Surface-Water Characterization

For purposes of calibrating the sediment mobility model, Tierra conducted various surface water characterization activities within the Study Area. As part of this, 1,317 TSS samples were collected from eight transects during each of three rounds of sampling. In addition, physicochemical parameters, including temperature, pH, and conductivity depth profiles, were measured at the eight transect locations during the program to help assess stratification.

To continuously measure the direction and magnitude of the river current, as well as the variation in flow regime during data collection activities, three continuously recording current meters (with digital data loggers) were moored within the channel. The three mooring locations were selected prior to each survey, but generally were located near the upstream boundary of the Study Area, near the downstream boundary of the sediment transport modeling area, and at Transect 10, located within the Study Area. Current velocity profiles also were measured periodically across the River at the transect locations using an acoustic Doppler current profiler (ADCP). In addition, three tide gages were installed to monitor water levels and tide elevations. One tide gage was deployed at each of the following stations: Station 0+00 (Conrail Bridge), Station 120+00 (north bank of Passaic River), and Station 362+00 (railroad bridge at Rapp's Marina).

Finally, an attempt was made to sample bedload sediment transport. A sample was never collected, however, apparently because bedload sediment coarse enough to be caught in the sampler bag was not encountered during the sampling times.

ESP

Fifteen sampling stations were selected for the ESP. Two stations, each consisting of mudflats and shallow water areas comprising a discrete area along a bank of the River, were selected in each river mile within the Study Area (i.e., six strata, one for each river mile) for a total of 12 sampling stations. The sediment and biological sampling locations were randomly selected at each sampling station during each sampling event, thus achieving a stratified random sampling design (USEPA, 1992). In addition to these 12 sampling stations, three judgmental sampling stations were selected consistent with USEPA guidance (USEPA, 1988). Study Area sampling locations are shown on Figure 3.

The Mullica River, a tidal tributary to Great Bay in southern New Jersey, was selected by the USEPA as the reference area for the ESP (herein referred to as Reference Area). As indicated below, the Reference Area was used in the ESP for a limited number of the activities planned for the Study Area.

Each ESP activity is discussed below.

Surface-Water Characterization

Limited surface-water characterization was conducted to qualitatively evaluate the water quality of the Study Area relative to that of the rest of the NY/NJ Harbor Estuary, and other industrialized estuaries. Physicochemical parameters, including temperature, pH, salinity, dissolved oxygen (DO), and conductivity, were measured at each mudflat sampling station within the Study Area and the Reference Area at a minimum frequency of once per week during the caged bivalve investigation (August to September 1999), and three times during May 2000 for the Study Area sampling stations only.

Surface Sediment Characterization

The primary objective of the surface sediment characterization activities was to collect sediment chemical and toxicity data to evaluate relationships between surface sediment chemistry and the following biological measurement endpoints: benthic invertebrate mortality and community structure, and tissue-residue (i.e., bioaccumulation) analyses, when possible.

Within each mudflat station, three composite samples were collected in late summer/early fall 1999 in the Study Area and Reference Area. Each composite sample consisted of sediments from 10 discrete, randomly located samples. One composite sample was also collected at each station in the Study Area and Reference Area during spring 2000. Fifty-four composite sediment samples (45 Study Area, nine Reference Area samples) were collected during late summer/early fall 1999, and 18 composite sediment samples (15 Study Area, three Reference Area samples) were collected during spring 2000.

Composite sediment samples were analyzed for organotins, PAHs, PCDDs/PCDFs, coplanar PCBs, herbicides, PCB congeners, metals, PCB homologues, ammonia nitrogen, cyanide, pH, TOC, TPH, PCB/pesticides, percent moisture, water content, grain size, and SVOCs. In addition to the composite samples, one discrete sediment sample (corresponding to each composite) was collected for analysis of acid-volatile sulfide/simultaneously extractable metals (AVS/SEM).

Sediment Toxicity Testing

A portion of each of the 1999 composite surface sediment samples was used for bulk sediment toxicity testing to quantify the acute (lethal) and chronic (sublethal) toxicity to benthic invertebrates. A standardized 10-day static laboratory test with the infaunal marine/estuarine amphipod *Ampelisca abdita* was used to conduct the amphipod toxicity tests. A standardized 28-day static laboratory toxicity test was also performed to evaluate the effects of Study Area sediments on the survival and growth of polychaetes (*Neanthes arenaceodentata*).

Caged Bivalve Investigation

A caged bivalve investigation was conducted during late summer/early fall 1999 to qualitatively evaluate surface-water quality in the Study Area using the ribbed mussel *Geukensia demissus*. Twenty-five individuals were placed in each cage, and three replicate cages were deployed at each of the 15 Study Area and three Reference Area sampling stations for 28 days.

Bivalves were monitored each week for survival and growth, and dead individuals were culled from the cages. After the deployment period, the remaining bivalves were retrieved, and one whole-body (soft-tissue) sample was composited per station from the combination of the surviving bivalves from the three cages. Twenty-four bivalve samples were collected from the Study Area and the Reference Area. Tissue samples were analyzed for organotins, PAHs, PCDDs/PCDFs, coplanar PCBs, herbicides, PCB congeners, metals, PCB homologues, PCB/pesticides, percent moisture, percent lipid, and SVOCs.

Biological Tissue Sampling

The biological tissue sampling program was designed to provide data for the HERA to evaluate risks to ecological receptors and humans that may consume aquatic organisms from the Study Area. Biological tissue samples were collected in conjunction with the fish community surveys.

Three types of resident and/or migratory organisms were collected and analyzed: mummichog (*Fundulus heteroclitus*), blue crab (*Callinectes sapidus*), and other fish at the primary consumer (trophic) level or above. Fifty-six composite mummichog samples were collected from the Study Area and the Reference Area in late summer/early fall 1999, and seven mummichog samples were collected in spring 2000. Fifty-two crab tissue samples were collected from the Study Area and the Reference Area in the late summer/early fall 1999, and seven crab tissue samples were collected during spring 2000.

The target fish species (other than mummichog) to be sampled were chosen during the fish community survey and included striped bass (*Morone saxatilis*), white perch (*Morone americana*), and American eel (*Anguilla rostrata*) for both whole-body and edible-fillet samples. These species were collected in the Study Area during the late summer/early fall 1999 and/or spring 2000 sampling events. Atlantic menhaden, bluefish, and inland silverside were also sampled during the late summer/early fall 1999 and/or spring 2000 sampling events.

In the Study Area, 41 fish tissue samples were collected during late summer/early fall 1999, and 30 samples were collected during spring 2000. In addition, five fish tissue samples were collected from the Reference Area during late summer/early fall 1999. No fish tissue samples were collected from the Reference Area during spring 2000. Composite fish tissue samples were analyzed for organotins, PAHs,

PCDDs/PCDFs, coplanar PCBs, SVOCs, herbicides, PCB homologues, PCB/pesticides, metals, percent moisture, and percent lipid.

To supplement the samples described above, additional fish were targeted for collection from the Study Area in August 2001, including American eel *(Anguilla rostrata),* brown bullhead *(Ameiurus nebulosus),* and common carp *(Cyprinus carpio).* These species were selected based on the results of the Creel/Angler Survey described in the Supplemental Programs subsection, below. In all, six eel and six bullhead samples were obtained. Carp were not available at the time of sampling, and, therefore, carp samples were not obtained. All composite samples were analyzed for the same constituents listed above.

Ecological Habitat and Community Surveys

Ecological habitat characterization and community surveys (including the avian community, fish community, and benthic invertebrate surveys) were performed in the Study Area in 1999 and 2000. The overall objectives of these surveys were to:

- quantify the amount of available habitat present in the Study Area;
- qualitatively characterize the available habitats; and
- quantify and characterize, to the extent practicable, the presence and population structure of fish, birds, and other organisms that may inhabit the Study Area on a seasonal basis.

Visual habitat surveys were conducted during periods around low tide and high tide during both late summer/early fall 1999 and spring 2000. During each survey event, the entire shoreline of the Study Area was videotaped and photographed. Shoreline vegetation was documented, and detailed notes were taken regarding observations of wildlife or general ecology of the system.

Benthic Invertebrate Survey

Benthic invertebrate surveys were conducted during late summer/early fall 1999 and spring 2000 as part of the sediment characterization sampling. Triplicate (discrete) surface sediment grab samples were collected from the middle sediment sampling grid at each sampling station in the Study Area (15 stations/45 samples) and Reference Area (three stations/nine samples). The results of the benthic invertebrate surveys were quantitatively evaluated for species richness (total number of taxa), abundance (total number of organisms), and the relative abundance of pollution-tolerant species.

Fish Community Survey

The fish community survey was conducted primarily in subtidal (deep-water) areas of the Study Area and the Reference Area during late summer/early fall 1999 and spring 2000 to document the types of fish that use the Study Area seasonally. Captured fish were identified, weighed, measured (total length), and examined for gross pathological condition, including any abnormalities.

Avian Community Survey

A one-year avian community survey was conducted to document and quantify bird occurrence in, and use of, the Study Area daily and seasonally. Individual survey events were conducted during each of four seasons beginning in late summer/early fall 1999 and running through summer 2000.

During each survey event, birds were identified and counted along the entire stretch of the Study Area, and these identifications/counts were marked by specific locations on Study Area maps. The results of the bird survey were tabulated by event, day, and season, and analyzed by location in the Study Area and various habitat types.

CSO Sampling

Trial Run Program

Prior to developing a full-scale CSO sampling plan, Tierra conducted a Trial Run Program at the Saybrook Place CSO from December 1999 through March 2000 to evaluate two sampling methodologies for collecting settleable solids samples from CSOs (filtration versus sediment traps). Tierra also implemented a field reconnaissance of the 29 Study Area CSOs, the results of which are to be considered for the full-scale CSO investigation.

The Trial Run Program showed that solids obtained by filtering bulk CSO effluent produced a more representative sample than that obtained from the sediment traps. Results also indicated that the filtered solids contained a high moisture content, and that the filtering material created the potential for sample contamination. After considering several different drying/separation procedures, Tierra tested and retained continuous flow centrifugation as the preferred solids collection methodology, which is included as part of the full-scale program currently under USEPA's review (see discussion below).

The field reconnaissance consisted of obtaining pipe elevations, recording the condition of the CSOs, determining whether tidal intrusion into the CSOs is a regular occurrence or likely to happen, evaluating whether the CSOs could accommodate the proposed sampling activities, and evaluating the degree of difficulty in accessing and sampling the CSOs based upon local traffic conditions. All of this information will be considered, as appropriate, for the full-scale program.

The Trial Run Program results were documented in the *June 2000 Summary of CSO Trial Run Program and Full-Scale Recommendations Report* (CLH, 2000).

Full-Scale Program

In May 2002, Tierra submitted to the Agency the *Passaic River Study Area Combined Sewer Overflow Investigation Work Plan/Field Sampling Plan* (CSO WP/FSP) (Volume 1) for implementation of a full-scale CSO sampling program, along with a CSO Quality Assurance Project Plan (RI-CSO QAPP) (Volumes 2 and 3) (Tierra, 2002). The CSO WP/FSP and QAPP contained the necessary protocols, standard operating procedures (SOPs), tables, and figures required to complete a full-scale CSO investigation within the Study Area.

The full-scale CSO sampling strategy was developed in part using the results generated during Tierra's 1999/2000 Trial Run Program described above. In addition, and as requested by the USEPA, Tierra expanded its full-scale target analyte list to incorporate constituents assessed under the NY/NJ Harbor Estuary Program (HEP) Contaminant Assessment and Reduction Program (CARP).

At this time, Tierra anticipates sampling up to 29 CSOs under various weather conditions. However, a second preliminary field assessment (to be conducted prior to the full-scale program), along with input from the Passaic Valley Sewerage Commissioners (PVSC), will help to better define the actual nature and scope of the sampling efforts.

To date, formal approval of this plan has not been provided by the USEPA and, as such, full-scale field activities have not been implemented.

Supplemental Programs

Creel/Angler Survey

From August 1, 2000 through July 31, 2001, Tierra conducted a Creel/Angler Survey on the Passaic River. The area for this survey covers the same section of River as the Study Area, from a point just

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Table 1

Study Area Executive Summary
January 2003

Study Area Investigatory Programs Used for Data Interpretation

Year	Sampling Event Description	Sponsor	Validation Status
1990	Surficial Sediment Investigation	Tierra	Unvalidated
1991	Core Sediment Investigation	Tierra	Partial Validation (10% validation of all analytical data; 15% validation of SVOC data; 100% validation of one SDG); QC review for remainder
1992	Core Sediment Investigation	Tierra	Partial Validation (10% validation of all analytical data; 15% validation of SVOC data; 100% validation of one SDG); QC review for remainder
1993	Sediment Toxicity Evaluation	NOAA	Status Unknown
1993	Core Sediment Investigation (March 1993)	Tierra	Unvalidated – QC review of data
1993	Core Sediment Investigation (July 1993)	Tierra	Unvalidated – QC review of data
1993	Surficial Sediment Program	USEPA	Unvalidated
1994	R-EMAP Study	USEPA	Status Unknown
1994	Surficial Sediment Investigation	Tierra	Unvalidated – QC review of data
1994	Evaluation of Aquatic and Terrestrial Habitats	Tierra	NA
1994	Finfish and Benthic Invertebrate Survey	Tierra	NA
1995	Biological Sampling Program	Tierra	Full Validation
1995	RI Sampling Program	Tierra	Full Validation
1995	Sediment Grab Sampling Program	Tierra	Full Validation
1995	USACE Minish Park Investigation	USACE	Unvalidated
1997	Outfall Sampling Program	Tierra	Unvalidated
1999	Drift Removal Program	Tierra	Full Validation
1999	Late Summer/Early Fall ESP Sampling Program	Tierra	Full Validation
1999	Sediment Sampling Program	Tierra	Unvalidated
1999/ 2000	Minish Park Monitoring Program	Tierra	Method Compliance Review
2000/ 2001	Creel/Angler Survey	Tierra	NA
2000	Spring ESP Sampling Program	Tierra	Full Validation
2001	Supplemental ESP Biota Sampling Program	Tierra	Full Validation

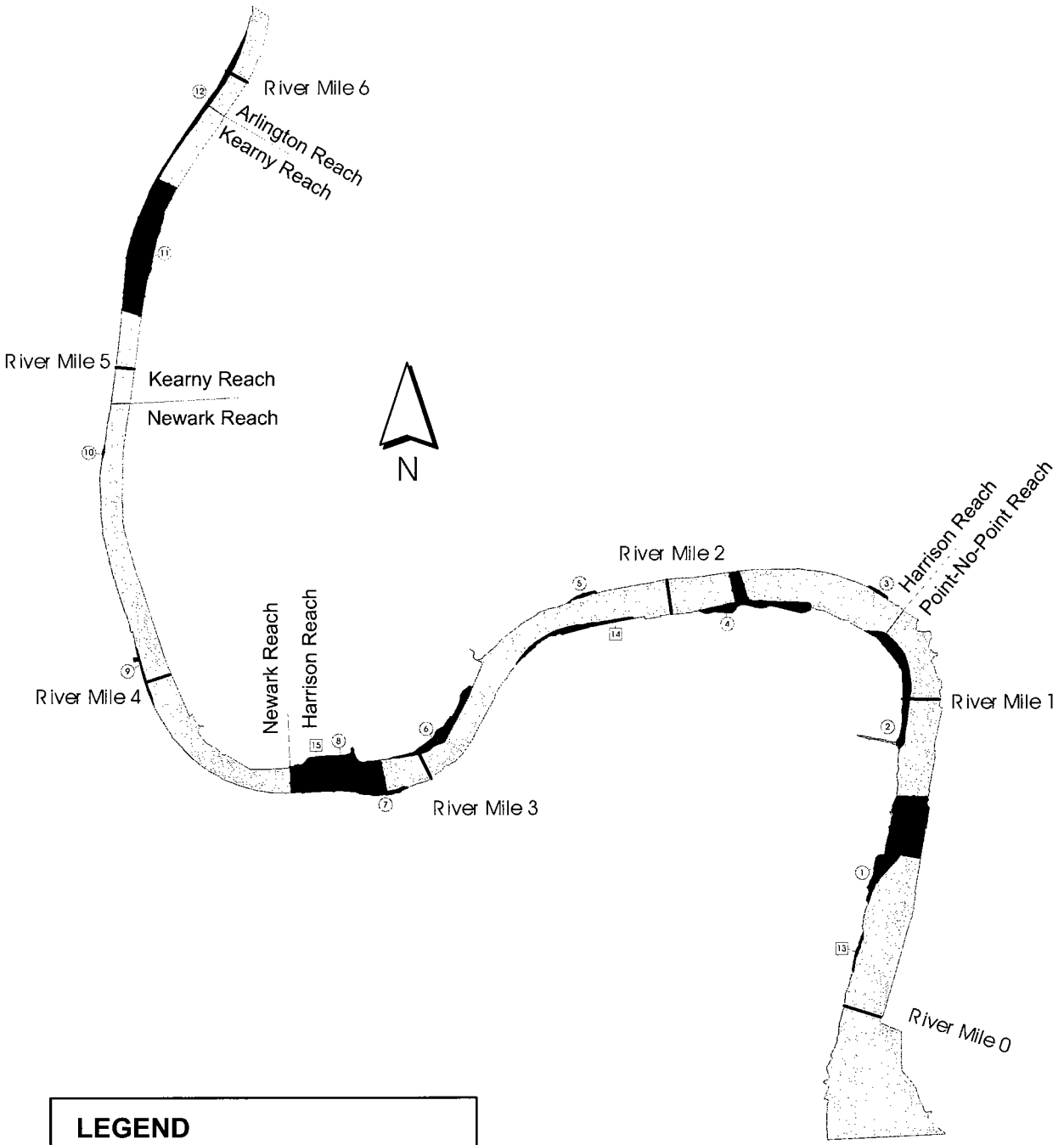
Table 2

Study Area Executive Summary
January 2003

Horizontal Distribution: Comparison of Mean Detections by Reach for 1995 RI-IWP and 1999/2000 ESP Sampling Programs

Constituent (units)	Depth	Kearny Reach	Newark Reach	Harrison Reach	Point-No-Point Reach
2,3,7,8-TCDD (ug/kg)	Surficial (0 - 0.5')	0.874	0.404		0.285
	Subsurface (> 0.5')	4.51	3.62		1.85
Mercury (mg/kg)	Surficial (0 - 0.5')	2.62	2.56	3.25	
	Subsurface (> 0.5')	6.65	5.1		7.87
Total PCBs as Aroclors (ug/kg)	Surficial (0 - 0.5')		1,170	1,370	1,200
	Subsurface (> 0.5')		3,220	3,550	3,360
Total PAHs (ug/kg)	Surficial (0 - 0.5')	29,100		35,600	21,000
	Subsurface (> 0.5')	34,400		39,200	24,000

Notes:
1. "Mean Detection" calculated as arithmetic mean of detected concentrations.
2. Total PCBs Aroclors calculated as the sum of detected Aroclors.
3. Orange highlighting indicates the reach with the highest mean in the PRSA for that constituent and depth.
4. Yellow highlighting indicates the reach with the second highest mean in the PRSA for that constituent and depth.



TIERRA SOLUTIONS, INC.

PASSAIC RIVER STUDY AREA
EXECUTIVE SUMMARY

ESP STUDY AREA SAMPLING LOCATIONS

BBL® BLASLAND, BOUCK & LEE, INC. engineers & scientists

FIGURE 3

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