Lower Passaic River Restoration Project

Draft

Field Sampling Plan

Volume 2

In partnership with

June 2006

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Draft

Field Sampling Plan
Volume 2

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FIELD SAMPLING PLAN, VOLUME 2

LOWER PASSAIC RIVER RESTORATION PROJECT

Prepared by:

Malcolm Pirnie, Inc. in conjunction
with EarthTech, Inc. and Battelle

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LOWER PASSAIC RIVER RESTORATION PROJECT

DRAFT FIELD SAMPLING PLAN, VOLUME 2

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1.0 INTRODUCTION

The Field Sampling Plan (FSP) for the Lower Passaic River Restoration Project is a three-volume document that presents the technical approach for conducting site characterization activities for the Lower Passaic River Study Area (refer to Section 1.2 "Site Background" for definition of the Study Area). FSP Volume 2 (this document) addresses the following tasks:

- Reference site selection process.
- Habitat delineation (including wetlands delineation).
- Terrestrial vegetation survey.
- Avian community survey.
- Aquatic vegetation survey.
- Fish community survey.
- Benthic invertebrate (including shellfish) community survey.
- Biological tissue-residue sampling.
- Toxicity testing.
- Resource agency coordination for the presence of threatened and endangered species.
- Literature review to support food web model development, to determine if pathogens are impacting water quality, and to evaluate biota consumption rates.

FSP Volume 2 was developed to collect ecological and biological data to satisfy requirements for evaluation of restoration options and components of the human health risk assessment and the ecological risk assessment. These data collection efforts are designed to achieve the data quality objectives (DQOs) and address the ecological functional assessment metrics, which are presented in Section 4.0 "Data Quality Objectives and Ecological Functional Assessment Metrics." The DQOs were developed to answer the fundamental study questions provided in Attachment 1 of the Quality Assurance Project Plan [QAPP (Malcolm Pirnie, Inc., 2005a)]. These fundamental study

questions address goals that are associated with various authorities applicable to the study, including the Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA (USEPA, 1988)], Water Resources Development Act (WRDA), and Natural Resource Damage Assessment (NRDA).

1.1. FIELD SAMPLING OBJECTIVES

The objectives of the FSP documents (Volumes 1 through 3) are to:

- Characterize contaminant sources and evaluate nature and extent of contamination.
- Evaluate hydrodynamics, sediment transport and stability, and biotic processes to assess the fate and transport of contaminants in sediments, water, and biota.
- Evaluate exposure pathways and receptors for the human health risk assessment and the ecological risk assessment.
- Characterize the existing conditions of the ecosystem and ecological communities to evaluate restoration sites based on the ecological functional assessment metrics and assess injury to natural resources.
- Share pertinent data collected in support of restoration actions with NRDA data users.

To date, numerous investigations, including environmental sampling, have been conducted in the Lower Passaic River by various entities having differing objectives. Consequently, available information continues to be compiled and evaluated in preparation of the FSP documents. (Historical biological and ecological data relevant to FSP Volume 2 activities are summarized in Section 3.1 "Available Data and Data Gaps.") The content of each volume of the FSP is described below:

Volume 1: FSP Volume 1 (Malcolm Pirnie, Inc., 2006) addresses the investigation of sediment and surface water quality in the Lower Passaic River and in major tributaries. These investigations are being conducted to obtain chemical and physical data necessary to evaluate the nature and spatial extent of contamination, to support human health and ecological risk assessments, and to characterize contaminant fate and transport within the

system (including measuring hydrodynamic and sediment transport characteristics of the Lower Passaic River and major tributaries).

Volume 2: FSP Volume 2 (this document) pertains to the study of biota and ecological aspects of the Lower Passaic River and its riparian corridor (but not the floodplains). Investigation of other areas of the Lower Passaic River, including major and minor tributaries and upland sites, will be addressed in supplemental field sampling plans once potential restoration areas are prioritized (refer to Section 1.4 "Potential Restoration Areas"). Investigations include inventorying and cataloging the species found within and around the Lower Passaic River, obtaining tissue samples to determine contaminant concentrations, and characterizing the condition or "health" of the various ecological communities.

Volume 3: FSP Volume 3 (Malcolm Pirnie, Inc., 2005b) addresses additional non-biological investigations at potential restoration areas, upland areas, and wetland areas in the Study Area (refer to Section 1.2 "Site Background" for definition of Study Area"). FSP Volume 3 also includes the 17-mile bathymetric survey of the Lower Passaic River conducted in 2004 (USACE, 2004) and the geophysical surveys conducted in spring 2005.

1.2. SITE BACKGROUND

The Lower Passaic River Restoration Project (herein referred to as the Study) is an interagency effort to remediate and restore the complex ecosystem of the Lower Passaic River, which is a 17-mile tidally influenced river located in northern New Jersey. The Study Area (118 miles^2) is defined as the Lower Passaic River and its basin, which comprises the tidally influenced portion of the river from the Dundee Dam [River Mile (RM) 17.4] to Newark Bay, and the watershed of this river portion, including the Saddle River, Second River, and Third River (Figure 1-1). The Study Area does not include the watershed upriver of the dam or the portion of the watershed that is located in the State of New York.

The U.S. Environmental Protection Agency (USEPA), U.S. Army Corps of Engineers (USACE), and New Jersey Department of Transportation – Office of Maritime Resources (NJDOT-OMR) have partnered to bring together the authorities of CERCLA and WRDA to produce a comprehensive restoration study of the Lower Passaic River and its tributaries. The Study is an integrated, joint effort among the partner agencies to examine the ecosystem problems within the watershed and to identify remediation and restoration options to address these problems. The partner agencies are also working with the federal and state Trustee agencies, including the National Oceanic and Atmospheric Administration (NOAA), U.S. Fish and Wildlife Services (USFWS), and New Jersey Department of Environmental Protection (NJDEP), so that natural resource injuries are addressed in this comprehensive plan. The scope of the Study is to gather data needed to make decisions on:

- Remediating contamination in the river to reduce human health and ecological risks.
- Improving the water quality of the river.
- Improving and creating aquatic habitat.
- Reducing contaminant loading in the Lower Passaic River and the New York/New Jersey Harbor Estuary.

USEPA initiated work on the project using funds from the federal Superfund program. USEPA has also signed an agreement with over 30 private companies (Cooperating Parties) for them to fund the Superfund portion of the project. Congress provides the USACE-New York District with funds for WRDA study elements in its annual Energy and Water Development Appropriations Act. NJDOT-OMR is utilizing funds from the New York/New Jersey Joint Dredging Plan and the Transportation Trust Fund to fulfill its contribution as local sponsor. As part of the project, the partnership will examine the best authorities to implement and fund the recommendations.

1.3. CONCEPTUAL SITE MODEL

An initial conceptual site model (CSM) for the Study and the methods associated with updating this CSM were developed during preparation of the Work Plan [Attachment A of the Work Plan (Malcolm Pirnie, Inc., 2005c)]. The CSM addresses the assumed sources of contaminants, routes of environmental transport, contaminated media, and routes of exposure.

The ecological component of this CSM was enhanced during the current evaluation of existing biological and ecological data, which is presented in Section 3.0 "Field Task Status." In turn, this enhanced CSM has guided the development of the FSP Volume 2 sampling programs. For purposes of the Study, the CSM divides the Lower Passaic River into 3 river sections based upon the location of the salt wedge, which is defined as the interface between the freshwater flowing downriver and the brackish waters derived from Newark Bay (Malcolm Pirnie, Inc., 2005c). The predominant location of the salt wedge within the river defines the Transitional River Section, while the Freshwater and Brackish River Sections are located above and below the salt wedge, respectively. The Transitional River Section is anticipated to extend several miles in length since the incursion of the salt wedge into the river will depend on a variety of environmental factors including tides, seasonal effects on temperature, wind direction, and recent precipitation.

1.3.1. Preliminary Boundaries of River Sections

To address the distinctions needed for sampling program development, an initial attempt was made to further characterize the above listed River Sections by defining preliminary boundaries using available salinity data. The preliminary boundaries of the Transitional River Section have been defined between RM 6.0 and RM 9.0, and the Brackish and Freshwater River Sections are defined as occurring between RM 0 and RM 6.0 and between RM 9.0 and RM 17.4, respectively (Figure 1-1). Note that these boundaries are preliminary and are based on limited salinity data; additional salinity data are warranted

to formally define the migration of the salt wedge in the Lower Passaic River. Salinity data were collected from 8 mooring stations between RM 1.0 and RM 10.0 by Malcolm Pirnie, Inc. and Rutgers University. Salinity data reported by Malcolm Pirnie, Inc. were collected from December 15, 2004 to February 21, 2005; Rutgers University's salinity data were collected from July 8 to September 10, 2004 and November 20, 2004 to January 25, 2005 (Figure 1-2).

The Rutgers University data suggest that river salinity was either mesohaline [5-18 parts per thousand, or "per mil" (‰)] or polyhaline (18-30 ‰) downriver of RM 5.3 (Figure 1-2a and 1-2b), representing brackish river conditions during December 2004 to January 2005. During the same time period, the salt wedge was located between RM 5.3 and RM 6.7. This characterization is indicated by the presence of oligohaline (0.5-5.0 ‰) conditions at RM 5.3 and freshwater conditions (less than 0.5 ‰) at RM 6.7 (Figure 1-2c). The location of the salt wedge between RM 5.0 and RM 6.0 is also consistent with data collected during the winter months by Malcolm Pirnie, Inc. These data indicate that the salinities at the RM 8.5 and RM 10.0 stations were less than 0.5 ‰ (indicative of freshwater; Figure 1-2d). The presence of freshwater at these 2 sampling locations indicates that the salt wedge was consistently located downriver of RM 8.5 during these winter months. Furthermore, the salinity measurements observed at RM 8.5 and RM 10.0 are similar in magnitude to readings of 0-0.4 ‰ observed at the U.S. Geological Survey (USGS) gauge at Little Falls, New Jersey, located upriver of the Dundee Dam (Figure 1-2e).

In contrast, during the summer months, the salt wedge appears to extend farther upriver. For example, data collected between July 8, 2004 and September 10, 2004 at RM 8.0 shows that river salinity was consistently at least oligohaline and was regularly mesohaline (Figure 1-2f; upper right-hand graph). These data indicate that the salt wedge is upriver of RM 8.0, and likely extending at least to RM 9.0. The upriver incursion of the salt wedge is likely due to low freshwater flow in the Lower Passaic River, which

may be caused by summer droughts and high rates of evapotranspiration in the surrounding watershed. Hence, the preliminary boundaries of the Transitional River Section have been defined to encompass the seasonal variation in the upriver range of the salt wedge location between RM 6.0 and RM 9.0. The Brackish and Freshwater River Sections are then defined as occurring between RM 0 and RM 6.0 and between RM 9.0 and RM 17.4, respectively.

1.3.2. Preliminary Habitat Characterization of River Sections

To further characterize these River Sections, shoreline conditions and surrounding habitats were summarized using photographs that were collected during field reconnaissance activities [refer to the *Draft Restoration Opportunities Report* (Earth Tech, Inc. and Malcolm Pirnie, Inc., 2005)]. Selected photographs are presented in Figures 1-3a through 1-3e. The shoreline and land use conditions vary considerably between the Brackish, Transitional, and Freshwater River Sections. The Brackish River Section is characterized by industrial and urban lands, typically with hardened shorelines comprised of bulkheads or riprap (Figure 1-3a and Figure 1-3b). The Transitional River Section is largely surrounded by residential communities; accordingly, the river shoreline in this area typically features natural riverine vegetation (Figure 1-3c). The Freshwater River Section is the least industrialized of the three river sections and features the lowest density of development. This section is also characterized by shorelines with natural vegetation communities, often with overhanging tree canopies (Figure 1-3d). In the Freshwater River Section, the river gradually transitions from a wide, slowly-flowing river in the lower portion of the Section (RM 9.5 to RM 15.9) to a narrower and swiftly-flowing stream above RM 16.6, with a substrate composed of rock and coarse gravel (Figure 1-3e).

To supplement the photolog of shoreline conditions and surrounding habitat, sediment texture data [as interpolated using side-scan sonar images (Aqua Survey, Inc., 2005a)] was used preliminarily in describing the subtidal habitat in the Lower Passaic River. (Refer to the map book presented in Figure 1-4, which shows one river-mile per plate.)

Throughout much of the Brackish and Transitional Sections (*i.e.*, RM 0 to RM 8.0) the river substrate is dominated by silts with some larger-grained sands located only on the river banks (Figure 1-4a to Figure 1-4h). Farther upriver, between RM 8.0 and RM 11.0, an increased abundance of sands, interspersed with large patches of silts, was observed (Figure 1-4i to Figure 1-4k). Upriver of RM 11.0 and throughout the remainder of the Freshwater River Section, the river sediments are dominated by sands and gravel with large areas of rock and coarse gravel observed on the river margins (Figure 1-4l to Figure 1-4r).

1.4. POTENTIAL RESTORATION AREAS

The field sampling activities discussed in FSP Volume 2 are designed, in part, to characterize potential restoration areas. Programs in FSP Volume 1 (Malcolm Pirnie, Inc., 2006) and FSP Volume 3 (Malcolm Pirnie, Inc., 2005b) may be extended in the future to support this characterization, as appropriate. Some potential restoration areas are described in the *Draft Restoration Opportunities Report* (Earth Tech, Inc. and Malcolm Pirnie, Inc., 2005) and include:

- Brackish River Section, Transitional River Section, and Freshwater River Section, representing subtidal, intertidal, and riparian areas in and along the river (but not the floodplains).
- Large contiguous sites adjacent to the Study Area, including Oak Island Yards in Newark, New Jersey, and Kearny Point in Kearny, New Jersey.
- Main tributaries of the Lower Passaic River, including Second River, Third River, and Saddle River.

Note that additional restoration sites can be nominated by the public and other stakeholders throughout the course of the Study. The natural resource trustees will be seeking other restoration sites within or outside the Lower Passaic River watershed, including areas in the Newark Bay Complex, to restore services that have been lost as a result of site-related contamination [refer to the *Draft Restoration Opportunities Report*

(Earth Tech, Inc. and Malcolm Pirnie, Inc., 2005)]. The potential restoration areas discussed in FSP Volume 2 are limited to those areas located within the Lower Passaic River and its riparian corridor (but not the floodplains). As other potential restoration areas become prioritized (including major and minor tributaries), FSP Volume 2 will be amended to include sampling plans appropriate for those additional areas.

1.5. OVERVIEW OF FSP VOLUME 2

FSP Volume 2 includes the biological and ecological sampling programs necessary to collect appropriate data to satisfy the DQOs and environmental functional assessment metrics for the Study, specifically centering on the main stem of the Lower Passaic River and associated riparian areas (but not the floodplains). Sampling programs for specific investigation elements are presented and discussed in Sections 5.0 through 14.0 of the document. Each program is accompanied by the DQO questions that it satisfies (refer to Section 4.0 "Data Quality Objectives and Environmental Functional Assessment Metrics). Sampling programs are also designed to address the following task identifier and individual subtasks that are listed in the Project Management Plan (PMP; USACE *et al.*, 2003):

- JDE: Environmental Resource Inventory Report (including JDEB: Assess Human and Ecological Risk).
- JDF: Mitigation Analysis Report.
- JDG: Endangered Species Analysis.
- JDN: Other Environmental Documents.
- JFBDC: Investigate and Define Study Area Physical and Biological Characteristics.

FSP Volume 2 investigations are anticipated to commence in fall 2006 or spring 2007. Table 1-1 outlines the 9 sampling programs and provides the anticipated sampling schedule.

Table 1-1: FSP Volume 2 Sampling Programs and Anticipated Schedule

Sampling Programs	Program Duration	Sampling Frequency	Schedule
Reference Site Selection	Growing Season	1 event	May – September 2007 [a]
Habitat Delineation	Growing Season	1 event	May – September 2007
Terrestrial Vegetation Survey	Growing Season	1 event	May – September 2007
Avian Community Survey	1 year	4 events	Every 3 months starting September 2006
Aquatic Vegetation Survey	Growing Season	1 event	August – September 2007
Fish Community Survey	1 year	6 events	Every 2 months starting September 2006
Benthic Invertebrate Survey [b]	1 year	4 events	Every 3 months starting September 2006
Biological Tissue-Reside Survey	Growing Season	2 events	April – May 2007 [c] August – September 2007 [d]
Toxicity Testing	Growing Season	1 event	May – September 2007

a: Schedule considers the reference site selection process only (not sampling).
b: Sampling of blue crab will not occur in the winter months.
c: Sampling of gravid females only.
d: Sampling of other target species.

FSP Volume 2 discusses a review of existing data and describes planned field programs based on the DQOs provided in Section 4.0 "Data Quality Objectives and Ecological Functional Assessment Metrics." Each sampling program contains a discussion of rationale, outlines the sampling methodology, and presents proposed sampling locations. Corresponding geographical coordinates for these proposed sampling locations are provided where appropriate, but these locations have not been verified via field reconnaissance. Therefore, professional judgment may be required to identify alternate locations (*e.g.*, locations with similar bathymetry) in instances where field conditions may prevent the collection of a planned sample. Coordinates have not been included in this draft document for cases where field reconnaissance was considered essential to sampling location selection by the sampling program designer.

2.0 GENERAL FIELD REQUIREMENTS

2.1. SITE FACILITIES

The field office/sample processing facility and staging areas are located at a waterfront industrial park in East Rutherford at 1 Madison Street. This space is an 8,700 feet^2 facility containing a 7,200 feet^2 open warehouse with 20-foot ceilings, 2 roll-up loading dock doors, and an office area that is approximately 1,500 feet^2. The space is located about 200 yards from the east bank of the Lower Passaic River at approximately RM 13.5. This facility is equipped with an investigation derived waste (IDW) storage facility, work stations, laboratory benches, and office equipment. The USEPA, USACE-New York District, and NJDOT-OMR have agreed that leasing this facility is acceptable to their respective agencies.

The owner of the industrial park (the Lessor) has riparian rights and is responsible for maintaining the bulkhead along the Lower Passaic River. The lease contains a written provision giving Malcolm Pirnie, Inc. (the Lessee) permission to install a floating dock against the bulkhead. NJDEP has issued the necessary permits and licenses for the installation of the floating dock within the Lower Passaic River. The dock is currently being stored at the supplier's location (Bristol Industries; Bristol, Pennsylvania) and will be installed once Malcolm Pirnie, Inc. receives notification from the USEPA and USACE – Kansas City District to proceed.

2.2. HEALTH AND SAFETY

Field tasks must be conducted in accordance with a site-specific Health and Safety Plan (HASP). The HASP (Malcolm Pirnie, Inc., 2005d) developed for FSP Volume 1 will require an update or addendum to support the FSP Volume 2 sampling programs. Pertinent guidance documents for a revised HASP include:

- Occupational Safety and Health Administration (OSHA) requirements contained in 29 Code of Federal Regulations (CFR) 1910 including the final rule contained in 29 CFR 1910.120.
- *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*, which was prepared jointly by the National Institute for Occupational Safety and Health (NIOSH), OSHA, U.S. Coast Guard (USCG), and USEPA (NIOSH *et al.*, 1985).
- USACE's Safety and Health Requirements Manual, Engineering Manual (EM) 385-1-1 (USACE, 2003).

2.3. STANDARD OPERATING PROCEDURES

Standard Operating Procedures (SOPs) have been developed as required over the course of the Study. SOPs 1 through 3 are presented in the QAPP (Malcolm Pirnie, Inc. 2005a) and SOPs 4 through 24 are presented in FSP Volume 1 (Malcolm Pirnie, Inc. 2005b). SOPs specifically associated with FSP Volume 2 are listed below and provided in Attachment A. [For convenience, SOPs from FSP Volume 1 (Malcolm Pirnie, Inc., 2006) and the QAPP (Malcolm Pirnie, Inc., 2005a) that are referenced in the FSP Volume 2 sampling programs are also provided in Attachment A.]

- SOP 25: Decontamination of Biological Sampling Equipment.
- SOP 26: Habitat and Vegetation Characterization.
- SOP 27: Avian Survey.
- SOP 28: Belted Kingfisher Field Monitoring.
- SOP 29: Fish Surveys, Collection, and Tissue Sampling.
- SOP 30: Benthic Invertebrate Community Survey and Sampling.
- SOP 31: Crab Collection and Tissue Sampling.
- SOP 32: Field and Laboratory Processing of Fish and Invertebrate Tissue.
- SOP 33: Measuring Sediment Contaminant Toxicity with Invertebrates.
- SOP 34: Collection and Processing of Sediment Grab Samples.

The SOPs listed above were either developed to satisfy specific FSP Volume 2 data needs, or they were adapted from existing SOP documents. SOP 26: Habitat and Vegetation Characterization and SOP 27: Avian Survey were adapted from procedures outlined in the 1999 Tierra Solutions Inc. (TSI) *Ecological Sampling Plan* (TSI, 1999) to provide additional survey detail. SOP 28: Belted Kingfisher Field Monitoring is based on the methodology established by the NJDOT-OMR for the preliminary 2006 program for monitoring the belted kingfisher (*Ceryle alcyon)* population. SOP 29: Fish Surveys, Collection, and Tissue Sampling; SOP 30: Benthic Invertebrate Community Survey and Sampling; and SOP 31: Crab Collection and Tissue Sampling are based on the methodology established in the 1999 *Ecological Sampling Plan* (TSI, 1999).

2.4. EQUIPMENT DECONTAMINATION

SOP 6: Decontamination of Soil Sampling Equipment and SOP 7: Decontamination of Water Sampling Equipment are provided in FSP Volume 1 (Malcolm Pirnie, Inc., 2006); these SOPs address the decontamination procedure for tools and equipment used for soil/sediment and water sampling. Decontamination of biological equipment and tools will follow either SOP 25: Decontamination of Biological Sampling Equipment or the decontamination procedure outlined in the respective sampling program SOPs.

2.5. SAMPLE MANAGEMENT AND PRESERVATION

The current QAPP for the Study does not address all FSP Volume 2 sampling programs and will require an update prior to FSP Volume 2 implementation. USEPA Contract Laboratory Program (CLP) laboratories may be used for certain sample analyses, as appropriate, should Malcolm Pirnie, Inc. be authorized to proceed with FSP Volume 2 activities. However, if the Cooperating Parties perform the sampling programs, then subcontracted (non-CLP) laboratories may be used.

Sample management will comply with *Contract Laboratory Program Guidance for Field Samplers* (USEPA, 2004a) and will follow guidance provided in SOP 1: Procedure to Conduct Sample Management for CLP and non-CLP Samples, which is provided in the

QAPP (Malcolm Pirnie, Inc., 2005a). Collected samples will be preserved in accordance with SOP 2: Procedure to Conduct Sample Preservation or specific preservation procedures outlined in the respective sampling program SOPs.

The management and disposal of IDW will follow SOP 22: Management and Disposal of Investigation Derived Waste provided in FSP Volume 1 (Malcolm Pirnie, Inc., 2006). This SOP describes the methods used to manage, store, and dispose of IDW produced during environmental sampling. The procedures specifically address waste generated from collection of sediment, soil, and water samples and equipment decontamination. Disposal of biological (non-medical) IDW (*i.e.*, animal or fish carcasses) generated during the FSP Volume 2 sampling programs will follow the general solid waste management procedures discussed in SOP 22: Management and Disposal of Investigation Derived Waste.

3.0 FIELD TASK STATUS

To focus the FSP Volume 2 sampling programs, available historical data were evaluated to identify data gaps. FSP Volume 2 tasks were organized and conducted to complement the historical data and fill in data gaps. Historical data reviewed included: habitat surveys, terrestrial and aquatic vegetation surveys, a terrestrial fauna community survey, benthic invertebrate community surveys, fish and aquatic vegetation surveys, biological tissue-residue sampling, toxicity testing, and caged-bivalve studies. These historical data include data collected, submitted, and made available by TSI and their consultants. While the corresponding planning documents were reviewed and approved by the USEPA (except for the 2000-2001 TSI creel/angler survey), the data were not compiled into a final report for formal interagency review.

Historical data are not organized relative to the Brackish, Transitional, and Freshwater River Sections as described in Section 1.3.1 "Preliminary Boundaries of River Sections" since these boundaries are unique to this current Study. Instead, the historical data tend to be grouped into areas located inside and outside the historical Superfund area, or the Passaic River Study Area, which is situated between RM 1.0 and RM 7.0 in the Study Area as identified in Section 1.2 "Site Background." Since the RM 1.0 to RM 7.0 area encompasses parts of the Brackish River Section and Transitional River Section, historical data in Section 3.1 "Available Data and Data Gaps" is referenced according to river mile instead of river section to minimize confusion.

In addition to these historical data sets, three field investigations have been completed (or are currently in progress) as part of the restoration activities for the Study. These investigations (described in Section 3.2 "Field Tasks Completed") include sediment profile imaging (SPI) of the benthic invertebrate community, a geophysical survey, and a belted kingfisher field monitoring program.

3.1. AVAILABLE DATA AND DATA GAPS

3.1.1. Historical Habitat, Terrestrial Vegetation, and Aquatic Vegetation Data

Earth Tech, Inc. and Malcolm Pirnie, Inc. previously conducted a review of habitat data for the Lower Passaic River (Earth Tech, Inc. and Malcolm Pirnie, Inc., 2004). In general, the results of this data review revealed that approximately 8% of the habitat in RM 1.0 to RM 7.0 consists of intertidal mudflats.[1] The remaining area (92%) is dominated by high-density industrial and commercial developments with limited public access to the river and limited "green space." This area is characterized as follows: emergent wetland vegetation comprises 6% of the shoreline; riprap with significant over-hanging riparian vegetation comprises 12% of the shoreline; riprap comprises 30% of the shoreline; and bulkheads comprise 52% of the shoreline (Earth Tech, Inc., 2004). Wetlands (RM 1.0 to RM 7.0) are dominated by either smooth cordgrass (*Spartina alterniflora*) or common reed (*Phragmites australis*) whereas the floodplains are comprised of riparian and upland communities (Earth Tech, Inc. and Malcolm Pirnie, Inc., 2004).

The upper stretches of the Lower Passaic River (RM 7.0 to RM 17.4) are characterized by estuarine subtidal and intertidal habitats plus a riverine tidal habitat. While more public access and "green space" areas were observed between RM 7.0 to RM 17.4, commercial and residential development is still prominent. Limited data are available to characterize the shoreline in this area, which encompasses sections of riprap and bulkhead (Earth Tech, Inc. and Malcolm Pirnie, Inc., 2004).

[1] A videotape containing footage of shoreline vegetative communities along RM 1.0 to RM 7.0 was recorded by TSI in 2002 (TSI, 2002a as cited in Earth Tech, Inc. and Malcolm Pirnie, Inc., 2004). A complete review of this videotape is provided in the *Draft Final Biological Literature Review* (Earth Tech, Inc. and Malcolm Pirnie, Inc., 2004), which contains an analysis of habitat type including linear footage, percentage, and breakdown by both river banks.

No data are available for any part of the Lower Passaic River on the submerged aquatic vegetation (SAV) community, and limited data exist for the evaluation of the plankton community (Earth Tech, Inc. and Malcolm Pirnie, Inc., 2004).

Based on the review of existing data, the following data gaps were identified:

- More habitat data (*i.e.,* data on physical structure) and vegetation inventories are necessary to characterize the Lower Passaic River (RM 0 to RM 7.0.
- Limited data exist for habitat characterization and vegetative inventories for RM 7 to RM 17.4 of the Lower Passaic River.
- Limited data exist to characterize the aquatic communities for RM 0 to RM 17.4 of the Lower Passaic River, including aquatic vegetation and plankton.
- No data have been collected for SAV communities for any part of the Lower Passaic River.
- No data have been collected on critical and sensitive habitats for any part of the Lower Passaic River (refer to Section 6.0 "Habitat Delineation" for definition of critical and sensitive habitats).

3.1.2. Historical Terrestrial Fauna Community Survey Data

As part of the *Pathways Analysis Report* (Battelle, 2005), available terrestrial fauna data were summarized, and terrestrial receptors of concern were identified, including avian species, mammals, reptiles, and amphibians (refer to Table 7 in Section 6.3 in Battelle, 2005). In general, limited data are available for the communities in RM 0 to RM 7.0; hence, these communities cannot be characterized fully. An avian survey conducted from fall 1999 to summer 2000 documented a total of 48 avian species (including 28 aquatic and piscivorous bird species) between RM 1.0 to RM 7.0 (BBL, 2002 as cited in Battelle, 2005). Various species of gulls, wading birds (egrets and herons), and waterfowl species accounted for most of the sighting of aquatic birds. The most commonly observed species were herring gull (*Larus argentatus*), laughing gull (*Larus atricilla*), ring-billed

gull (*Larus delawarensis*), mallard (*Anas platyrynchos*), and double-crested cormorant (*Phalacrocorax auritus*).

A USACE survey of piscivorous mammals was completed in 1987; however, it was concluded subsequently that a more appropriate survey of terrestrial and semi-aquatic species may be necessary to identify terrestrial receptors of concern (Battelle, 2005). A data review by Earth Tech, Inc. and Malcolm Pirnie, Inc. also showed that no community data are available for terrestrial communities in wetlands, floodplains, shoreline, and mudflat habitats (Earth Tech, Inc. and Malcolm Pirnie, Inc., 2004).

Based on the review of existing data, the following data gaps were identified:

- Limited data exist to characterize the terrestrial fauna communities for RM 0 to RM 17.4 of the Lower Passaic River, including mammal, reptile, and amphibian species.
- Limited data exist to characterize the avian community in RM 7 to RM 17.4.
- Limited data exist on the presence of threatened or endangered aquatic species for the Lower Passaic River. The NJDEP Natural Heritage Program, NJDEP Landscape Program, USFWS, and the National Marine Fisheries Service (NMFS) will be contacted during a literature review for threatened or endangered terrestrial species data for the Study Area (refer to Section 14.2. "Threatened and Endangered Species").

3.1.3. Historical Fish Community Survey Data

In the *Pathways Analysis Report* (Battelle, 2005), the fish community was described as a mixture of marine, estuarine, and freshwater demersal and pelagic fish, including mummichog (*Fundulus heteroclitus*), American eel (*Anguilla rostrata*), and striped bass (*Morone saxatilis*). Similar results were observed with a survey conducted in fall 1999 and spring 2000 by TSI, which found that mummichog was the most abundant fish species and accounted for 32% of sampled organisms in 1999 and 63% in 2000 (TSI, 2003 as cited in Earth Tech, Inc. and Malcolm Pirnie, Inc., 2004). Other fish species observed in either 1999 or 2000 included Atlantic menhaden (*Brevoorita tyrannus*),

gizzard shad (*Dorosoma cepedianum*), striped bass, white perch (*Morone americana*), American eel, and inland silverside (*Menidia beryllina*). A large number of blue crabs (*Callinectes sapidus*) were also collected during this fish community study. Blue crab was found to account for 36% of sampled organisms in 1999 and 14% in 2000 (TSI, 2003 as cited in Earth Tech, Inc. and Malcolm Pirnie, Inc., 2004). Note that this survey consisted of 2 sampling events, and therefore, has limited information on seasonal variations in the fish community.

While field data for fish species in RM 7 to RM 17.4 are not available, the USFWS (2005) suggests that the fish community in this section of the Lower Passaic may include, but is not necessarily limited to, pumpkinseed (*Lepomis gibbosus*), largemouth bass (*Micropterus salmoides*), brown bullhead (*Ameirus nebulosus*), carp (*Carpoides cyprinus*), and black crappie (*Pomoxis nigromaculatus*). A 1987 USACE survey of fish in the lower 12.3 miles of the river characterized the community as comprising mainly pollution tolerant fish, such as carp, goldfish (*Carassinus auratus*), white sucker (*Catostomus commersoni*), American eel, and killifish (USACE, 1987 as cited in Earth Tech, Inc. and Malcolm Pirnie, Inc., 2004). Meanwhile, NJDEP documented in 1983-1984 the presence of brown bullhead, carp, goldfish, and American eel in the Lower Passaic River proximal to its confluence with Third River (Clifton Health Department, 1999). In addition, it was concluded, based on a 1999 electro-fishing study conducted from the upper reaches of Third River to its confluence with the Lower Passaic River, that the freshwater fish community of Third River was dominated by white sucker, American eel, and blacknose dace (*Rhinichthys atratulus*; Clifton Health Department, 1999).

Based on the review of existing data, the following data gaps were identified:

- Fish community data for RM 1.0 to RM 7.0 of the Lower Passaic River are available, but the data are limited to a spring and fall community assemblage.
- Limited data exist to characterize the fish community for RM 7 to RM 17.4.

- Limited data exist on the presence of threatened or endangered aquatic species for the Lower Passaic River. The NJDEP Natural Heritage Program, NJDEP Landscape Program, USFWS, and NMFS will be contacted during a literature review for threatened or endangered terrestrial species data for the Study Area (refer to Section 14.2. "Threatened and Endangered Species").

3.1.4. Historical Benthic Invertebrate Community Survey Data

Similar to the distribution of fish data, few historical data are available to characterize accurately the benthic invertebrate community for RM 7 to RM 17.4. A limited survey conducted in 1998 by NJDEP at the Dundee Dam found that this location was dominated by blood-red chironomid larvae and tubificidae worms. The presence of these pollution tolerant organisms led the NJDEP to characterize the benthic community as "moderately impaired" (NJDEP, 1998 as cited in Earth Tech, Inc. and Malcolm Pirnie, Inc., 2004).

Several historical surveys were conducted along the Lower Passaic River to characterize and catalog the aquatic communities in RM 1.0 to RM 7.0. The local benthic invertebrate community, which was surveyed in 1994, was characterized as being heavily influenced by the urban and industrial surroundings and typical of a "degraded estuarine environment" (ChemRisk, 1995 as cited in Battelle, 2005). The dominant species observed include polychaete and oligochaete worms, amphipods, grass shrimp (*Palaemonetes pugio*), and blue crabs (*Callinectes sapidus*). Similar results were found in another benthic survey conducted by TSI in fall 1999 and spring 2000, which showed that the benthic community for RM 1.0 to RM 7.0 represented a stressed community since it was largely comprised of pollution tolerant organisms, such as oligochaete and polychaete worms (TSI, 2002b as cited in Earth Tech, Inc. and Malcolm Pirnie, Inc., 2004). However, the TSI stations were primarily located on intertidal mudflats; hence, little or no data were collected from subtidal areas. Another survey, which focused specifically on the benthic macroinvertebrate community for RM 0 to RM 1.0, was completed in 2001 by the Jacques Whitford Company for the BASF Corporation. The results of this study showed that the benthic community was relatively low in diversity

while exhibiting moderate abundance, which was "fairly representative" of similar estuaries (Jacques Whitford Company, 2002 as cited in Earth Tech, Inc. and Malcolm Pirnie, Inc., 2004).

Based on the review of existing data, the following data gaps were identified:

- Benthic invertebrate community data (including shellfish) for RM 0 to RM 7.0 of the Lower Passaic River are available, but the data are limited to a spring and fall community assemblage and do not consider subtidal habitats.
- Limited data exist to characterize the benthic invertebrate communities (including shellfish) for RM 7 to RM 17.4 of the Lower Passaic River.

3.1.5. Historical Biological Tissue-Residue Data

Biological tissue samples were collected in 1999 and 2000 to measure contaminant residues (TSI, 2003). As part of this collection, the following species were collected from RM 1.0 to RM 7.0: blue crab, mummichog, striped bass, white perch, American eel, bluefish (*Potomatus saltatrix*), and inland silverside. These samples were analyzed for various contaminants and other parameters, including percent lipid. Limited biological tissue data are available for RM 7 to RM 17.4; note that species sampled in the 1999 and 2000 programs are typically found in marine or brackish waters, and they may only be found in the freshwater sections of the Lower Passaic River as transients, or during certain times of the year, or during specific life stages.

A screening of historical tissue data may assist in identifying contaminants that may result in human and ecological exposure. Contaminants measured in these historical biological tissues [refer to Table 3 in the *Pathways Analysis Report* (Battelle, 2005)] include metals, semivolatile organic compounds (SVOCs), polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), and chlorinated pesticides. Volatile organic compounds were not measured in biological tissue because their chemical properties limit their ability to bioaccumulate. In general, the availability of biological tissue data for RM 7 to RM 17.4 was limited. Only 3 tissue samples were analyzed for inorganic metals, SVOCs, PCBs,

and pesticides while only 5 tissue samples were analyzed for PAH (Attachment A in *Pathways Analysis Report*; Battelle, 2005). A study conducted for NJDEP to monitor contaminant concentrations in fish revealed that specimens from several locations on the Lower Passaic River exhibited relatively high concentrations of 1,1,1-trichloro-2,2-bischlorophenylethane (DDT) and its metabolites, PCBs, chlordane, dieldrin, heptachlor epoxide, or mercury (Horowitz *et al*., 2005). However, some of these elevated levels were also observed in fish tissue collected from sampling sites upriver of the Dundee Dam.

Based on the review of existing data, the following data gaps were identified:

- Biological tissue-residue data exist for RM 1.0 to RM 7.0 of the Lower Passaic River; however, more data may need to be collected, depending on the target species selected for the human health risk assessment and ecological risk assessment.
- Limited biological tissue-residue data exist for RM 7 to RM 17.4 of the Lower Passaic River.

3.1.6. Historical Toxicity Testing Data

Toxicity testing determines the relationship between the magnitude of exposure to a contaminant and the nature and magnitude of adverse health effects that may result from such exposure. Sediment toxicity testing was conducted in 1999 on samples collected from RM 1.0 to RM 7.0 of the Lower Passaic River. A 10-day acute static laboratory toxicity test of Passaic River sediment samples was conducted with the marine and estuarine amphipod, *Ampelisca abdita*; a 28-day chronic static laboratory toxicity test of Lower Passaic River sediment samples was conducted with the polychaete, *Neanthes arenaceodentata* (TSI, 2003).

Based on the review of existing data, the following data gaps were identified:

- Sediment toxicity data exist for RM 1.0 to RM 7.0 of the Lower Passaic River; however, more data may be needed to support the human health risk assessment and ecological risk assessment.

- No sediment toxicity tests were conducted in RM 7 to RM 17.4.
- No surface water toxicity tests were conducted on the Lower Passaic River.
- Limited chronic duration bioassay data exist to meet the current DQOs.

3.1.7. Historical Caged Bivalve Studies

A caged bivalve study was conducted in the Lower Passaic River in 1999 (TSI, 2003). As part of this study, ribbed mussels (*Geukensia demissus*) were deployed in 3 replicate cages at each of 15 sample locations within RM 1.0 to RM 7.0. Each cage was monitored on a weekly basis for general specimen condition; dead individuals, if present, were removed. After a 28-day exposure period, surviving test specimens from each cage were composited and analyzed for contaminant residues in tissue samples and percent lipid.

Caged bivalve studies represent a unique water column exposure pathway. However, this pathway may not be significant in the Lower Passaic River since the sediments are too unstable to support bivalve populations. Hence, while the historical caged bivalve data will be integrated into the risk assessments, no additional caged bivalve studies are planned for FSP Volume 2. Instead, bioaccumulation will be accounted for in other sampling programs (refer to Section 12.0 "Biological Tissue-Residue Sampling" and Section 13.0 "Toxicity Testing"). Note that caged bivalve studies are anticipated as part of the Newark Bay study.

3.2. FIELD TASKS COMPLETED

3.2.1. Sediment Profiling Imaging

A SPI survey of the Lower Passaic River was performed over a 5-day period in June 2005 (Germano & Associates, Inc., 2005). This survey also included 28 benthic invertebrate samples collected for field verification of the SPI photographs, which comprised approximately 25 percent of the SPI locations (Aqua Survey, Inc., 2005b). SPI was used to characterize the Lower Passaic River's benthic biological and physical habitat (*e.g.*, sediment particle size, the Redox Potential Discontinuity depth, and infaunal

usage) and provide needed preliminary information on the benthic habitats from RM 7 to RM 17.4. The results of the survey indicate that the benthic invertebrate community at the mouth of the river was dominated by polychaete, *Streblospio benedicti* and *Scolopus sp.*, and oligochaete (Naididae) worms. Benthic invertebrates that dominated RM 1.0 to RM 7.0 include Naididae oligochaetes, amphipods (*Gammarus spp.*), and the polychaete worm (*Marenzelleria viridis*). Benthic invertebrates that dominated RM 7 to RM 17.4 include chironomid larvae, *Hydra sp*., amphipods (*Gammarus spp*.), and mosquito larvae (*Culicidae*).

Moreover, the SPI survey suggests that the Freshwater River Section has greater habitat diversity than the Brackish River Section. This habitat diversity is suitable for supporting moderate to high numbers of tubificid oligochaetes, which are considered to be representative of an advanced successional status (Stage III) in freshwater systems. It was hypothesized that the somewhat better habitat conditions within the Freshwater River Section are due to lower organic loading rates, resulting from less industrialization and lower-density development in the surrounding watershed (Germano & Associates, Inc., 2005). Conversely, the benthic communities in the Brackish River Section appeared to be dominated by lower-order, opportunistic Stage I taxa (an initial community of tiny, densely populated polychaete assemblages). At a limited number of SPI stations, a better-developed, Stage III community was evident; however, only a small number of Stage III organisms (*i.e.*, mature, equilibrium community of deep-dwelling, head-down deposit feeders) appeared to be present. For example, only one or two-feeding voids were present, and very few larger-bodied individuals visible at depth were observed (Germano & Associates, Inc., 2005).

Based on the results of the SPI survey, it is recommended that additional benthic sampling occur to provide a more accurate picture of the Lower Passaic River's benthic community. Moreover, additional sampling would provide a basis for the selection of potential restoration sites and a baseline dataset to measure the success of restoration.

3.2.2. Geophysical Survey

The geophysical survey was conducted between April 21, 2005 and June 16, 2005 (Aqua Survey, Inc., 2005a) and included a gradiometric survey, side-scan sonar survey, and sub-bottom profiling. The survey was designed to support the following data needs:

- Determine surficial sediment texture to characterize the Lower Passaic River bottom and existing benthic habitat.
- Determine the extent of debris and other targets (*e.g.*, utilities and wrecks) to assess feasibility of remedial alternatives.
- Determine the sediment types, depths, and thicknesses of geologic layers.

The gradiometric and side-scan sonar data identified debris fields in the Lower Passaic River as well as individual objects of significant size. In general, the gradiometric data detected the presence of submerged ferrous debris and the location of buried pipes and cables. The survey revealed 147 distinct magnetic anomalies: 9 anomalies are associated with non-vehicle/side-scan sonar targets; 46 anomalies have signatures that are indicative of large shallow objects; and 92 anomalies have signatures that are indicative of large deep objects. A complete list of these anomalies, including geographical coordinates and magnetic (gamma) intensities, is provided in the *Draft Technical Report, Geophysical Survey: Lower Passaic River Restoration Project* (Aqua Survey, Inc., 2005a).

Surficial sediment texture was classified using visual, acoustical, and geotechnical data. The sediment classification and delineation was completed using the QTC Sideview ™ software. A complete discussion of the delineation and creation of mosaics is included in the *Draft Technical Report, Geophysical Survey: Lower Passaic River Restoration Project* (Aqua Survey, Inc., 2005a). Figure 1-4 contains a one-mile-per-plate map book with the surficial sediment texture as classified by Aqua Survey, Inc. Note that the sediment texture map only displays surficial sediment texture and does not identify sub-bottom sediment texture. In general, the Brackish River Section is dominated by silt, which mainly occurs in the channel. Larger grain sizes (*e.g.*, coarse sand and gravel)

become more predominant on the shoreline. The Transitional River Section is characterized by a gradual transition of sediment texture from mainly silt to coarse-grain sediments. This coarse-grained sediment texture then persists in the Freshwater River Section with granular material dominating RM 16.0.

Results of the sub-bottom profiling and the geotechnical borings (which were collected to confirm the sub-bottom profiles) are presented in the *Draft Technical Report, Geophysical Survey: Lower Passaic River Restoration Project* (Aqua Survey, Inc., 2005a). At the time that FSP Volume 2 was written, several acoustical reflections were identified in the sub-bottom data; however, further evaluations are necessary to connect these reflections to sediment horizons.

3.2.3. Belted Kingfisher Field Monitoring

A preliminary monitoring program of belted kingfisher (*Ceryle alcyon)* population is currently being implemented by the partner agencies. This monitoring program began in late April 2006 and will continue through June 2006. The purpose of this preliminary screening is to:

- Identify active belted kingfisher burrows along the banks and riparian zones of the Lower Passaic River.
- Characterize the suitability of available habitat for breeding belted kingfishers using the USFWS habitat suitability index (HSI) model (Prose, 1985). This model characterizes the habitat suitability by considering the percent of the shoreline subject to wave action, average water transparency, percent water surface obstruction, percent of the water area that is ≤ 60 centimeters in depth, percent riffles, number of lentic shoreline locations (*e.g.*, shoreline adjacent to slow-moving or still-water) or river sub-sections that contain one or more perches, and distance to nearest suitable bank from 1 kilometer sections of lentic shoreline or river.
- Determine reproductive success, including clutch size, egg hatchability, and fledgling success.

During the monitoring program, other avian species that were observed (visual or audio inspection) were documented. The results of the 2006 belted kingfisher monitoring program will be integrated into future restoration alternatives. Results will also guide the future avian monitoring programs (as presented in Section 8.3 "Avian Community Survey Method") by shifting or adding survey areas to correspond to areas identified as supporting active burrows.

4.0 DATA QUALITY OBJECTIVES AND ECOLOGICAL FUNCTIONAL ASSESSMENT METRICS

4.1. REVISED DATA QUALITY OBJECTIVES FOR FSP VOLUME 2

DQOs are developed to identify the specific problems; the activities and associated goals to evaluate the problems; the decisions that will need to be made to attain those goals; and the specific data and analyses methods that will be collected and used to support the decisions.

As part of the Study, DQOs were previously developed to identify the data collection requirements associated with the water column and sediment sampling and the physical characterization of the Study Area [refer to Attachment 1 of the QAPP (Malcolm Pirnie, Inc., 2005a)]. To support the sampling activities of FSP Volume 2, either new biological-habitat DQOs were developed, or previously developed DQOs were modified to include the data collection activities associated with inventorying the biota and habitat in the Study Area and collecting biotic samples. These DQOs are briefly discussed below and provided in Attachment B, Tables B1 through B5.

4.1.1. DQOs for Ecological Restoration

DQOs specific to the Ecological Restoration (Table B1) were developed to address the problem of ecosystem function in the Lower Passaic River and riparian areas (but not the floodplains). The principal goals of this DQO are:

- Determine which Lower Passaic River ecological functions are impaired.
- Determine what restoration actions would improve the impaired functions.
- Determine the degree to which restoration efforts were successful (if post-construction monitoring is deemed valuable).

Data collection activities associated with this DQO are proposed for the Lower Passaic River, adjacent riparian areas (but not the floodplains), and within a reference area. Six distinct field sampling programs are proposed to address the problem; they involve surveying and inventorying (1) habitats (refer to Section 6.0 "Habitat Delineation"); (2) terrestrial vegetation (refer to Section 7.0 "Terrestrial Vegetation Survey"); (3) avian population (refer to Section 8.0 "Avian Community Survey"); (4) aquatic vegetation (refer to Section 9.0 "Aquatic Vegetation Survey"); (5) fish (refer to Section 10.0 "Fish Community Survey"); and (6) benthic invertebrates (refer to Section 11.0 "Benthic Invertebrate Community Survey").

4.1.2. DQOs to Assess Risk to the Fish Population

DQOs were developed for the ecological risk assessment to determine if an unacceptable risk to the fish population exists (Table B2). The principal goals are:

- Determine if exposure to site-related chemical stressors are posing an unacceptable risk to fish population.
- Differentiate other stressors from site-related chemical stressors.

The complete 7-step DQO process, including analytical approach and performance or acceptance criteria, is presented in Table B2. For this DQO, both historic and newly collected data will be evaluated to address the problem, including sediment and surface water chemistry, tissue-residue concentrations, and community health of fish and benthic invertebrates. Data collection activities, proposed for this sampling program, include analyzing contaminant-residue in tissue samples of fish and shellfish. The scope of the sampling program, relevant SOPs, and description of the method are provided in Section 12.0 "Biological Tissue-Residue Sampling").

4.1.3. DQOs to Assess Human Health Risk from Consuming Fish or Shellfish

DQOs specific to the assessment of human health risks (Table B3) were developed to determine if an unacceptable risk to human receptors (recreational and high-intake residents) exists from the consumption of fish and crab. The principal goal is:

- Determine if consumption of fish or crabs poses unacceptable current or future risk to human receptors.

The complete 7-step DQO process, including analytical approach and performance or acceptance criteria, is presented in Table B3. Both historic and newly collected data will be evaluated to address this problem and complete the human health risk assessment. The scope of the sampling program, relevant SOPs, and description of the method are provided in Section 12.0 "Biological Tissue-Residue Sampling").

4.1.4. DQOs to Assess Ecological Risk from Consuming Fish or Shellfish

DQOs specific to the assessment of ecological risks (Table B4) were developed to determine if an unacceptable risk to ecological receptors (piscivorous and omnivorous wildlife receptors) exists from the consumption of fish and crab. The principal goal is:

- Determine if consumption of fish or crabs poses unacceptable current or future risk to ecological receptors.

The complete 7-step DQO process, including analytical approach and performance or acceptance criteria, is presented in Table B4. Both historic and newly collected data will be evaluated to address the problem and complete the ecological risk assessment. Data collection proposed for this sampling program include analyzing contaminant-residue in tissue samples of fish and shellfish. The scope of the sampling program, relevant SOPs, and description of the method are provided in Section 12.0 "Biological Tissue-Residue Sampling".

4.1.5. DQOs to Assess Risk to the Benthic Invertebrate Population

DQOs were developed for the ecological risk assessment to determine if an unacceptable risk to benthic invertebrate community exists (Table B5). The principal goal is:

- Determine if site-related chemical stressors are posing an unacceptable risk to benthic invertebrate populations.

The complete 7-step DQO process, including analytical approach and performance or acceptance criteria, is presented in Table B5. To evaluate the benthic invertebrate community, a Sediment Triad Approach is identified for concurrently assessing sediment chemistry, performing toxicity tests on 3 species, and evaluating benthic invertebrate communities. [The DQOs for sediment chemistry are discussed in the QAPP (Malcolm Pirnie, Inc., 2005a)]. The scope of the sampling program, relevant SOPs, and description of the method are provided in Section 13.0 "Toxicity Testing."

4.2. SELECTION OF CANDIDATE ECOLOGICAL FUNCTIONAL ASSESSMENT METRICS

Numerous habitat assessment procedures, including wetland assessment procedures, have been developed using differing approaches and assessment metrics to support the habitat restoration actions. The *Ecological Functional Assessment Technical Memorandum* (Earth Tech, Inc., 2004) summarizes the applicability of 40 assessment methodologies to formulate and evaluate habitat restoration actions in the Study Area. This summary describes these methodologies in terms of the geographic coverage, habitat types, and the values and functions they assess.

4.2.1. Metric Selection for River and Riparian Habitats

A variety of habitats in the Study Area have been identified as potentially suitable for restoration. Broadly classified, these habitats include subtidal areas in the Lower Passaic River and its tributaries as well as intertidal, wetland (freshwater and tidal), and riparian areas (refer to Section 6.1 "Data Needs and Objectives of Habitat Delineation"). However, few habitat assessment methodologies have been developed to assess a wide range of habitats. Consequently, the adoption of a single methodology as the core of the Lower Passaic River ecological functional assessment (EFA) is not recommended (Earth Tech, Inc., 2004). Rather, as outlined under PMP task identification numbers JDN "Other Environmental Documents," specific metrics from applicable methodologies will be integrated into the EFA. [Sampling programs are designed to provide appropriate field data to satisfy or to fulfill the specific metrics, not the model. Specific metrics that

are relevant to each restoration sampling program are listed in the appropriate sections (Section 6.0 through Section 11.0).] This integration will depend on conditions within the Study Area and the metrics most likely to be affected by the restoration measures. In addition, metrics may be modified based on local conditions particular to the highly urbanized characteristics and the high degree of habitat disturbance that is characteristic of the Study Area (because specific urban river metrics may not be available).

Metrics from the following assessment methodologies are proposed for primary application to the Study Area (although metrics from other methodologies may also be used):

- Habitat Evaluation Procedures (HEP).
- Hydrogeomorphic Approach (HGM).
- Rapid Bioassessment Protocols (RBPs).

In combination, these methodologies use assessment procedures and metrics that are applicable to the full range of potential restoration habitats observed in the Lower Passaic River, and the methodologies are widely used and recognized. In brief, the methodologies generate results, such as the size of a particular area (*i.e.*, acreage), to measure or assess the environmental function. The results are expressed on a scale of 0 to 1.0 for the function index. The methodologies enable formulation of a standardized approach for tracking structure, function, and size of the restoration areas, which allows the comparison of alternative restoration plans. This comparison encompasses several restoration activities on varying assemblages of restoration sites.

4.2.2. Selection of Environmental Functional Assessment

The following outlines the step-wise method used to select EFA metrics for use in river and riparian habitats in the Lower Passaic River. The results of this selection process are presented in Attachment C.

Step 1: Utility of Metrics. The utility of the candidate metrics was evaluated by the "utility of the metric by action domain" and the "utility of the metric by habitat."

- Utility of Metric by Action Domain: Metrics were rated as being or not being (score = 1 or 0, respectively) a direct gauge of actions that remove contaminants from the water column; remove contaminants from the substrate; change the depth of inundation or flow characteristic; physically alter habitat features (including sediment characteristics but excluding vegetation structure); and change the coverage, structure, or composition of vegetation.
- Utility of Metric by Habitat: Metrics were rated as being or not being (score = 1 or 0, respectively) a direct gauge of restoration actions in benthic, fish, mudflat, wetland-mudflat, wetland, armored, riparian, and upland habitats.

Step 2: Potential Effectiveness of Metrics. Metrics were then evaluated across action domains and habitat types in terms of their expected responsiveness to potential restoration actions. This evaluation was completed by multiplying the ratings from three variables: Utility by Action Domain times Utility by Habitat times the estimated Probability of Implementing Effective Action, which is the expected likelihood that a generic class of restoration actions could be implemented in the Study Area. Ratings of high, low, or no potential (score = 2, 1, or 0, respectively) were obtained.

Step 3: Assignment of Metrics. Metrics with maximum Potential Effectiveness of Metric scores, ranging from 1 to 2, and additional metrics specific to the Study, were assigned to restoration goals and objectives [refer to the *Draft Restoration Opportunities Report* (Earth Tech, Inc. and Malcolm Pirnie, Inc., 2005) for a description of the restoration goals and objectives].

Step 4: Selection of River and Riparian Metrics for River Sections. Assigned metrics from Step 3 were evaluated for use in river and riparian habitats in all three river sections. The following EFA objectives were considered in evaluating the expected utility of the

metrics and selecting those metrics that are expected to be most effective as river and riparian metrics for the three river sections:

- Establish existing ecological conditions in the Study Area.
- Assist in the formulation of habitat restoration alternatives.
- Determine success criteria following implementation of preferred alternatives.
- Quantify increases in ecological outputs associated with plans and plan scales.

Step 5: Evaluation by Restoration Actions. The selected river and riparian metrics were rated as either direct or indirect measures of the effectiveness of potential restoration actions in either action or sampling domains for each river section. The following potential restoration actions were considered:

- Reduce contributions of contaminants in sediments.
- Remove manmade structures.
- Re-grade and bio-stabilize shoreline.
- Remove invasive flora and restore native flora.
- Remove debris and trash.
- Enhance fish and benthic habitat and aquatic structure.
- Promote fish passage.

The results of this 5-step selection process are presented in tabular format in Attachment C. Selected metrics are listed for each of the restoration action along with the appropriate rating. A metric denoted as "direct," or D in the table, represent a direct measurement or evaluation of the restoration action on the action/sampling domain. Conversely, a metric denoted as "indirect," or I in the table, represents an indirect evaluation. For example, the RBP metric assigned to evaluate the "percent of infaunal macrobenthos tolerant of perturbation" will provide a direct evaluation for the benthic and fish fauna while indirectly evaluating the sediment and water quality (refer to Attachment C).

5.0 REFERENCE SITE SELECTION

5.1. DATA NEEDS AND OBJECTIVES OF REFERENCE SITE SELECTION

The selection of appropriate reference sites is required to support the following data needs (note that candidate reference sites will be evaluated by the partner agencies and the stakeholder Sampling Workgroup for appropriateness):

- Reference habitats and shorelines in the Lower Passaic River to habitats and shorelines in the reference site.
- Reference contaminant concentrations in biological tissue-residue samples collected from the Lower Passaic River to tissue-residue samples collected at appropriate reference sites.
- Reference biological response (both laboratory and field derived data) attributable to Lower Passaic River sediment exposures to appropriate reference site sediment exposures.
- Support the restoration design at potential restoration areas.

The objectives of selecting reference and background sites are to establish representative, background levels and to provide a benchmark for proposed restoration activities. Benchmark conditions necessary to meet risk assessment DQOs include: sediment contaminant concentrations, sediment toxicity, fish tissue contaminant concentrations, and functional elements of the fish and invertebrate communities. Conversely, benchmark conditions necessary to meet restoration DQOs include ecological function of aquatic habitats, river banks, and benthic, fish, and avian communities. Note that multiple reference sites will be necessary for the Lower Passaic River because separate reference sites will be needed for the Brackish River Section and the Freshwater River Section. In addition, the use of multiple reference sites will serve to account for the natural variability that is observed in ecological systems.

5.2. REFERENCE SITE SELECTION SCOPE

5.2.1. Technique and Rationale

Reference sites are minimally impaired water bodies that reflect the ecological potential for surface waters if they were not adversely impacted by anthropogenic activity. Reference standard sites should represent the optimum conditions that could be reasonably achieved during the restoration of an impacted water body (Hughes *et al.*, 1986; Hughes, 1995). Ideally, the reference site should match the impacted site in all aspects except contamination (USEPA, 1994; USEPA, 1997). Degraded reference sites are locations that have experienced impacts similar to restoration sites, but are left unrestored. (Degraded reference sites may be selected for the Study; however, this selection is to be determined.) Degraded sites can be compared to post restoration sites to evaluate success and are similar to controls used in laboratory experiments (Merkin, 2003). Certain sampling programs, such as Biological Tissue-Residue Sampling (Section 12.0) require reference sites that have similar levels of urbanization as the impacted sites but relatively lower concentrations of contaminants of concern. The establishment of reference conditions is critical for environmental assessments and can assist in defining an attainable ecological condition.

Since the impacted site and reference sites are rarely completely similar in nature, a number of physicochemical and ecological characteristics, which are summarized in Table 5-1, are often used to evaluate the compatibility between the impacted site and the reference site or background conditions. A qualification of these characteristics as criteria, which can guide the comparison of the impacted and reference sites, is to be determined.

Table 5-1. Criteria for Reference Site Selection

General Criteria Type	Physicochemical Media or Ecological Features	Physicochemical or Ecological Criteria to be Evaluated
Physicochemical	Surface Water	Salinity, Depth, Flow Rate, Temperature
	Sediment	Grain Size, Total Organic Carbon
Ecological	Floral and Faunal Communities	Species Diversity, General Trophic Structure
	Habitat Structure	River Bottom Structure, Shoreline Structure, Fallen Dead Vegetation, Percent Vegetative Cover, land use development

Factors, such as climate, landform, and land use patterns, can cause variation in natural surface-water characteristics. These variations can prevent the development of nationwide or even statewide reference conditions. Hence, data from several reference sites are often combined when a single reference site can not be chosen, or when a water body contains more than one distinct habitat type (such as an estuary, like the Lower Passaic River). Two principal approaches that are typically used to establish reference conditions are:

- Select "site-specific reference" sites for the impacted site.
- Select "regional reference site," or ecologically similar reference site, for comparison with the impacted site located within the same region (USEPA, 1990).

Site-specific reference conditions compare the impacted site to a relatively un-impacted or significantly less impacted site, which has similar habitat to the impacted site and is located on the same water body. Often site-specific reference sites are located upstream of the impacted site when the water bodies have a strong directional flow (*i.e.*, rivers and streams). This approach allows an assessment of background conditions of the watershed to estimate incremental risk. However, this method is hindered if multiple point sources are present; if the shoreline, channel, or bottom is extensively modified; or if strong environmental gradients (*e.g.*, salinity gradients) are present. Since these conditions exist in the Lower Passaic River, a site-specific reference condition approach is inappropriate for this Study and an upriver site may not accurately represent background conditions.

Regional reference sites operate on the assumption that the character of the water bodies is strongly influenced by the watershed character. For this reason, water bodies within a given region share a greater degree of similarity among themselves compared to water bodies located in different regions. Following this regional approach, reference conditions should, if possible, be selected from water bodies in the same ecological region as the impacted site.

A distribution of ecological aquatic regions can be conceptually developed based on physical parameters, including soil type, landform, climate, vegetation, and land use. Then, to establish regional reference conditions, water bodies of similar habitat type are selected in discrete geomorphological and ecological regions. Ideally, regional reference sites should have physicochemical and ecological characteristics that are similar to those characteristics of the impacted water bodies being studied.

5.2.2. Potential Reference Sites for the Study Area

The Study Area for the Lower Passaic River is located in the "Urban/Industrial Zone New Jersey Ecoregion" (NJDEP, 1994), which is characterized by heavy commercial development, a high degree of point source inputs into local water bodies, and large areas of impervious surfaces. Hence, the identification of non-impacted reference sites in the same ecoregion as this Study Area could be problematic. In the absence of a suitable reference site in the Urban/Industrial Zone New Jersey Ecoregion, reference sites from the surrounding zones, including the North Piedmont, Northeastern Coastal Zone, or Middle Atlantic Coastal Plain, may be appropriate.

In addition, the Lower Passaic River is an estuary; the various salinity levels have resulted in three broad habitat types: brackish, transitional, and freshwater (refer to Section 1.3 "Conceptual Site Model"). Hence, the choice of a single water body to represent the estuarine reference condition is difficult and is complicated by the extent of industrial development in the Study Area.

Accordingly, several reference sites should be identified to represent the varying conditions across the different sections of the Lower Passaic River. Section 5.3 "Reference Site Selection Method" outlines the procedure or method for selecting appropriate reference sites for the Lower Passaic River. A preliminary screening of local water bodies identified the Mullica River (refer to the location map presented in Figure 5-1) as a suitable reference site for the Brackish River Section; however, other reference sites will be necessary for comparison to the Transitional and Freshwater River Sections.

The Mullica River is a tidal tributary to Great Bay in southern New Jersey and was recommended by the Biological Technical Advisory Group (or BTAG composed of USEPA, NOAA, USFWS, and NJDEP) as a suitable reference site for the Lower Passaic River in a previous study (TSI, 1990). A 1998 investigation of the Mullica River found that the brackish portion of the river exhibited a high degree of physiochemical and biological compatibility with the brackish section of the Lower Passaic River (Rosman, 1998). However, comparisons between these two water bodies should be made with care since surface water characteristics are different between the Mullica River and the Lower Passaic River. For example, the Mullica River is located in a flat plain with marshy or swampy areas; the area around the Mullica River is relatively undeveloped with well drained soils underlain by a prolific sand and gravel aquifer. The Lower Passaic River, by contrast is located in a heavily developed, urbanized area where soils are poorly drained and underlain by a fractured rock aquifer.

In addition to the Mullica River, other reference sites for comparison with the Freshwater and Transitional River Sections are needed and may include sites located on the Hackensack River, Manasquan River, Navesink River, Raritan River, Shark River, Shrewsbury River (all located in New Jersey; refer to Figure 5-1), or possibly other rivers. However, the suitability of these candidate reference sites must be further investigated through field sampling and field reconnaissance. Candidate reference sites

will be evaluated by the partner agencies and the stakeholder Sampling Workgroup for appropriateness.

5.3. REFERENCE SITE SELECTION METHOD

5.3.1. Method to Select Reference Site

A reference site selection SOP will not be provided in this document; the reference site selection process will follow procedures and general guidance outlined in Hughes *et al*., (1986); Plafkin *et al*., (1986); USEPA (1990); USEPA (1994); and USEPA (2000a). Identification of surface water bodies that may serve as suitable reference sites for the impacted site [*i.e.*, waters that exhibit similar physicochemical and ecological characteristics to the impacted site (Table 5-1)] may be accomplished through a combination of reviewing historical data and field sampling candidate reference sites. (Criteria that will guide the comparison of the impacted and reference sites are to be determined.) The reference site selection process will be completed after the field sampling of candidate reference sites, which will be conducted during the growing season (anticipated schedule: May – September 2007) consistent with other FSP 2 sampling programs.

Prior to evaluation of the available historical data, a set of candidate reference areas will be selected based upon the results of interviews with federal/state natural resource managers and other regional experts. The evaluation of historical data then serves to identify sites that have similar physical characteristics. Important physical characteristics include: adjacent land uses in the river drainage basin, river bottom and sediment type, and various river dimensions such as gradient, width, sinuosity, fetch, and bathymetry. Data on these physical characteristics may be obtained from various sources, including aerial photographs, bathymetric or sediment surveys, and USGS topographical maps. The availability of existing data on other physical and biological characteristics, such as flow rates, salinity, pH, temperature, biological species composition, and trophic structure, should also be investigated. Data on these river characteristics may be

available from federal and state agencies, published literature, private conservation organizations, and college and university departments.

Candidate reference sites identified through the historical data review may then be further evaluated by field sampling and field reconnaissance. This field program is necessary to fill gaps in the available existing data and to highlight reference site characteristics that are not evident from the existing data. In addition, field reconnaissance may be used to collect data pertaining to separate habitat types within the candidate reference sites, such as subtidal, intertidal, and shoreline habitats. Potential characteristics to be measured during field sampling may include water depth, presence of point source, composition of substrate (grain size distribution), total organic carbon content of sediments and vegetative cover of shoreline or riparian zone. The collective field sampling data obtained from the various candidate reference sites can be used to provide a reference range for physical or biological river characteristics for comparisons to the impacted site. Depending on the results of field reconnaissance, reference sites for the Transitional section of the river may be selected from either appropriate brackish or freshwater candidate reference sites. The data obtained from the combination of existing or historical data sources and the field program will be evaluated to identify suitable candidate reference site(s) that represents the best range of minimally impaired conditions, which can be obtained within a region.

5.3.2. Anticipated Sampling at Reference Sites

Once the reference sites are selected, an appropriate sampling plan will be developed to collect data that will satisfy the DQOs. The sampling programs at the reference sites will utilize the procedures and SOPs presented in FSP Volume 2. Table 5-2 outlines the anticipated number of sampling locations and the anticipated program durations for the reference sites:

Table 5-2 Anticipated Sampling and Program Duration at Reference Site

Sampling Program	Number of Anticipated Sampling Locations	Anticipated Program Duration
Habitat Delineation	Survey to delineate habitats	1 event during growing season
Terrestrial Vegetation Survey	Variable - depends on size of reference site	1 event during growing season
Avian Community Survey	Variable - depends on size of reference site	4 events within 1-year time frame
Aquatic Vegetation Survey	Variable - depends on size of reference site	1 event during growing season
Fish Community Survey	3 sampling locations	6 events within 1-year time frame
Benthic Invertebrate Survey	3 sampling locations	4 events within 1-year time frame
Biological Tissue-Reside Survey	20 sampling locations	2 events during the growing season
Toxicity Testing	36 sampling locations	1 event during growing season

5.4. REFERENCE SITE SELECTION REPORTING

The sampling program will include post-processing, analysis, and interpretation of field and analytical data. These results, along with maps and surveys, will be included in the draft and final reports.

6.0 HABITAT DELINEATION

6.1. DATA NEEDS AND OBJECTIVES OF HABITAT DELINEATION

Habitat refers to the physical structure that ultimately becomes the environment where fauna and flora can live. For the purposes of the Study, habitats will be delineated into the following categories: "subtidal" defined as habitats located below mean low water; "intertidal" defined as habitats located between mean low water and mean high water (including wetland areas); "riparian" defined as habitats located above mean high water to the top of river bank (but not the floodplains); and "critical and sensitive habitats." Together, the subtidal and intertidal habitats encompass the riverine environment while the riparian habitat encompasses the upland environment. Inventories of fauna and flora that reside in each habitat is discussed in Section 7.0 "Terrestrial Vegetation Survey," Section 8.0 "Avian Community Survey," Section 9.0 "Aquatic Vegetation Survey," Section 10.0 "Fish Community Survey," and Section 11.0 "Benthic Invertebrate Community Survey."

The habitat delineation will determine the spatial coverage of each habitat and will satisfy the following data needs associated with the DQOs and metrics, including EFA data acquisition (refer to Attachments B and C):

- Evaluate the spatial coverage of the subtidal, intertidal (including vegetated wetlands and mudflats), and riparian habitats as well as the critical and sensitive habitats.
- Evaluate the habitats to provide data for the ecological CSM and potential restoration area characterization.
- Support the restoration design at potential restoration areas.

The objectives of the habitat delineations are to obtain recent delineation data and to develop a map of the various habitats (including subtidal, intertidal, riparian, and critical and sensitive habitats). Data collected during this program will contribute to resolution

of the following principal questions developed in the DQO process (Table B1 in Attachment B) and the restoration metrics (Attachment C):

- What restoration actions would most effectively increase the ecological functions and value of the Lower Passaic River?
- To what degree have the ecological functions and value of the Lower Passaic River increased due to implementation of the restoration actions?
- Restoration metrics: *RBP Bank Stability* [whether the steam banks are eroded (or have the potential for erosion)]; *HGM-TFW VNHC* (a measure of the habitat heterogeneity of a site based on the comparison of the number of subhabitat types present at a site relative to the number of possible subhabitats known to occur in the reference site); and *RBP Epifaunal Substrate / Available Cover* [relative quantity and variety of natural structures in the stream (such as: cobble or riffles, large rocks, fallen trees, logs and branches, and undercut banks) available as refugia, feeding, or sites for spawning and nursery functions of aquatic macrofauna].

This task will include the mapping and field confirmation of the Study Area and potential restoration areas using available maps, aerial photography, and field surveying. It is anticipated that the habitat delineation data will also feed into the Lower Passaic River food web model to identify fish habitat and distribution, which will affect the exposure-component of the risk assessments. If post-construction monitoring of habitat is appropriate, then the methodology outlined in Section 6.0 "Habitat Delineation" will be followed.

6.2. HABITAT DELINEATION SCOPE

The scope of the habitat delineation task is to evaluate the spatial coverage of the subtidal, intertidal (including wetlands and mudflats), and riparian habitats as well as the critical and sensitive habitats in the Study Area. This delineation will address the data gaps identified in Section 3.1.1 "Historical Habitat, Terrestrial Vegetation, and Aquatic Vegetation Data" and will provide data to:

- Compare the number of habitat types present at a site relative to the number of possible habitats known to occur at the appropriate reference site (refer to Section 5.0 "Reference Site Selection").
- Evaluate the relative quantity and variety of natural structural features in the river, such as cobbles (riffles), large rocks, fallen trees, logs and branches, and undercut banks, that are available as refugia, feeding areas, or sites for spawning and nursery functions of aquatic macrofauna.
- Evaluate the percent cover (logs, boulders, cavities, brush, debris, or standing timber) during summer within pools, backwater areas, and littoral areas.
- Evaluate the percent in-river and overhanging shoreline cover.
- Evaluate river bank stability (*e.g.*, condition of banks), including: whether the river banks are eroded (or have the potential for erosion) and the amount of vegetative protection afforded to the river bank and the near-river portion of the riparian zone.
- Evaluate characteristics of the riparian zone including; the width of natural vegetation from the edge of the river bank out through the riparian zone; and the proportion of a site covered with undesirable plant species.

Habitat delineation will be accomplished through a combination of activities including: aerial photography; geographic information system (GIS) mapping to evaluate existing bathymetric and topographic surveys; and land-based surveying of potential restoration areas [using standard survey techniques as outlined in FSP Volume 3 Section 4.2 "Task 2 – Supplemental Land Survey" (Malcolm Pirnie, Inc., 2005b)]. Since habitats are primarily defined by elevation data, the appropriate topographic or bathymetric elevations will be selected through GIS mapping to identify preliminary boundaries of the various habitat areas. Aerial photographs will then provide a documentation of current existing conditions and will confirm GIS mapping data. (The aerial photography will be supplemented with field verification surveys to characterize the habitat.)

Detailed habitat delineations should be able to quantify restoration acreage and the potential level of impact to either potential restoration areas that have conceptual designs prepared or to areas potentially impacted by disturbances.[2] Moreover, the detailed potential restoration area mapping will include establishment of benchmarks, collection of survey data, and development of electronic deliverables, including surface generation or contouring, planimetric mapping, and base-map drawing preparation (*i.e.*, field-to-finish topographic and planimetric mapping effort). Wetland delineation will need to be performed at potential restoration areas or areas of potential disturbance in the Study Area. The State of New Jersey has adopted the delineation methodology presented in the *Federal Manual for Identifying and Delineating Jurisdictional Wetlands* (USACE, 1989) in implementing its wetland protection program under the Freshwater Wetlands Protection Act, PL 1987, c. 156.

6.3. HABITAT DELINEATION METHOD

The habitat delineation task will be completed within a single field surveying event, which will be conducted during the growing season (anticipated schedule: May – September 2007). Subtidal, intertidal (including wetlands), riparian, and critical and sensitive habitats will be delineated from RM 0 to RM 17.4. Methods and associated SOPs are discussed below.

6.3.1. Subtidal Habitat Delineation Method

Subtidal habitats will be defined as areas inundated at low tide (*i.e.*, located below mean low water). This habitat will then be further differentiated into shallow and deep areas during the development of future restoration alternatives (criteria for differentiation to be determined). To delineate the subtidal habitat, the mean low water elevation will be identified from NOAA nautical charts or other suitable reference materials and will be

[2] Subtidal and intertidal habitats will encompass the riverine environment while the riparian habitat will encompass the bank area. It is anticipated that the subtidal habitat will be homogeneous and that the greatest opportunities for restoration will occur in the intertidal, riparian, and critical and sensitive habitats.

overlaid on previously mapped bathymetric contours of the river bed. [The subtidal habitat may also be identified with aerial photographs recorded at mean low water and through field verification of the intertidal habitats (refer to Section 6.3.2 "Intertidal Habitat Delineation Method").] Subtidal areas will then be characterized to identify habitat area, bottom conditions (*e.g.*, sediment type, structural elements, and other habitat features), percent coverage of plants and dominant species, and observed sessile and motile fauna (refer to SOP 5: Documenting Field Activities and SOP 26: Habitat and Vegetation Characterization). Sampling plans designed to characterize the river water in the subtidal zone, including temperature, conductivity, and turbidity measurements, are described in Attachment 2 of FSP Volume 1 (Malcolm Pirnie, Inc., 2006).

6.3.2. Intertidal Habitat Delineation Method

Intertidal habitat will be defined as those areas exposed between low tide and high tide. [These intertidal areas include mudflat and wetland areas (refer to Section 6.3.3 "Wetland Habitat Delineation Method" for more detail).] The low tide and high tide elevations will be identified as mean low water and mean high water, respectively, from NOAA nautical charts or other suitable reference materials and will be overlaid on previously mapped bathymetric contours of the river bed. The intertidal areas will then be characterized to identify habitat area, bottom conditions (*e.g.*, sediment type, structural elements, and other habitat features), percent coverage of plants and dominant species, and observed sessile and motile fauna (refer to SOP 5: Documenting Field Activities and SOP 26: Habitat and Vegetation Characterization). If fauna are absent, then ecologists will determine potential fauna that could be present based on the habitat characteristics including substrate type, water depth, duration of tidal exposure, and floral communities.

Since the exposure of intertidal areas may vary due to environmental factors (*e.g.*, erosion, tide cycles, and rainfall), aerial photographs will be required to supplement the GIS mapping of bathymetric contours. The initial identification and the delineation of intertidal areas will be conducted by obtaining and analyzing color-infrared aerial photographs. The photographs must capture mean high high water and mean low low

water to achieve the maximum amount of subtidal exposure. (Aerial photographs will not be taken within 72 hours of a rainfall event but will be taken in the late summer-fall season at a period of low flow.) The photographs will be produced at a scale to allow the identification of intertidal areas and the extent of intertidal vegetation. The color-infrared aerial photographs will have a scale of 1 inch = 50 feet. The identified mudflats will be confirmed in the field. During this confirmation, approximate boundaries of mudflats will be established through the use of Global Positioning System (GPS) techniques (refer to SOP 4: Locating Sample Points Using a GPS). The GPS system is expected to have an accuracy of ±1 meter with regard to horizontal position.

6.3.3. Wetland Habitat Delineation Method

Freshwater and tidal wetlands may occur within the Study Area. (According to Section 404 of the Clean Water Act, the maximum elevation of jurisdictional tidal waters is the spring high tide line. With the absence of high marshes along the Lower Passaic River, the 404-demarcation will be used in this Study to delineate the extent of freshwater and tidal wetlands.) Freshwater wetlands will be defined as wetlands located in areas higher than the spring high tide elevation; hence, they are considered "non-tidal" wetlands. Conversely, tidal wetlands will be defined as wetlands located at elevations between the spring high tide and 1.8 meters (or 6 feet) below mean low water. A field investigation will be conducted to establish the extent of each wetland habitat using SOP 5: Documenting Field Activities and SOP 26: Habitat and Vegetation Characterization. The lateral extent of freshwater (non-tidal) wetlands will be identified using the techniques specified in the *Federal Manual for Identifying and Delineating Jurisdictional Wetlands* (USACE, 1989). The boundaries of the vegetated tidal wetlands and non-vegetated intertidal areas as depicted on aerial photographs will be verified by field measurements using GPS (refer to Section 6.3.2 "Intertidal Habitat Delineation Method").

During the freshwater (non-tidal) wetland delineation, approximate boundaries of freshwater wetlands will be established using GPS techniques (refer to SOP 4: Locating Sample Points Using a GPS) and the *Federal Manual for Identifying and Delineating*

Jurisdictional Wetlands (USACE, 1989). The GPS system is expected to have an accuracy of ±1 meter with regard to horizontal position. Then, maps will be prepared based on the field reconnaissance and interpretation of the aerial photographs to depict the location of freshwater wetlands and major communities within the Study Area. These maps will allow for an overlay of the proposed project alternatives and existing freshwater wetlands for presentation and evaluation in the Environmental Impact Statement (EIS). This report will also include dominant vegetation and wildlife documented during the freshwater wetland delineation (refer to SOP 5: Documenting Field Activities). If additional potential restoration areas are selected, freshwater wetland delineations of these areas will occur using the *Federal Manual for Identifying and Delineating Jurisdictional Wetlands* to identify actual metes and bounds (USACE, 1989).

6.3.4. Riparian Habitat Delineation Method

Riparian habitat will also be identified through GIS mapping and aerial photographs. Using GIS, a map will be produced that depicts the land areas that are located between mean high water and the top of bank elevation. The riparian habitats will be depicted on aerial photographs, classified by their cover type (***e.g.***, forested wetland, successional field), and field verified (refer to SOP 5: Documenting Field Activities and SOP 26: Habitat and Vegetation Characterization). The dominant flora and avifauna of each habitat will then be identified (refer to Section 7.0 "Terrestrial Vegetation Survey" and Section 8.0 "Avian Community Survey"). Upland areas that are identified as being contiguous with the riparian corridor will be noted in the field logs.

6.3.5. Critical and Sensitive Habitat Delineation Method

Critical and sensitive habitat will be defined (for the purposes of the Study) as rare habitats (***e.g.***, vernal pools) or habitats that support threatened and endangered species. Rare habitats, if present, will be identified during in the field during the habitat delineation. Threatened and endangered species will be identified by correspondence with federal and state regulatory agencies and by the extent that their corresponding habitats and ranges delineate within the Study Area (refer to literature review task

Section 14.2 “Threatened and Endangered Species”). Critical and sensitive habitat will be identified by available mapping or during the field investigation and will be marked using GPS techniques (refer to SOP 4: Locating Sample Points Using a GPS, SOP 5: Documenting Field Activities, and SOP 26: Habitat and Vegetation Characterization).

6.3.6. Habitat Features

A measure of the habitat heterogeneity at a site is required to demonstrate the success of restoration and to answer questions within the DQOs. Habitat heterogeneity is measured by comparing the number of habitat features present at a site relative to the number of possible habitat features known to occur in the reference site (refer to Section 5.0 “Reference Site Selection”). At potential restoration areas, the habitat features that will be measured (according to SOP 26: Habitat and Vegetation Characterization) include:

- Whether the river banks are eroded (or have the potential for erosion).
- Percent of vegetation overhanging the shoreline.
- Amount of vegetative protection afforded to the river bank and the near-river portion of the riparian zone.
- Width of natural vegetation from the edge of the river bank out through the riparian zone.
- Proportion of a site covered with exotic or other undesirable plant species.

In the Freshwater River Section only, additional habitat features that will be measured include:

- Relative quantity and variety of natural structures in the river, such as cobbles (riffles), large rocks, fallen trees, logs and branches, and undercut banks, that are available as refugia, feeding areas, or sites for spawning and nursery functions of aquatic macrofauna.
- Percent cover (logs, boulders, cavities, brush, debris, or standing timber) during summer within pools, backwater areas, and littoral areas.

Habitat features described in Section 6.3.6 "Habitat Features" will be measured and estimated in the field at the potential restoration areas. The habitat heterogeneity of a potential restoration area will be measured before restoration by comparing the habitat features in the restoration area relative to those features at the reference site. Habitat heterogeneity will be measured again after restoration by comparing the habitat features in the restoration area relative to both those features in the area before restoration and to those features at the reference site. Representative photos will be collected during the field survey of these habitat features.

6.4. HABITAT DELINEATION REPORTING

The sampling program will include post-processing, analysis, and interpretation of field and analytical data. The analytical approach for evaluating the habitat data as well as the performance/acceptance criteria are described in the DQOs (Attachment B, Table B1). These results, along with maps and surveys, will be included in the draft and final reports.

Land survey reports and maps that include digital data files [in GIS and Computer Aided Drafting and Design (CADD) formats] will be checked by the surveyor for completeness, topologic accuracy, unclosed polygons, missing segments, multiple or missing label points, and other extraneous (dangling) segments. Land surveys and maps will follow the requirement outlined in FSP Volume 3, Section 4.2 "Task 2 – Supplemental Land Survey" (Malcolm Pirnie, Inc., 2005b) and those requirements listed below. Vector files will meet United States National Map Accuracy Standards (http://geography.usgs.gov/standards) when field verified. Map deliverables will be produced and submitted electronically on compact disc-read only memory (CD-ROM):

- Vertical datum will be referenced to National Geodetic Vertical Datum of 1929 (NGVD29), and the horizontal datum will be referenced to the New Jersey State Plane coordinate system in feet: North American Datum of 1983 (NAD83).
- Hard-copy Mylar sets of the detailed site mapping (planimetrics and contours).

- Shoreline and planimetric electronic data in GIS [Environmental Systems Research Institute, Inc. (ESRI) shape file format] and CADD (AutoCAD 2004 and MicroStation ® Version 8 formats).
- Digital Elevation Model (DEM) elevation data in format(s) directly compatible with the latest versions AutoCAD Land Development and ESRI Spatial Analyst applications.
- Raster images of aerial photographs.

Any Wetland Delineation Report and/or a Letter of Interpretation (if necessary) will be in a format acceptable to the NJDEP and the USACE. The delineation report will document research methodology, including literature and field research, and will comply with Section 404 of the Clean Water Act. Other wetland reports or products to be prepared include the following: Wetlands Finding Summary; National Environmental Policy Act (NEPA), Section 404 Coordination Report: Conceptual Mitigation Plan and Design Documents, and a USACE 404 public notice.

7.0 TERRESTRIAL VEGETATION SURVEY

7.1. DATA NEEDS AND OBJECTIVES OF TERRESTRIAL VEGETATION SURVEY

A terrestrial flora survey will satisfy the following data needs associated with the DQOs and metrics, including EFA data acquisition (refer to Attachments B and C):

- Evaluate the terrestrial flora community, including a measure of the expanse of vegetation cover from the edge of the river bank out through the riparian zone and the proportion of a site covered with undesirable plant species.
- Support the restoration design at potential restoration areas.

The objective of the terrestrial flora survey is to characterize and inventory terrestrial flora within a given habitat. Data collected during this program will contribute to resolution of the following principal questions as developed in the DQO process (Table B1 in Attachment B) and the restoration metrics (Attachment C):

- What restoration actions would most effectively increase the ecological functions and value of the Lower Passaic River?
- To what degree have the ecological functions and value of the Lower Passaic River increased due to implementation of the restoration actions?
- Restoration metrics: *HSI-WS V9* (percent in-river and overhanging shoreline cover); *RBP Bank Vegetative Protection* (amount of vegetative protection afforded to the river bank and the near-river portion of the riparian zone); *RBP Riparian Vegetative Zone Width* (width of natural vegetation from the edge of the river bank out through the riparian zone); and *HSI-ChC V2* [percent cover (logs, boulders, cavities, brush, debris, or standing timber) during summer within pools, backwater areas, and littoral areas].

This survey will collect data to allow for the characterization of existing environmental conditions, to complete the impact analysis in the EIS, and to support the ecological

functional assessment. If post-construction monitoring of terrestrial vegetation is appropriate, then the methodology outlined in Section 7.0 "Terrestrial Vegetation Survey" will be followed.

7.2. TERRESTRIAL VEGETATION SURVEY SCOPE

The scope of the terrestrial vegetation survey task is to inventory the terrestrial vegetation in the riparian habitats in the Study Area (but not the floodplains). This survey will augment historical terrestrial vegetation data and will address the data gaps identified in Section 3.1.1 "Historical Habitat, Terrestrial Vegetation, and Aquatic Vegetation Data," which indicate that limited data exist to characterize the terrestrial vegetation communities for RM 0 to RM 17.4.

Color-infrared aerial photography in conjunction with field investigations will be employed to complete a terrestrial vegetation map. Similar to the habitat delineation (refer to Section 6.3.2 "Intertidal Habitat Delineation Method"), aerial photographs will have a scale of 1 inch = 50 feet scale and a resolution of 1 foot per pixel. The source of the photographs will be either the mapping being prepared for this Study (refer to Section 6.3 "Habitat Delineation Method") or existing mapping prepared by the State of New Jersey. Note that habitat delineation maps developed during the Study will have more current information than historical maps prepared by the state. Vegetative cover identified from the photography and located on potential restoration areas will be confirmed with field verification surveys.

7.3. TERRESTRIAL VEGETATION SURVEY METHOD

Many areas along the Lower Passaic River are disturbed and occupied by opportunistic roadside or urban vegetation. Other areas that are part of municipal and county parks are subject to landscaping activities. The terrestrial flora within these areas will be qualitatively assessed since their ecological value is low. For undisturbed areas, terrestrial flora communities will be surveyed and quantitatively assessed at designated sampling locations (Figure 7-1) to identify dominant trees, shrub layers, and herbaceous

vegetation. Table 7-1 provides a summary of the sampling locations and frequency for the proposed vegetation sampling. This sampling program will be completed within a single field surveying event, which will be conducted during the growing season (anticipated schedule: May – September 2007). Field work will be conducted by a team of ecologists who are familiar with the vegetation of New Jersey.

Table 7-1: Sampling Summary for the Terrestrial Vegetation Survey

Sample	Frequency	Location	Sample Stations per Location	Other Information
Terrestrial vegetation	1 event during the growing season (May - September).	Refer to Figure 7-1 for 20 sampling locations.	Variable - depends on linear length of restoration area. Partition each sampling location into 100-foot sampling stations.	Identify dominant trees, shrub layers, and herbaceous vegetation.

The terrestrial vegetation survey will occur along the shoreline at the designated sampling locations marked in Figure 7-1. A total of 20 sampling locations (variable in length along the river axis) have been identified from RM 2.4 to RM 17.4; these locations coincide with potential terrestrial restoration activities at locations previously identified in the *Draft Restoration Opportunities Report* (Earth Tech, Inc. and Malcolm Pirnie, Inc., 2005).

Each sampling location will be further partitioned into 100-foot long sampling stations covering the width of the riparian area. At each station, over-story trees will be identified. Each tree over 4 inches diameter at breast height (DBH) will be identified by species and its relative basal area estimated. All tree saplings (less than 4.0 inches DBH and over 4.5 feet tall) and shrubs (less than 20 feet tall with several stems) in the sampling station will be identified and enumerated by species. All woody plants less than 1-foot tall will be evaluated in an herbaceous layer. Herbaceous plants will be sampled at two 5-foot radius plots (randomly located prior to the field activities using a random number table with the resulting value being the center point of each plot). Within each plot, herbaceous plants will be enumerated for estimates of density and percent

coverage across the station. Basal stalks of woody vines for each species will be counted within the sampling station. A qualitative assessment of the maturity of the vegetation will also be provided by the field team (refer to SOP 5: Documenting Field Activities and SOP 26: Habitat and Vegetation Characterization).

7.4. TERRESTRIAL VEGETATION SURVEY REPORTING

The sampling program will include post-processing, analysis, and interpretation of field and analytical data. The analytical approach for evaluating the terrestrial vegetation data as well as the performance/acceptance criteria are described in the DQOs (Attachment B, Table B1). These results, along with maps and surveys (refer to Section 6.4 "Habitat Delineation Reporting" for mapping requirements), will be included in the draft and final reports.

8.0 AVIAN COMMUNITY SURVEY

8.1. DATA NEEDS AND OBJECTIVES OF AVIAN COMMUNITY SURVEY

An avian community survey will satisfy the following data needs associated with the DQOs and metrics, including EFA data acquisition (refer to Attachments B and C):

- Evaluate the avian community to provide data for the ecological CSM and to characterize potential restoration areas, including avian community richness (diversity indices to be determined) and abundance of wading birds, shore birds, waterfowl, migratory passerines, and belted kingfisher (*Ceryle alcyon)*(to be determined based on historical data).
- Support the restoration design at potential restoration areas.

The objectives of the avian community survey are to obtain recent inventory data, to characterize avifauna, and to evaluate avian receptors within the Study Area. Data collected during this program will contribute to resolution of the following principal questions as developed in the DQO process (Table B1 in Attachment B) and the restoration metrics (Attachment C):

- What restoration actions would most effectively increase the ecological functions and value of the Lower Passaic River?
- To what degree have the ecological functions and value of the Lower Passaic River increased due to implementation of the restoration actions?
- Restoration metrics: *LPR Vwadingbirds* [abundance of wading birds (*e.g.*, herons and egrets)]; *LPR Vshorebirds* (abundance of shore birds); *LPR Vwaterfowl* [abundance of waterfowl (*e.g.*, ducks and geese)]; *LPR Vmigratory* (abundance of migratory passerines); and *LPR Vkingfisher* (abundance of belted kingfisher).

This community survey will collect data to allow for the characterization of existing environmental conditions, to complete the impact analysis in the EIS, and to support the ecological functional assessment. If post-construction monitoring of the avian population

is appropriate, then the methodology outlined in Section 8.0 "Avian Community Survey" will be followed.

8.2. AVIAN COMMUNITY SURVEY SCOPE

The scope of the avian survey task is to inventory the avian species in the Study Area. This survey will augment available historical avian data for RM 1.0 to RM 7.0 and will address the data gaps identified in Section 3.1.2 "Historical Terrestrial Fauna Community Survey Data," which indicate that limited data exist to characterize the avian communities for RM 7 to RM 17.4.

The avian community survey will be performed after reviewing historical avian data, which will provide a summary of birds that occur within the Study Area. Avian data will be compiled for each species, including: season(s) of occurrence, species distribution, migratory status, foraging habitats, and breeding habits or requirements. The information collected will be used to develop preliminary checklists of bird species, which will be used in the field.

The avian community survey will then be conducted at designated sampling locations (refer to Section 8.3 "Avian Community Survey Method" for more detail). This avian survey will be a semi-quantitative survey where the presence or absence of avian species and abundance are determined; however, other quantitative statistics, such as density, will not be calculated. Consequently, avian ecologists will identify avifauna by visual and audible observations in the field, and on-site activity of the avifauna will be noted. Additional studies (*e.g.*, counting of individual species nest sites) may be necessary for potential restoration areas and/or demonstrating the effectiveness of restoration activities (*e.g.*, belted kingfisher populations).

8.3. AVIAN COMMUNITY SURVEY METHOD

The avian community survey will be conducted in 4 separate sampling events occurring every 3 months for 1 year (anticipated to begin September 2006) using SOP 5:

Documenting Field Activities and SOP 27: Avian Survey. The belted kingfisher monitoring program will also be continued as part of the avian community survey in the Study Area and reference site locations, according to SOP 28: Belted Kingfisher Field Monitoring.

During each sampling event, the avian survey will be conducted at designated sampling locations (Figure 7-1) and will comprise 18 survey days over a 2-month time period. Avifauna sampling locations will occur within each river mile along the Lower Passaic River (totaling 18 sampling locations from RM 0.4 to RM 17.4). Sample locations are located throughout the river, including areas that have adjacent upland or wetland habitats, mudflats, and cliffs or bridges. This distribution will allow the sampling to measure qualitatively the usage of the Lower Passaic River by different avifauna guilds: wading birds, shorebirds, waterfowl, migratory birds, and certain target species (*e.g.*, belted kingfishers). Note that geographical coordinates are not provided for the avian survey, since sampling locations displayed in Figure 7-1 represent a geographical area encompassing several habitats, not a specific sampling point. At each avian sampling location, observations will be recorded from an anchored boat located at one sampling station within the sampling location areas marked in Figure 7-1. Table 8-1 provides a summary of the sampling locations and frequency for the proposed avian sampling.

Table 8-1: Sampling Summary for the Avian Community Survey

Sample	Frequency	Location	Sample Stations per Location	Other Information
Avifauna	4 events; every 3 months for 1 year.	Every mile for a total of 18 locations (refer to Figure 7-1).	One station per sampling location (total of 18 sampling stations).[a]	At each station, the field crew will be in an anchored boat.

a. Each sampling station will be sampled on 3 separate occasions during each sampling event.

One avian sampling event will correspond to 3 observation periods at each sampling location. At least one observation period will start at official sunrise and continue for the next 2 hours. Two other 2-hour observation periods will then occur between sunrise and midday during each quarterly sampling event. Avian ecologists will identify avifauna by

visual and audible observations in the field. When observed, avifauna species will be identified and the number of individuals per species will be estimated. In addition, on-site activity of the avifauna will be noted; for example, the ecologist will assess whether the bird is passively utilizing a particular site (*i.e.*, flying over at a high altitude) or actively utilizing the site (*i.e.*, nesting, swimming, breeding or courtship displays, or feeding). At each sampling location, sampling would be rotated to capture bird usage of each site after sunrise, during mid-morning, and at midday during various tidal cycles. Sampling would only occur during periods of clement weather.

The belted kingfisher monitoring program, which was initiated by the partner agencies in 2006 (refer to Section 3.2.3 "Belted Kingfisher Field Monitoring"), will be continued as part of the avian community survey. The results from the 2006 monitoring program will guide the anticipated 2007 belted kingfisher monitoring program and will determine if any additional field monitoring or sampling is necessary. The 2007 monitoring program will follow SOP 28: Belted Kingfisher Field Monitoring and will include identifying active belted kingfisher burrow, characterizing suitable available habitat, and determining reproductive success.

8.4. AVIAN COMMUNITY SURVEY REPORTING

The sampling program will include post-processing, analysis, and interpretation of field notes and analytical data. The analytical approach for evaluating the avian data as well as the performance/acceptance criteria are described in the DQOs (Attachment B, Table B1). These results, along with maps and surveys (refer to Section 6.4 "Habitat Delineation Reporting" for mapping requirements), will be included in the draft and final reports.

9.0 AQUATIC VEGETATION SURVEY

9.1. DATA NEEDS AND OBJECTIVES OF AQUATIC VEGETATION SURVEY

An aquatic vegetation survey will satisfy the following data needs associated with the DQOs and metrics, including EFA data acquisition (refer to Attachments B and C):

- Evaluate the aquatic vegetation within the Study Area and measure the habitat heterogeneity by comparing the number of habitat types present at a site relative to the number of possible habitats known to occur at the reference site.
- Support the restoration design at potential restoration areas.

The objectives of the aquatic vegetation survey are to obtain recent inventory data and to characterize SAV within the Study Area. Data collected during this program will contribute to resolution of the following principal questions as developed in the DQO process (Table B1 in Attachment B) and restoration metric (Attachment C):

- What restoration actions would most effectively increase the ecological functions and value of the Lower Passaic River?
- To what degree have the ecological functions and value of the Lower Passaic River increased due to implementation of the restoration actions?
- Restoration metric: *HGM-TFW VNHC* (a measure of the habitat heterogeneity of a site based on the comparison of the number of subhabitat types present at a site relative to the number of possible subhabitats known to occur in the reference site).

No known historical SAV survey exists to determine the presence or absence of SAV within the Lower Passaic River. In the proposed SAV survey, it is assumed that measurable SAV beds (greater than 1 meter^2 in size) occur within the Lower Passaic River (RM 0 to RM 17.4); however, SAV beds are probably unlikely in this system. Tributaries will be surveyed once they have been prioritized as potential restoration areas (refer to Section 1.4 “Potential Restoration Areas”). The aquatic vegetation survey will

collect data to allow for the characterization of existing environmental conditions, to complete the impact analysis in the EIS, and to support the ecological functional assessment. If post-construction monitoring of aquatic vegetation is appropriate, then the methodology outlined in Section 9.0 "Aquatic Vegetation Survey" will be followed.

9.2. AQUATIC VEGETATION SURVEY SCOPE

The scope of the aquatic vegetation task is to inventory the aquatic vegetation, including SAV beds but not wetland emergent vegetation. This survey will address the data gaps identified in Section 3.1.1 "Historical Habitat, Terrestrial Vegetation, and Aquatic Vegetation Data," which indicate that limited data exist to characterize the aquatic vegetation communities for RM 0 to RM 17.4 and no historical data are available to characterize SAV beds.

The aquatic vegetation survey will be completed through field reconnaissance. These investigations will include observations that will determine the range of aquatic vegetation species present and identification of the dominant species. Information gathered during this sampling program will be used to assess the presence of SAV and potential impacts due to SAV, including the removal of the SAV bed. Data will also be used to understand the impacts of SAV on local hydrology and re-suspended sediment. Once field observations and data collection is completed, maps will be generated depicting the location of wetland communities and ecological habitats within the near-shore zone (refer to Section 6.3.3 "Wetland Habitat Delineation Method"). These maps will allow for an overlay of proposed sampling activities, and therefore, determine the extent of impacts to wetlands

9.3. AQUATIC VEGETATION SURVEY METHOD

The extent of SAV beds will be estimated based on aerial photography and field observations. The aerial photography will involve specific fly-time and fly-patterns to capture late summer conditions at low tide on the river; however, some near-bank width of the river may be obscured by overhanging trees. Identified SAV beds will then be

confirmed in the field by visual surveys and will be characterized to the greatest extent feasible (refer to SOP 5: Documenting Field Activities and SOP 26: Habitat and Vegetation Characterization). SAV surveys will be conducted once in the late summer at low tide (for best visibility) by a plant ecologist (anticipated schedule August-September 2007) from RM 0 to RM 17.4. SAV beds will be characterized by estimates of density and percent coverage of dominant species within each major distinct bed. Plant density will be estimated by counting the number of stems per species in a 1-meter^2 quadrat. The number of quadrats used per SAV bed will vary depending on its size and configuration. Density information will be extrapolated to estimate the percent coverage within the bed. The boundaries of the SAV beds will be recorded using GPS techniques with a ±1 meter horizontal accuracy (refer to SOP 4: Locating Sample Points Using GPS).

9.4. AQUATIC VEGETATION SURVEY REPORTING

The sampling program will include post-processing, analysis, and interpretation of field notes and analytical data. The analytical approach for evaluating the aquatic vegetation data as well as the performance/acceptance criteria are described in the DQOs (Attachment B, Table B1). These results, along with maps and surveys (refer to Section 6.4 "Habitat Delineation Reporting" for mapping requirements), will be included in the draft and final reports.

10.0 FISH COMMUNITY SURVEY

10.1. DATA NEEDS AND OBJECTIVES OF FISH COMMUNITY SURVEY

A fish community survey will satisfy the following data needs associated with the DQOs and metrics, including EFA data acquisition (refer to Attachments B and C):

- Evaluate the fish community survey to support the ecological and human health risk assessments and to characterize potential restoration areas by measuring fish diversity (diversity indices to be determined) and abundance of perturbation-tolerant fish (species to be determined).
- Support the restoration design at potential restoration areas.

The objectives of the fish community survey are to obtain recent inventory data, to characterize fish populations and assemblages in the Study Area, to identify edible fish species, to identify fish preferred for consumption, and to evaluate receptors within the Study Area. Data collected during this program will contribute to resolution of the following principal questions as developed in the DQO process (Table B1 in Attachment B) and restoration metrics (Attachment C):

- What restoration actions would most effectively increase the ecological functions and value of the Lower Passaic River?
- To what degree have the ecological functions and value of the Lower Passaic River increased due to implementation of the restoration actions?
- Restoration metrics: *LPR Vfishdiversity* (overall diversity of fish); *LPR Vanadromous* (abundance of anadromous fish); *LPR Vcatadromous* (abundance of catadromous fish); and *LPR Vtolerantfish* (abundance of fish tolerant of perturbation).

Fish samples collected during the fish community survey will be used in the tissue-residue sampling program (refer to Section 12.0 "Biological Tissue-Residue Sampling" for data needs and DQO questions). This community survey will collect data to allow for the characterization of existing environmental conditions, to complete the impact analysis

in the EIS, and to support the ecological functional assessment. [For the purposes of the Study, shellfish sampling will be incorporated into the benthic invertebrate community survey (refer to Section 11.0 "Benthic Invertebrate Community Survey").] If post-construction monitoring of the fish population is appropriate, then the methodology outlined in Section 10.0 "Fish Community Survey" will be followed.

10.2. FISH COMMUNITY SURVEY SCOPE

The scope of the fish survey task is to inventory the fish populations in the Study Area. This survey will address the data gaps identified in Section 3.1.3 "Historical Fish Community Survey Data," which indicate that limited data exist to characterize the fish communities for RM 7 to RM 17.4 while fish data from RM 1.0 to RM 7.0 do not consider seasonal variation.

Fish community surveys will be conducted in the Lower Passaic River from river mile 0-17. The surveys will include sampling by gill net, minnow traps, and eel traps. These sampling methods are appropriate data to survey the fish species (and their life stages) that inhabit the water bodies of the Study Area and to document fish migration (*i.e.*, runs) in the Lower Passaic River. [Shellfish will be incorporated into the benthic invertebrate community survey (refer to Section 11.0 "Benthic Invertebrate Community Survey").] Trawling and seine netting are not recommended since floating and submerged debris and/or loose substrate would restrict their application. Electro-shocking may be possible in the Freshwater River Section, provided that the conductivity is low.

The proposed bi –monthly sampling is necessary to gain a full evaluation of the river's functional ecology and to collect the necessary data for a valid comparison of the existing conditions before and after the restoration efforts. Bi-monthly sampling would provide a comprehensive analysis of anadromous and catadromous fish usage. This sampling scheme would also identify other fish species that may be present during brief periods of time, such as shad or winter flounder, and potentially other species [*e.g.*, different life stages of red hake (*Urophycis chuss*), windowpane flounder (*Scophthalmus aquosus*),

Atlantic sea herring (*Clupea harengus*), bluefish (*Pomatomus saltatrix)*, summer flounder (*Paralichthys dentatus*), and scup (*Stenotomus chrysops*)].

10.3. FISH COMMUNITY SURVEY METHOD

The fish community survey will be conducted in 6 separate sampling events covering one day and one night every other month for 1 year (anticipated to begin September 2006) using SOP 5: Documenting Field Activities and SOP 29: Fish Surveys, Collection, and Tissue Sampling. Sampling will occur at designated sampling locations approximately every 2 miles (totaling 9 sampling locations from RM 0.6 to RM 16.5). Each sampling location will encompass approximately 675 meter^2 and will include areas in the deepest part of the river and near the bank (Figure 7-1). Note that geographical coordinates are not provided for the fish survey, since sampling locations displayed in Figure 7-1 represent a geographical area encompassing several habitats, not a specific sampling point. Table 10-1 provides a summary of the sampling locations and frequency for the proposed fish sampling program.

Table 10-1: Sampling Summary for the Fish Community Survey

Sample	Frequency	Location	Sampling Stations per Location	Other Information
Fish	6 events; every 2 months for 1 year.	Every two miles for a total of 9 locations (refer to Figure 7-1).	One station per sampling location (total of 9 sampling stations).	Each sampling location will encompass an area approximately 675 meter^2. The number and exact location of fish traps and gill nets are to be determined.

The selection of the sampling locations was based on consideration of the following four criteria: (1) the sampling location is representative of its respective 2-mile stretch, respectively; (2) the sampling location is in some way accessible by land; (3) the sampling location is situated near a confluence with a tributary, potential restoration area, or other areas of interest; and (4) the sampling location is isolated from potential damage by boat traffic and theft or vandalism.

10.3.1. Gill Net Sampling Technique

Gill nets approximately 45 meters (or 150 feet) long and comprised of 6 panels with varying mesh sizes will be deployed. The nets will be anchored with weights and buoy lines and will be deployed perpendicularly to the shore during the late afternoon and retrieved the following morning. Netted fish will be used for both the fish community survey and tissue sample collection (refer to Section 12.0 "Biological Tissue-Residue Sampling"). Fish removed from the gill net will be identified, counted, weighed, measured for total length, and examined for gross pathological abnormalities (including deformities, fin erosion, lesions, and tumors). If gross abnormalities are present, then these abnormalities will be photographed and described to satisfy NRDA requirements. Captured-live fish will be either returned to the water alive or will be used in the tissue sampling program (refer to Section 12.0 "Biological Tissue-Residue Sampling"). Fish that succumb during capture will be preserved (according to SOP 29: Fish Surveys, Collection, and Tissue Sampling) and used in the tissue sampling program, or will be disposed of at a suitable facility (according to SOP 22: Management and Disposal of Investigation Derived Waste). The number and exact location of gill nets are to be determined.

10.3.2. Baited Minnow and Eel Trap Sampling Techniques

Baited minnow and eel traps will be deployed in conjunction with each gill net set. Baited traps will be anchored on the shoreline and will be deployed during the day on an incoming tide to ensure that the traps will be submerged for one full tidal cycle (12 hours). If traps cannot be deployed during incoming tide, they will be deployed with the gill nets. Fish caught in the traps will be used for the fish community survey and tissue sample collection (refer to Section 12.0 "Biological Tissue-Residue Sampling"). Fish removed from the traps will be identified, counted, weighed, measured for total length, and examined for gross pathological abnormalities (including deformities, fin erosion, lesions, and tumors). If gross abnormalities are present, then these abnormalities will be photographed and described to satisfy NRDA requirements. Captured-live fish will be either returned to the water alive or will be used in the tissue sampling program (refer to

Section 12.0 “Biological Tissue-Residue Sampling”). Fish that succumb during capture will be preserved (according to SOP 29: Fish Surveys, Collection, and Tissue Sampling), or will be disposed of at a suitable facility (according to SOP 22: Management and Disposal of Investigation Derived Waste). The number and exact location of traps are to be determined.

10.4. FISH COMMUNITY SURVEY REPORTING

The sampling program will include post-processing, analysis, and interpretation of field notes and analytical data. The analytical approach for evaluating the fish data as well as the performance/acceptance criteria are described in the DQOs (Attachment B, Table B1). These results, along with maps and surveys (refer to Section 6.4 “Habitat Delineation Reporting” for mapping requirements), will be included in the draft and final reports.

11.0 BENTHIC INVERTEBRATE COMMUNITY SURVEY

11.1. DATA NEEDS AND OBJECTIVES OF BENTHIC COMMUNITY SURVEY

A benthic invertebrate community survey will satisfy the following data needs associated with the DQOs and metrics, including EFA data acquisition (refer to Attachments B and C):

- Evaluate the benthic invertebrate community survey to support the ecological risk assessment and human health risk assessment, to characterize potential restoration area, and to measure benthic community richness (diversity indices to be determined) and the abundance of perturbation-tolerant species (species to be determined).
- Evaluate benthic species to complement the SPI (refer to Section 3.2.1 "Sediment Profiling Imaging).
- Support the restoration design at potential restoration areas.

The objectives of the benthic invertebrate community survey are to obtain recent inventory data, to characterize the benthic invertebrate communities in the Study Area, to identify benthic species to complement the SPI data, and to evaluate receptors within the Study Area. Data collected during this program will contribute to resolution of the following principal questions as developed in the DQO process (Table B1 in Attachment B) and restoration metrics (Attachment C):

- What restoration actions would most effectively increase the ecological functions and value of the Lower Passaic River?
- To what degree have the ecological functions and value of the Lower Passaic River increased due to implementation of the restoration actions?
- Restoration metrics: *RBP Total Number of Taxa* (measures the overall variety of the macroinvertebrate assemblage) and *RBP Percent Pollution Tolerant Organisms* (percent of infaunal macrobenthos tolerant of perturbation).

The benthic invertebrate survey will characterize the benthic invertebrates, including shellfish, present in the biological active zone (BAZ), which encompasses the top 4-8 inches of the sediment bed. Collected samples will be used in the tissue-residue sampling program (refer to Section 12.0 "Biological Tissue-Residue Sampling" for data needs and DQO questions) and the toxicity test sampling program (refer to Section 13.0 "Toxicity Testing" for data needs and DQO questions). This community survey will also collect data to allow for the characterization of existing environmental conditions, to complete the impact analysis in the EIS, and to support the ecological functional assessment. If post-construction monitoring of the benthic invertebrate population is appropriate, then the methodology outlined in Section 11.0 "Benthic Invertebrate Community Survey" will be followed.

11.2. BENTHIC INVERTEBRATE COMMUNITY SURVEY SCOPE

The scope of the benthic invertebrate survey task is to inventory the benthic species in the top 4-8 inches of the sediment beds. This survey will address the data gaps identified in Section 3.1.4 "Historical Benthic Invertebrate Community Survey Data." Although a limited benthic sampling program occurred in the Lower Passaic River in June 2005 (refer to Section 3.2.1 "Sediment Profiling Imaging), a comprehensive benthic sampling program that provides seasonal data on benthic assemblages that utilize both the intertidal and subtidal sediments of the Lower Passaic River is warranted.

As part of this comprehensive program, quarterly sampling is proposed to provide appropriate data to demonstrate the potential success, and need for, restoration. This benthic invertebrate program would also compliment the fish sampling program (refer to Section 10.3 "Fish Community Survey Method") since benthic invertebrates comprise a portion of the diet of certain fish species that may be present in the river during brief periods of time (*e.g.*, winter flounder (*Pleuronectes americanus*), anadromous and catadromous fish). Quarterly sampling would also fulfill the DQO goal of measuring the overall variety of the macroinvertebrate assemblages.

11.3. BENTHIC INVERTEBRATE COMMUNITY SURVEY METHOD

The benthic invertebrate community survey will be conducted in 4 separate sampling events occurring every 3 months for 1 year (anticipated to begin September 2006) using SOP 5: Documenting Field Activities, SOP 30: Benthic Invertebrate Community Survey and Sampling, and SOP 31: Crab Collection and Tissue Sampling. However, the blue crab sampling will not occur during the winter quarterly event since these crabs tend to move to deeper waters in the winter. During the growing season (anticipated May-September 2007), one sampling event of the benthic invertebrate survey will coincide with the toxicity test sampling program (refer to Section 13.0 "Toxicity Testing") and will include 90 sampling stations. During the remaining 3 sampling events, the benthic invertebrate survey will only be conducted at 45 of the 90 designated sampling stations (the specific 45 sampling stations to be determined).

Similar to the Fish Community Survey (Section 10.0 "Fish Community Survey"), the Lower Passaic River will be segregated into eight 2-mile-long units, or sampling locations, with the last unit equal to 3.4 miles (from RM 14 to RM 17.4). Each unit of the river will be further segregated into two strata, "subtidal" and "intertidal," based on available bathymetry data and habitat conditions. The benthic invertebrate survey will be conducted at 6 subtidal sampling stations and 6 intertidal sampling stations within each 2-mile unit (Figure 11-1). Sampling stations were identified by randomly locating the required sample numbers within the bathymetrically-defined GIS polygons using a geostatistical software program (Visual Sample Plan®, Version 4.4, Statistical Sciences, Pacific Northwest National Laboratory; http://dqo.pnl.gov/index.htm). Limited intertidal habitat is present between RM 0 to RM 2.0 (Figure 11-1a) and the single identified intertidal area (just upriver of the Route 1 Bridge at RM 1.8) was combined with the other RM 2.0 to RM 4.0 intertidal sampling stations. Hence, there are a total of 42 intertidal sampling stations from RM 1.8 to RM 15.5 and 48 subtidal sampling stations from RM 0.6 to RM 17.4 (Figure 11-1). Attachment D, Table D1 contains a list of geographical coordinates corresponding to the benthic invertebrate sampling locations

presented on Figure 11-1. Since these locations have not yet been confirmed by a field reconnaissance, professional judgment may be necessary to adjust locations in the field.

At each sampling station, benthic samples will be obtained in triplicate for statistical analysis [*e.g.*, taxon richness, dominance index, and species diversity (refer to Section 11.3.2 "Benthic Invertebrate Evaluation")], except for the blue crab traps. Table 11-1 provides a summary of the sampling locations and frequency for the proposed benthic invertebrate sampling.

Table 11-1: Sampling Summary for the Benthic Invertebrate Community Survey

Sample	Frequency	Location	Sampling Stations per Location	Other Information
Benthic Invertebrate	4 events; every 3 months for 1 year.	Eight 2-mile-long units of the river (refer to Figure 11-1).	6 subtidal and 6 intertidal sampling stations per 2-mile unit of the river.	Stations will be located in varying water depths. Samples collected in triplicate at each station.
Blue Crab (*Callinectes sapidus*)	3 events; no collection in the winter.	Same as benthic invertebrate.	Same as benthic invertebrate.	Stations will be located in varying water depths.

11.3.1. Benthic Invertebrate Sampling Techniques

Benthic habitats in the Lower Passaic River consist of rock bottom, soft substrate, or vegetation (*i.e.*, dense emergent or SAV). The bottom conditions at each benthic invertebrate sampling location will dictate which sampling device will be used; however, it is anticipated that for most areas of the Lower Passaic River soft-substrate sampling would be needed. Processing and collecting benthic invertebrates will follow SOP 30: Benthic Invertebrate Community Survey and Sampling and SOP 31: Crab Collection and Tissue Sampling.

Rocky Bottom sampling stations will employ an artificial substrate sampler, such as a rock basket. A rock basket is an 18-inch long, 10-inch diameter chicken wire cylinder filled with rocks. (For this sampling technique, 3 replicates will be collected at each sampling location.) The rock basket is placed on the river bottom for 4 to 6 weeks. *In-*

situ water quality measurements (*i.e.*, temperature, salinity, and dissolved oxygen) will be collected at each sampling location. Upon retrieval, the rock basket will be placed in a large tub containing water with preservative (10% solution of buffered formalin or equivalent preservative) and delivered to the laboratory according to SOP 30: Benthic Invertebrate Community Survey and Sampling. The basket will be opened in the laboratory, and the rocks will be carefully removed. Sessile organisms attached to the rocks and motile fauna will be identified to the lowest practicable taxon (minimum taxon classification is *Genus*) and will be counted.

Soft Substrate sampling stations will employ either a petite ponar or Ekman grab based on field conditions. For this sampling technique, 3 replicates will be collected at each sampling location for statistical analysis. Sampling will be conducted from a boat, and *in-situ* water quality measurements (*i.e.*, temperature, salinity, and dissolved oxygen) will be collected at each location. All samples will be sieved in the field, and the material remaining on the sieve will be placed in sample jars according to SOP 30: Benthic Invertebrate Community Survey and Sampling. Samples will be shipped to a selected laboratory for sorting and analysis. In the laboratory, each benthic sample will be washed again through a U.S. Standard No. 30 sieve to remove any additional fine sediment. All organisms removed from the sample will be identified under a microscope to the lowest practical taxon (minimum taxon classification is *Genus*) and counted. For comparative purposes and quality control, a representative specimen of each species will be preserved and maintained in a reference collection. The remaining material will be placed back into the labeled sample jar with preservative solution for possible future quality control checks.

Vegetated Area sampling stations will involve in-field counting of sessile organisms within a 0.25-meter^2 quadrat. For this sampling technique, 3 replicates will be collected at each sampling location for statistical analysis. All vegetation within the quadrat will be inspected for the presence of benthic organisms (*e.g.*, snails and mussels). All benthic

invertebrates observed will be identified to the lowest practicable taxon (minimum taxon classification is *Genus*) and counted. Due to the limited wetland and SAV resources, removal of vegetation to count organisms in a laboratory is not anticipated.

Crab traps are designed to capture large crabs [*e.g.*, blue crabs (*Callinectes sapidus*)] in deeper waters of the Lower Passaic River (refer to SOP 31: Crab Collection and Tissue Sampling). Since the crabs collected during the benthic invertebrate survey will also be used for tissue analysis, sufficient traps will be deployed at each sampling station to collect the required number of individual crabs to satisfy the tissue-residue sampling program (refer to Section 12.3 "Tissue-Residue Sampling Method"). Captured-live crabs will either be returned to the water alive or will be used in the tissue sampling program (refer to Section 12.0 "Biological Tissue-Residue Sampling"). Crabs that succumb during capture will be preserved (according to SOP 31: Crab Collection, and Tissue Sampling), or will be disposed of at a suitable facility (according to SOP 22: Management and Disposal of Investigation Derived Waste).

11.3.2. Benthic Invertebrate Evaluation

Benthic invertebrates collected at each sampling station will be prepared and identified to the lowest practical taxon (minimum taxon classification is *Genus*). This information will then be used to describe the benthic community. A statistical comparison for ecological metrics will be conducted between the benthic invertebrates observed at Lower Passaic River sampling stations and those benthic invertebrates observed at the reference sites (refer to Section 5.0 "Reference Site Selection"). Typical ecological metrics will include:

Taxon Richness will be determined by counting the different number of taxa per replicate. For example, if 5 taxa are observed in a replicate, then the species richness is 5. The average of the 3 replicates will then be computed. Data from each replicate will be pooled together to determine the total number of taxa observed at each sampling location.

Dominance Index will be computed by determining the total percent composition of the 3 most abundant species. This computation will be performed by first determining the 3 taxa with the highest individual abundance in a replicate. The percent composition of these 3 taxa will be determined by dividing the abundance (*i.e.*, the total number of individuals of the 3 taxa) by the total number of all individuals in the replicate.

Abundance of Indicator Species will be determined by enumerating the taxa within each replicate that are neither Oligochaeta nor Chironomidae. In general, species of oligochaetes and chironomids are tolerant of pollution stress and, therefore, are species indicative of an unhealthy ecosystem. (Note that some polychaetes species are tolerant of pollution stress and can also serve as an indicator of an unhealthy ecosystem). As described above, data from each replicate will be pooled together to determine the total number of indicator species observed at each station.

Species Diversity will be determined using the Shannon-Wiener function (Krebs, 1977).

In addition to the metrics mentioned above, subsequent exploratory analyses will determine the cause of the observed patterns using multivariate techniques. Classification analysis is a multivariate technique recommended for evaluating benthic invertebrate communities in the Great Lakes by the International Joint Commission (International Joint Commission, 1988). The key attributes of the approach are that it provides an integrative evaluation of all benthic taxa and has the power to detect relatively subtle patterns (International Joint Commission, 1988).

11.4. BENTHIC INVERTEBRATE COMMUNITY SURVEY REPORTING

The sampling program will include post-processing, analysis, and interpretation of field and analytical data. The analytical approach for evaluating the benthic invertebrate data as well as the performance/acceptance criteria are described in the DQOs (Attachment B, Table B1). In addition, results from the evaluation of the benthic data, including the

ecological metrics presented in Section 11.3.2 “Benthic Invertebrate Evaluation” will be presented and discussed. These results, along with maps and surveys (refer to Section 6.4 “Habitat Delineation Reporting” for mapping requirements), will be included in the draft and final reports.

12.0 BIOLOGICAL TISSUE-RESIDUE SAMPLING

12.1. DATA NEEDS AND OBJECTIVES OF TISSUE-RESIDUE SAMPLING

Biological tissue-residue sampling and analysis will satisfy the following data needs associated with the DQOs and will support the human health risk assessment and the baseline ecological risk assessment (refer to Attachment B):

- Evaluate potential risks to piscivorous and omnivorous wildlife species, which catch and consume fish and shellfish from the Study Area.
- Evaluate potential exposure to Anglers/Sportsmen and Homeless Residents, who may catch and consume sportfish and shellfish from the Study Area.
- Evaluate potential exposure to aquatic receptors, including shellfish (*e.g.*, blue crab) and fish.
- Develop a numerical estimate of the relationship between sediment and biological tissue-residue concentrations [*i.e.*, biota-sediment accumulation factors (BSAF)] for use in estimating tissue concentrations in dose models.
- Develop a numerical estimate of the relationship between maternal and egg fish tissue concentration [*i.e.*, biotransfer factor (BTF)] for use in estimating exposures to early life stage embryos.
- Develop an exposure factor for prey items in dose assessment models for assessing risk to higher trophic-level organisms, including piscivorous birds [*e.g.*, belted kingfisher (*Ceryle alcyon*), double-crested cormorant (*Phalacrocorax auritus*)] and mammals [*e.g.*, river otter (*Lutra Canadensis*)].
- Share pertinent data collected in support of restoration actions with NRDA data users.

The objectives of the biological tissue-residue sampling are to obtain the site-specific analytical data necessary to estimate exposures to human and ecological receptors and to estimate bioaccumulation for the purpose of calibrating and validating the bioaccumulation model. Data collected during the tissue-residue sampling program will

contribute to resolution of the following principal questions as developed in the DQO process (Tables B2 through B4 in Attachment B):

- Are exposures to site-related chemical stressors throughout the Lower Passaic River posing an unacceptable risk to fish populations?
- Do contaminants of concern in biota (fish and crab) pose an unacceptable current or future risk to human receptors and piscivorous and omnivorous wildlife species?

It is anticipated that the fish and shellfish tissue samples will be collected as part of the Fish Community Survey (refer to Section 10.0 "Fish Community Survey") and the Benthic Invertebrate Community Survey (refer to Section 11.0 "Benthic Invertebrate Community Survey"). To better assess bioaccumulation and sediment toxicity, additional forage fish samples will be collected at sampling locations where both composite surface sediments are planned to be collected (to be addressed in a future, updated FSP Volume 1) and macroinvertebrate bioassays are anticipated (refer to Section 13.0 "Toxicity Testing").

12.2. TISSUE-RESIDUE SAMPLING SCOPE

The scope of the tissue-residue task is to evaluate contaminant residue in the tissue of fish and shellfish species collected in the Study Area. This task will address the data gaps identified in Section 3.1.5 "Historical Biological Tissue-Residue Data," which indicate that limited data exist to satisfy the human health risk assessment and the ecological risk assessment.

Aquatic organisms, such as finfish and shellfish, are potentially exposed to contaminants from multiple exposure routes, including direct contact with sediment and surface water as well as from ingestion of their prey. As a result, aquatic organisms are "integrators" of contaminants. To assess the contamination in the finfish and shellfish populations, tissue-residue samples consisting of whole-body organisms, fillets, or selected tissues of target organisms will be collected from the Study Area. Sportfish, shellfish, and their associated edible portions will be collected to support the human health risk assessment

while forage and higher trophic level fish species and shellfish will be collected for the ecological risk assessment. The study sampling design was developed following the *USEPA Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories* (USEPA, 2000b).

12.2.1. Tissue-Residue for Human Health Risk Assessment

Tissue-residue samples for the human health risk assessment will target those species that have a relatively high abundance in the Study Area and may be appreciably consumed by humans (*e.g.*, recreational anglers/sportsmen). The *Passaic River Study Area Creel/Angler Survey* (Desvousges, *et al.*, 2001) identified the white perch (*Morone americana*) and American eel (*Anguilla rostrata*) as the most commonly caught fish at 56% and 17%, respectively. Striped bass (*Morone saxatilis*), catfish (no specific species), and carp comprised 20% of the catch while crab accounted for the remaining 7.5% of the catch. Target species selected for tissue-residue analysis were based on the consumption data from this survey, historical fish community surveys (refer to Section 3.1.3 "Historical Fish Community Survey Data"), and the needs of the human health risk assessment. These target species are:

- White perch, *Morone americana* (predatory).
- American eel, *Anguilla rostrata* (bottom feeder of crabs, fish, and crayfish).
- Blue crab, *Callinectes sapidus* (bottom feeder).

In addition to being commonly caught, these three species inhabit brackish waters and freshwaters, and therefore, they are suitable target species for the entire river. The target species were further selected to encompass two distinct ecological groups of fish: bottom-feeders and predators. The selection of two groups of fish allows for the assessment of a variety of habitats, feeding strategies, and physiological factors that are anticipated to result in different exposures and uptake rates of contaminants. For instance, bottom-feeding species may bioaccumulate contaminants from direct physical contact with contaminated sediment or by consuming epibenthic organisms and benthic invertebrates that live in contaminated sediment. Predator species are good indicators of persistent

contaminants, such as mercury, DDT, or polychlorinated dibenzodioxins/furans (PCDD/F), which may be biomagnified through several trophic levels of the food web.

12.2.2. Tissue-Residue for Ecological Risk Assessment

Tissue-residue samples for the ecological risk assessment will target species that represent the forage base for predatory fish and higher trophic-level piscivorous receptors (*e.g.*, wading birds, raptors, and mammals). Target species for the Brackish and Transitional River Sections include:

- Mummichog, *Fundulus heteroclitus* (forage fish).
- White perch, *Morone americana* (predatory).
- American eel, *Anguilla rostrata* (bottom feeder of crabs, fish, and crayfish).
- Blue crab, *Callinectes sapidus* (bottom feeder).

Target species for the Freshwater River Section include:

- Darter, shiners, killifish, or dace (forage fish).
- White perch, *Morone americana* (predatory).
- American eel, *Anguilla rostrata* (bottom feeder of crabs, fish, and crayfish).
- Blue crab, *Callinectes sapidus* (bottom feeder).

The mummichog and Atlantic silverside (*Menidia menidia*) are important forage fish that are relatively abundant in brackish and tidal creeks and comprise a majority of the food for predatory fishes. Mummichogs are opportunistic bottom-feeders; hence, they have a close association with sediments and ingest sediment-associated organisms such as invertebrates; amphipods; epibenthic, free-swimming, floating, and demersal fish eggs; and various worms. These aquatic organisms represent a potentially significant pathway of contaminant transfer from sediment to higher trophic-level organisms, such as striped bass and white perch, which are important secondary consumers and are likely dominant predatory species within the Study Area. Common carp (*Cyprinus carpio*) and channel

catfish (*Ictalurus punctatus*) are freshwater demersal fish that have close association with sediments and are likely to be present in the Freshwater River Section.

12.3. TISSUE-RESIDUE SAMPLING METHOD

Fish and crab samples will be obtained during the fish community survey (refer to Section 10.0 "Fish Community Survey") and the benthic invertebrate community survey (refer to Section 11.0 "Benthic Invertebrate Community Survey"). The anticipated schedule is to sample white perch and mummichog (gravid females only) in April-May 2007 and again in August-September 2007 along with other target species. The spring sampling period will include analysis of both maternal and egg tissue concentrations, whereas only adult organisms will be sampled in late summer.[3] Specimens will be collected and shipped to a laboratory for analysis. Processing of tissue samples will occur at the laboratory following SOP 29: Fish Surveys, Collection, and Tissue Sampling, SOP 31: Crab Collection and Tissue Sampling, and SOP 32: Field and Laboratory Processing of Fish and Invertebrate Tissue.

12.3.1. Tissue-Residue Sampling for Human Health Risk Assessment

Table 12-1 provides a summary of the target species (and alternative species), tissue matrix, and number of tissue samples required to support the human health risk assessment. Each tissue sample will be comprised entirely of a single species, and to the extent possible, a tissue sample will include individuals of comparable age, sex, length, and weight. In the event that a sufficient quantity of the same sex and size class of a particular species is not obtained during sampling activities, tissue from either the opposite sex or from a different size class (but never different species) will be added to achieve the desired mass (note that sex has higher priority than size).

[3] The need for additional sampling of biota tissue to support the food-web model and better define seasonal variability in residue concentrations will be determined following a literature review of available bioenergetic data (refer to Section 14.1 "Food Web Structure and Bioenergetics").

In the event that target species are not available, alternate species (*e.g.*, catfish, carp, and striped bass) will be substituted. Past studies have indicated that it may be difficult to obtain sufficient numbers of each target species and that it may be necessary to collect alternative species to meet sample number requirements. For example, if a sufficient number of American eels cannot be obtained to meet evaluation requirements, striped bass, catfish, or carp may be collected instead. These alternative species, which have similar habitat characteristics to the target species, have been identified for tissue-residue sampling and are indicated in Table 12-1.

Table 12-1: Summary of Targeted Species to Support the Baseline Human Health Risk Assessment

Targeted Fish Species	**Tissue Matrix**	**Number of 2-mile-long Units in the River [a]**	**Number of Tissue Samples per 2-mile Unit**	**Total Number of Tissue Samples**
Lower Passaic River – Brackish and Transitional River Sections				
White Perch (*Morone americana*)	Edible fillet	4	10	40
American Eel (*Anguilla rostrata*)	Skin-off/Gutted whole body [b]	4	10	40
Blue Crab *(Callinectes sapidus)*	All soft tissue Edible tissue [c] Hepatopancreas [d]	4 4 4	10 1 1	40 4 4
Alternative Species: Striped Bass, Catfish, Common Carp				
Lower Passaic River –Freshwater River Section				
White Perch (*Morone americana*)	Edible fillet	4	10	40
American Eel (*Anguilla rostrata*)	Skin-off/Gutted whole body [b]	4	10	40
Blue Crab *(Callinectes sapidus)*	All soft tissue Edible tissue [c] Hepatopancreas [d]	4 4 4	10 1 1	40 4 4

a: A 2-mile-long unit as defined for the fish community survey and benthic invertebrate survey.
b: Sample preparation technique selected to be consistent with local eating habits.
c: Edible tissue includes thoracic, claw, leg, and tail meat sections.
d: Composite samples of hepatopancreas tissue collected from numerous crabs (up to 15 – 30) will be required to meet the analytical requirement of 10 grams for the PCDD/F congeners. If it is not possible to collect a sufficient number of crabs for the additional hepatopancreas/edible tissue samples from each sampling station, the sampling may be reduced to so that at least one set of samples is obtained from the Brackish, Transitional, and Freshwater River Sections.

The number of tissue samples required to meet DQO specifications was determined based on the variability of the historical biological tissue-residue data and USEPA guidance documents (USEPA, 2002 and USEPA, 2004b). For each target species (or alternative

species, where appropriate), 10 tissue samples are required for every 2-mile unit of the river as defined by the fish community survey (Section 10.3 "Fish Community Survey Method") and the benthic invertebrate community survey (Section 11.3 "Benthic Invertebrate Community Survey Method"). Since there are eight 2-mile units[4] and 10 tissue samples per unit, a total of 80 tissue samples will be collected for each target species to support the human health risk assessment (Table 12-1). Sampling will occur between late summer and early fall to avoid the spring spawning season since contaminant tissue concentrations may decrease during this time in target finfish species (USEPA, 2000b). The sampling program is designed to allow the substitution of alternative species at individual sampling locations when a target species is not available; however, the use of an alternate species at one sampling location does not justify collecting an alternate species at another sampling location. At each location, a sample most closely reflecting the intended target will be collected, and a consistent hierarchy of alternative species selection will be used from station to station when the target species is not available.

Each tissue sample for the tissue-residue sampling program must satisfy the requirements listed in Table 12-2, including the target species, size requirements, and anticipated number of individuals that may be required to provide the target tissue mass. Since the required sample mass to complete the analytical work is approximately 150 grams, composite samples of fillets from individual fish (approximately 3 to 4 fishes) will be necessary to obtain adequate sample mass for tissue-residue analysis. (Composite samples are defined as homogeneous mixtures of samples from two or more individual organisms of the same species collected at a particular site and analyzed as a single sample.) The target chemical classes and analytes for tissue-residue sampling were identified based on the results of the preliminary chemical screening in the *Pathways Analysis Report* (Battelle, 2005). These target chemical classes include: metals, methyl mercury and tributyl tin, SVOCs and PAHs [total of 34 PAHs, including C1 – C4

[4] The last unit of the river will encompass 3.4 miles (from RM 14.0 to RM 17.4).

alkylated series, necessary to derive Equilibrium-Sediment Benchmarks (ESB; USEPA, 2004c)], pesticides, PCBs (Aroclors and congeners), and PCDD/F congeners [refer to the *Pathways Analysis Report* (Battelle, 2005) for analyte-specific compounds within each chemical class]. Note that VOCs will not be analyzed because their chemical properties limit bioconcentration in biological tissue.

For crabs, composite samples will include soft tissues,[5] including the hepatopancreas (often called the tamale in culinary dishes). Approximately 3 crabs, preferably male, are anticipated to yield the required 150 grams of mass (Table 12-2). This homogenized-blend approach ensures a worst case human exposure and allows the analytical data to be used for the ecological risk assessment as well, thus reducing the number of discrete samples required.

Because the highest level of bioaccumulation compounds in crab tissue are likely to be found in the hepatopancreas, one additional sample will be collected from each unit of the river and subdivided into a hepatopancreas tissue and other edible tissue (*i.e.*, thoracic, claw, leg, and tail meat) for a separate PCDD/F congener analysis (refer to SOP 31: Crab Collection and Tissue Sampling). These additional samples (a total of 8 edible tissue samples and 8 hepatopancreas samples; Table 12-1) will then be used to determine the bioaccumulation differential between the two tissue-types so that the uncertainty associated with risk can be more concretely addressed in the risk assessment. Unlike the ecological risk assessment, no alternative species has been identified for the blue crab for the human health risk assessment; if blue crab samples are not available in the Freshwater River Section, then this exposure pathway will not be evaluated in this river section.

[5] The soft tissue refers to the edible portion of the crab, including the hepatopancreas, and does not include gills or shell.

Table 12-2: Target Species, Size Requirements, and Alternative Species to Support the Human Health Risk Assessment.

Target Species	Target Size Range (mm) [a]	Average Individual Length [b](mm)	Target Tissue Mass (g)	Average Individual Weight [b](g)	No. of Individuals Required for Fillet Composite[c]
White Perch (*Morone americana*)	> 152 (>6 inch)	206	150	161	3
American Eel (*Anguilla rostrata*)	> 305 (>12 inch)	366	150	120	4
Blue Crab (*Callinectes sapidus*)	> 76 (>3 inch)	119	150	103[d]	Enough "edible meat" to provide ~150 g of tissue (assume up to 3 crabs preferably male)
Alternative Species					
Catfish (various species)	> 305 (>12 inch)	251	150	294	1
Common Carp (*Cyprinus carpio*)	> 305 (>12 inch)	562	150	2573	1
Striped Bass (*Morone saxatilis*)	> 610 (>24 inch)	396	150	933	1

a: Minimum target size based on 2006 New Jersey fishing regulations.
b: Average weights and lengths from TSI fish community data sampled 1999/2000.
c: Approximate number of fish/crab required for composite using an average-sized fish and assuming all analytical parameters are necessary. Sample size requirements for target analytes are as follows: pesticides- 30 g; PCBs- 30 g; PCDD/Fs- 10 g; PAHs/SVOCs- 30 g; metals- 10 g; percent lipid - 5 g; and + 10% sample loss during homogenization.
Total ~150 g wet weight for all analyses, if done separately. A 30 g sample should be sufficient for both pesticide and PCB analysis if the same analytical laboratory conducts both methods. For fish samples, edible fillets are assumed to be equal to 1/3 of the total body weight.
d: This assumes that one sample is equivalent to 150 g and 10 samples are required for each 2-mile unit of the river.

To the extent possible, the proposed sampling for the biological tissue-residue program will be coincident with future sampling efforts for sediment and the water column, which will be addressed in a future, updated FSP Volume 1.

12.3.2. Tissue-Residue Sampling for Ecological Risk Assessment

Table 12-3 provides a summary of the target species (and alternative species), tissue matrix, and number of samples required to support the ecological risk assessment. Each sample will be comprised entirely of a single species, and to the extent possible, a sample will include individuals of comparable age, sex, length, and weight. In the event that a sufficient quantity of the same sex and size class of a particular species is not obtained

during sampling activities, tissue from either the opposite sex or from a different size class (but never different species) will be added to achieve the desired mass (note that sex has higher priority than size).

Table 12-3: Summary of Targeted Species to Support the Baseline Ecological Risk Assessment

Targeted Fish Species	**Tissue Matrix**	**Number of 2-mile-long Units of the River**	**Number of Tissue Samples per 2-mile-long Unit**	**Total Number of Tissue Samples**
Lower Passaic River – Brackish and Transitional River Sections				
Mummichog (*Fundulus heteroclitus*)	Whole Body	3	6	18
Mummichog (*Fundulus heteroclitus*)	Whole Body Eggs	3 3	3 3	9 9
White Perch (*Morone americana*)	Reconstituted Whole Body [a]	4	10	40
White Perch [b] (*Morone americana*)	Whole Body Eggs	4 4	2 2	8 8
American Eel [b] (*Anguilla rostrata*)	Reconstituted Whole Body [a]	4	10	40
Blue Crab (*Callinectes sapidus*)	Soft tissue [c]	4	10	40
Alternative Species: Catfish, Common Carp				
Lower Passaic River – Freshwater River Section				
White Perch [b] (*Morone americana*)	Reconstituted Whole Body [a]	4	10	40
White Perch (*Morone americana*)	Whole Body Eggs	1 1	2 2	2 2
American Eel [b] (*Anguilla rostrata*)	Reconstituted Whole Body [a]	4	10	40
Blue Crab (*Callinectes sapidus*)	Soft tissue [c]	4	10	40
Various species of darter, shiner, killifish, or dace	Whole Body	4	6	24
Alternative Species: Sunfish (Bluegill, Red-Breasted, Crappie), Crayfish (e.g., *Orconectes limosus*)				

a: Whole body concentrations will be derived by combining the relative weight-adjusted analytical results for fillet and carcass composite fractions; see Section 12.3.3.
b: Samples to be collected in spring prior to spawning and analyzed for PCDD/F congeners and lipid only. A total of 10 paired mummichog and egg composite samples will be collected throughout the Study Area.
c: These samples will also meet human health data requirements

Forage fish tissue samples will include mummichogs from the Brackish and Transitional River Sections as well as various species of darter, shiner, killifish, or dace from the Freshwater River Section. Forage fish will be collected using baited minnow/eel traps

from intertidal areas (refer to Section 10.3.2 "Baited Minnow and Eel Trap Sampling Techniques"). If these traps are unsuccessful in capturing adequate numbers of forage fish, then handheld seines may be employed (refer to SOP 29: Fish Surveys, Collection, and Tissue Sampling). The 42 intertidal sampling stations for forage fish samples (Figure 12-1) are co-located with the intertidal benthic invertebrate survey sampling stations presented in Figure 11-1. (Attachment D, Table D2 contains a list of geographical coordinates corresponding to the forage fish sampling locations presented on Figure 12-1. Since these locations have not yet been confirmed by field reconnaissance, professional judgment may be necessary to adjust locations in the field. Sampling locations can be adjusted in the field without affecting the statistical design by moving parallel to shore as necessary to avoid obstructions or outfall scour zones, for instance.)

To provide an estimate of tissue concentration in higher-consumer level, adult fish, tissues from individuals collected as part of the Fish Community Survey will be analyzed (Section 10.0 "Fish Community Survey"). Similar to the methodology discussed in Section 12.3.1 "Tissue-Residue Sampling for Human Health Risk Assessment," a total of 10 fish tissue samples, composited as necessary to achieve analytical mass requirements, will be collected for white perch and American eel (or alternative species, as appropriate) from all 8 unit of the river (refer to Figure 7-1). In addition, a total of 19 gravid female mummichog and white perch whole body and egg composite samples will be collected in the spring prior to spawning in order to estimate the transfer of PCDD/F between maternal whole body tissue and eggs (Table 12-3). The sampling program is designed to allow the substitution of alternative species at individual sampling locations when a target species is not available; however, the use of an alternate species at one sampling location does not justify collecting an alternate species at another sampling location. At each location, a sample most closely reflecting the intended target will be collected, and a consistent hierarchy of alternative species selection will be used from station to station when the target species is not available.

Blue crabs (*Callinectes sapidus*) will be collected as part of the Benthic Invertebrate Community Survey (Section 11.0 "Benthic Invertebrate Community Survey"). A total of 80 crabs (preferably male) will be collected from 10 sampling locations located in every 2-mile-long unit of the river (Figure 11-1). These 80 crab samples will support both the human health risk assessment and ecological risk assessment. Blue crab samples will be composited and include standardized edible portions, including the thoracic, claw, leg, and tail meat, as well as the hepatopancreas (refer to Section 12.3.1 "Tissue-Residue Sampling for Human Health Risk Assessment"). While ecological receptors do consume the whole crab, including the shell, it is assumed that the contaminants of concern will not appreciably bioaccumulate in the shell. It is anticipated that crayfish (the alternative species) rather than blue crab will be collected and evaluated in the Freshwater River Section.

Each tissue sample must satisfy the requirements listed in Table 12-4, including target species, size requirements, and anticipated number of individuals that may be required to satisfy the target tissue mass. (Note that the difference in size requirement for the human health and ecological risk samples reflects the legal size limits for human consumption and the desire to collect data on age-specific trophic levels for wildlife does modeling.) In addition to the target species, alternative species are also listed in the event that the target species are unavailable. As noted above in Section 12.3.1 "Tissue-Residue Sampling for Human Health Risk Assessment," only a single species will be used in the preparation of an individual composite sample. For each individual organism collected, the species identification, length, sex, and weight will be recorded (refer to SOP 5: Documenting Field Activities). Those individuals meeting the sampling size specifications on Tables 12-4 will be randomly pooled together based on sampling station to obtain a sufficient number of individuals to meet the required mass of 150 grams. Effort will be made to collect a sufficient quantity of fish to ensure that each composite sample represents the same species of fish, sex, and size.

The samples will be analyzed for percent lipid and the following target chemical classes: metals, methyl mercury and tributyl tin, SVOCs and PAHs [total of 34 PAHs, including C1 – C4 alkylated series, necessary to derive ESB (USEPA, 2004c)], pesticides, PCBs (Aroclors and congeners), and PCDD/F congeners [refer to the *Pathways Analysis Report* (Battelle, 2005) for analyte-specific compounds within each chemical class]. VOCs will not be analyzed because their chemical properties limit bioconcentration in biological tissue. These target analytes were previously identified in the *Pathways Analysis Report* (Battelle, 2005).

Table 12-4: Target Species, Size Requirements, and Alternative Species to Support the Baseline Ecological Risk Assessment.

Target Species	**Target Size Range [a] (mm)**	**Average Individual Length [b] (mm)**	**Target Tissue Mass (g)**	**Average Individual Weight [b] (g)**	**No. of Individuals Required for Whole Body Composite [c]**
Mummichog (*Fundulus heteroclitus*)	25-120 (1-5 inch)	71	150	5	30
White Perch (*Morone americana*)	> 225 (>9 inch)	206	150	161	1
American Eel (*Anguilla rostrata*)	> 400 (>15 inch)	366	150	120	2
Blue Crab (*Callinectes sapidus*)	> 76 (>3 inch)	119	150	103[c]	3 (preferably male)
Crayfish (*Orconectes limosus*) [d]	25-140 (1-5 inch)	140	150	25	6
Alternative Species					
Catfish (various sp.)	> 305 (>12 inch)	251	150	294	1
Common Carp (*Cyprinus carpio*)	> 305 (>12 inch)	562	150	2573	1
Various species of Darters, Shiners, Killifish, or Dace	25- 120 (1-5 inch)	NC	150	NC	TBD
Sunfish (Bluegill, Red-Breasted, Crappie)	> 152 (>6 inch)	NC	150	NC	TBD

a: Minimum size requirements established based on consideration of age-specific feeding biology to ensure that conservative residue estimates are obtained for the wildlife dose modeling. For example, adult white perch begin including more fish in their diet (*i.e.*, change trophic status) when they reach approximately 225 mm in size and eels establish a more catholic diet that includes crabs as they mature.

Table 12-4 (continued)

b: Average weights and lengths from TSI fish community data sampled 1999/2000; NC – not collected, TBD – to be determined.

c: Approximate number of whole-body fish required for composite, using an average-sized fish and assuming all analytical parameters are necessary: pesticides- 30 g; PCBs- 30 g; PCDD/Fs- 10 g; PAHs/SVOCs- 30 g; metals- 10 g; percent lipid- 5 g; and + 10% sample loss during homogenization. Total ~150 g wet weight for all analyses, if done separately. A 30 g sample should be sufficient for both pesticide and PCB analysis if the same analytical laboratory conducts both methods.

d: Crayfish weight from Ollivaux and Soyez (2000). Crayfish length from "Crayfish of the Americas" http://www.shrimpcrabsandcrayfish.co.uk/Shrimp.htm?crayfishamerica.html~mainFrame

To the extent possible, the proposed sampling for the biological tissue-residue program will be coincident with future sampling efforts for sediment and the water column, which will be addressed in a future, updated FSP Volume 1.

12.3.3. Tissue-Residue Sampling Processing

Target species will be collected and shipped to a laboratory for analysis. Processing of tissue samples including fish eggs, will occur at the laboratory following SOP 29: Fish Surveys, Collection, and Tissue Sampling, SOP 31: Crab Collection and Tissue Sampling, and SOP 32: Field and Laboratory Processing of Fish and Invertebrate Tissue. For target species of interest to the human health risk assessment and the ecological risk assessment, fillet samples will be prepared as specified in SOP 32: Field and Laboratory Processing of Fish and Invertebrate Tissue. The remaining fish carcasses (*i.e.*, offal) will also be weighed and analyzed as a discrete composite sample. Estimated tissue concentrations for the whole body composite samples will be derived using the separate analytical results for the fillet and offal samples and adjusted by their relative weight fractions as inputs for the dose modeling in the ecological assessment. (The skin that is removed during the fish filleting process will be added to the offal to obtain an appropriate estimate of the whole body burden.) The sample identification numbers for the fillet composites will correspond to the appropriate offal composites. Analytical requirements will be defined by the QAPP (Malcolm Pirnie, Inc., 2005a), which will require revision to address FSP Volume 2 tasks.

12.4. TISSUE-RESIDUE SAMPLING REPORTING

Tissue-residue samples will be reported by the analytical laboratory as defined by the requirements in the QAPP (Malcolm Pirnie, Inc., 2005a), which will require revision to address FSP Volume 2 tasks. The reported data will include species name, weight of sample, number of fish in sample, all associated analytical chemistry and data qualifiers, and percent lipid. In the event that offal fish composites are utilized, the analytical results from the fillet composites and offal composites are reported separately.

Results of the sampling program will also include post-processing, analysis, and interpretation of field and analytical data. All field notes obtained during the conduct of the fish community surveys will be tabulated. These notes will include fish species, length, weight, sex (if possible), age (if possible), and any gross abnormalities (*e.g.*, hemorrhagic lesions, tumors). The analytical approach for evaluating the tissue-residue data as well as the performance/acceptance criteria are described in the DQOs (Attachment B, Table B2 through Table B4). Calculation of the exposure point concentration value will be determined using the measured tissue-residue concentrations and ProUCL software (Version 3.00.02; Las Vegas TSC; USEPA, 2004b). These results, along with maps and surveys (refer to Section 6.4 "Habitat Delineation Reporting" for mapping requirements), will be included in the draft and final reports.

13.0 TOXICITY TESTING

13.1. DATA NEEDS AND OBJECTIVES OF TOXICITY TESTING

Toxicity testing will satisfy the following data needs associated with the DQOs and will support the baseline ecological risk assessment (refer to Attachment B):

- Evaluate if chronic exposures to site-related chemical stressors within sediments are posing an unacceptable risk to the benthic invertebrate community of the Lower Passaic River.
- Determine if the toxicity effects on benthic invertebrates are related to the contaminant concentrations within Lower Passaic River sediments.

The objectives of the toxicity testing and co-located surface sediment chemistry analysis are to obtain quantitative data necessary to determine whether sediment contamination is adversely affecting aquatic benthic organisms and to understand the spatial scale of the potential impacts of sediment contamination in the Study Area. Data collected during the toxicity testing and sediment chemistry analysis will contribute to resolution of the following principal question as developed in the DQO process (Tables B5 in Attachment B):

- Are exposures to site-related chemical stressors throughout the Lower Passaic River posing an unacceptable risk to benthic invertebrate populations?

The Sediment Triad Approach assesses the potential risks to the benthic invertebrate community (*i.e.*, benthic invertebrate assessment endpoint). This approach combines three lines of evidence including laboratory toxicity tests, the corresponding analytical chemistry data from synoptically-collected sediment subsamples, and the results of the benthic invertebrate community survey (refer to Section 11.0 “Benthic Invertebrate Community Survey”).

13.2. TOXICITY TESTING SCOPE

Macroinvertebrates located in the sediment (known as infaunal species) or located at the sediment-water interface (known as epifaunal species) are ecologically important because of their role in the recycling of nutrients. They are also a critical component of the aquatic food chain in brackish and freshwater riverine habitats. Toxicity testing is important for determining whether these biological resources have been impacted by multiple exposures to sediment contamination.

The scope of the toxicity testing task is to evaluate the impacts of contaminated sediments on benthic invertebrates that may reside in the Study Area. This task will address the data gaps identified in Section 3.1.6 "Historical Toxicity Testing Data," which indicate that limited data exist to satisfy the ecological risk assessment. Some historical sediment toxicity data have been collected in the Brackish River Section (limited to intertidal habitat) of the Study Area (TSI, 2004) using both a polychaete (*Neanthes arenaceodentata*) and an amphipod species (*Ampelisca abdita*). However, no previous toxicity assessment of the Freshwater River Section has been conducted (Section 3.1.6 "Historical Toxicity Testing Data"). Consequently, toxicity tests will be conducted with laboratory bioassays using a combination of freshwater and brackish species with exposures to distinct microhabitats within the subtidal sediment environment (*e.g.*, epibenthic, tube-forming, and free burrowing).

These tests will serve to provide more data to corroborate historical findings; satisfy toxicity data needs for the Freshwater River Section; and provide an indication of the range of toxicity effects in the Lower Passaic River resulting from different microhabitat requirements, different potential for contaminant exposures, and different sensitivities to known contaminants. These test results and data assessment will provide information that relates directly to the primary risk questions posed in the baseline ecological risk assessment.

13.3. TOXICITY TESTING METHOD

The toxicity test sampling program will be completed within a single field collection event, which will be conducted during the growing season (anticipated schedule: May – September 2007). Data collection for this task will coincide with one of the benthic invertebrate community survey sampling events (Section 11.0 "Benthic Invertebrate Community Survey"). As part of the Sediment Triad Approach, sample stations for the toxicity tests will be co-located with the benthic invertebrate survey sampling stations (42 intertidal sampling stations and 48 subtidal sampling stations).

13.3.1. Toxicity Testing Methodology

Toxicity tests will be conducted using laboratory bioassay tests (*i.e.,* tests to determine the toxicity of a contaminant by measuring its effect upon animals or other living things) and surface sediment samples to provide information on combined effects (including additive and interactive effects) of chronic contaminant mixtures on the test organisms. A total of 3 laboratory bioassay tests are proposed to evaluate toxicity conditions that exist within the Brackish and combined Transitional/Freshwater River Sections of the Study Area. The following chronic toxicity tests will be conducted:

- 42-day survival, growth, and reproduction test with the epibenthic freshwater amphipod, *Hyalella azteca* [refer to SOP 33: Measuring Sediment Contaminant Toxicity with Invertebrates, which follows USEPA (2000c) and the American Society for Testing and Materials (ASTM; 2005) standardized methods].
- 20-day life cycle survival and growth test with the infaunal freshwater midge, *Chironomus dilutus* (formerly known as *C. tentans*) [refer to SOP 33: Measuring Sediment Contaminant Toxicity with Invertebrates, which follows USEPA (2000c) and ASTM (2005) standardized methods].
- 28-day survival, growth, and reproduction test with the infaunal estuarine amphipod, *Leptocheirus plumulosus* [refer to SOP 33: Measuring Sediment Contaminant Toxicity with Invertebrates, which follows USEPA (2001a) and ASTM (2004) standardized methods].

These toxicity tests evaluate both mortality and sub-lethal responses. They also provide a measure of the effects of sediment toxicity on sensitive biological endpoints related to growth and reproduction, including the number of alive or dead animals, rates of biomass growth, and the number of neonates produced.

The proposed laboratory bioassays will be conducted using surface sediment samples collected throughout the Lower Passaic River. These sediment samples will represent the BAZ, which has been estimated as the top 4-8 inches of sediment (TSI, 2005). These BAZ sediments will be collected in accordance with the sampling techniques specified in current USEPA guidance *Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Memorandum* (USEPA, 2001b) and the SOP 34: Collection and Processing of Sediment Grab Samples. Bioassay data for the Lower Passaic River sediment samples will be compared to both laboratory control and reference area results to determine which responses are statistically significant. Laboratory control sediment will be provided by the selected contractor and specific details will be discussed with the contractor to ensure that the control sediment used will meet testing requirements as specified in the applicable ASTM method (ASTM, 2004). The laboratory bioassays will be compared to the corresponding data from sediment chemistry analysis (which is a sub-sample of the homogenized sediment sample collected in the field) regarding contaminant concentrations. Analytical requirements will be defined by the QAPP (Malcolm Pirnie, Inc., 2005a), which will require revision to address FSP Volume 2 tasks.

13.3.2. Toxicity Testing Sampling Locations

As part of the Sediment Triad Approach, sample stations for the toxicity tests will be co-located with the benthic invertebrate survey sampling stations, including 42 intertidal sampling stations and 48 subtidal sampling stations (Figure 11-1). A roughly equal number of toxicity tests will be conducted within each of these two habitat strata because although subtidal habitat is more extensive in spatial extent, the remaining intertidal

habitat provides some unique ecological values with the river. Table 13-1 summarizes the sample design and the volume of sediment material required to support each of the laboratory bioassays. Sufficient quantities of sediment will be collected (top 4-8 inches of sediment) and homogenized in the field to support all expected laboratory bioassays, and will be utilized for both toxicity testing and for sediment chemistry analysis. Thus, before the sediment sample is homogenized, a sub-sample will be collected for acid volatile sulfides (AVS) analysis.

To obtain sufficient quantities of sediment, homogenized composites of several surface grab samples collected from each location will be used. Grab samples will be collected and homogenized in the field following SOP 34: Collection and Processing of Sediment Grab Samples. It is estimated that approximately 4 liters of sediment will be required for laboratory bioassays in the Brackish River Section while approximately 8 liters of sediment will be required in the Transitional and Freshwater River Sections. The additional sediment volume for the freshwater locations is to accommodate 2 laboratory bioassays, each requiring 4 liters of material (Table 13-1). To achieve DQO decision error specifications for the more sensitive (and variable) reproductive endpoint, 10 replicates plus laboratory controls are required per sampling location.

Table 13-1: Summary of Sample Design for Laboratory Bioassays Utilized for Toxicity Testing

Laboratory Bioassay	**Type of Assay**	**Amount of Surface Sediment per Sample Station**	**Number of 2-mile-long Units of the River**	**Number of Strata[a] (Intertidal and Subtidal)**	**Number of Samples Stations per Strata[b]**	**Total Number of Toxicity Samples**
Hyalella azteca	42-day survival, growth, and reproduction	4 liters	4	2	6	48
Chironomus dilutus	20-day survival and growth	4 liters	4	2	6	48
Leptocheirus plumulosus	28-day survival, growth, and reproduction	4 liters	4	2	6	42[c]

a. Strata are defined as in the intertidal and subtidal areas of the river
b. Sample locations determined by random design within each strata
c. Due to lack of suitable habitat, no testing of intertidal substrate in RM 0 to RM 2.0 will be conducted.

13.3.3. Corresponding Sediment Chemistry Analysis

A sub-sample of the homogenized sediment sample collected in the field will be analyzed concurrently with samples for toxicity testing to determine if the observed toxicological responses are associated with the contaminants in the sediment. Sediment samples will be analyzed for the following target chemical classes: metals, methyl mercury and tributyl tin, SVOCs and PAHs [total of 34 PAHs, including C1 – C4 alkylated series, necessary to derive ESB (USEPA, 2004c)], pesticides, PCBs (Aroclors and congeners), PCDD/F congeners, AVS, and simultaneously extracted metals (SEM) [refer to the *Pathways Analysis Report* (Battelle, 2005) for analyte-specific compounds within each chemical class]. Analytical requirements for sediment chemistry are defined in the QAPP (Malcolm Pirnie, Inc., 2005a).

Sediment chemistry data will also aid in assessing bioaccumulation and biomagnification as part of the forage fish tissue-residue sampling program (refer to Section 12.0 "Biological Tissue-Residue Sampling). To manage and quantify potentially confounding factors in the toxicological tests, the following parameters will also be measured in the sediment samples from each location: total organic carbon, grain size, total solids, ammonia, total sulfides, and percent moisture. (Hydrogen sulfide, ammonia, pH, and temperature will be analyzed in sediment elutriates prior to toxicity test commencement.) In addition to the specific toxicological test protocols, the water from each laboratory bioassay, which provides the aquatic environment necessary for the subject organisms within the bioassay, will be monitored for the following parameters: pH, temperature, dissolved oxygen, total ammonia, temperature, and salinity. Analytical requirements for the bioassay water will be defined by the QAPP (Malcolm Pirnie, Inc., 2005a), which will require revision to address FSP Volume 2 tasks.

13.4. TOXICITY TESTING REPORTING

Toxicity data will consist of results from laboratory bioassays including test organism observations during the test and summary sheets describing test endpoints (*e.g.*, number

of alive or dead animals, growth measured as weight or biomass, number of neonates produced) at test termination. The associated analytical data and abiotic measurements of laboratory bioassay water will be reported as defined by the requirements in the QAPP (Malcolm Pirnie, Inc., 2005a), which will require revision to address FSP Volume 2 tasks. The analysis and interpretation of these results will support the baseline ecological risk assessment. Bioassay data for the Lower Passaic River sediment samples will be compared to both laboratory control and reference area results to determine which responses are statistically significant. The analytical approach for evaluating the toxicity data as well as the performance/acceptance criteria are described in the DQOs (Attachment B, Table B5). These results, along with maps and surveys (refer to Section 6.4 "Habitat Delineation Reporting" for mapping requirements), will be included in the draft and final reports.

14.0 LITERATURE REVIEW TASK

A literature review is intended to further characterize potential restoration areas and to fill in data gaps that were identified in Section 3.1 "Available Data and Data Gaps." This task includes review (1) to identify the presence or occurrences of threatened and endangered species, (2) to support the food web model development, (3) to evaluate the impact of pathogens on water quality in potential restoration areas, and (4) to evaluate biota consumption rates. This literature evaluation is in addition to the historical data review that occurred during the development of this FSP Volume 2 document. The historical data review was designed to provided the background necessary to develop the sampling programs presented in FSP Volume 2, not to support the specific data needs of these four literature tasks; hence, additional research is warranted. At the completion of the literature evaluation, it may be determined that more data (in the form of field data) are warranted. If that is the case, existing literature tasks will be changed to field tasks and the planning documents amended.

14.1. FOOD WEB STRUCTURE AND BIOENERGETICS

14.1.1. Data Needs and Objectives of Food Web Structure

A literature review of food web structure and bioenergetics is required to support the following data needs:

- Develop the food web model, which will in turn support the human health risk assessment and the ecological risk assessment.
- Support the restoration design at potential restoration areas.

The objectives of this literature review are to further develop and to provide detail on the food web structure of the Lower Passaic River [refer to the *Final Modeling Work Plan* (HydroQual, Inc., 2006)] as well as to quantify related bioenergetics parameters. The literature review will be conducted in conjunction with the risk assessment to collect

appropriate data. At the completion of the literature review, it may be determined that more data (in the form of field data) are warranted to satisfy all the modeling and risk assessment data needs. These data needs may include information on the zooplankton, ichthyoplankton, and phytoplankton communities as well as information on seasonal effects on tissue-residue concentrations.

14.1.2. Food Web Structure Scope and Method

A literature review will be conducted to collect information that will further assist the development of the food web structure for the Lower Passaic River. Development of a site-specific food web structure will facilitate evaluation of contaminant transfer in complex aquatic systems, planned food web modeling for the human and ecological risk assessments, and restoration efforts. This literature review will attempt to answer several fundamental questions:

- What are the representative species present at each trophic level in the Lower Passaic River?
- What are the predator or prey relationships between representative species?
- What are the feeding patterns of the representative species?
- What are the bioenergetics (*e.g.*, growth rates, respiration rates, and spawning season) of the representative species?
- Are the representative species migratory? If so, what are the patterns?
- What are the "home-ranges" of the representative resident species?

Information gathered in this literature review task will assist in the development of the bioaccumulation model and the risk assessment evaluations. It is intended that information uncovered in this task will supplement reviews already conducted during the selection of receptors noted in the *Pathways Analysis Report* (Battelle, 2005). Where possible, site-specific information is preferred; however, for the bioenergetics in particular, information from other estuarine and euryhaline systems may be useful. Examples of literature studies to be reviewed include species inventories, tagging studies,

isotopic nitrogen uptake experiments, and gut content assays. The isotopic concentration approach is based on the observation that selective metabolism of the lighter isotopes of these elements during food assimilation and waste excretion causes animals to become enriched in the heavier isotopes relative to their diets. This expected stepwise-isotopic increase through the food chain can be used to construct relative trophic positions of the biota. A review of gut content assays can provide direct information on an organism's recent foraging preferences; however, these analyses do not distinguish what an organism ingests and what it assimilates. Other literature reviews will consider nutrient inputs from upriver sources and the energetic drivers of the system that may assist in developing a food web model. Ultimately, the results of the literature review will lead to the preparation of a community food web illustrating the interdependencies of the various organisms.

14.2. THREATENED AND ENDANGERED SPECIES

14.2.1. Data Needs and Objectives of Threatened and Endangered Species

Submittal of formal coordination letters to NJDEP, USFWS, and NMFS for the presence of threatened and endangered species (terrestrial and aquatic) is required to support the following data needs:

- Evaluate threatened and endangered terrestrial species and habitats as well as critical and sensitive habitats within the Lower Passaic River and potential restoration areas.
- Support the restoration design in potential restoration areas.

The objectives of the threatened and endangered species coordination are to identify known occurrences of threatened and endangered species and the presence of suitable habitat for these species and to evaluate receptors within the Study Area.

14.2.2. Threatened and Endangered Species Scope and Methods

Correspondence received from state and federal regulatory agencies, including the NJDEP Natural Heritage Program, NJDEP Landscape Program, USFWS, and NMFS,

will be reviewed to determine the known or potential occurrences of threatened and endangered species within the Study Area. If an occurrence of a threatened or endangered species is identified during the literature review, a search of the Study Area will be performed to determine if suitable habitat for this species is present. Consultation with regulatory agencies and field surveys for suitable habitat will determine if a Section 7 Biological Assessment (BA) will be required for this project.

At the present time it is unknown if a Section 7 Biological Assessment (BA) will be required for the Lower Passaic River Restoration Plan. A BA is performed to determine the potential affects of the project on a listed species or its habitat. If a BA is required due to the presence of a threatened and endangered species, it will be performed in consultation with regulatory agencies. The BA will include the results of field surveys to determine if the listed species are permanently or seasonally present; views of recognized experts on the species; analysis of direct, indirect and cumulative effects of the action on the species; analysis of alternative actions; and a thorough literature review. The literature review will determine if a potential restoration area possesses habitat that may support threatened and endangered species or if a threatened and endangered species has been previously identified (historically) at a potential restoration area. The BA will be submitted as a separate document appended to the Draft EIS.

Coordination letters from NJDEP, USFWS, or NMFS will be reviewed to determine if a threatened and endangered species has been previously identified (historically) at a potential restoration area or if a known habitat that supports threatened and endangered species is present. If a threatened and endangered species or habitat is identified, the FSP Volume 2 sampling programs will be reviewed and, if necessary, modified with assistance from the regulatory agencies. These modifications to the sampling programs will serve to remove the potential for the "taking" of a listed species thereby avoiding the need for an Endangered Species Act Section 10 permit for scientific purposes. Furthermore, during the completion of the restoration process, potential restoration areas

will be continuously evaluated for their potential to accommodate threatened and endangered species and for opportunities to enhance or create suitable habitat for listed species.

14.3. PATHOGEN SURVEY

14.3.1. Data Needs and Objectives of Pathogen Survey

A literature review of available pathogen data is required to support the following data need:

- Determine potential water quality parameters that will impact the design of potential restoration areas.

The objectives of the pathogen survey literature review are to obtain recent survey data and to determine if pathogens are impacting water quality at potential restoration areas, which are anticipated to provide recreational benefits. Note that these pathogens data will not be used in the risk assessments.

14.3.2. Pathogen Survey Scope and Methods

The term "pathogens" refers to a variety of microorganisms, including bacteria, viruses, protozoa, and parasites that occur naturally in the environment or that may originate from humans or animals. Enteric pathogens in human or animal wastes can cause a variety of gastrointestinal illnesses, nausea, headaches, or other symptoms in humans and may pose considerable health hazards for infants, young children, and individuals with severely compromised immune systems.

Pathogens enter water bodies during wet weather flows, including combined sewer overflows (CSOs), sanitary sewer overflows (SSOs), and storm water discharges. Once in the water, pathogens can affect the suitability of water bodies for primary or secondary contact recreation. Fecal coliform bacteria have traditionally served as the microbiological indicators for the potential presence of waterborne pathogens.

Enterococci, however, may be a more accurate indicator than coliform bacteria, especially in saltwater where their resistance time and survival rate is similar to that of pathogenic bacteria.

The pathogen literature review will include evaluating available data from the following sources:

- Pathogen data collected from the Lower Passaic River through the New Jersey Harbor Dischargers Group (a workgroup of 10 sewerage agencies with 12 water treatment plants that discharge into the New York/New Jersey Harbor Estuary).
- Water quality data including the most recent *New Jersey Integrated Water Quality Monitoring and Assessment Report* (NJDEP, 2005) and the Integrated List of Water Bodies Report.
- Information from the New Jersey Pollution Discharge Elimination System (NJPDES) and stormwater permits.
- Health advisories for the Lower Passaic River and associated water bodies.

14.4. EVALUATION OF BIOTA CONSUMPTION RATE

14.4.1. Data Needs and Objectives of Biota Consumption Rate

A literature review of existing fish and shellfish consumption rates is required to support the following data needs:

- Evaluate literature data to support the human health risk assessment.
- Identify the type and amount of locally-caught fish and shellfish that are consumed by humans to support the human health risk assessment.
- Support the restoration design in potential restoration areas.

The objective of the literature review is to collect applicable data on consumption of locally-caught fish and shellfish within the Study Area.

14.4.2. Biota Consumption Rate Scope and Methods

As noted in the *Pathways Analysis Report*, a review of existing fish and shellfish consumption studies is anticipated as part of the future human health risk assessment (Battelle, 2005). This review will include an evaluation of published literature, NJDEP statewide surveys for the Lower Passaic River, and the TSI 2000-2001 creel/angler survey.[6] Information collected will be used to estimate the intake and consumption of fish and shellfish on the Lower Passaic River. Special consideration will be given to distinguish fish consumption from shellfish consumption and to evaluate preferred fish species.

14.5. LITERATURE REVIEW REPORTING

An interpretation of the literature data will be included in the Draft and Final RI Reports. Recommendations for future sampling that will supplement the literature data will be included in these reports as well as recommendations on the refinement of existing FSP Volume 2 field tasks.

[6] The Work Plan for the TSI 2000-2001 creel/angler survey did not conform to USEPA or NJDEP approved methodology.

15.0 ACRONYMS

AVS	Acid Volatile Sulfides
BA	Biological Assessment
BAZ	Biologically Active Zone
BSAF	Biota-Sediment Accumulation Factors
BTAG	Biological Technical Advisory Group
BTF	Biotransfer Factor
CADD	Computer Aided Drafting and Design
CD-ROM	Compact Disc-Read Only Memory
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
CSM	Conceptual Site Model
CSO	Combined Sewer Overflow
DBH	Diameter at Breast Height
DDT	1,1,1-trichloro-2,2-bischlorophenylethane
DEM	Digital Elevation Model
DQO	Data Quality Objective
EFA	Environmental Functional Assessment
EIS	Environmental Impact Statement
EM	Engineering Manual
ESB	Equilibrium-Sediment Benchmarks
ESRI	Environmental Systems Research Institute, Inc.
FSP	Field Sampling Plan
GIS	Geographic Information System
GPS	Global Positioning System
HASP	Health and Safety Plan

HEP	Habitat Evaluation Procedures
HGM	Hydrogeomorphic Approach
HSI	Habitat Suitability Index
IDW	Investigation Derived Waste
NAD83	North American Datum of 1983
NEPA	National Environmental Policy Act
NGVD29	National Geodetic Vertical Datum of 1929
NIOSH	National Institute for Occupational Safety and Health
NMFS	National Marine Fisheries Service
NJDEP	New Jersey Department of Environmental Protection
NJDOT-OMR	New Jersey Department of Transportation – Office of Maritime Resources
NJPDES	New Jersey Pollution Discharge Elimination System
NOAA	National Oceanic and Atmospheric Administration
NRDA	Natural Resource Damage Assessment
OSHA	Occupational Safety and Health Administration
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PCDD/F	Polychlorinated Dibenzodioxins/Furans
PMP	Project Management Plan
QAPP	Quality Assurance Project Plan
RBPs	Rapid Bioassessment Protocols
RM	River Mile
SAV	Submerged Aquatic Vegetation
SEM	Simultaneously Extracted Metals
SOP	Standard Operating Procedure
SPI	Sediment Profile Imaging
SSO	Sanitary Sewer Overflow
SVOCs	Semivolatile organic compounds
TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin

TSI	Tierra Solutions, Inc.
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Services
USGS	U.S. Geological Survey
WRDA	Water Resource Development Act
‰	"per mil" or parts per thousand

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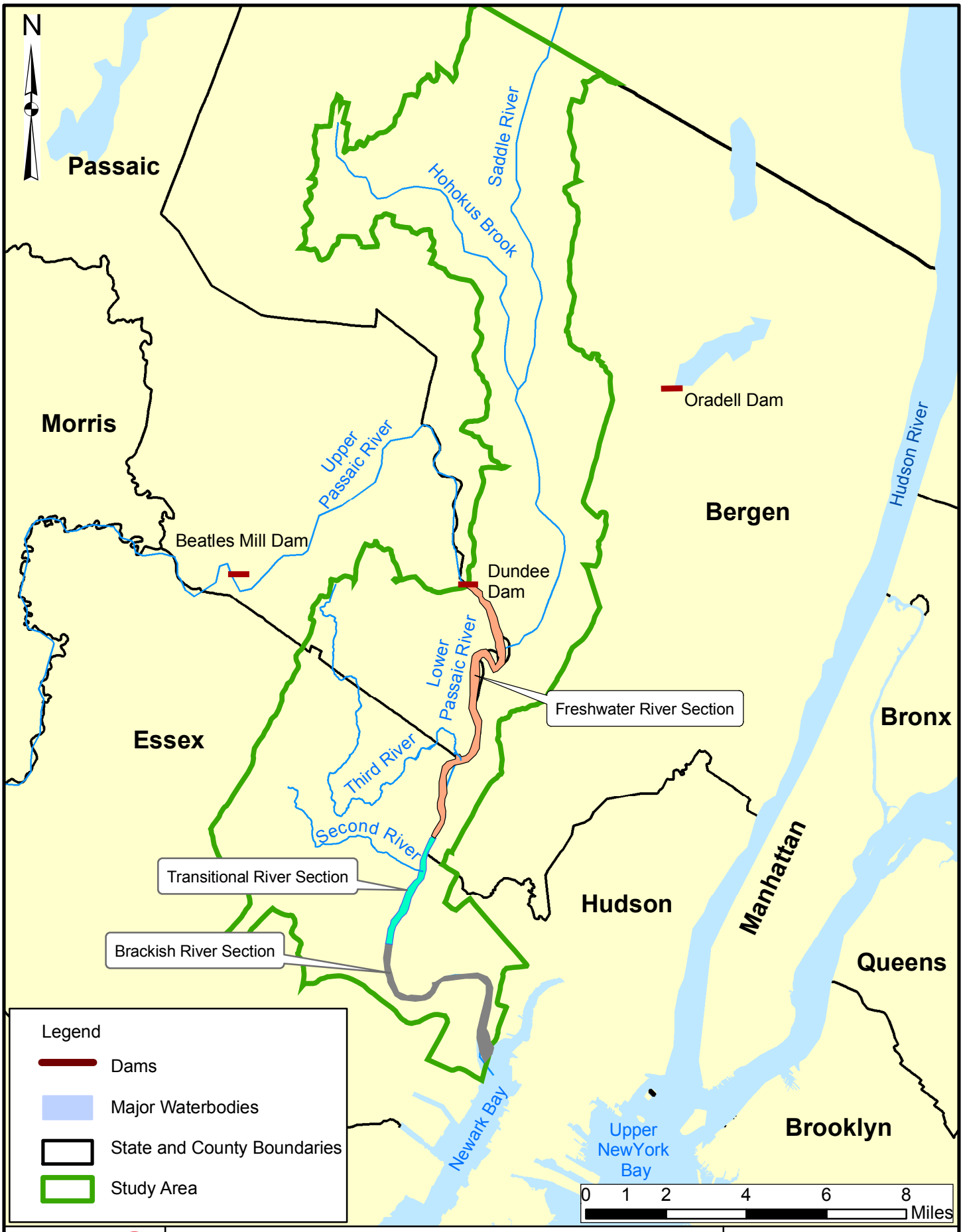
FIGURES



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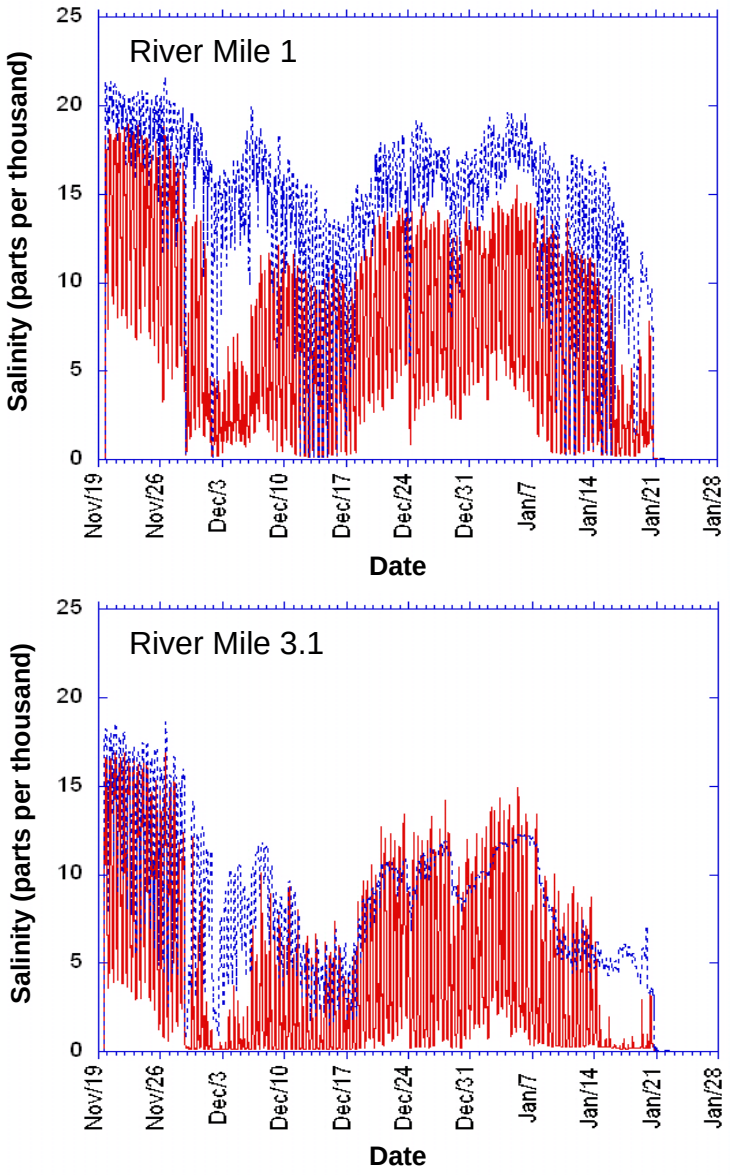
Study Area Location Map

Lower Passaic River Restoration Project

FIGURE 1-1

June 2006
Draft



Legend

Salinity measurements collected by Rutgers University near the water surface

Salinity measurements collected by Rutgers University near the water bottom

Notes

Measurements were collected between November 20, 2004 and January 25, 2005 by Rutgers University.

River Mile 1 – Data collected from Rutgers University Buoy #M1.

River Mile 3.1 – Data collected from Rutgers University Buoy #M2a.

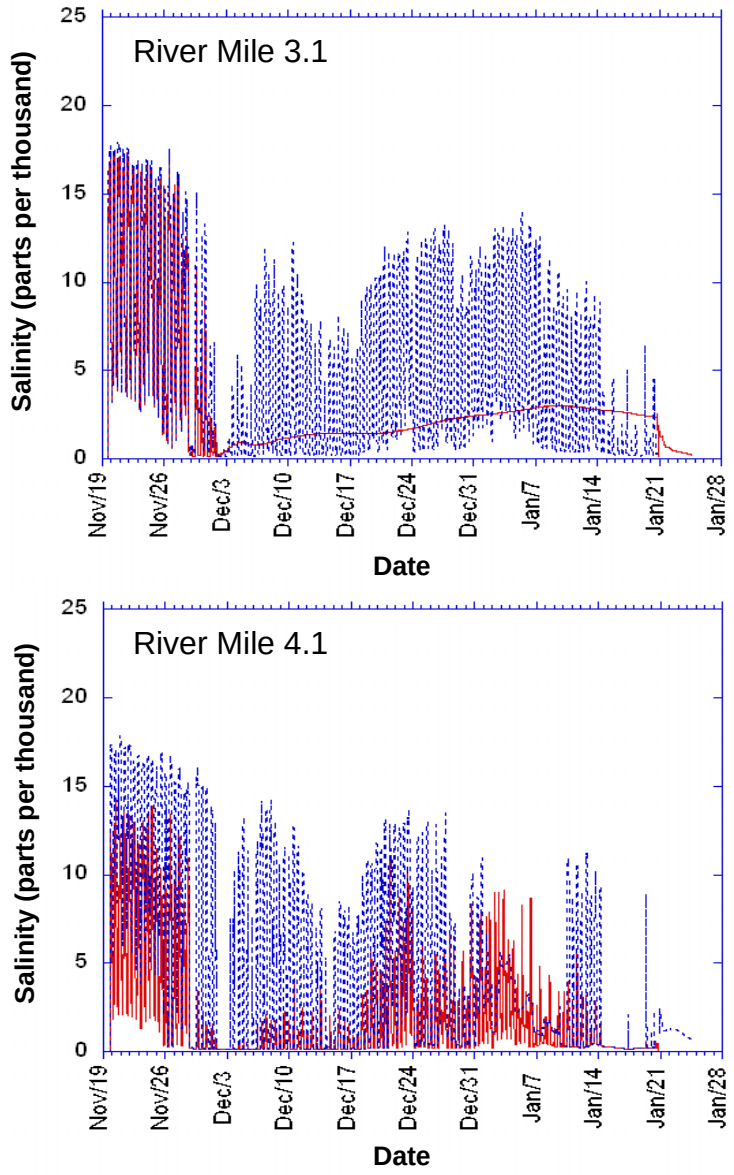
Source for Rutgers University data: http://marine.rutgers.edu/cool/passaic

Temporal Trends in Salinity at River Miles 1 and 3.1

Lower Passaic River Restoration Project

Figure 1-2a

June 2006
Draft



Legend

Salinity measurements collected by Rutgers University near the water surface

Salinity measurements collected by Rutgers University near the water bottom

Notes

Measurements were collected between November 20, 2004 and January 25, 2005 by Rutgers University.

River Mile 3.1 – Data collected from Rutgers University Buoy #M2b.

River Mile 4.1 – Data collected from Rutgers University Buoy #M3.

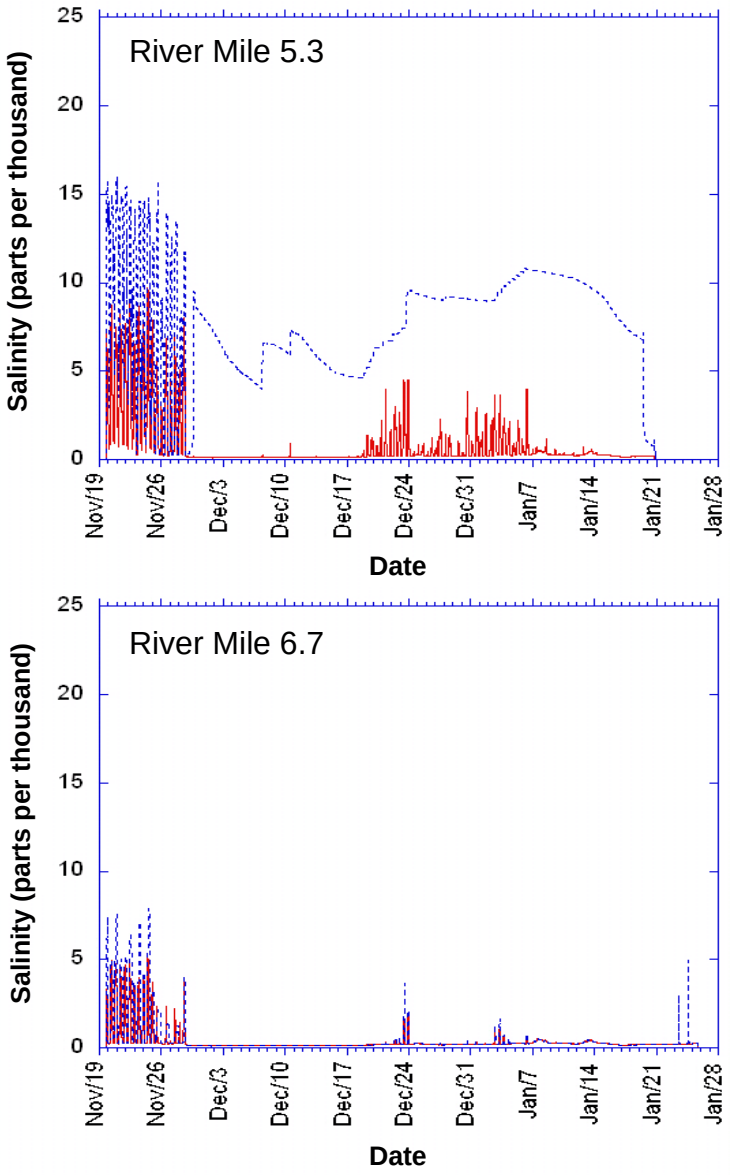
Source for Rutgers University data: http://marine.rutgers.edu/cool/passaic

Temporal Trends in Salinity at River Miles 3.1 and 4.1

Lower Passaic River Restoration Project

Figure 1-2b

June 2006
Draft



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Salinity measurements collected by Rutgers University near the water surface

Salinity measurements collected by Rutgers University near the water bottom

Notes

Measurements were collected between November 20, 2004 and January 25, 2005 by Rutgers University.

River Mile 5.3 – Data collected from Rutgers University Buoy #M4.

River Mile 6.7 –Data collected from Rutgers University Buoy #M5.

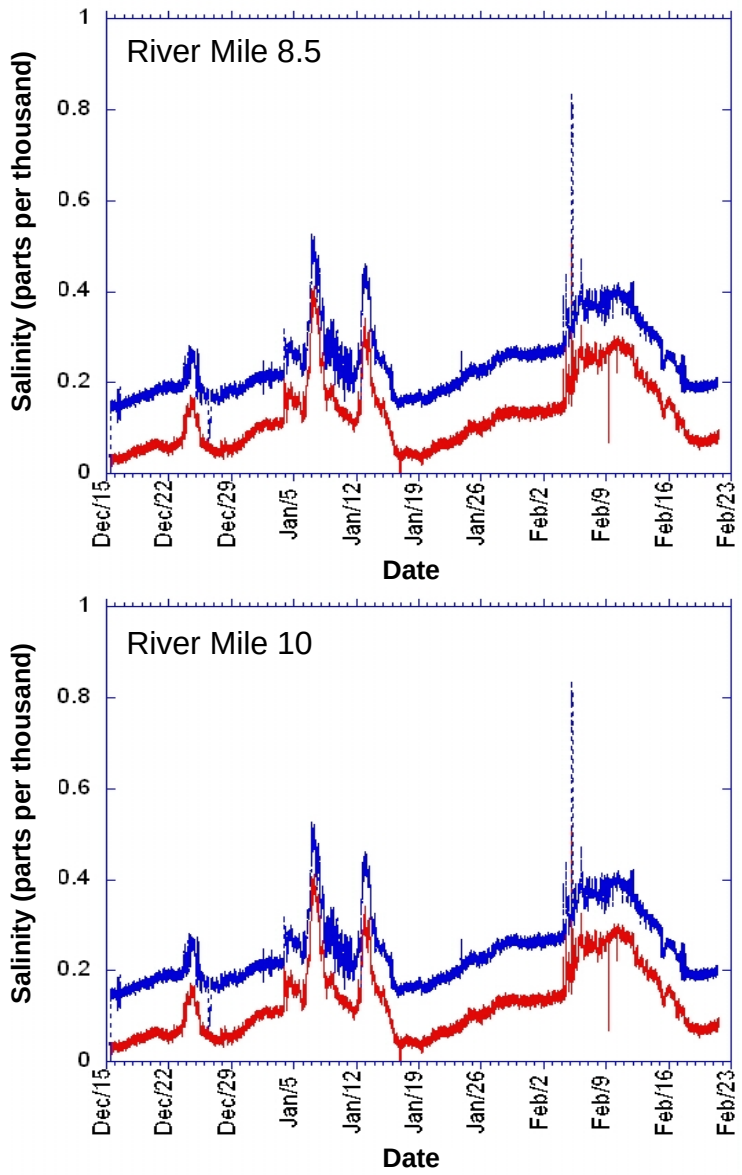
Source for Rutgers University data: http://marine.rutgers.edu/cool/passaic

Temporal Trends in Salinity at River Miles 5.3 and 6.7

Lower Passaic River Restoration Project

Figure 1-2c

June 2006
Draft



Legend

Salinity measurements collected one meter from the water surface

Salinity measurements collected one meter from the water bottom

Notes

Salinity values were calculated from conductivity, temperature, and depth data recorded by a CTD probe.

Data collected from December 15, 2004 to February 21, 2005 by Malcolm Pirnie, Inc.

River Mile 8.5 – Data collected from Malcolm Pirnie, Inc. Buoy #3.

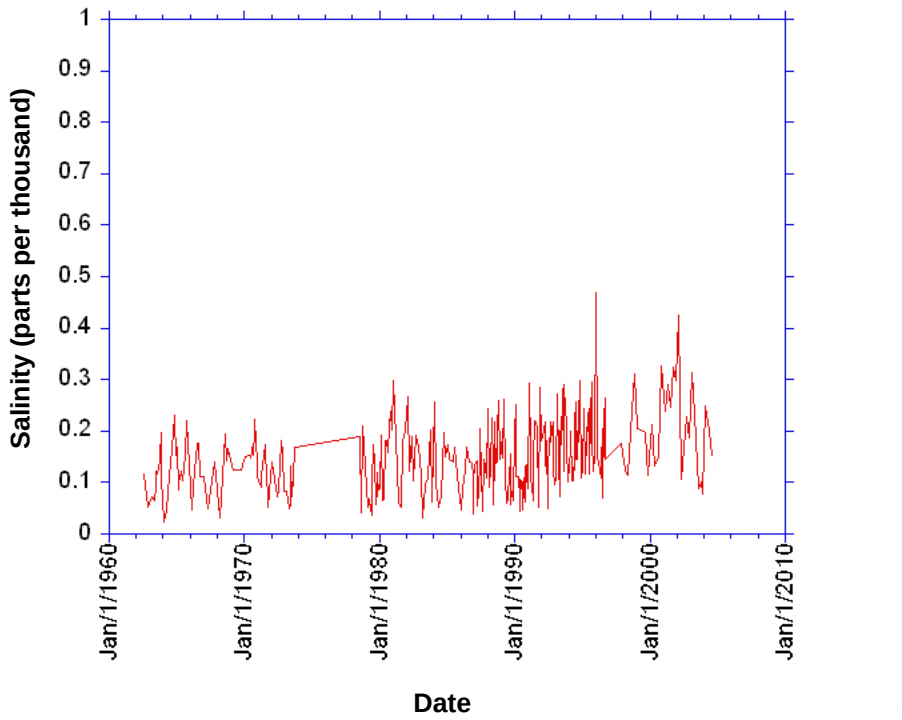
River Mile 10 – Data collected from Malcolm Pirnie, Inc. Buoy #2.

Temporal Trends in Salinity at River Miles 8.5 and 10

Lower Passaic River Restoration Project

Figure 1-2d

June 2006
Draft



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Salinity measurements recorded by a U.S. Geological Survey gauging station

Notes

Salinity measurements were taken between July 30, 1962 and August 19, 2004 at the USGS Gauge at Little Falls.

Temporal Trends in Salinity at U.S. Geological Survey Gauge at Little Falls

Lower Passaic River Restoration Project

Figure 1-2e

June 2006
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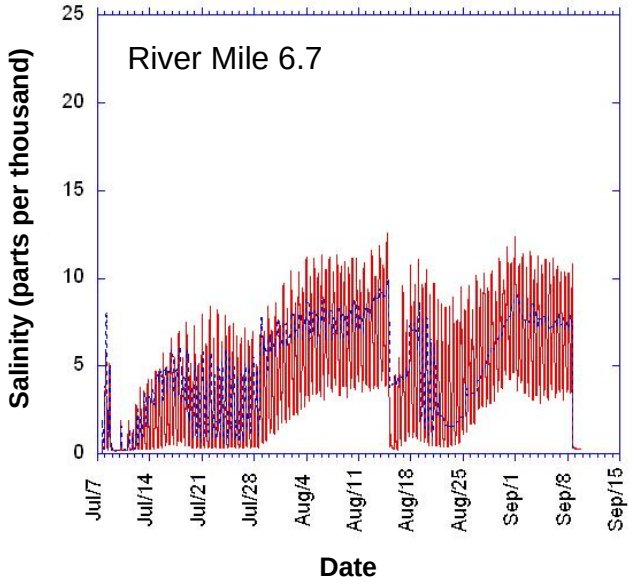

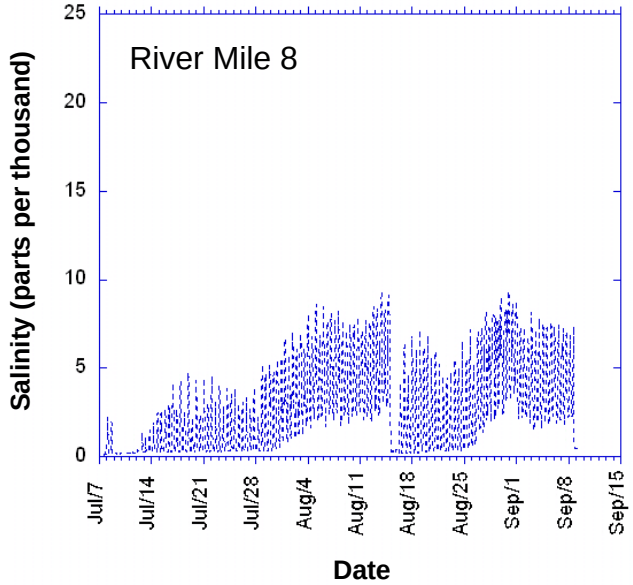

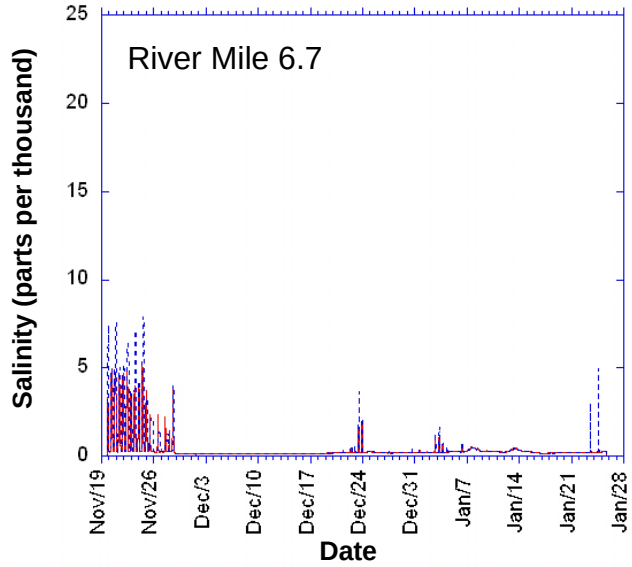

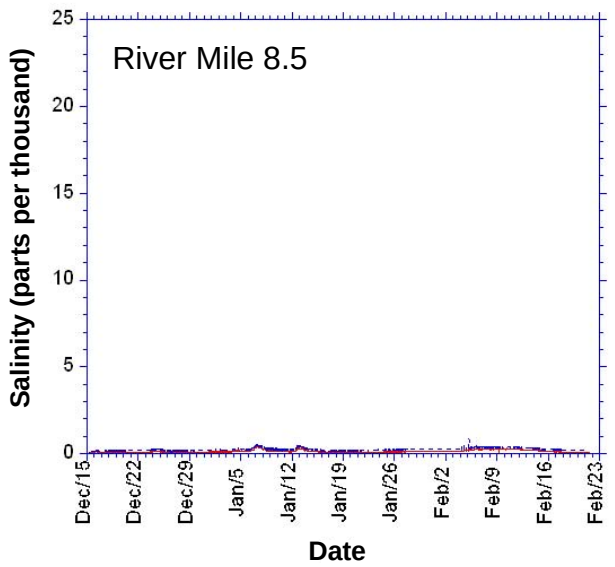

Legend

Salinity measurements collected from the water surface

Salinity measurements collected from the water bottom

Notes

River Mile 6.7 – Data collected from July 8, 2004 to September 10, 2004 at Rutgers University Buoy #M5.

River mile 8 – Data collected from July 8, 2004 to September 10, 2004 at Rutgers University Buoy #M6.

River Mile 6.7 – Data collected from November 20, 2004 to January 25, 2005 at Rutgers University Buoy #M6.

River mile 8.5 – Data collected from December 15, 2004 to February 21, 2005 at Malcolm Pirnie, Inc. Buoy #3. Same data as Figure 1-2d on a different scale.

Source for Rutgers University data: http://marine.rutgers.edu/cool/passaic

Seasonal Effects on Salinity

Lower Passaic River Restoration Project

Figure 1-2f

June 2006
Draft

River Mile 1.4 (left-bank descending) Kearny, NJ

River Mile 1.6 (left-bank descending) Kearny, NJ

River Mile 1.7 (left-bank descending) Kearny, NJ

River Mile 2.1 (right-bank descending) Newark, NJ

Photolog of Shoreline Conditions and Surrounding Habitat
Brackish River Section (Part 1)

Lower Passaic River Restoration Project

Figure 1-3a

June 2006
Draft

River Mile 3.5 (left-bank descending) Newark, NJ

River Mile 4.0 (right-bank descending) Newark, NJ

River Mile 5.1 (right-bank descending) Newark, NJ

River Mile 5.5 (left-bank descending) Harrison, NJ

Photolog of Shoreline Conditions and Surrounding Habitat
Brackish River Section (Part 2)

Lower Passaic River Restoration Project

Figure 1-3b

June 2006
Draft

River Mile 6.3 (left-bank descending) Kearny, NJ

River Mile 6.8 (left-bank descending) Kearny, NJ

River Mile 7.1 (left-bank descending) Kearny, NJ

River Mile 7.8 (right-bank descending) Kearny, NJ

Photolog of Shoreline Conditions and Surrounding Habitat
Transitional River Section

Lower Passaic River Restoration Project

Figure 1-3c

June 2006
Draft

River Mile 9.5 (left-bank descending) North Arlington, NJ

River Mile 12.8 (right-bank descending) Passaic, NJ

River Mile 15.8 (right-bank descending) Passaic, NJ

River Mile 15.9 (right-bank descending) Passaic, NJ

Photolog of Shoreline Conditions and Surrounding Habitat
Freshwater River Section (Part 1)

Lower Passaic River Restoration Project

Figure 1-3d

June 2006
Draft

River Mile 16.6 (left-bank descending) Garfield, NJ

River Mile 17.2 (left-bank descending) Garfield, NJ

River Mile 17.2 (left-bank descending) Garfield, NJ

River Mile 17.4 (Dundee Dam) Clifton and Garfield, NJ

Photolog of Shoreline Conditions and Surrounding Habitat
Freshwater River Section (Part 2)

Lower Passaic River Restoration Project

Figure 1-3e

June 2006
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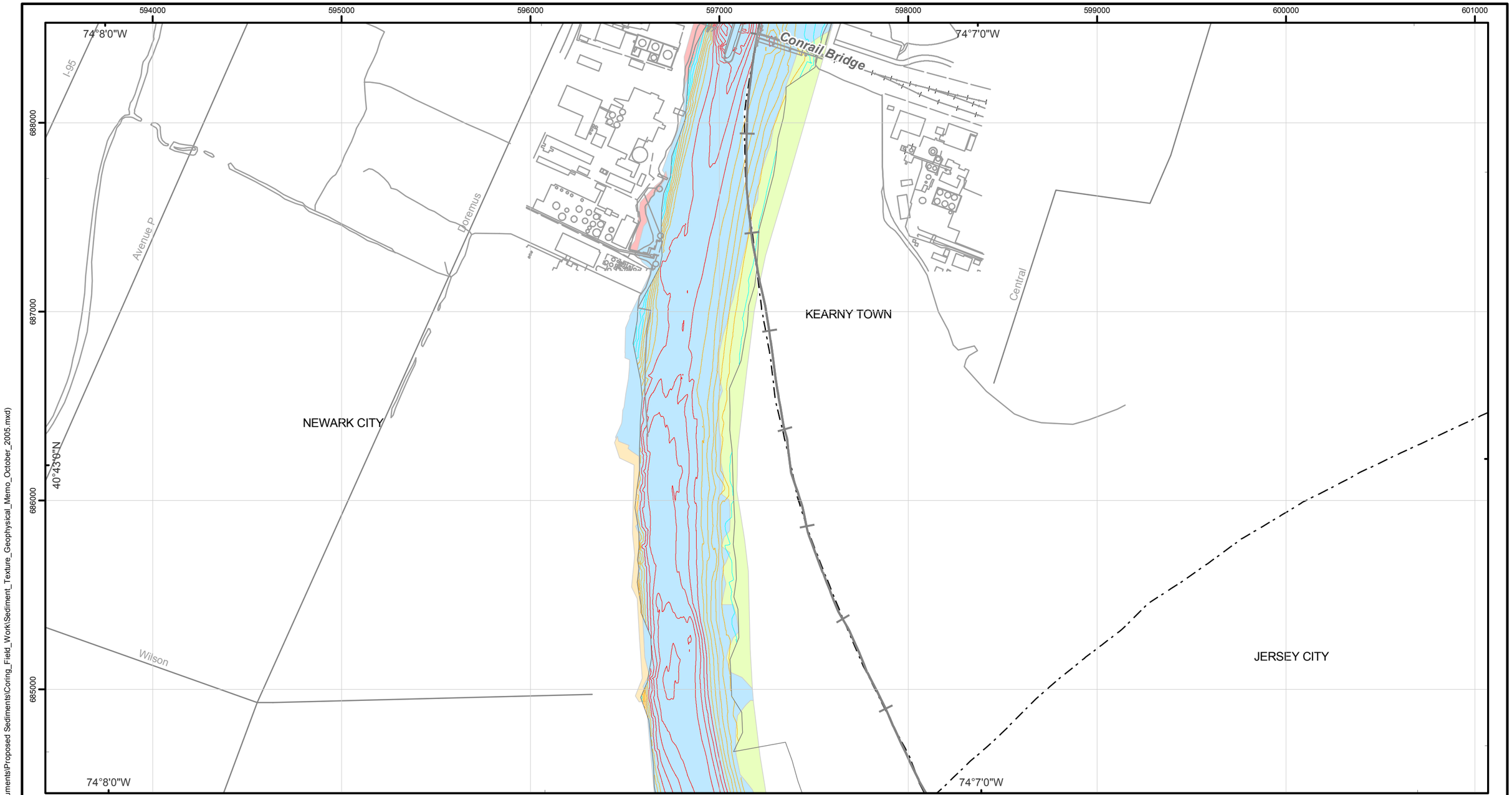


Sediment Texture Map

Lower Passaic River Restoration Project

Figure 1-4a
June 2006
Draft

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet) Relative to NGVD29

- -30 to -20
- -18 to -10
- -8 to 0
- 2 to 10

N

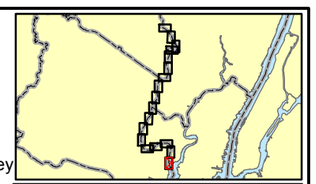
0 250 500 1,000

1 " equals 500 '

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet



Mile 0 to 1

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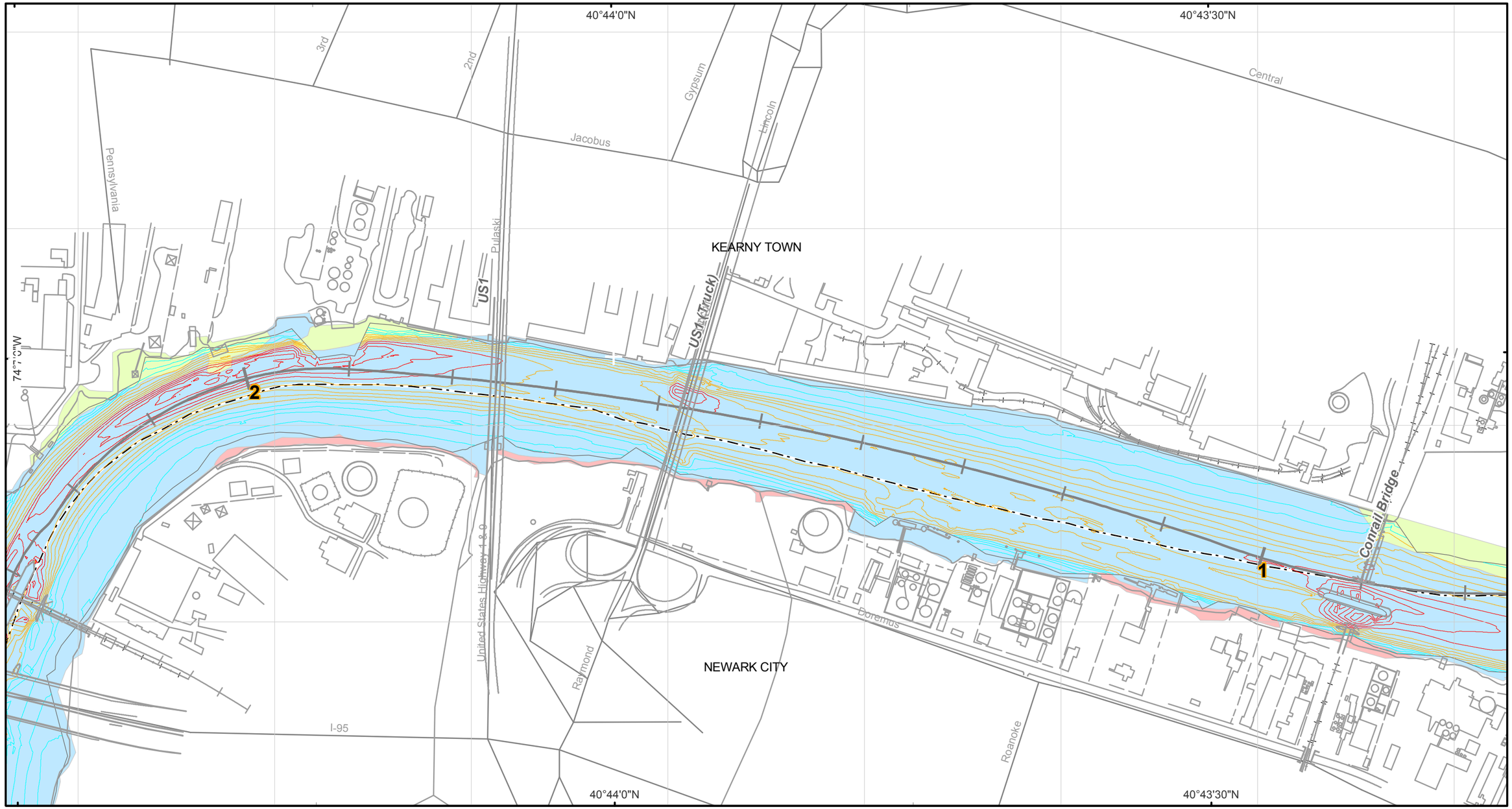

Sediment Texture Map

Lower Passaic River Restoration Project

Figure 1-4b
June 2006
Draft

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet)
Relative to NGVD29

- -30 to -20
- -18 to -10
- -8 to 0
- 2 to 10

N

0 250 500 1,000

1 " equals 500 '

Bathymetric Control Data:
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Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
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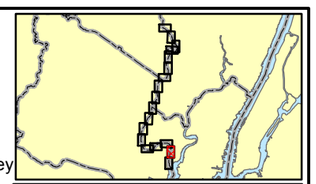
Units: Feet



Mile 1 to 2

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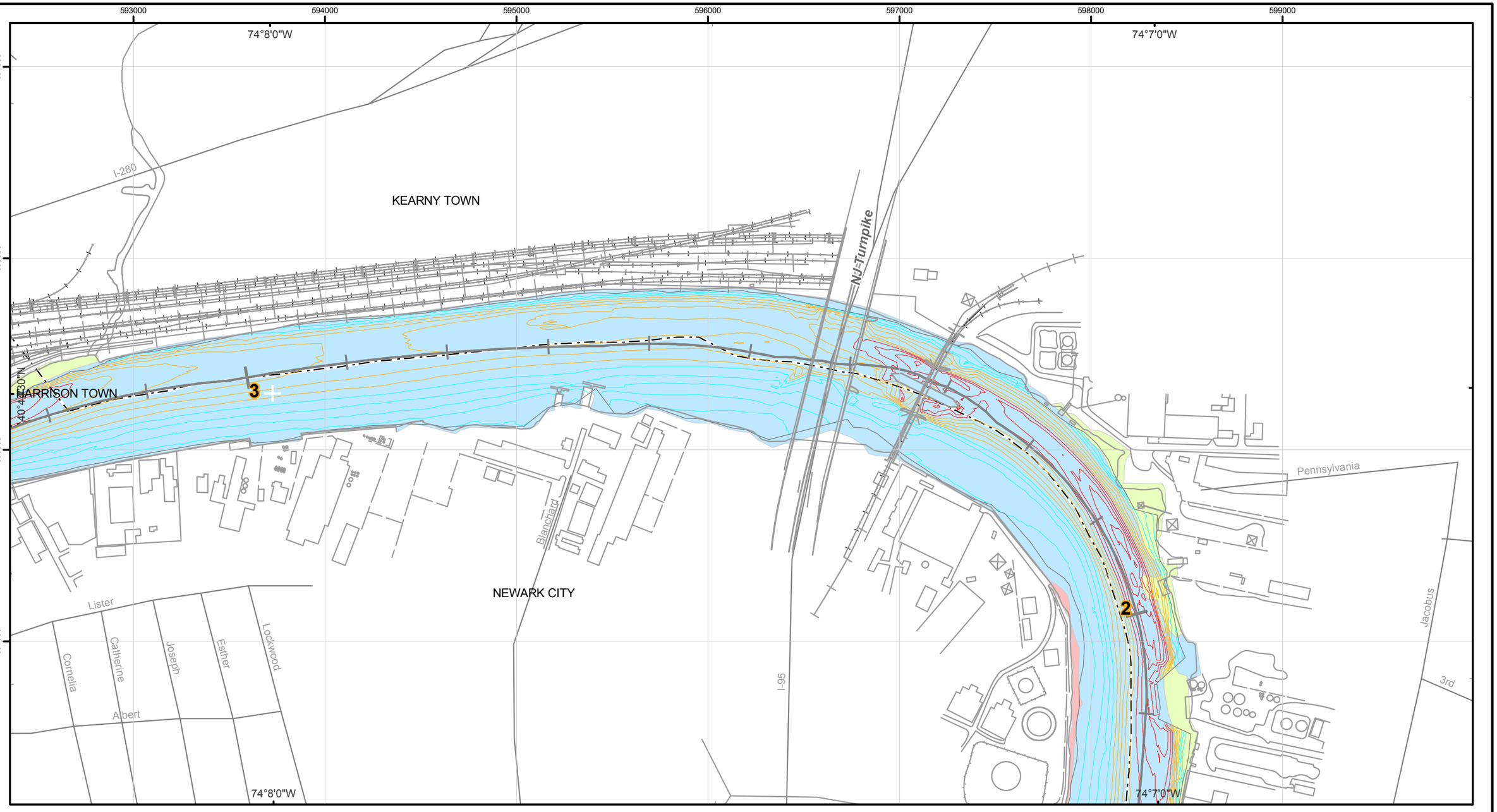

Sediment Texture Map

Lower Passaic River Restoration Project

Figure 1-4c
June 2006
Draft

US Army Corps of Engineers®

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet)
Relative to NGVD29

-30 to -20 | -18 to -10 | -8 to 0 | 2 to 10

N

0 250 500 1,000

1 " equals 500 '

Bathymetric Control Data:
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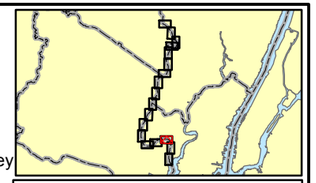
Units: Feet



Mile 2 to 3

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HARRISON TOWN

Cape May

Frank E Rodgers

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Lister Joseph Esther Lockwood Catherine Albert Cornelia

NEWARK CITY

Riverview Chapel Euclid Blanchard

Ferry Foundry Waydell

Exchange Oxford Freeman Brill Richards Schalk Fleming

74°9'0"W 74°8'0"W

US Army Corps of Engineers®

Sediment Texture Map

Lower Passaic River Restoration Project

Figure 1-4d
June 2006
Draft

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet)
Relative to NGVD29

-30 to -20 -8 to 0
-18 to -10 2 to 10

N

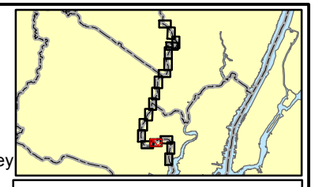
0 250 500 1,000

1 " equals 500 '

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet



Mile 3 to 4

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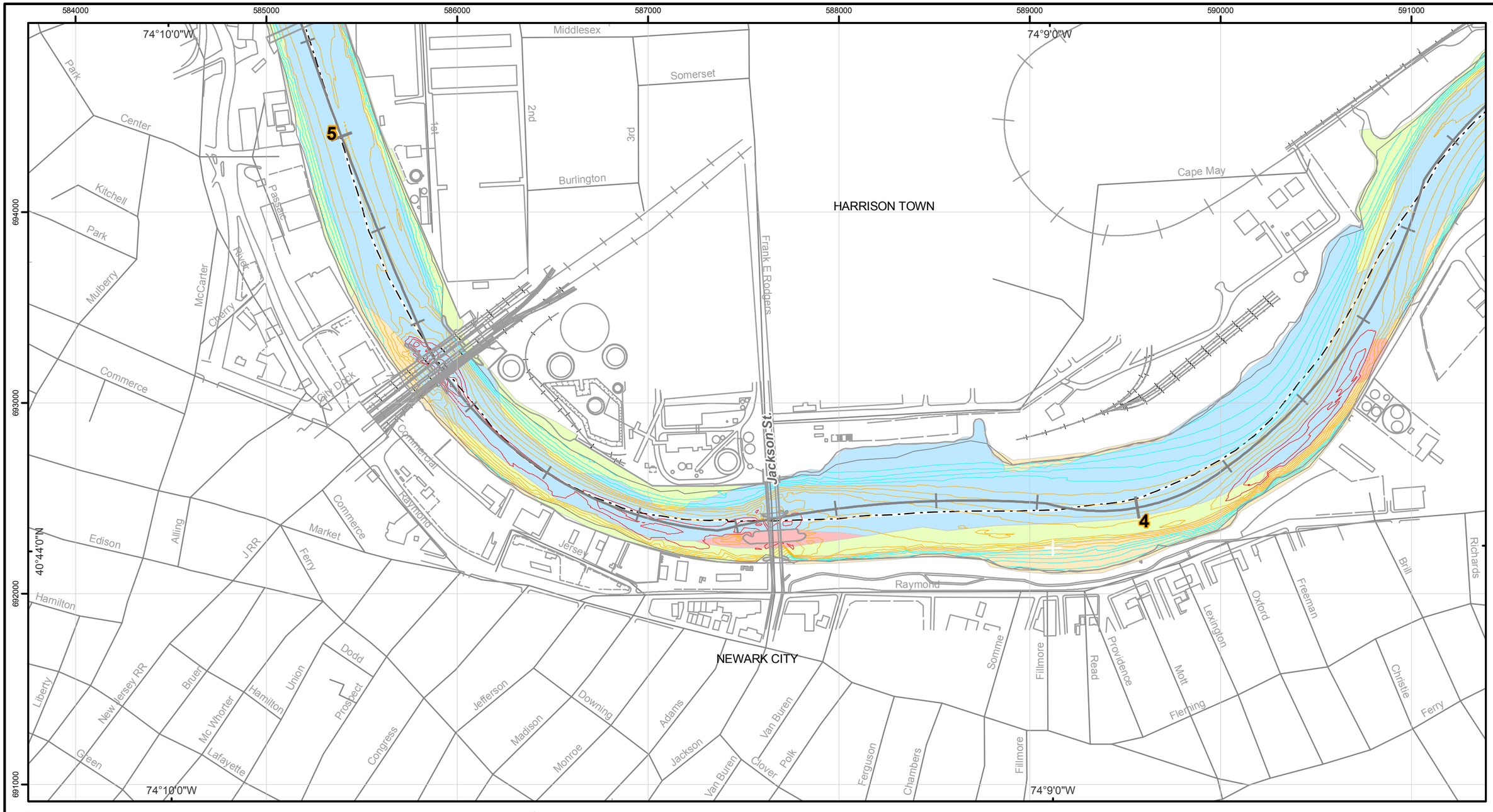

Sediment Texture Map

Lower Passaic River Restoration Project

Figure 1-4e
June 2006
Draft

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet)
Relative to NGVD29

- -30 to -20
- -18 to -10
- -8 to 0
- 2 to 10

N

0 250 500 1,000

1 " equals 500 '

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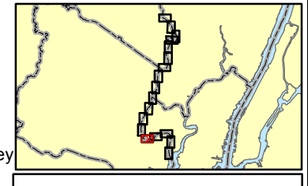
Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet



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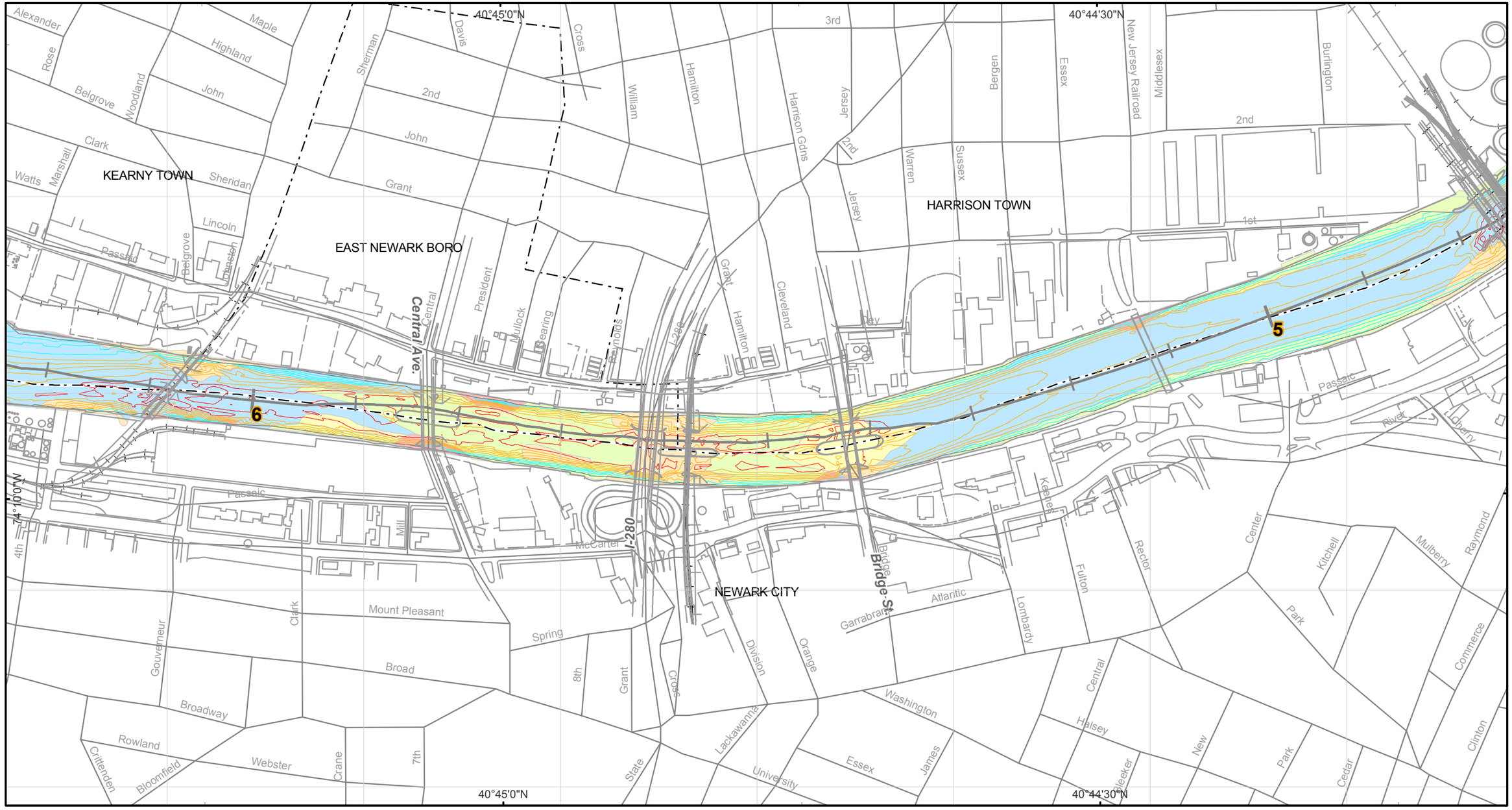

Sediment Texture Map

Lower Passaic River Restoration Project

Figure 1-4f
June 2006
Draft

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet)
Relative to NGVD29

- -30 to -20
- -18 to -10
- -8 to 0
- 2 to 10

N

0 250 500 1,000

1 " equals 500 '

Bathymetric Control Data:
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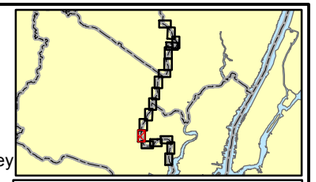
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet



Mile 5 to 6

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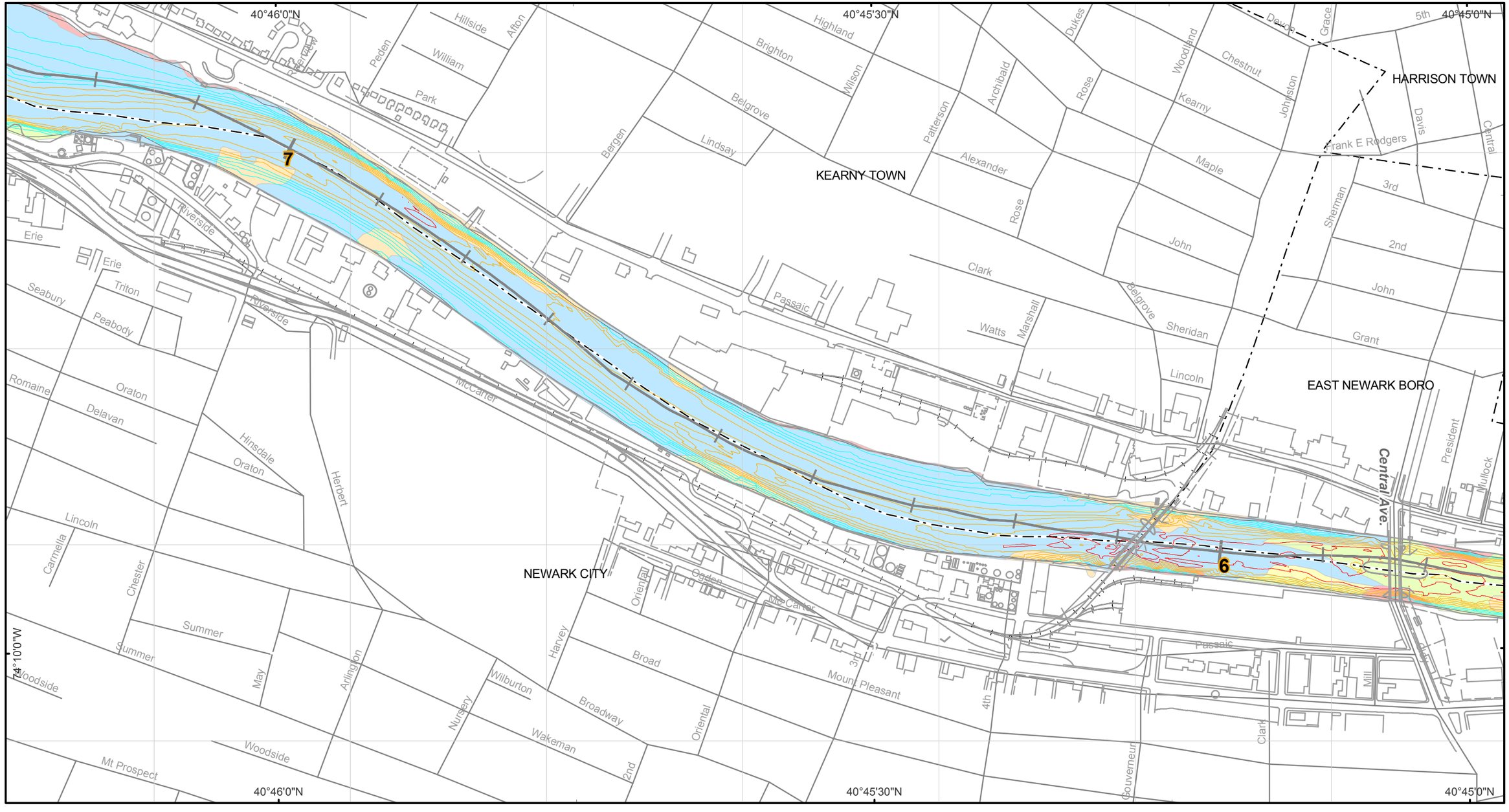


Sediment Texture Map

Lower Passaic River Restoration Project

Figure 1-4g
June 2006
Draft

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet)
Relative to NGVD29

- -30 to -20
- -18 to -10
- -8 to 0
- 2 to 10

N

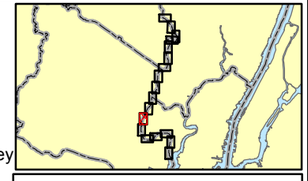
0 250 500 1,000

1 " equals 500 '

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet



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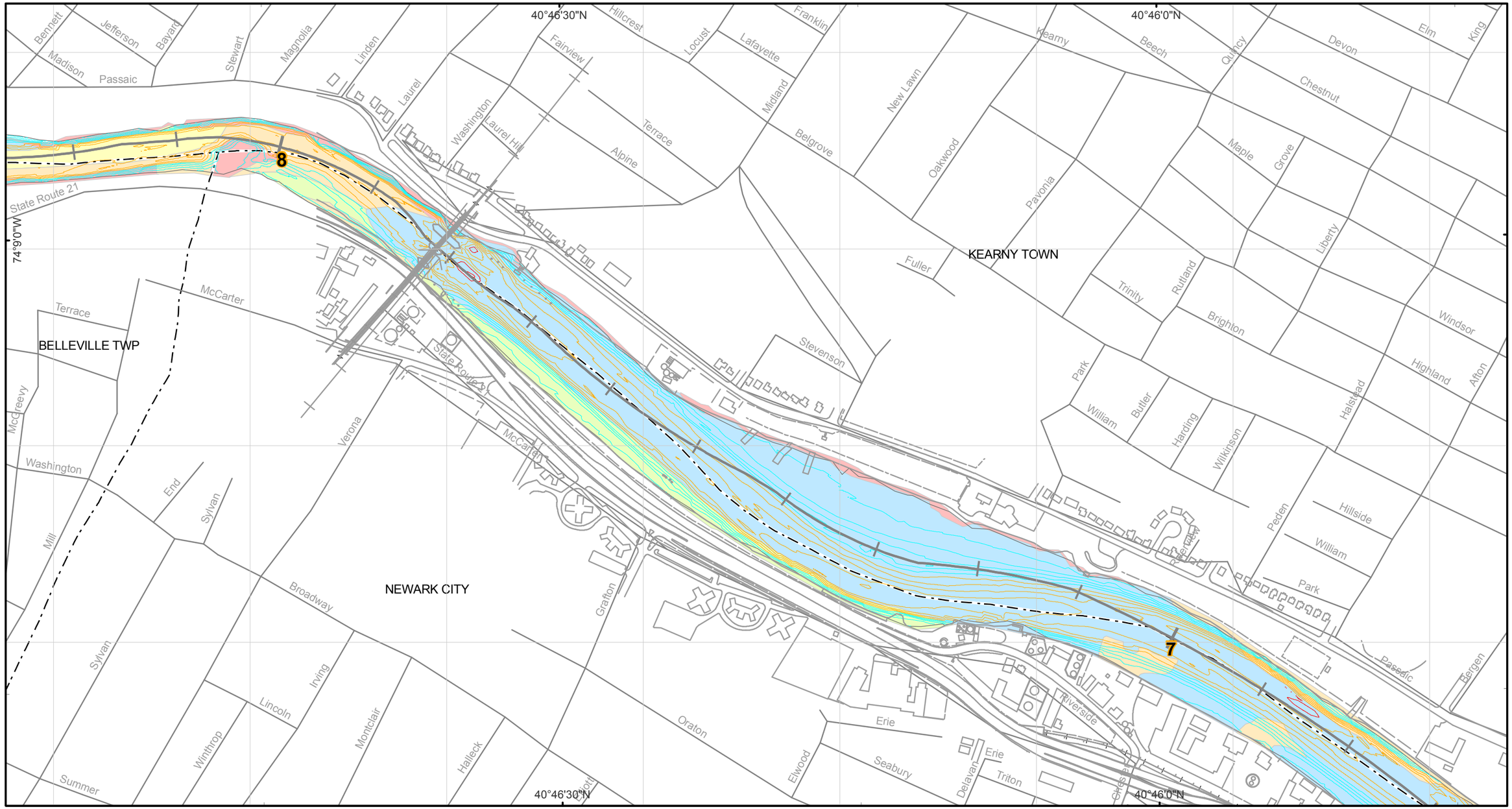


Sediment Texture Map

Lower Passaic River Restoration Project

Figure 1-4h
June 2006
Draft

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet)
Relative to NGVD29

-30 to -20 | -20 to -18 | -18 to -10 | -10 to -8 | -8 to 0 | 0 to 2 | 2 to 10

N

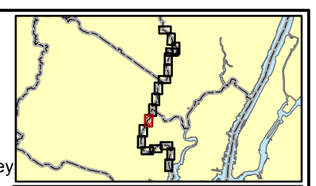
0 250 500 1,000

1 " equals 500 '

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet



Mile 7 to 8

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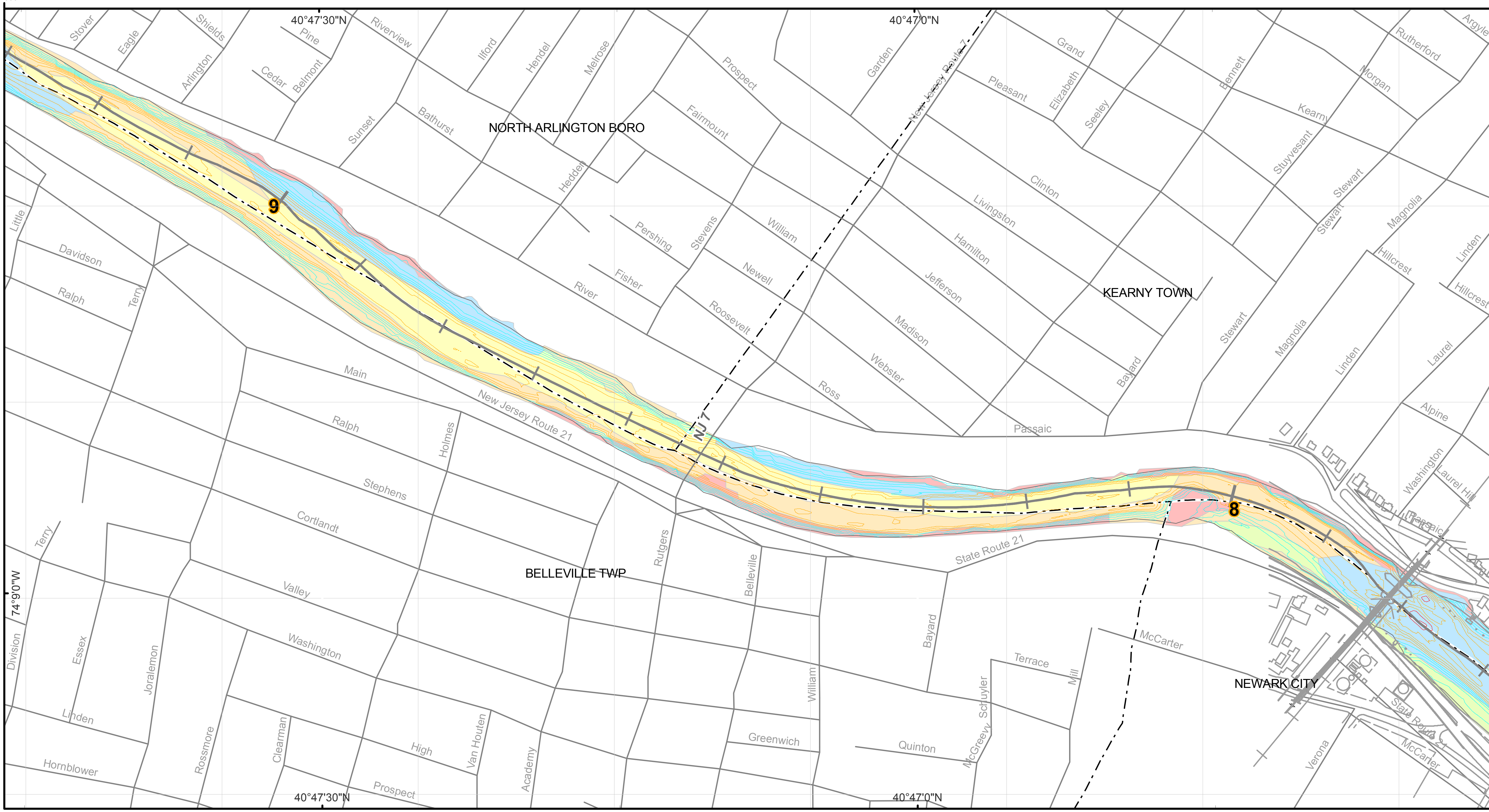


40°47'30"N
40°47'0"N
74°9'0"W
NORTH ARLINGTON BORO
KEARNY TOWN
BELLEVILLE TWP
NEWARK CITY
9
8
NJ 7
New Jersey Route 7
New Jersey Route 21
State Route 21
Stover
Eagle
Shields
Arlington
Pine
Cedar
Belmont
Riverview
Ilford
Hendel
Melrose
Sunset
Bathurst
Hedden
Prospect
Fairmount
Garden
Grand
Pleasant
Elizabeth
Seeley
Bennett
Rutherford
Argyle
Morgan
Kearny
Stuyvesant
Stewart
Magnolia
Linden
Hillcrest
Clinton
Livingston
Hamilton
Jefferson
Madison
Webster
Ross
Passaic
Bayard
Pershing
Stevens
William
Newell
Fisher
Roosevelt
River
Little
Davidson
Ralph
Terry
Main
Stephens
Cortlandt
Holmes
Rutgers
Belleville
Valley
Washington
Division
Essex
Joralemon
Linden
Hornblower
Rossmore
Clearman
High
Van Houten
Academy
Prospect
Greenwich
Quinton
McGreevy
Schuyler
Terrace
Mill
McCarter
Verona
Laurel
Alpine
Laurel Hill
State Route

Sediment Texture Map

Lower Passaic River Restoration Project

Figure 1-4i
June 2006
Draft

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet) Relative to NGVD29

- -30 to -20
- -18 to -10
- -8 to 0
- 2 to 10

N

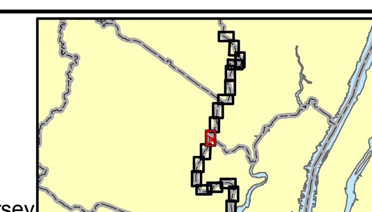
0 250 500 1,000

1 " equals 500 '

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet



Mile 8 to 9

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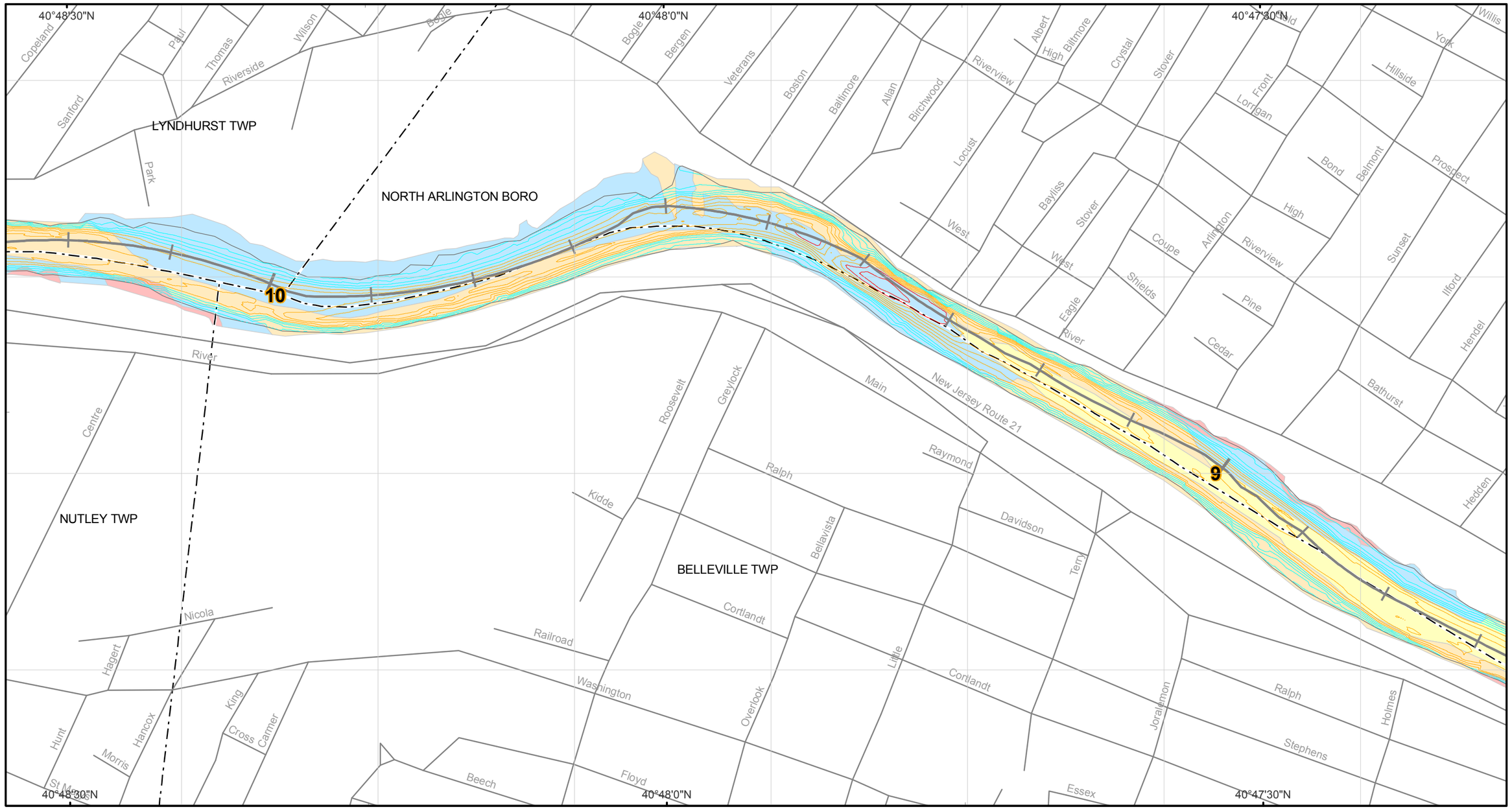

Sediment Texture Map

Lower Passaic River Restoration Project

Figure 1-4j
June 2006
Draft

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet)
Relative to NGVD29

- -30 to -20
- -18 to -10
- -8 to 0
- 2 to 10

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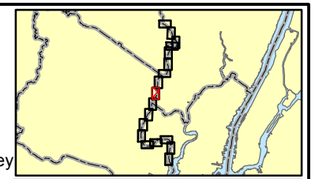
Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet



Mile 9 to 10

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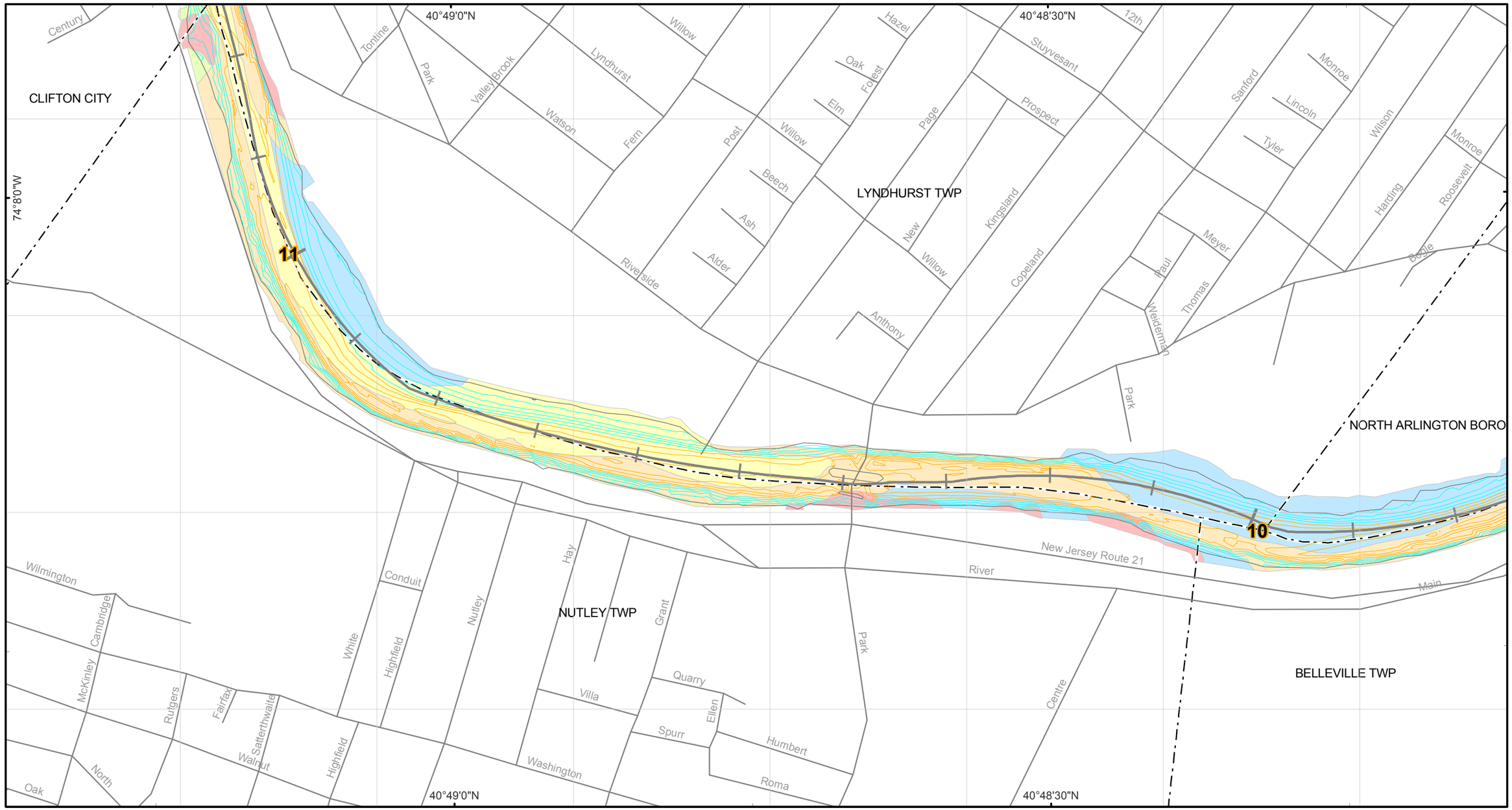

Sediment Texture Map

Lower Passaic River Restoration Project

Figure 1-4k
June 2006
Draft

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet)
Relative to NGVD29

-30 to -20 | -20 to -18 | -18 to -10 | -10 to -8 | -8 to 0 | 0 to 2 | 2 to 10

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Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

Mile 10 to 11

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sediment_Texture_Geophysical_Memo_October_2005.mxd)
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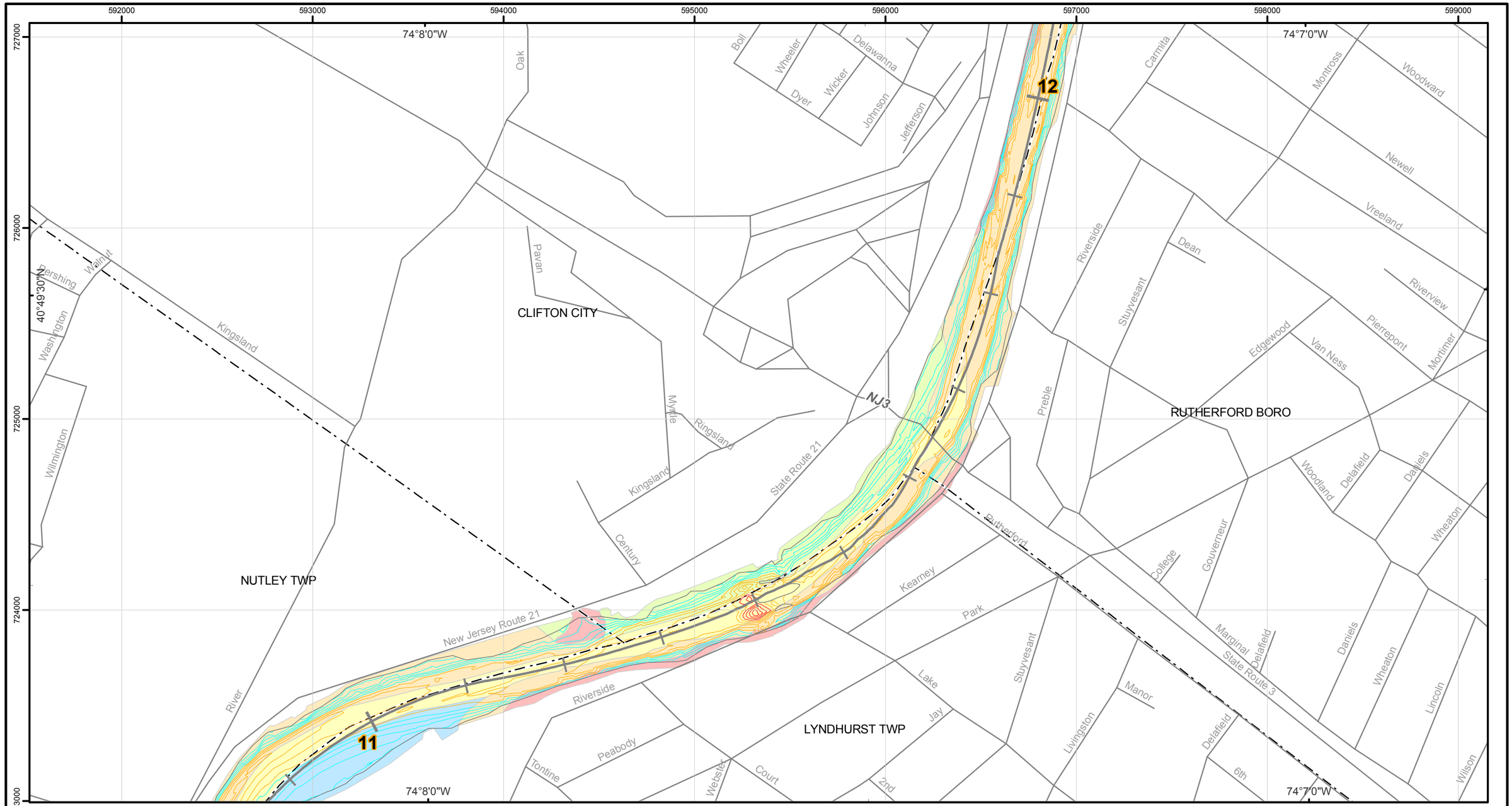

US Army Corps of Engineers®

Sediment Texture Map

Lower Passaic River Restoration Project

Figure 1-4l
June 2006
Draft

Legend

- Rock and Coarse gravel
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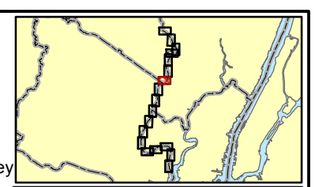
Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet



Mile 11 to 12

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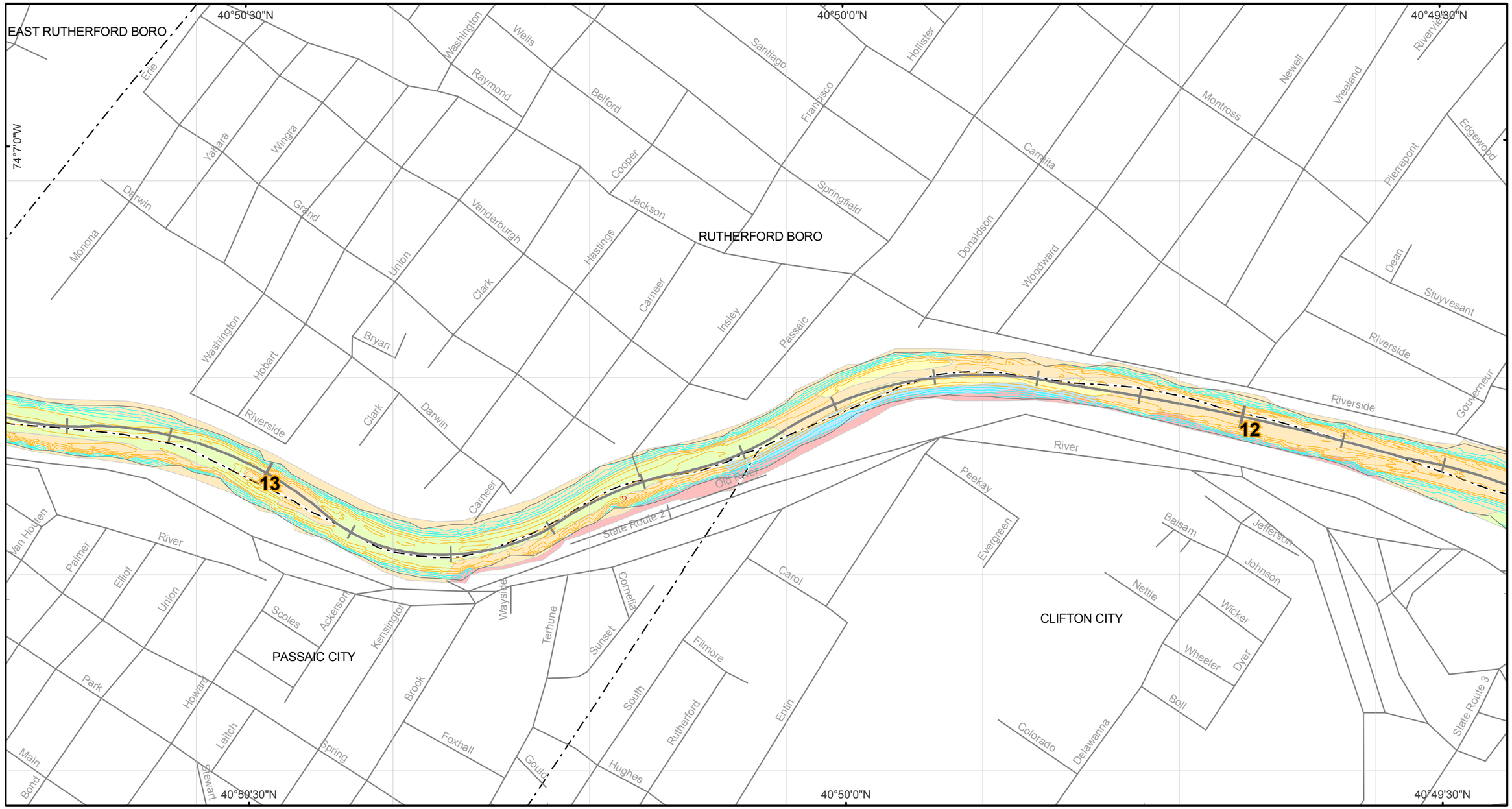

Sediment Texture Map

Lower Passaic River Restoration Project

Figure 1-4m
June 2006
Draft

Legend

- Rock and Coarse gravel
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Elevation: 15.76 FEET (NGVD 29)

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet

Mile 12 to 13

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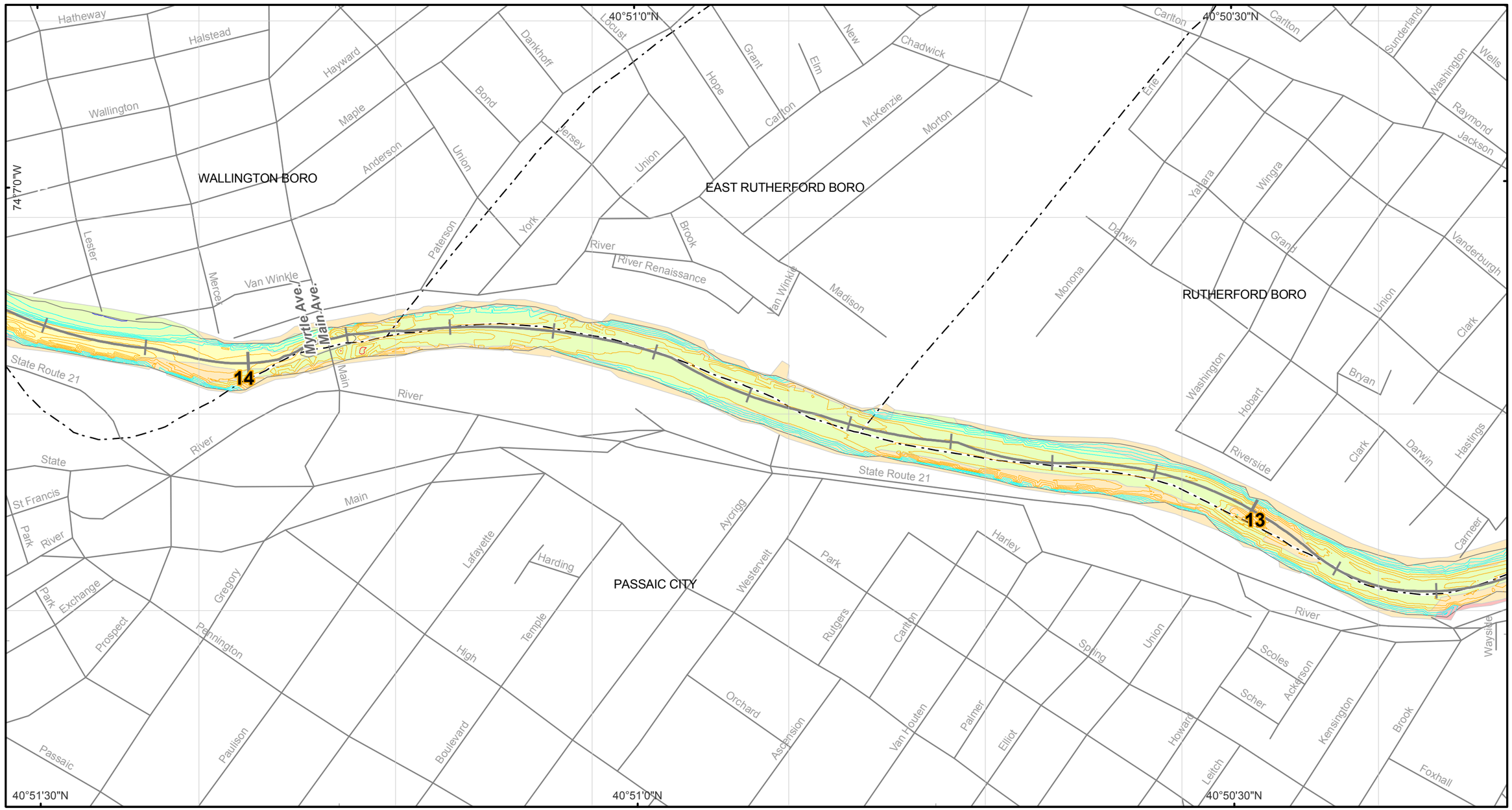

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US Army Corps of Engineers®

Sediment Texture Map

Lower Passaic River Restoration Project

Figure 1-4n
June 2006
Draft

Legend

- Rock and Coarse gravel
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Elevation: 15.76 FEET (NGVD 29)

Coordinate System: State Plane New Jersey
Datum: NAD 83
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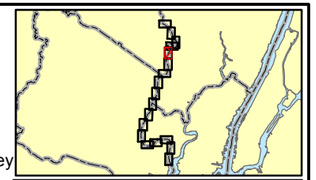
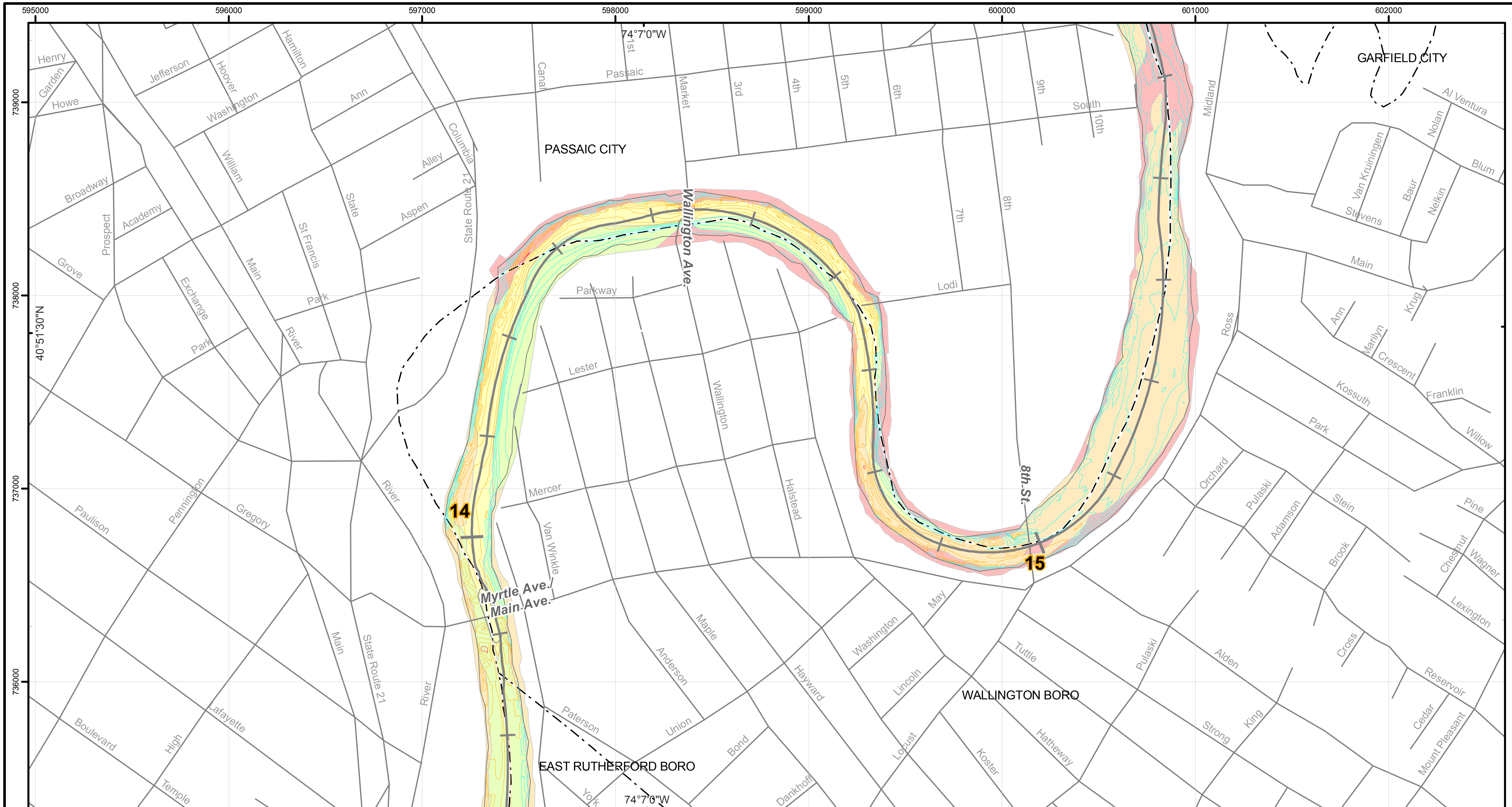


Mile 13 to 14



595000
596000
597000
598000
599000
600000
601000
602000
739000
738000
737000
736000
74°7'0"W
40°51'30"N
PASSAIC CITY
GARFIELD CITY
WALLINGTON BORO
EAST RUTHERFORD BORO
Wallington Ave.
Myrtle Ave./
Main Ave.
8th St.
14
15
Henry
Garden
Howe
Jefferson
Hoover
Hamilton
Washington
Ann
Canal
1st
Passaic
Market
3rd
4th
5th
6th
9th
South
10th
Midland
Al Ventura
Nolan
Van Kruiningen
Blum
Baur
Nelkin
Stevens
Main
Krug
Ann
Marilyn
Crescent
Franklin
Kossuth
Park
Willow
Columbia
Alley
Aspen
State Route 21
State
William
Broadway
Academy
Prospect
Grove
Exchange
St Francis
Park
River
Parkway
Lodi
7th
8th
Ross
Lester
Wallington
Mercer
Van Winkle
Halstead
Orchard
Pulaski
Adamson
Stein
Pine
Chestnut
Wagner
Lexington
Brook
Cross
Paulison
Pennington
Gregory
River
Main
State Route 21
River
Paterson
Anderson
Maple
Union
Hayward
Washington
May
Lincoln
Tuttle
Pulaski
Alden
Reservoir
Cedar
Mount Pleasant
Strong
King
Hatheway
Koster
Locust
Bond
Dankhoff
York
Boulevard
High
Lafayette
Temple

Sediment Texture Map

Lower Passaic River Restoration Project

Figure 1-4o
June 2006
Draft

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
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- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet)
Relative to NGVD29

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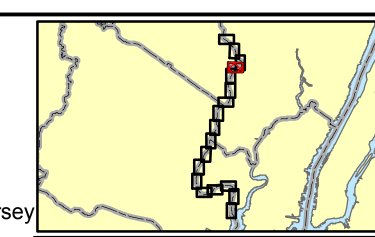
Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet



Mile 14 to 15

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sediment_Texture_Geophysical_Memo_October_2005.mxd)
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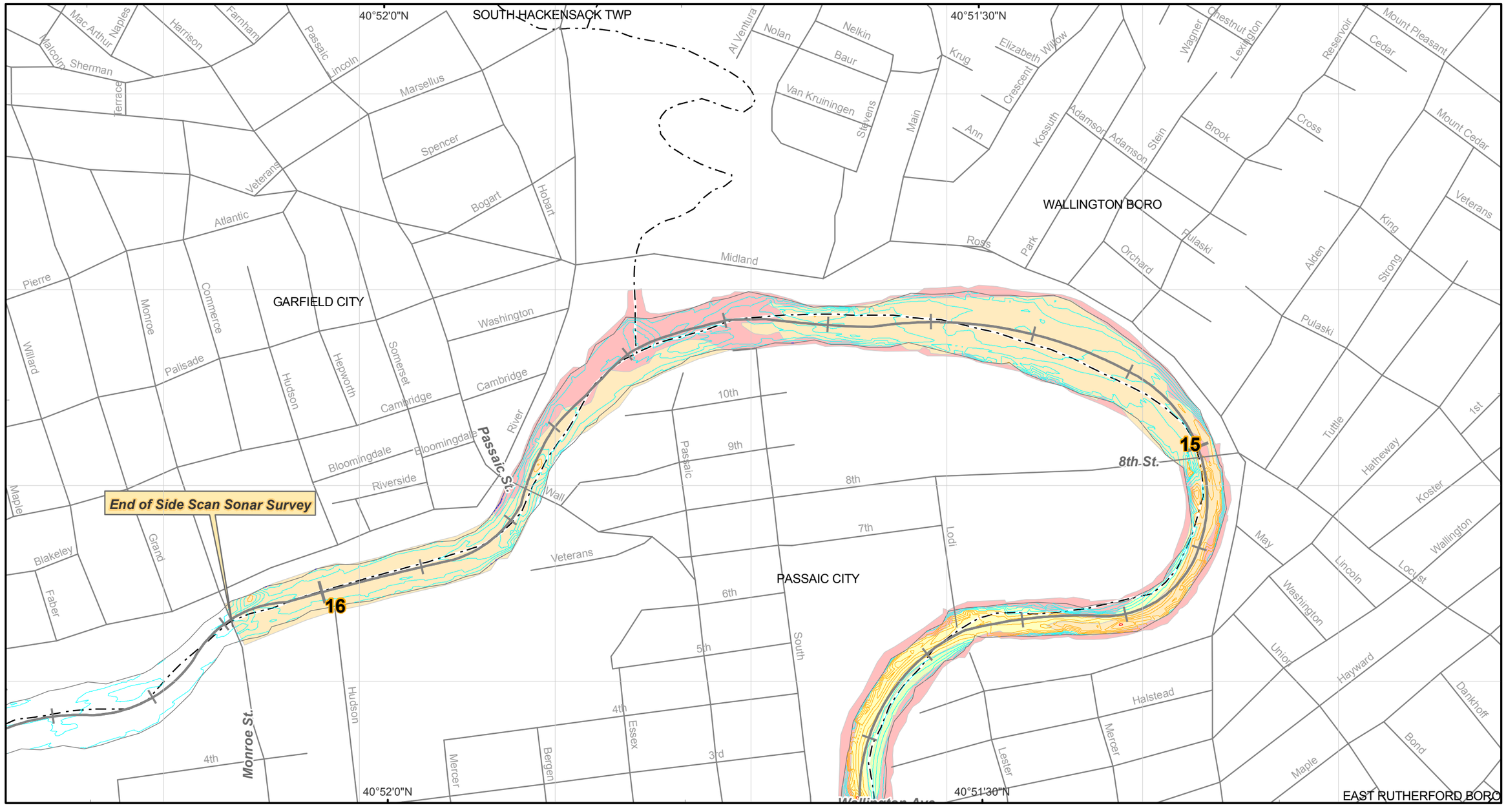


Sediment Texture Map

Lower Passaic River Restoration Project

Figure 1-4p
June 2006
Draft

US Army Corps of Engineers

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet)
Relative to NGVD29

- -30 to -20
- -18 to -10
- -8 to 0
- 2 to 10

N

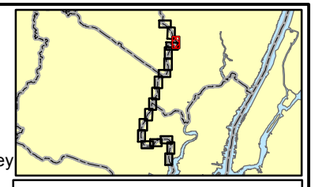
0 250 500 1,000

1 " equals 500 '

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet



Mile 15 to 16

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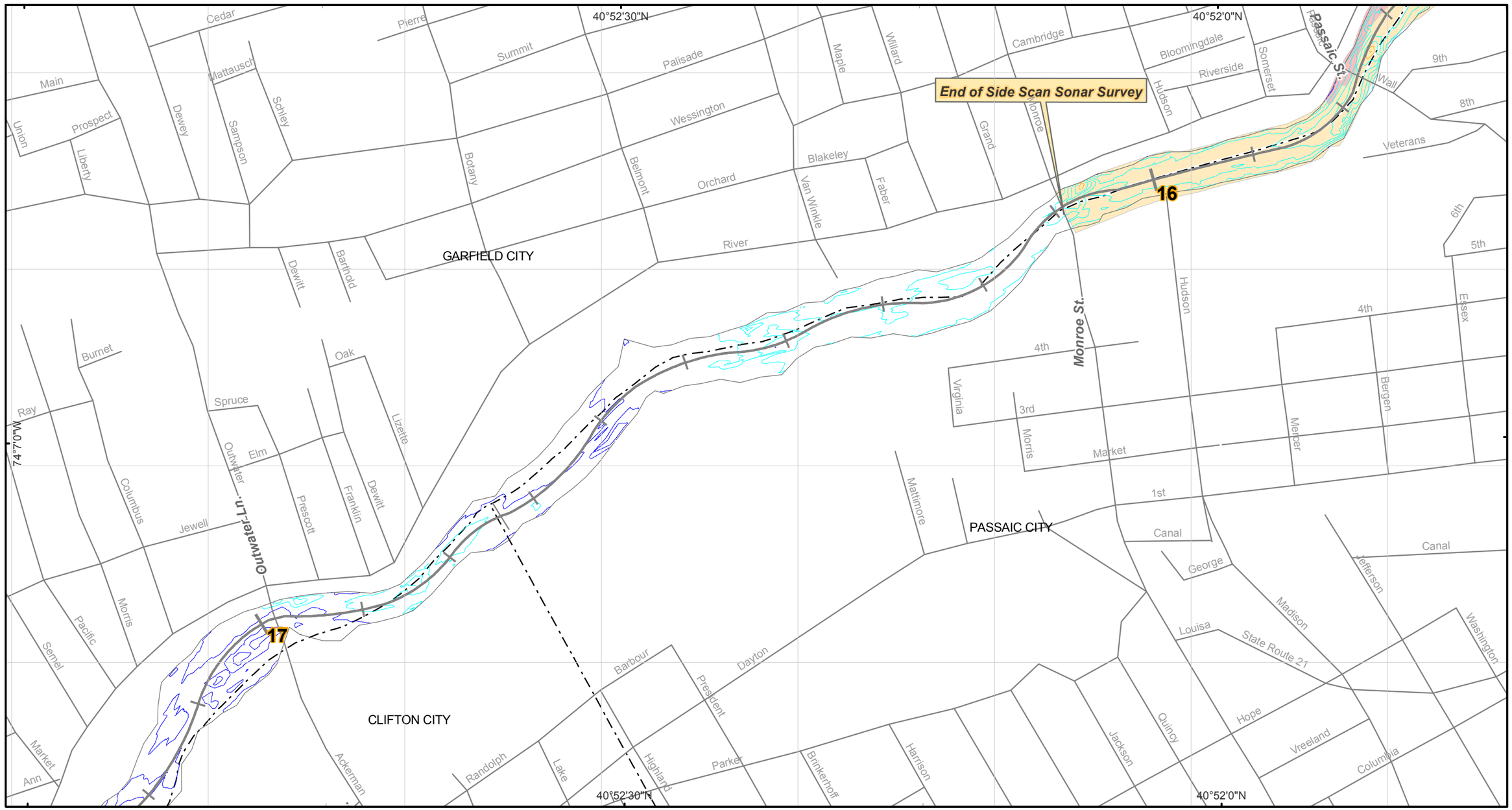


Sediment Texture Map

Lower Passaic River Restoration Project

Figure 1-4q
June 2006
Draft

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet)
Relative to NGVD29

-30 to -20 | -20 to -18 | -10 to -8 | 0 to 2

N

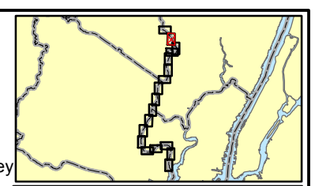
0 250 500 1,000

1 " equals 500 '

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet



Mile 16 to 17

Map Document: (S:\Projects\PASSAIC\MapDocuments\Proposed Sediments\Coring_Field_Work\Sediment_Texture_Geophysical_Memo_October_2005.mxd)
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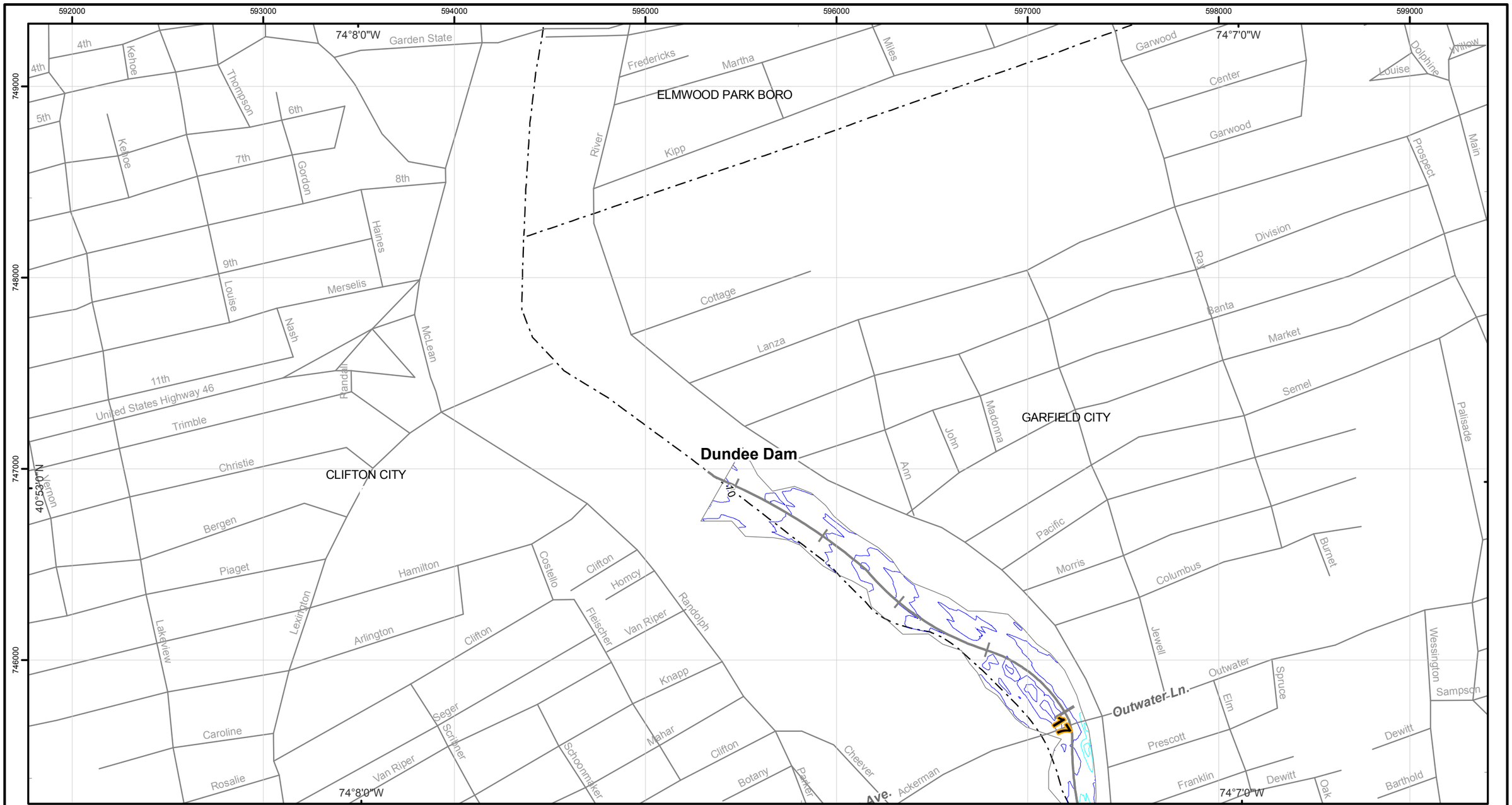


Sediment Texture Map

Lower Passaic River Restoration Project

Figure 1-4r
June 2006
Draft

US Army Corps of Engineers®

Legend

- Rock and Coarse gravel
- Gravel and Sand
- Sand
- Silt and Sand
- Silt
- River Mile Post

2004 USACE Bathymetric Survey

Elevation (Feet)
Relative to NGVD29

- -30 to -20
- -18 to -10
- -8 to 0
- 2 to 10

N

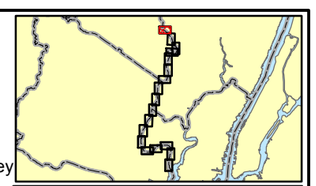
0 250 500 1,000

1 " equals 500 '

Bathymetric Control Data:
Benchmark: X 71 (NGS PID: KV0256)
Elevation: 15.12 FEET (NGVD 29)

Benchmark: V 71 (NGS PID: KV0254)
Elevation: 15.76 FEET (NGVD 29)

Coordinate System: State Plane New Jersey
Datum: NAD 83
Units: Feet



Mile 17 to Dundee Dam

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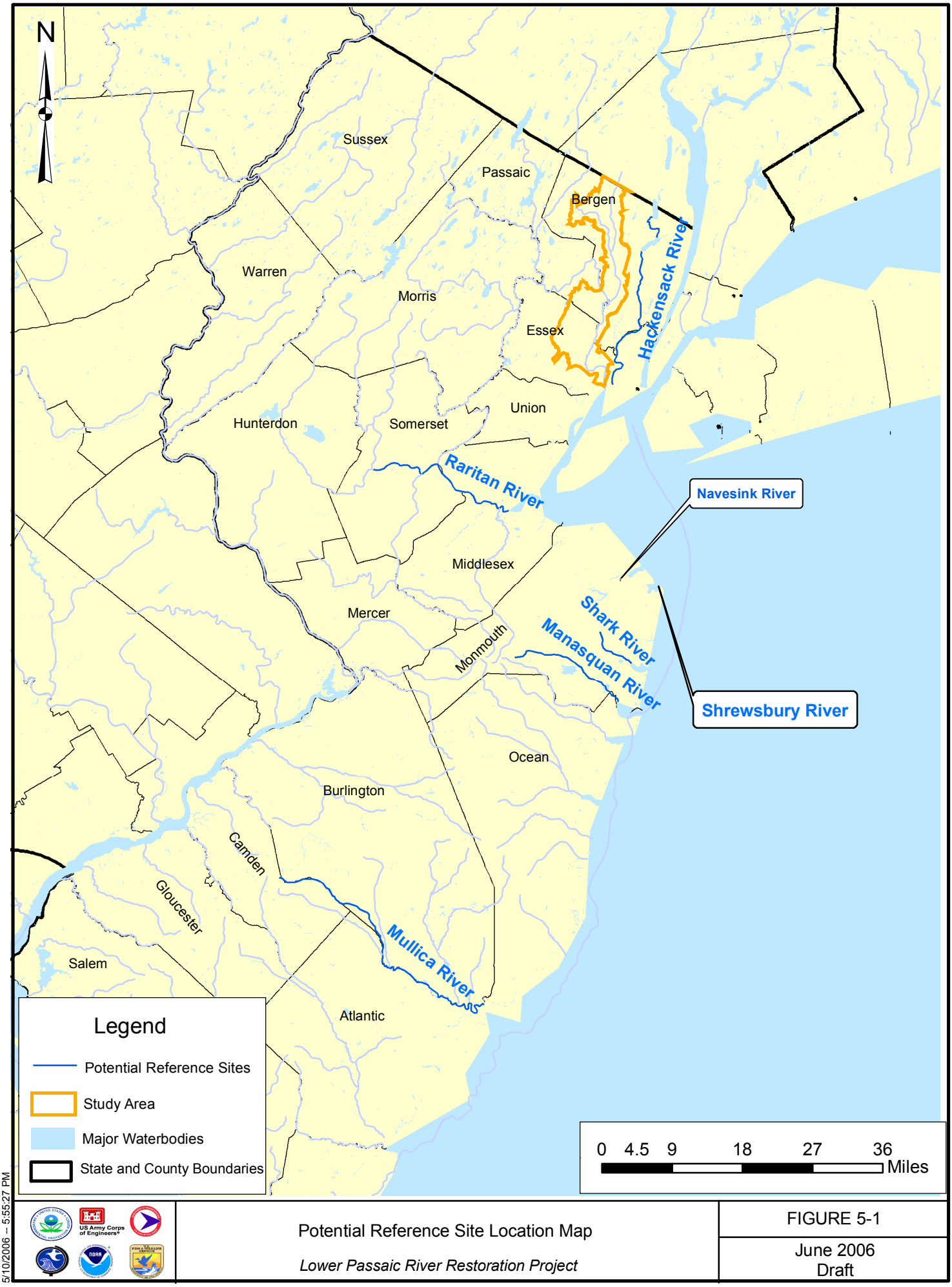

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5/10/2006 -- 5:55:27 PM

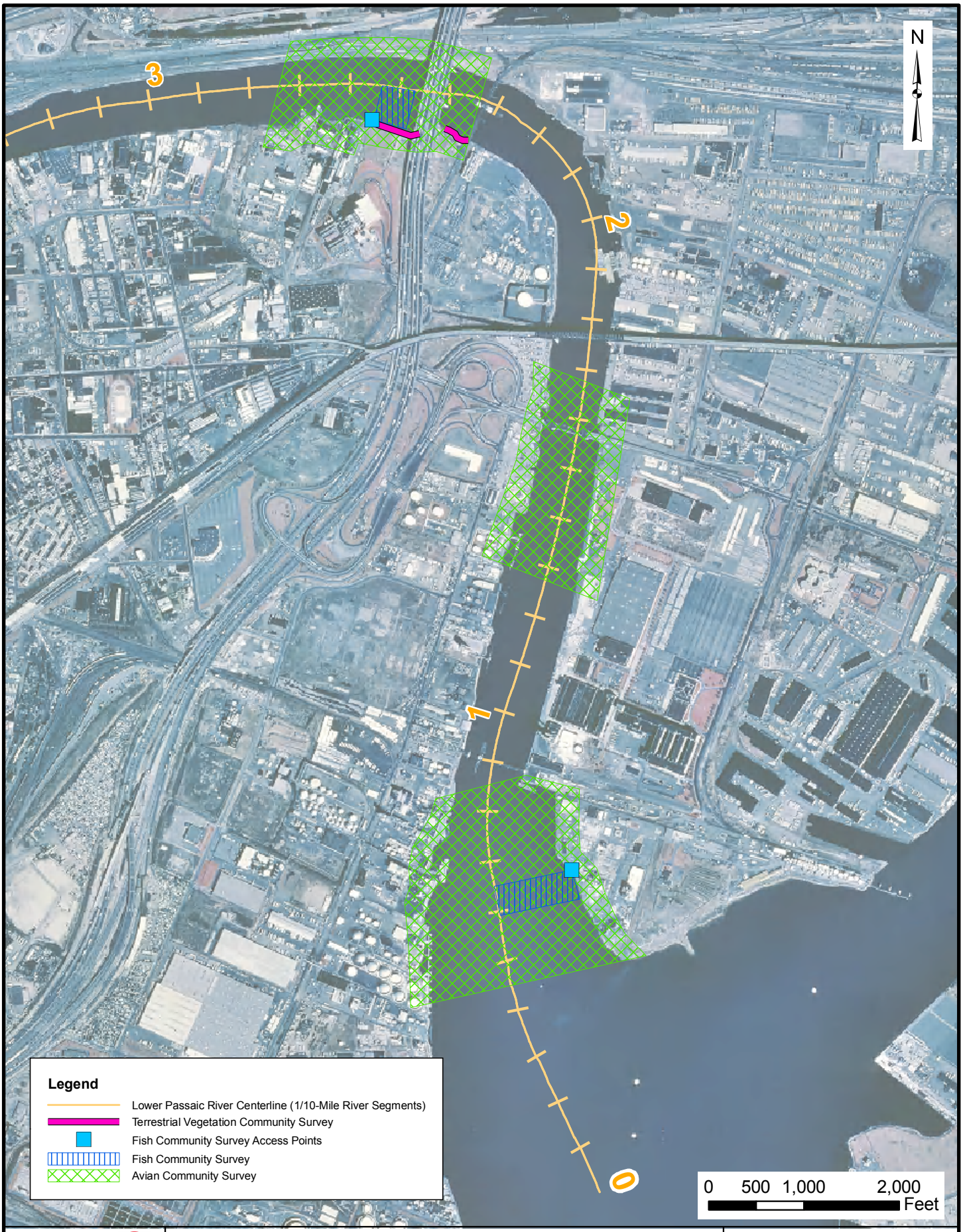
US Army Corps of Engineers

Potential Reference Site Location Map

Lower Passaic River Restoration Project

FIGURE 5-1

June 2006
Draft



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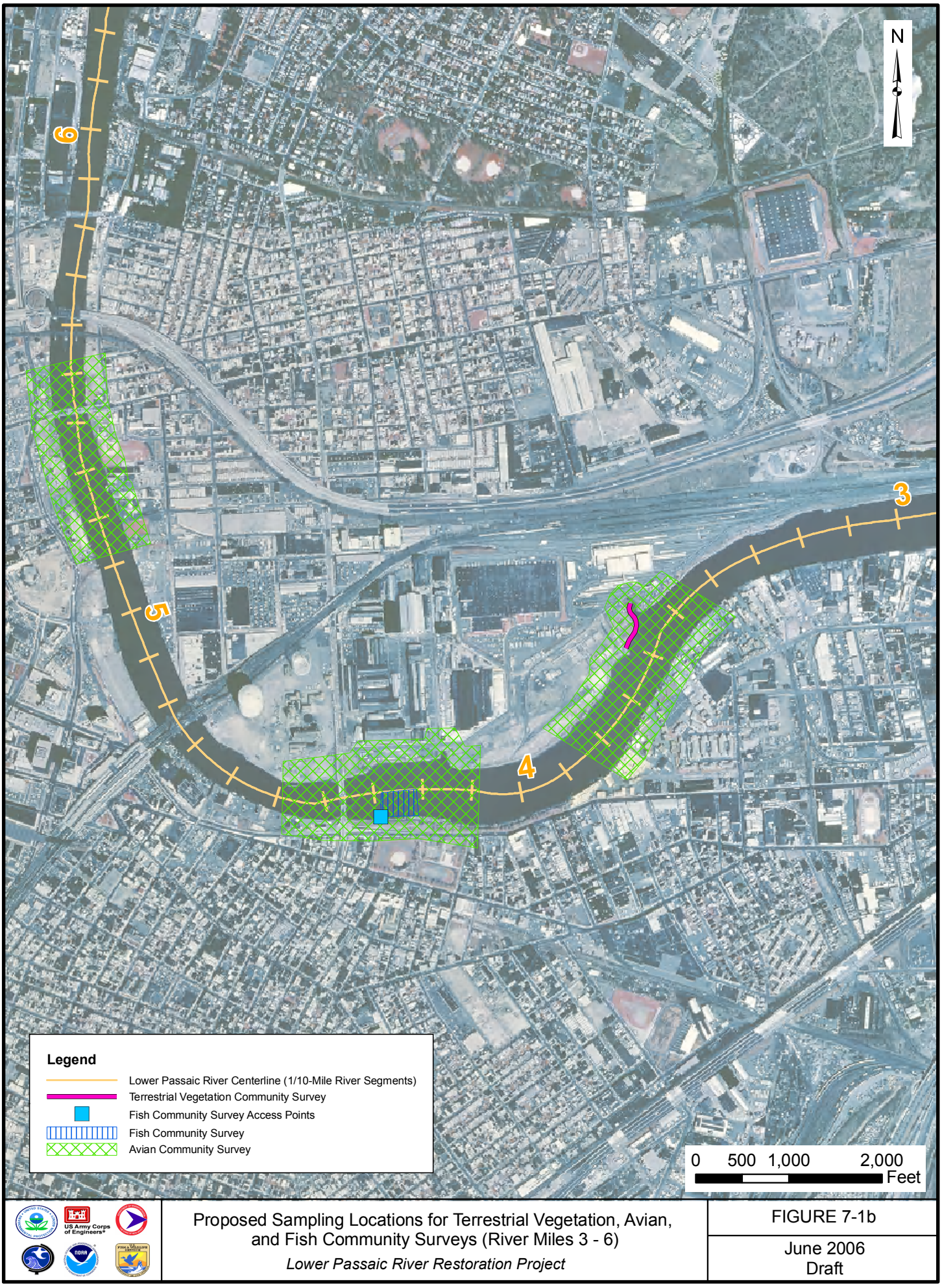
US Army Corps of Engineers

Proposed Sampling Locations for Terrestrial Vegetation, Avian, and Fish Community Surveys (River Miles 0 - 3)

Lower Passaic River Restoration Project

FIGURE 7-1a

June 2006
Draft



Proposed Sampling Locations for Terrestrial Vegetation, Avian, and Fish Community Surveys (River Miles 3 - 6)

Lower Passaic River Restoration Project

FIGURE 7-1b

June 2006
Draft

Map Document: (S:\Projects\PASSAIC\MapDocuments\4622001-WRDA\MXD\FSP2_033106\MXDS\community_surveys\cs_Miles_3-6.mxd)
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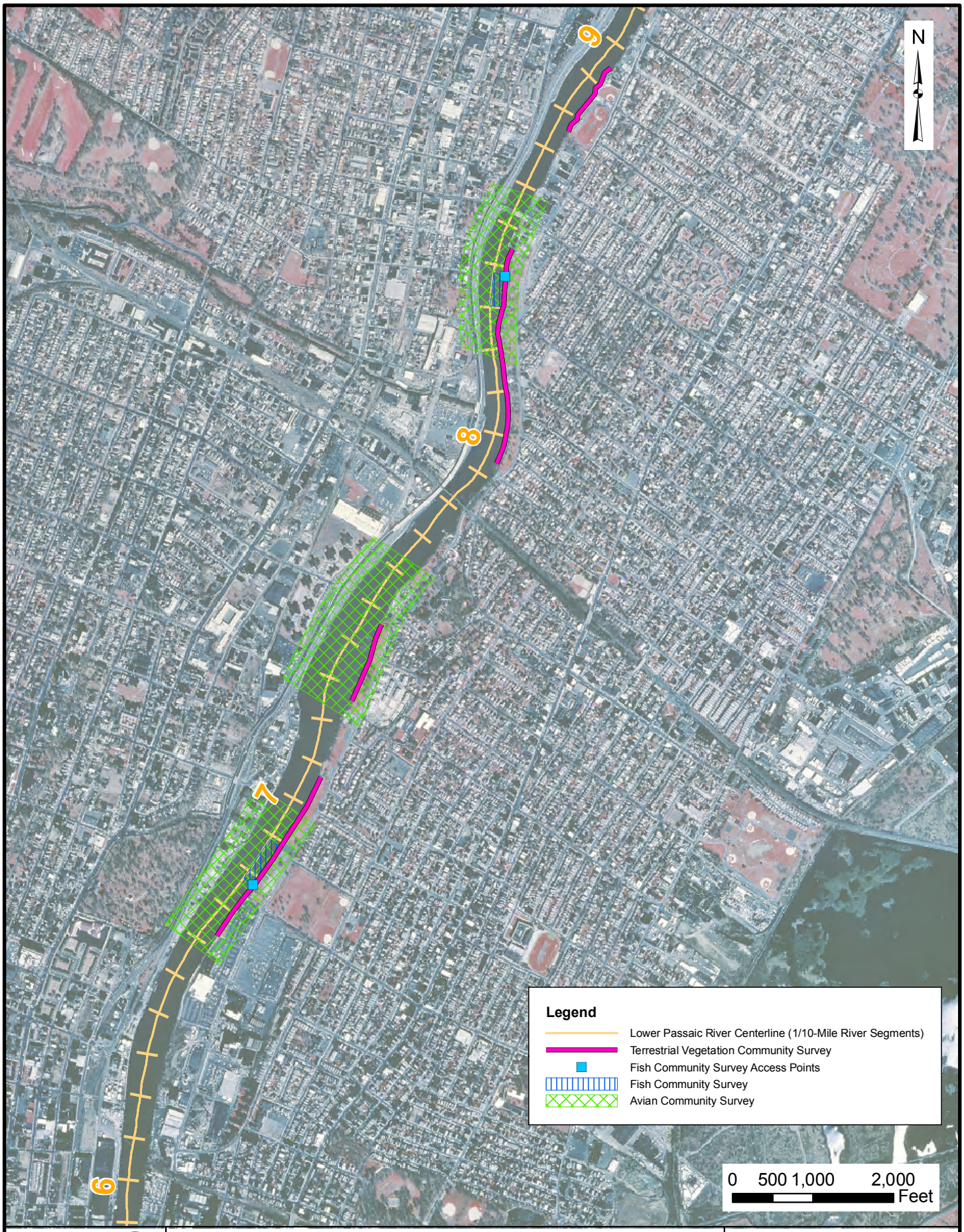

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6/13/2006 -- 3:55:03 PM

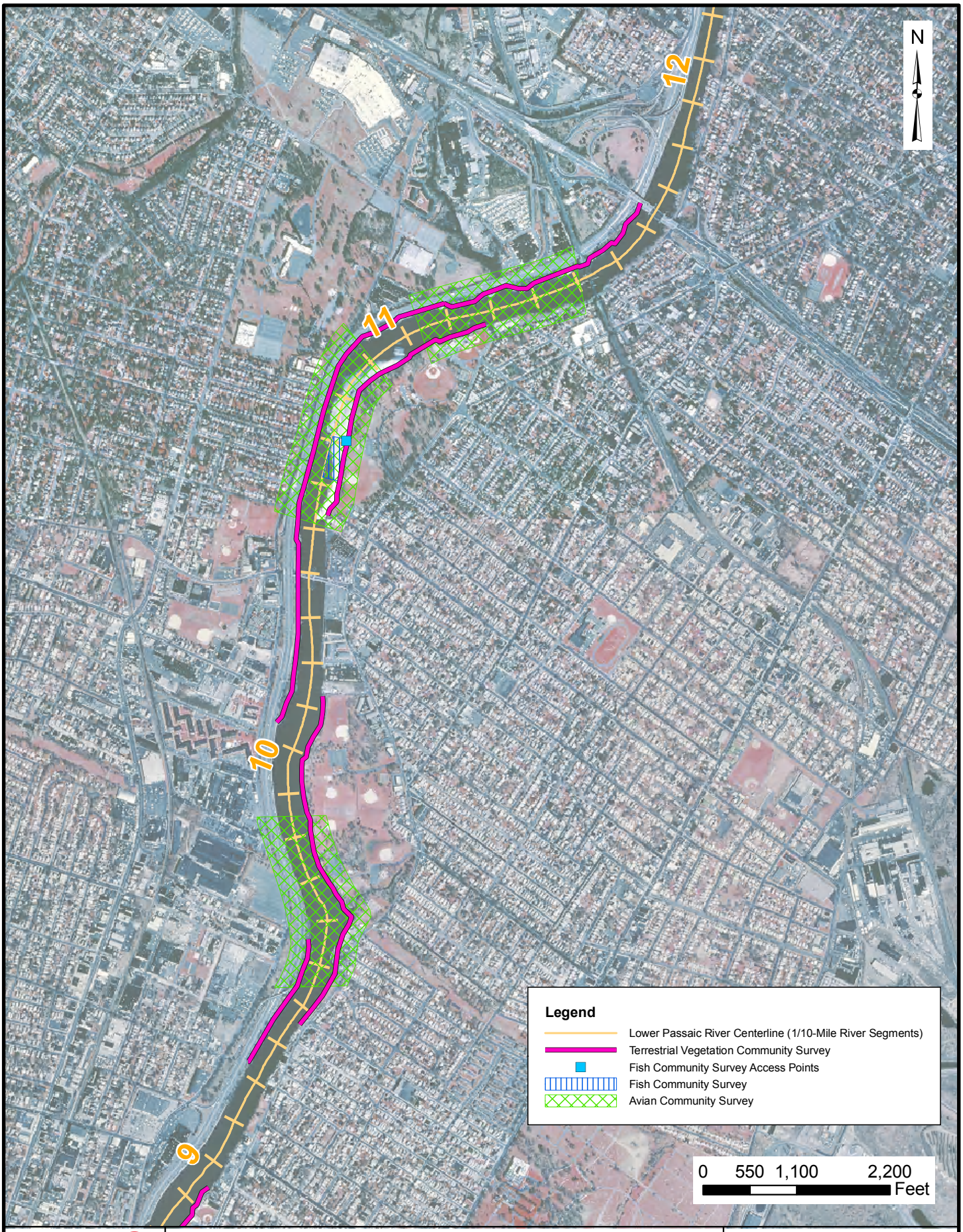
US Army Corps of Engineers

Proposed Sampling Locations for Terrestrial Vegetation, Avian, and Fish Community Surveys (River Miles 6 - 9)

Lower Passaic River Restoration Project

FIGURE 7-1c

June 2006
Draft



Proposed Sampling Locations for Terrestrial Vegetation, Avian, and Fish Community Surveys (River Miles 9 - 12)

Lower Passaic River Restoration Project

FIGURE 7-1d

June 2006
Draft

Map Document: (S:\Projects\PASSAIC\MapDocuments\4622001-WRDA\MXD\FSP2_033106\MXDS\community_survey\cs_Miles_9-12.mxd)
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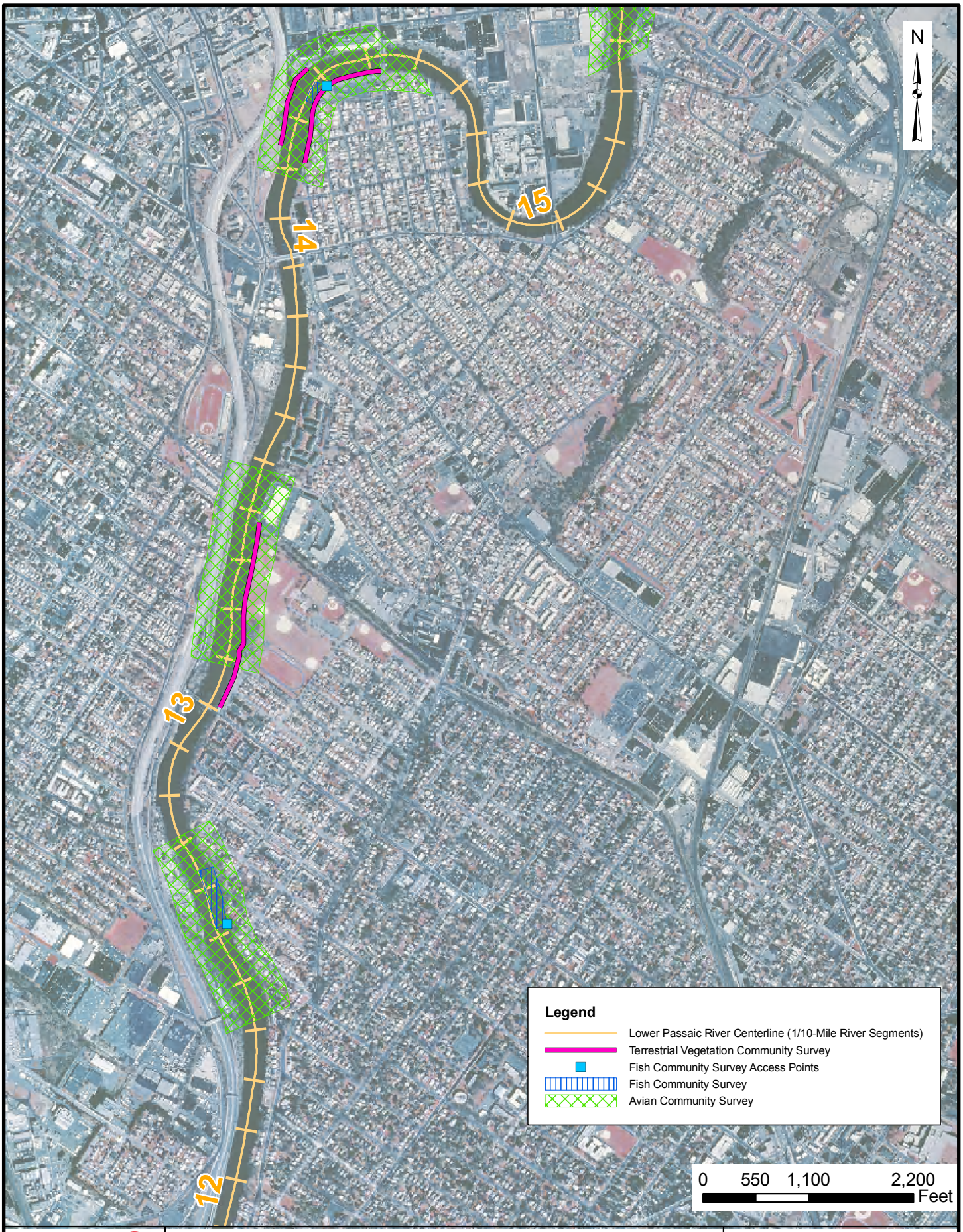

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US Army Corps of Engineers

Proposed Sampling Locations for Terrestrial Vegetation, Avian, and Fish Community Surveys (River Miles 12 - 15)

Lower Passaic River Restoration Project

FIGURE 7-1e

June 2006
Draft

Proposed Sampling Locations for Terrestrial Vegetation, Avian, and Fish Community Surveys (River Miles 15 - 17)

Lower Passaic River Restoration Project

FIGURE 7-1f

June 2006
Draft

Map Document: (S:\Projects\PASSAIC\MapDocuments\4622001-WRDA\MXD\FSP2_033106\MXDS\community_survey\cs_Miles_15-17.mxd)
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6/13/2006 -- 4:07:33 PM

US Army Corps of Engineers

Proposed Sampling Locations for Benthic Invertebrate Community Survey and Toxicity Testing
(River Miles 0 - 3)
Lower Passaic River Restoration Project

FIGURE 11-1a

June 2006
Draft

Map Document: (S:\Projects\PASSAIC\MapDocuments\4622001-WRDA\MXD\FSP2_033106\MXDS\toxicity\toxicity_Miles_3-6.mxd)
6/13/2006 -- 4:11:51 PM

US Army Corps of Engineers

Proposed Sampling Locations for Benthic Invertebrate Community Survey and Toxicity Testing
(River Miles 3 - 6)
Lower Passaic River Restoration Project

FIGURE 11-1b

June 2006
Draft

Map Document: (S:\Projects\PASSAIC\MapDocuments\4622001-WRDA\MXD\FSP2_033106\MXDS\toxicity\toxicity_Miles_6-9.mxd)
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Proposed Sampling Locations for Benthic Invertebrate Community Survey and Toxicity Testing
(River Miles 6 - 9)
Lower Passaic River Restoration Project

FIGURE 11-1c

June 2006
Draft

Map Document: (S:\Projects\PASSAIC\MapDocuments\4622001-WRDA\MXD\FSP2_033106\MXDS\toxicity\toxicity_Miles_9-12.mxd)
6/13/2006 -- 4:24:29 PM

US Army Corps of Engineers

Proposed Sampling Locations for Benthic Invertebrate Community Survey and Toxicity Testing
(River Miles 9 - 12)
Lower Passaic River Restoration Project

FIGURE 11-1d

June 2006
Draft

Map Document: (S:\Projects\PASSAIC\MapDocuments\4622001-WRDA\MXD\FSP2_033106\MXDS\toxicity\toxicity_Miles_12-15.mxd)
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US Army Corps of Engineers

Proposed Sampling Locations for Benthic Invertebrate Community Survey and Toxicity Testing
(River Miles 12 - 15)
Lower Passaic River Restoration Project

FIGURE 11-1e

June 2006
Draft

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US Army Corps of Engineers

Proposed Sampling Locations for Benthic Invertebrate Community Survey and Toxicity Testing
(River Miles 15 - 17)
Lower Passaic River Restoration Project

FIGURE 11-1f

June 2006
Draft

Proposed Sampling Locations for Biological Tissue-Residue
(River Miles 0 - 3)

Lower Passaic River Restoration Project

FIGURE 12-1a

June 2006
Draft

Map Document: (S:\Projects\PASSAIC\MapDocuments\4622001-WRDA\MXD\FSP2_033106\MXDS\biological_tissue_residue\bt_Miles_0-3.mxd)
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Proposed Sampling Locations for Biological Tissue-Residue
(River Miles 3 - 6)

Lower Passaic River Restoration Project

FIGURE 12-1b

June 2006
Draft

Map Document: (S:\Projects\PASSAIC\MapDocuments\4622001-WRDA\MXD\FSP2_033106\MXDS\biological_tissue_residue\bt_Miles_3-6.mxd)
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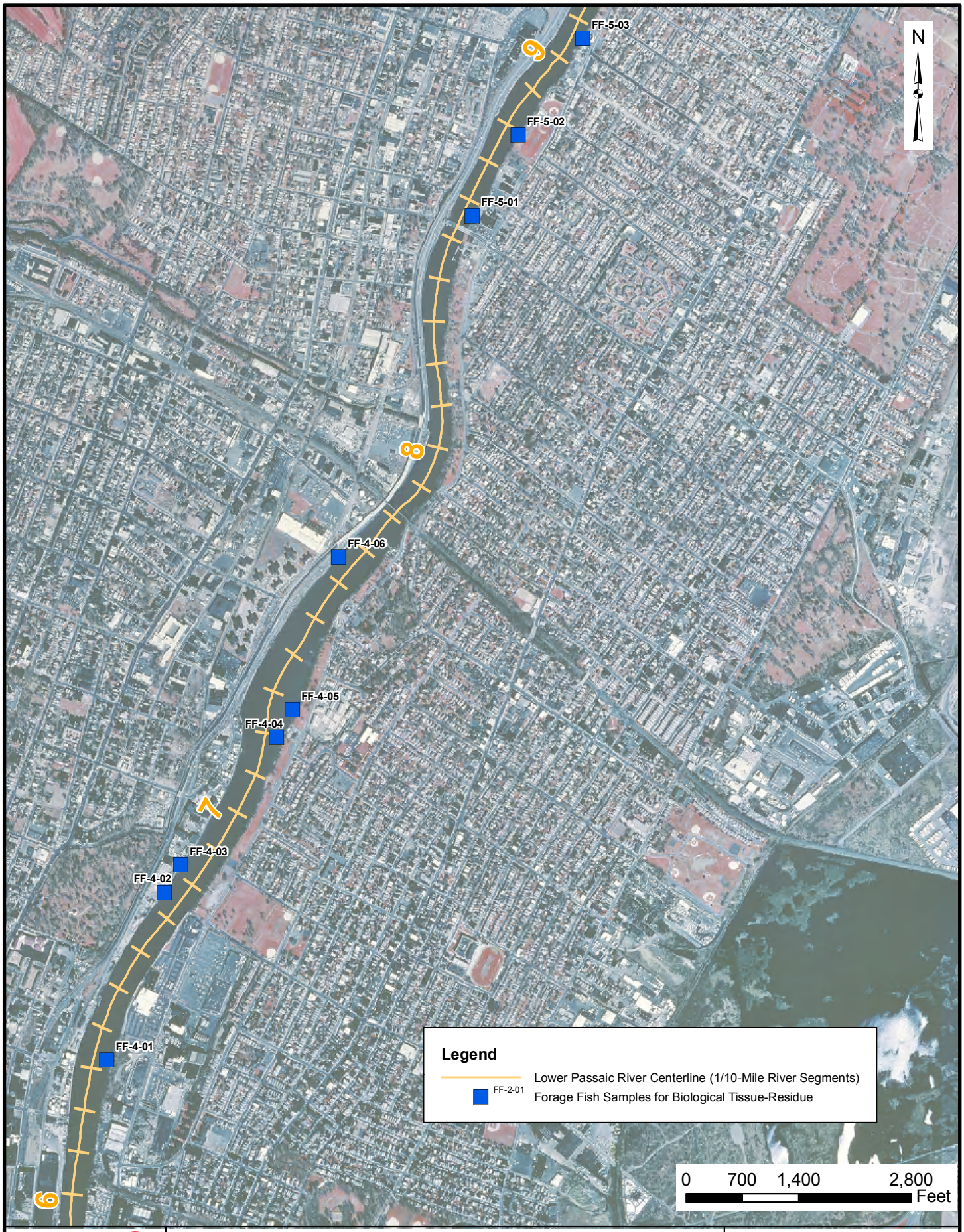

Proposed Sampling Locations for Biological Tissue-Residue
(River Miles 6 - 9)

Lower Passaic River Restoration Project

FIGURE 12-1c

June 2006
Draft

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5/10/2006 -- 5:31:22 PM

Proposed Sampling Locations for Biological Tissue-Residue
(River Miles 9 - 12)

Lower Passaic River Restoration Project

FIGURE 12-1d

June 2006
Draft

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Proposed Sampling Locations for Biological Tissue-Residue
(River Miles 12 - 15)

Lower Passaic River Restoration Project

FIGURE 12-1e

June 2006
Draft

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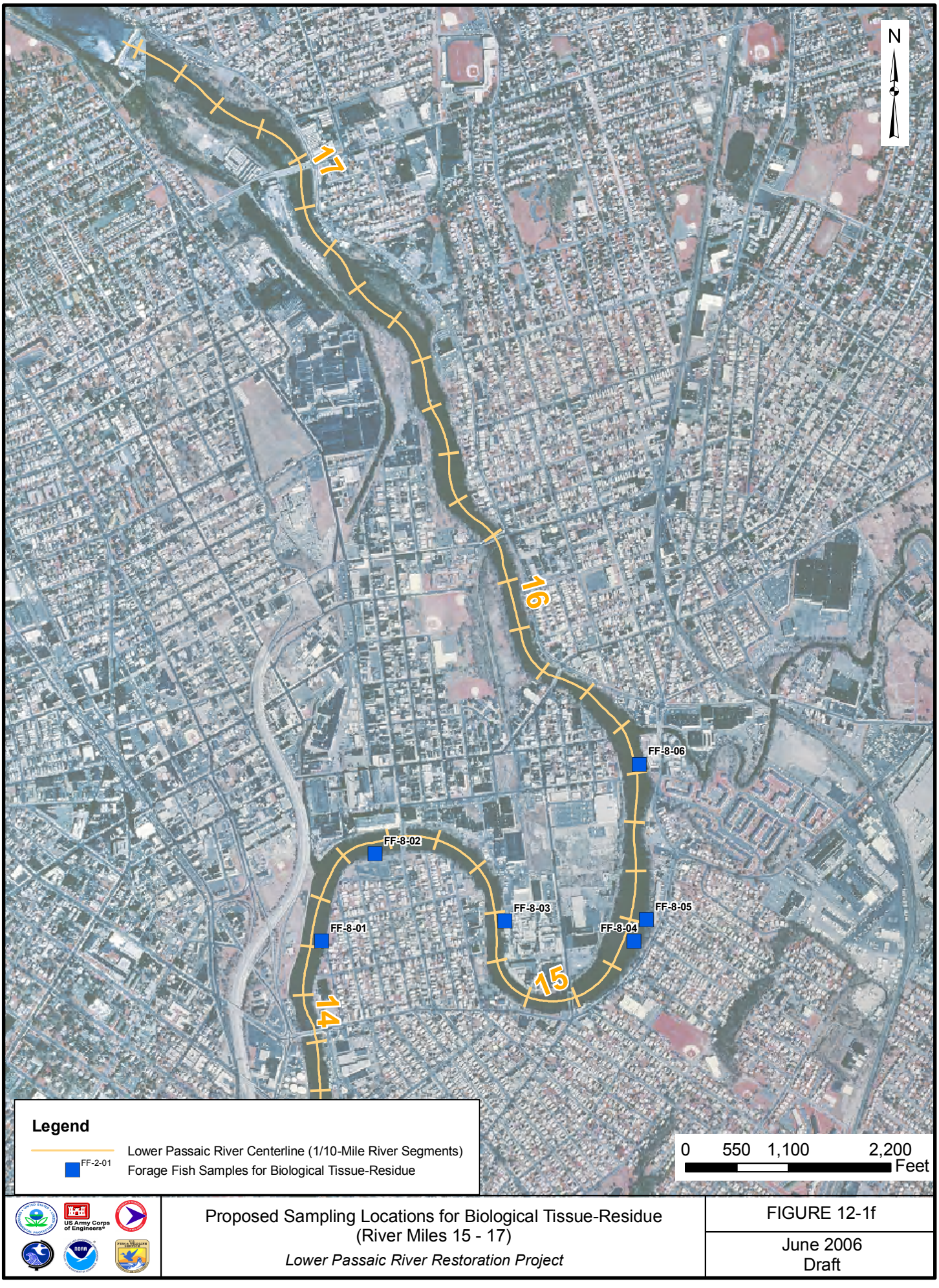

Proposed Sampling Locations for Biological Tissue-Residue
(River Miles 15 - 17)

Lower Passaic River Restoration Project

FIGURE 12-1f

June 2006
Draft

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ATTACHMENT A

STANDARD OPERATING PROCEDURES

Title: Procedure to Conduct Sample Management for CLP and non-CLP Samples

I. Introduction

This guideline is to provide reference information on sample management procedures.

II. Definitions

Contract Laboratory Program (CLP). The U.S. Environmental Protection Agency (USEPA) CLP was developed to retain laboratory services that will ensure that all environmental samples collected under the Superfund Program will be analyzed in accordance with recognized EPA laboratory methods and quality assurance/quality control (QA/QC) procedures.

Target Compound List (TCL). This is a list of organic compounds typically analyzed for by the CLP. The list is broken into three subdivisions; volatiles, semi-volatiles and pesticide/PCBs.

Target Analyte List (TAL). This is a list of inorganic parameters typically analyzed for by the CLP. Parameters on this list include heavy metals and cyanide.

Routine Analytical Services (RAS). Laboratory analysis for substances or parameters shown on the TCL and TAL in solid and aqueous samples.

non-RAS. Laboratory analysis for substances or parameters not shown on the TCL and TAL. Analysis of non-soil/sediment, nonaqueous matrices, and analysis of RAS compounds using non-RAS protocols.

Trip Blanks. Trip blanks are used to check for sample contamination originating from sample transport and shipping, as well as from site conditions. Trip blanks are necessary when aqueous environmental samples are collected for volatile organic analysis and when SPMD samples are collected.

Rinsate Blanks. Rinsate blanks, also known as field blanks, are used to check the efficacy of sampling equipment decontamination procedures. Rinsates are collected for each type of sampling equipment used on site. Demonstrated analyte-free water is poured over the equipment and collected into containers and analyzed for the analytes of concern.

Environmental Duplicate. These are two separate samples collected at the same sampling point. Environmental duplicates are used to determine field sampling precision and are

collected at a set frequency for each analyte group. For VOC samples, duplicate samples are collocated samples. For all other parameters, a sample aliquot is homogenized and split into two sampling containers.

Matrix Spike/Matrix Spike Duplicates (MS/MSD). This is the process by which standard mixes of various organic TCL compounds are added to environmental samples prior to extraction. The sample is split into duplicates and analyzed. The analysis is used to evaluate the matrix effect of the sample upon the analytical methodology. Triple volume of aqueous samples for MS/MSD analysis is collected in the field, at a frequency of at least 5 percent per matrix/concentration. No extra volume is required for the soil samples.

Matrix Spike/Matrix Duplicates (MS/MD). The spike analysis is the process by which standard mixes of various inorganic TAL parameters are added to environmental samples prior to digestion. The analysis is used to evaluate the matrix effect of the sample upon the analytical methodology. The duplicate analysis in the process where the assigned sample is split in two and analyzed at the laboratory. The analysis is an indicator of a laboratories analytical precision based on each sample matrix. Double volume of aqueous samples for MS/MD analysis is collected in the field, at a frequency of at least 5 percent per matrix/concentration. No extra volume is required for soil samples.

Low-Concentration Sample. Samples in which a compound may be present at concentration levels less than 10.0 ppm.

Medium-Concentration Sample. Samples in which a compound may be present at concentration levels equal to or greater than 10.0 ppm to as much as 15 percent 150,000 ppm) of the total sample.

High-Concentration Sample. Samples in which a compound may be present at concentration levels greater than 15 percent (150,000 ppm) of the total sample.

III. Guidelines

The purpose of sample management is to assure that all samples collected during this hazardous waste site investigation are accounted for when the project is completed. The sample management officer is also responsible for assuring that the proper quality assurance/quality control (QA/QC) samples are collected. These purposes are achieved by adhering to the following procedures:

1) Laboratory Coordination

a) CLP Samples

Prior to collecting any samples, a request must be made through RSCC for a laboratory. At this time, any requested modifications to the CLP SOWs must also be described (*e.g.,* lower detection limits, adding a parameter, such as titanium, to the TAL, requesting a quicker turnaround time (TAT)). A description of how to request CLP services is including in Section 2.4 of USEPA's CLP Guidance for Field Samplers, OSWER 9240.0-35, August 2004. A request for CLP services includes the following:

i) Contact RSCC to obtain CLP sample numbers – these are unique numbers used to identify each sample. For this project, a large block of CLP numbers will be set aside by RSCC prior to beginning sampling. Therefore, it is likely that these numbers will only need to be requested once. Refer to Attachment 1 for a memo describing some modifications to the CLP that were agreed to by RSCC for the Lower Passaic River Restoration Project.
ii) Fill out an RSCC request form. This must be sent to RSCC by 12:00 pm on the Tuesday prior to week of the sampling event.
iii) RSCC will contact the originator of the request by Friday with the Case Number and assigned laboratories. At times, the USEPA-DESA Laboratory will choose to perform all or part of the analysis requested.
iv) Since this is a long-term project, weekly contact will be maintained with RSCC.

b) Non CLP Samples

Two prime subcontractor laboratories will be procured for the Lower Passaic River Restoration project to conduct analysis of non-CLP parameters. Weekly contact must be maintained with these laboratories to inform them of upcoming sampling.

2) <u>Preparing the Sample Containers</u>

a) Malcolm Pirnie will purchase certified clean sample containers from an approved supplier. Copies of these certifications will be brought to the site while sampling and then kept in site files for future reference.

b) Each bottle used to collect a sample must be identified by a supplier and lot number to ensure that it is permanently associated with the sample collected in that particular container. This procedure also applies to containers used to carry demonstrated analyte-free water to be used for blank preparation. This is to ensure that for all samples collected, the specific sample bottles used can be traced to the sample container contractor, QC certification paperwork and custody records applicable to their identifying lot numbers.

3) <u>QA/QC Samples</u>

a) VOC Trip Blanks

i) One trip blank is required for each day that aqueous environmental samples are collected for volatile analysis.

ii) Trip blanks are only necessary for aqueous environmental samples. If rinsates are the only aqueous samples collected, then a trip blank is not necessary.

iii) Trip blanks consist of two 40 mL septum vials into which 4-5 drops of 1:1 hydrochloric acid (HCl) is introduced prior to filling them with demonstrated analyte-free water.

iv) Trip blanks are prepared in the field in the clean zone. They then remain with the field personnel throughout the sampling event and are shipped with the volatile cooler. Every aqueous environmental sample cooler must contain a trip blank in it.

v) The trip blank must be stored away from solvents and must be preserved, packaged, cooled to 4-6^{o}C and shipped to the laboratory with the other aqueous samples.

b) SPMD Trip Blanks

i) One SPMD trip blank is required for each day that SPMD samples are either deployed or collected.

ii) The SPMD trip blank consists of a non-deployed SPMD that is taken to the sampling locations and opened for the same amount of the time as the SPMD sampling devices.

iii) The SPMD trip blank is analyzed for the same parameters as the SPMD environmental samples.

c) Rinsate Blanks

i) Rinsate blanks are collected for each type of equipment used to collect samples. The rinsates will be collected at a timed frequency depending on the sample capacity. At a minimum, rinsates have to be collected at one per week. At a maximum, rinsates have to be collected at one per day. Decontaminated equipment must be properly stored in an area and in a manner that will prevent cross contamination.

ii) Where possible, composite rinsates will be collected from all equipment associated to a particular matrix for analysis of non-volatile parameters. A separate rinsate will be collected for each type of equipment associated to a particular sample matrix which will be analyzed for volatile organics.

iii) Rinsate blanks consist of pouring demonstrated analyte-free water over clean equipment and collecting it into sample containers to be analyzed for the analytes of concern.

iv) Rinsate blanks are preserved, packaged, and shipped in the same manner as low concentration aqueous environmental samples.

d) Environmental Duplicates

i) Samples for duplicate analysis are collected in the field, for each matrix sampled at a frequency as described in Lab Task Order.
ii) Sufficient quantity of matrix must be collected from the same sample location to fill a duplicate set of sample containers. The duplicate volume is shipped to the laboratory under a separate CLP sample number.
iii) For soil/sediment samples the volatile organic fraction is collected as collocated grab samples while the non-volatile fraction is homogenized prior to collection.

e) Matrix Spike/Matrix Spike Duplicate (MS/MSD) & Matrix Spike/Matrix Duplicate (MS/MD)

i) The designation of a sample for MS/MSD analysis for organics and MS/MD analysis for inorganics is required for 1 in 20 environmental samples per concentration/matrix.
ii) Three times the total volume is necessary for collection of aqueous MS/MSD organic samples. Two times the total volume is necessary for collection of aqueous inorganic MS/MD samples. No extra volume is required for the soil samples.
iii) MS/MSD and MS/MD samples are noted as such on the chain of custody (COC).

4) Sample Documentation, Packaging, and Shipping Procedures

One or more of the field personnel will be designated as the sample management officer(s). The sample management officer will bear the ultimate responsibility for the documentation, packaging, and shipping of the samples. These procedures are outlined below.

a) Documentation/Chain of Custody

For documentation purposes, the field team will enter information about each sample into the field laptop as they collect the sample. As this information is entered into the laptop, it is transmitted to the PREmis database. Information recorded includes the following:

- Sample date and time of collection
- Associated QC samples
- Analyses required
- Bar code number – since the bottles do not receive sample labels until they are returned to the field office, a sample bar code is placed on each bottle when the samples are collected. This information is entered into the field application so the bar code is permanently associated with a specific sample bottle.

i) Since all of the sampling information is recorded electronically the sample management officer can electronically generate the COC and sample labels. The

sample management officer needs to access the sample management PREmis module. This will allows the sample management officer to designate which samples are in which shipment. This is required since there will be numerous laboratories for this project.

ii) Once all of the samples are associated to a shipment, the COC and sample labels can be printed from PREmis. The sample labels are affixed to each sample container and covered with clear tape. In addition, for CLP samples, a sample label is placed on the sample tag. The sample labels will contain the following information:

- MALCOLM PIRNIE-designated sample number
- For CLP samples only, the assigned CLP Number
- The month, day, and year the sample was collected
- The type of analysis requested
- The type of preservation performed in the field.

b) Packaging and Shipping Samples

i) Make sure the caps on the sample bottles are tightly sealed. Wipe down the outside of all of the sample bottles.

ii) Preserve the samples according to the SOP No. 2 for Sample Preservation.

iii) Apply one custody seal around the circumference of the container or over the cap and onto the sides of the container. The custody seal must applied to sample containers in such a manner as to reveal if the container was opened during transit. Note: Septum vials should not be covered over the top.

iv) Place each container in its own ziplock bag. The two 40 ml vials may be placed in one bag. Eliminate extra air space from the bag before sealing. The EnCore® device comes in its own ziplock bag and this bag will be used.

v) For CLP samples, place the associated sample tag into the ziplock bag with the sample.

vi) Prepare the shipping container (usually a cooler). The cooler will be prepared so that no leakage can occur during shipping. All valves on the cooler will be securely duct taped, both inside and outside the cooler, and the cooler will be lined with either plastic or a large garbage bag. Only coolers that conform to the general design requirements in 49 CFR 173.410 will be used for shipment.

vii) The VOC samples should be packed together, without any other sample fraction, with the trip blank.

viii) Put 1-2 inches of packing material in the bottom of the coolers, then place the samples into the cooler.

ix) Surround the sample bottles with bags of ice (only the samples that need to be cooled – Refer to the SOP for Sample Preservation No. 2. The ice will not be kept in its original bag, but will be repacked into ziplock bags. Use enough ice to ensure that the proper temperature (4-6^{o}C) is maintained during transport. Place a temperature blank (40-mL vial filled with DI water) into the cooler.

x) Place packing material over and around the sample bottles. Sufficient packing material must be used to the bottles will not move or break during transport.

xi) Once the samples are packed, the plastic or garbage bag will be closed and securely taped.

xii) Prior to shipment the relinquished by and received by sections of the COC form will be filled in. Generally, the shipper will not sign the COC. Therefore, the carrier's name is filled in by the sample management officer. The original COC form will then be placed in a ziplock bag and taped to the inside of one of the lead cooler; one copy of the COC form(s) will be placed in a ziplock bag(s) and placed in the other cooler(s).

xiii) For CLP samples, one copy of the COC form will be retained by the sample management officer and one copy will be sent to RSCC. For non-CLP samples, one copy of the COC form will be retained by the sample management officer.

xiv) Close the cooler and seal with strapping tape. If visibly dirty, the outside of the cooler will be wiped down. Apply signed and dated custody seals to the cooler. Place two custody seals diagonally across from each other where the cooler lid meets the cooler. The custody seals will be applied in such a manner as to reveal if the cooler was opened during transit.

xv) An address label will be placed on the outside of each cooler. The label will be covered with clear tape. If more than one cooler is being sent to one destination, each cooler will be appropriately labeled as 1 of X, 2 of X, *etc.* The airbill will be attached to one of the coolers. Usually, the samples will be sent via overnight carrier for next day delivery. This should be confirmed with the Field Team Leader.

xvi) The laboratory will be notified of the shipment before 9 a.m. ET on the day after shipping. For CLP samples, fill out the Sample Shipping Call-In Form. Call or fax the shipping information to RSCC by 9:00 am the following morning. For non-CLP samples, the notification system agreed to in the subcontract will be followed.

Note: Some samples have very short holding times. In some limited instances, the samples may be either hand delivered to a laboratory or picked up by the laboratory's courier service.

ATTACHMENT 1

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION II

DATE: January 14, 2004

SUBJECT: Request for Modifications of CLP Requirements for the Lower Passaic River Restoration Project

FROM: Jennifer E. Feranda, CLP Project Officer/RSCC Coordinator
Hazardous Waste Support Section (2DESA-HWSB)

TO: Alice Yeh, Remedial Project Manager
2ERRD

The purpose of this memorandum is to follow up on your letter of July 25, 2003 and sub-sequent phone conversations concerning the request for modifications of Contract Laboratory Program (CLP) requirements for the Lower Passaic River Restoration Project. Below, I have outlined your specific requests as well as provided HWSB response(s) as to whether or not these requests can be accommodate.

If you have any questions or would like to discuss this in more detail, please do not hesitate to call me at (732) 321-6687.

Response to Requests for Modifications of CLP Requirements for
the Lower Passaic River Restoration Project

Request for Modification to FORMS II Lite Application Requirement

1) ***Request:*** Malcolm Pirnie has developed a web-based data management system named PREmis (the Passaic River Estuary management information system) to handle existing historical data and new data collected for the Remedial Investigation/Feasibility Study (RI/FS) of the Lower Passaic River. PREmis contains all the fields required by FORMS II Lite, but also has numerous additional data requirements associated with the unusually complex modeling effort planned for the Lower Passaic River Restoration Project. It was requested that the use of PREmis be granted in lieu of the use of FORMS II Lite. Information contained in the PRE mis database would be directly copied into the FORMS II Lite database, thereby satisfying the FORMS II Lite reporting requirements.

Response: PREmis can be used for the project, however, it can not be used in lieu of FORMS II Lite. Traffic Reports/Chain of Custody (TR/COC) forms that accompany samples to the laboratories will need to be generated by FORMS II Lite. In addition, either the XML files with information from the FORMS II Lite database or hard copies of the TR/COCs will need to be transmitted to the CLP's Sample Management Office (SMO) on a pre-determined schedule (within a day or two of sample shipment).

Request for Modifications to the Contract Laboratory (CLP) Requirements

2) ***Request:*** A specific cohort of laboratories (both organic and inorganic) would be assigned to the project for the duration of the Remedial Investigation sampling program (several years) prior to the beginning of sampling. The Passaic River Estuary project team would determine which laboratories receive specific samples.

***Response*:** This request can not be accommodate. Due to laboratory capacity, laboratory performance, and turn over of contracts, specific labs can not be committed to an entire project. The frequency that laboratory space is booked and the length of time that a lab or labs can be utilized will be determined as we get closer to the actual sampling event. Based on the number of labs being used and their capabilities per their contracts, the Lower Passaic River project team may or may not be able to determine what labs receive specific samples (*e.g.*, if there are two labs assigned, one organic and one inorganic, organic samples must go to the organic lab)

3) ***Request:*** All sample log-in information would be entered into the PREmis Website by the laboratory instead of onto hard copy log-in sheets.

Response: Due to the requirements and constraints of the CLP contracts, this request will not be able to be accommodated at this time.

4) ***Request***: A large block of sequential CLP number, both organic and inorganic, would be designated specifically for this project.

Response: Starting and ending CLP sample numbers will be assigned for this specific project. PREmis can be used to generate a large block of sequential CLP sample numbers, both organic and inorganic as needed during the project.

5) ***Request:*** Laboratories would be required to submit EDDs according to project specific standards in a timely manner, usually with the hard copy of the CLP package. If the EDD format were incorrect, the laboratory would need to submit a corrected EDD.

Response: Electronic data deliverables (EDDs) will be submitted to the data user(s) in the Multimedia Electronic Data Deliverable (MEDD) format. The EDDs will transmitted to the data users by EPA Hazardous Waste Support Section (HWSS) staff once data has been reviewed for contract compliance. Any incorrect or incomplete EDDs will be corrected prior to the data users receiving the files. The time frame for receipt of these deliverables will be pre-determined prior to the start of sampling for this project.

Title: Procedure to Conduct Sample Preservation

I. Introduction

This guideline is to provide reference information on the accepted methods of sample preservation.

II. Materials

Preservatives:

a. 1:1 HCl - (Hydrochloric Acid/Deionized Water)
b. HNO_3 - full strength (Nitric Acid)
c. NaOH - 10 N (Sodium Hydroxide)
d. H_2SO_4 - full strength (Sulfuric Acid)

Additional Materials:

a. Disposable Pasteur pipettes
b. Pipette pumps - 10 ml or 2 ml
c. Latex pipette bulbs
d. Squeeze bottle with deionized water
e. Clear wide mouth glass jar for water pipette
f. Paper towels
g. Lead acetate paper
h. Cadmium nitrate or cadmium carbonate (if using lead acetate paper)
i. Potassium iodide - starch test paper (KI-starch paper)
j. Ascorbic Acid (if using KI starch paper)
k. Filter paper
l. Filter funnels (disposable or decontaminated)
m. Filter vessel with hand pump
n. pH paper
o. Scale

Safety Materials:

a. 2 pair safety glasses
b. 2 pair solvex gloves
c. 2 lab coats
d. MSDS sheets
e. Eyewash

III. Discussion

Complete and unequivocal preservation of samples is a practical impossibility. At best, preservation techniques slow down the chemical and biological changes that inevitably continue after the sample is removed from the parent source. The changes that take place in a sample are either chemical or biological. In the former case, certain changes occur in the chemical structure of the constituents that

are a function of physical conditions. Metal cations may precipitate as hydroxides or form complexes with other constituents; cations or anions may change valence states under certain reducing or oxidizing conditions; other constituents may dissolve or volatilize with the passage of time; and metal cations may also adsorb onto surfaces (glass, plastic, quartz, *etc.*). Biological changes taking place in a sample may change the valence of an element or a radical to a different valence. Soluble constituents may be converted to organically bound materials in cell structures, or cell lysis may result in release of cellular material into solution. The well known nitrogen and phosphorus cycles are examples of biological influence on sample composition. Therefore, as a general rule, it is best to analyze the samples as soon as possible after collection. This is especially true when the analyte concentration is expected to be in the low ug/l range.

Methods of preservation are relatively limited and are intended generally to (1) retard biological action, (2) retard hydrolysis of chemical compounds and complexes, (3) reduce volatility of constituents, and (4) reduce absorption effects. Preservation methods not outlined below are generally limited to pH control, chemical addition, refrigeration, and freezing.

IV. Guidelines

All Samples

With few exceptions, most samples need to be cooled to between 4-6 ^{o}C immediately after sample collection.

Preserving Aqueous Volatile Organic Compound (VOC) Samples

Equipment

Field personnel should take the following materials for VOC sample preservation to the sampling locations:

1. One 40-mL VOA vial containing 1:1 HCl.

   The 1:1 HCl should be transferred on site from a 1-liter plastic-coated glass bottle to one properly labeled 40-mL glass vial by using a glass funnel. This should be performed at the field office. Hand and eye protection must be worn during the transfer and handling of hydrochloric acid. Field personnel must attempt to keep the 40 ml vial in an upright position during field sampling. The 1-liter plastic-coated bottle must be kept at the field office; the 40-mL vial must be kept in a plastic ziplock bag.
2. Plastic ziplock bag containing pH indicator strips for each sampling location.
3. Latex gloves
4. Eye protection
5. Plastic ziplock bag for disposal of used pH indicator strips and latex gloves.

Preservation Procedures

1. For each different type of aqueous sample to be collected (*e.g.*, river sample, CSO sample) a test sample must be preserved to determine if the preservation procedure will cause an adverse reaction. Note that a test vial must also be collected when the temperature changes (*e.g.*, each season) and whenever a sample is significantly different in appearance than the test sample. First, fill a test vial one-half full with the sample matrix to be collected. Note the color and clarity of the sample.
2. Test the pH by inserting one pH paper strip into the test vial. If the pH is less than 2.0, as indicated by a blue color on the strip, collect the samples without acidifying. Document this in the field application. The field sample management officer must document the sample as not preserved on the COC. If the pH is greater than 2.0, continue to Step 3. The pH indicator paper strip should be put into a plastic bag for later disposal.
3. Dispense 10 drops of 1:1 HCl from the pipette. Tap the vial gently to mix. If color develops, precipitates form, effervescing occurs, or an exothermic reaction (heat generation determined by holding the vial firmly) occurs, do not acidify the samples and document the reason for not acidifying in the field application. This information should also be included on the COC. If none adverse reactions occur when acid is added to the sample, proceed to Step 4.
4. Test the pH of the sample. If the pH is less than 2.0, proceed to Step 5. If the pH is greater than 2.0, add 1:1 HCl a few drops at a time (keeping count) until the pH is less than 2.0; then proceed to Step 5.
5. Fill the test vial with sample until the vial is nearly full to the top. Gently tap the side of the vial to mix, and test the pH of the sample. If the pH is less than 2.0 proceed to the next step. If the pH is greater than 2.0, again add 1:1 HCl a few drops at a time (keeping count) until the pH falls below 2.0. Proceed to the next step.
6. Note the amount of 1:1 HCl added to the test vial. Add this amount of 1:1 HCl to all of the samples, using the same glass pipette, after collecting the samples, and before capping the 40 ml vials. To avoid cross contamination, the sampler must be extremely cautious not to touch the glass pipette to the sides of the vial or the sample. Document the approximate quantity of 1:1 HCl added to each sample. These samples are then packaged and cooled to 4^0C prior to shipping to the CLP laboratory.
7. Store the samples at 4^0C until the time of analysis.
8. Properly dispose of the test vials and all used sample preservation equipment.

Preserving Aqueous Inorganic Samples with Acid

1. Add the acid to the sample using a pipette. Typically, depending on the size of the pipette and the original pH of the sample, approximately ½ a pipette of acid is required per liter of sample. Recap the sample bottle and turn it gently upside down to mix the contents.
2. Check the pH by pouring an aliquot of the sample over the pH paper; do no dip the pH paper directly into the sample. The pH of the sample should be < 2.
3. If the sample contains a significant particulate fraction, acidification without filtration could result in deceptively high values for the aqueous sample. Varying amounts of particulate matter can also give large differences in metal values for duplicate acidified aqueous samples. Observation, therefore, should be made and recorded in the field application and also noted on the COC. If an obvious change is observed during sample preservation, which may bias the results, the Site Quality Control Officer (SQO) should be consulted.

3. If the pH is still > 2, repeat steps 1 and 2 until the pH is < 2.
4. Store the samples at 4^0C until the time of analysis.

Preserving Aqueous Cyanide Samples

1. Test a drop of sample with potassium iodide-starch test paper (KI-starch paper). A resulting blue color indicates the presence of oxidizing agents and the need for treatment. Add ascorbic acid, a few crystals at a time, until a drop of sample produces no color on the indicator paper. Then add an additional 0.6 g of ascorbic acid for each liter of sample volume.
2. Add NaOH to the sample using a pipette. Typically, depending on the original pH of the sample, approximately 2 mL of NaOH per liter of sample is required. Recap the sample bottle and turn it gently upside down to mix the contents.
3. Check the pH by pouring an aliquot of the sample over the pH paper; do not dip the pH paper directly into the sample. The pH of the sample should be > 12.
4. If the pH is still < 12, repeat steps 2 and 3 until the pH is > 12.
5. Store the samples at 4^0C until the time of analysis.

Refer to the sample preservation tables (3-1 to 3-6) in the QAPP for specific sample preservation requirements.

Preservation of Biological Samples

Additional requirements for the preservation of biological samples are contained in the individual SOPs for the type of sample being collected.

Title: Locating Sample Points Using a Global Positioning System (GPS)

I. Purpose

The purpose of this procedure is to provide reference information for the documentation of sample locations using a GPS at the Lower Passaic River Restoration Project Superfund Site.

II. Definitions

1. GPS - The GPS is a satellite-based positioning system, operated and controlled by the U.S. Department of Defense. The GPS includes 24 satellites, and can be used by anyone who has a GPS receiver. The GPS receiver is used for position determination, navigation, and survey tasks on land, sea, and in the air. The method of utilizing GPS varies with each application and the type of GPS equipment used. Operating methods range from low precision, code phase systems to highly accurate, carrier phase systems that facilitate on-the-fly measurements, also known as real-time kinematic surveying (RTK). The Lower Passaic River Restoration Project Superfund Site will use a hand held GPS receiver with sub meter horizontal accuracy to capture the coordinates of sample locations.

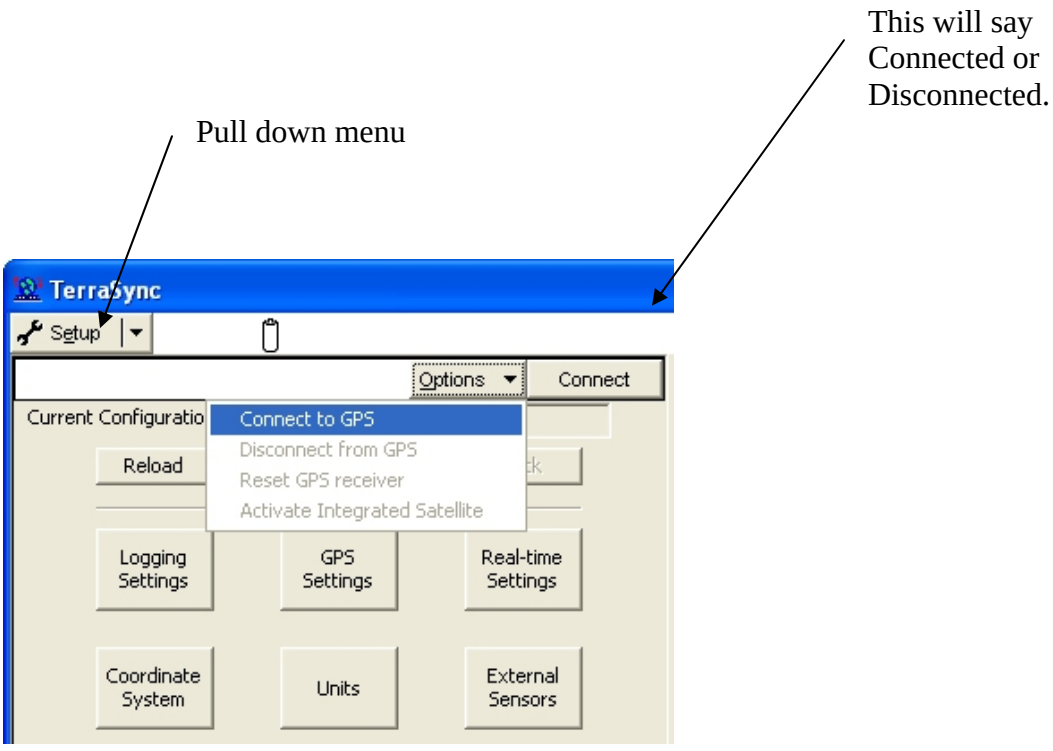
III. Equipment and Materials

1. Trimble Geo XT with related cable and power supply.

IV. Field Procedure

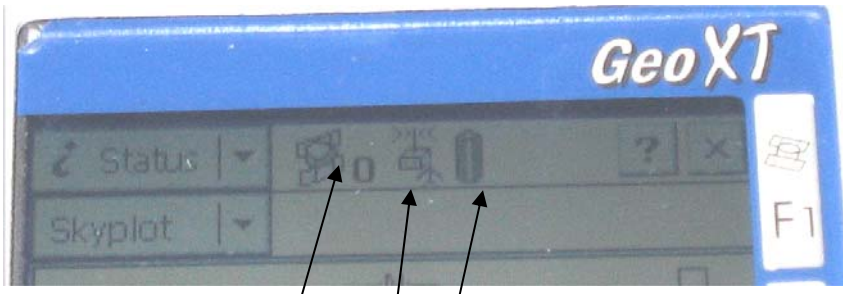
1. Getting Started

   A. Power up the unit by pressing the large gray button below the screen area and start the TerraSync application by selecting F1 or the Terra Sync icon. Wait about 5 minutes for the GPS unit to receive a new almanac and satellite information.
   B. Verify that the GPS unit is connected to the satellite network. After starting TerraSync, the status screen will appear, and will indicate if the GPS is connected or disconnected to the satellite network. If it is disconnected, use the stylus to click on the pull down menu in the upper left corner of the screen (see graphic below) and go to the Setup screen. Underneath the Setup pull down menu, select Options and select Connect to GPS.



2. Confirm Status of GPS

   A. The GeoXT will be collecting a new almanac and satellite readings. In the top tool bar you will see the number of satellites tracking, differential correction signal status, and the battery charge information. You must have 4 satellites available and the differential status must be on (i.e. the differential icon should not be blinking) to collect coordinate locations.



Satellites Tracking
Differential Correction Status
Battery Charge Indicator

3. Confirm the Coordinate System

   A. In the Setup menu choose Coordinate System
   B. On this screen you should see the following, or update entries to match:
      System = US State Plane 1983
      Zone = New Jersey 2900
      Altitude = Mean Sea Level (MSL)
      Altitude Units = Feet
      Geoid = DMA 10x10 (Global)
      Coordinate Units = Meters
      Display USNG = Off

4. Create a File

   A. From the pull down menu in the upper left corner choose Data
   B. Select the Dictionary Named Passaic and name the file using the input panel (if the input panel is not automatically present click on the icon in the lower right corner that looks like a key board)
   C. Click Create

5. Collecting Point Data

   A. Using the pull down menu choose Map (you can also collect data from the Data menu but you will not see where you are on the map).
   B. Click on the blue circle in the upper right corner of the screen enter the name of the sample you are taking as well as the matrix (sediment or water).
   C. You can insure you are collecting satellite data by seeing a pen and wavy line icon to the right of the main pull down menu. You will also see the number of data sets you have gathered, the number of satellites that you are collecting information from and the status of the differential correction.
   D. When you have collected more than 3 sets of data (indicated by the number next to the pen and wavy line icon) select OK.
   E. You should now see your collected data as a square with an X in it on the map.
   F. Move to you new location and repeat step 5 until you are finished.

6. Closing the data and shutting down

   A. When you are finished using the GPS unit shut the application down by clicking the X in the upper right corner of the screen.
   B. You will be asked if you are sure you want to do this. Click yes.
   C. Press the gray button at the bottom of the GeoXT and bring it back to the office for processing.

V. Quality Control

The GPS has quality control features that are built into the system. The system will not allow measurements to be taken if there are not enough satellites available to provide accurate readings, if the satellite geometry is not conducive to the survey, and for other reasons. The system maintains quality control records during a survey that contain information about the quality of the GPS position, including the number of available satellites, satellite geometry, and horizontal and vertical precision levels. These records can be accessed when the data is post processed in order to assure that the necessary quality standards are being achieved.

VI. Reference

TerraSync Operation Guide. Trimble Navigation Ltd., 2002.

Title: Documenting Field Activities

I. Introduction

The purpose of this guide is to provide reference information regarding the documentation of field activities conducted at the Lower Passaic River Restoration Project Superfund Site.

II. Definitions

1. Field Data – Any and all information collected during activities at the site.

2. Electronic Field Data Form – A standardized electronic data form used for the collection of information and/or technical data during field activities.

III. Guidelines

The documentation of field activities at uncontrolled hazardous waste sites is governed by a variety of legal guidelines that must be understood prior to the commencement of field activities. It is imperative that the personnel who will be conducting the field activities understand how the overall constitutional, statutory, and evidentiary legal requirements apply to the site inspection documentation and to the rights of potentially responsible parties.

The description of and observations made during field activities often provide the basis for technical site evaluations and other related written reports. All electronic records and notes generated in the field will be considered controlled evidentiary documents and may be subject to scrutiny in litigation. Consequently, it is essential that the Field Team Leader pay attention to detail and document to the greatest extent practicable every aspect of the inspection.

Personnel designated as responsible for the documentation of field activities must be aware that all electronic notes taken may provide the basis for the preparation of responses to legal interrogatories.

Field documentation must provide sufficient information and data to enable the reconstruction of field activities. A wireless field application using standardized electronic data forms will provide the basic means for documenting field activities.

Control and maintenance of wireless field applications used in documentation of field activities is the responsibility of the Field Team Leader. If the person responsible for

documenting site inspection activities is someone other than the Field Team Leader, the transfer of responsibility must be documented.

1. Documentation of Field Activities

Electronic field entries must provide an unbiased, concise, and detailed description of all field activities. Step-by-step instructions and procedures for documenting field activities are provided below. They are organized by the following:

A. The first set of instructions and procedures provides general guidance relating to the format and technique in which electronic field entries are to be made. It is important that field activities are documented in the most organized, chronological manner possible.

B. The second set of instructions and procedures provide guidance on the type of information to be recorded when field activities are electronically documented. In general, the following information must be recorded:

i. The identities and affiliation of the personnel conducting field activities.

ii. A description of the type of field work being conducted (*e.g.*, water column sampling, sediment core collection, etc.) and the equipment used.

iii. The date and time the field activities were conducted, with specific temporal information for each task (*e.g.*, record the time activities commenced at each individual location, or when different types of activities commenced at the same location), if applicable.

iv. The site where the field activities were conducted, and also any individual location within that site where work was performed (*e.g.*, specific sampling sites).

v. The general methodology used to conduct the activities.

vi. Deviations from FSP or SOP and reason for change

C. Instruction and procedures relating to the format and technique in which electronic field entries are to be performed should conform to the following:

i. Each day field activities are conducted the date, time, site name, location, names of Malcolm Pirnie personnel and their responsibilities, and names of non-Malcolm Pirnie personnel into the field application. Any

deviations from the work plan that occur while field activities are being conducted must also be documented.

ii. All photos taken must be associated with field entries and all photo locations must be referenced on a site map. Information in the photo log must include the date, time, photographer, and a description.

iii. All entries must be made in language that is objective, factual, and free of personal feelings or other terminology that might prove inappropriate.

iv. All entries must be accompanied by the appropriate 24-hour clock time (such as 1530 instead of 3:30). A time and status entry is recommended every 30 minutes or less.

v. If the individual designated for field documentation tasks transfers those tasks to another team member, he or she must clearly document this transfer of responsibility through logging out and the newly designated field member log back in with their assigned login and password.

2. Sampling Activities

A chronological record of each sampling activity must be kept. During sampling, the data entry person will choose the appropriate survey that the sampling falls under (*i.e.*, large volume water column sampling, high resolution coring, *etc.*). The field application will automatically prompt the user for required data and attributes based on pre-programmed survey requirements. Be sure that all required fields are properly filled in or field application will not allow user to continue. Container IDs are pre-printed and need to be affixed and entered into the field application for every sample. After data entry is complete for the day user accesses the shipping module and designates which coolers contain which samples and to where the samples are to be shipped. The generated sample ID labels should be printed out and affixed to the appropriate sample container. Print out generated chain of custody to accompany samples in shipment.

IV. References

U.S. EPA-Characterization of Hazardous Waste Sites - A Methods Manual, Volume I - Site Investigations, April 1985:

USACE Requirements for the Preparation of Sampling and Analysis Plans, September 1, 1999

Title: Decontamination of Soil Sampling Equipment

I. Introduction

This procedure describes the methods used to decontaminate soil sampling equipment and sample processing tools used at the Lower Passaic River Superfund Site. The procedures specifically address equipment used to collect sediment and soil samples.

II. Definitions

PPE-Personal Protective Equipment

III. Equipment and Supplies

The following equipment will be used to decontaminate equipment and tools used to collect sediment and soil samples:

1. Tap water for initial cleaning and rinsing of equipment.
2. De-ionized water for final rinsing of equipment after tap water or solvent rinse.
3. Non-phosphate detergent (*e.g.* Alconox™) for cleaning equipment.
4. Dishwashing detergent (*e.g.* Joy™ which provides suds in seawater) to remove oily or organic residue.
5. Nitric acid as a 10% solution for removing metal contaminants from equipment
6. Organic solvent for final cleaning of equipment (*e.g.* hexane)
7. Personnel protective equipment (PPE) - including disposable gloves (nitrile preferred), disposable wipes, eye wash system, first aid kit, and waterproof outerwear (if necessary).
8. Re-sealable buckets approved for waste collection and transportation.
9. Squirt bottles for water, alcohol, and solvents.
10. Brushes for cleaning equipment.
11. Field notebooks, pens, pencils, and digital camera to document decontamination procedures.

IV. Guidelines

The following equipment will be used to collect sediment cores and require decontamination:

1. Rotary drilling rig (truck-mounted or skid type) sampling equipment (e.g., split spoons). Large drilling equipment (*e.g.*, tri-cone bits, casing, augers, rods, etc.) will be steam-cleaned only.
2. Tripod drill – follow procedures for drill rig above.
3. Calibrated Steel Rod to investigate the sediment type and probe the depth of unconsolidated sediments at a sampling location and to determine the length of tubing to use.
4. Shelby tubes conforming to thin-walled tube specifications outlined in ASTM D 1587 with a 3-inch O.D.
5. Vibracorer and ancillary equipment.
6. Aluminum, Polycarbonate, Lexane, or Cellulose Acetate Butyrate (CAB) Tubing of appropriate diameter (approximately 3.75 inch O.D. and 0.07 inch wall thickness) for use with the vibracoring apparatus.
7. Sediment Grab Sampler (*e.g.*, Ponar, van Veen, Smith McIntire, or Eckman Grabs) used for surface sediment collection.
8. Stainless steel scoops, spoons, bowls, and other equipment that come into contact with the sample, are used for homogenization, or are used to segment core tubes.

Collection of sediment, soil, and water samples for chemical analysis requires that the equipment be cleaned between sample locations to avoid sample contamination. Generally, the cleaning procedures to be followed between sample locations are as follows:

Decontaminate all sample collection tools that contact the sample as well as all bowls and mixing/distribution implements in accordance with the following procedures.

1. Rinse each item with tap water to remove mud, dirt, or other visually present material.
2. Scrub the item with a brush and soapy water, using non-phosphate detergent such as Alconox™ for non-oily residue, or a detergent (*e.g.* Joy™) for items with oily or other sticky organic residue.
3. Rinse the item with tap water to remove all residual soap
4. Rinse the item with 10% nitric acid to remove residual metals
5. Rinse the item with de-ionized water
6. Rinse the item with organic solvent (*e.g.* hexane)

7. Rinse the item with de-ionized or analyte-free water and allow to air dry.
8. Wrap the item(s) in aluminum foil or plastic bag to protect it until it is used.

All solvents must be captured and disposed of in appropriate, labeled, aqueous waste containers. All instruments that come into contact with the sample (i.e. syringe, ruler, collection buckets) must be cleaned in the same manner as the sampling device. Liquids collected into the chemical waste container must be discarded in an appropriate waste stream. Staff performing decontamination procedures need to wear appropriate PPE, gloves (*e.g.* nitrile) and eye protection. Care must be taken in cleaning not to allow contact of cleaning solutions with clothing as much as possible. If circumstances dictate contact will occur (*e.g.* high pressure washing, splashing, high wind), waterproof outer clothing must be worn (*e.g.* foul weather gear or rain gear).

Decontamination procedures may vary depending on specific workplan specifications, and unique contaminants of concern at specific locations. The project workplan may designate collection of equipment rinse samples to document effectiveness of cleaning.

This SOP does not address radioactive decontamination, PPE for radioactive waste, or disposal of radioactive contaminated waste material.

IV. References

American Society for Testing and Materials (ASTM), 1994. Standard Practice for Decontamination of Field Equipment Used at Nonradioactive Waste Sites. Designation: D 5088 – 90.

Title: Decontamination of Water Sampling Equipment

I. Introduction

This procedure describes the methods used to decontaminate water sampling equipment and sample processing tools for the Lower Passaic River Restoration Project. The procedures specifically address equipment used to collect sediment samples.

II. Definitions

PPE - Personal Protective Equipment

III. Equipment and Supplies

The following equipment will be used to decontaminate equipment and tools used to collect water samples:

1. Tap water for initial cleaning and rinsing of equipment.
2. De-ionized water for final rinsing of equipment after tap water or solvent rinse.
3. Non-phosphate detergent (*e.g.*, Alconox™) for cleaning equipment.
4. Dishwashing detergent (*e.g.*, Joy™ which provides suds in seawater) to remove oily or organic residue.
5. Nitric acid as a 1% solution for removing metal contaminants from equipment
6. Isopropyl alcohol
7. Organic solvent for final cleaning of equipment (*e.g.*, hexane or equivalent)
8. Personnel protective equipment (PPE) - including disposable gloves (Nitrile preferred), disposable wipes, eye wash system, first aid kit, and waterproof outerwear (if necessary).
9. Re-sealable buckets approved for waste collection and transportation.
10. Squirt bottles for water, alcohol, and solvents.
11. Brushes for cleaning equipment.
12. Field notebooks, pens, pencils, and digital camera to document decontamination procedures.

IV. Guidelines

The following equipment will be used to collect water samples and require decontamination:

1. Infiltrex 300 Trace Organic Sampler: Pump, integral piping and other surfaces associated with the Infiltrex 300 Trace Organic Sampler's operation.
2. 5L Niskin bottles or equivalent.
3. Stainless Steel pressurized POP Canister
4. Vapor traps
5. Plastic tubing
6. Funnels
7. Graded cylinders
8. Graded tools used to measure river depth
9. Other equipment that comes into contact with the sample (*e.g.*, buckets, etc.).

Collection of water for laboratory analysis requires that the equipment be cleaned between sample locations to avoid sample contamination. Generally, the cleaning procedures to be followed between sample locations are as follows:

Decontamination: all sample collection tools that contact the sample as well as all bowls and mixing/distribution implements in accordance with the following procedures.

1. Disassemble item (except for Stainless Steel POP bottles and 5L Niskin or equivalent bottles at this stage).
2. Rinse each item with tap water.
3. For Stainless Steel POP Canister and 5L Niskin bottles (or equivalent): pour approximately 1 liter of non-phosphate detergent such as Alconox™ and lay on its side for at least 2 hours (roll the canister periodically to contact all interior surfaces.
4. Scrub the item with a brush and soapy water, using non-phosphate detergent such as Alconox™ for non-oily residue, or a detergent (*e.g.*, Joy™) for items with oily or other sticky organic residue. Prior to scrubbing, disassemble stainless steel containers, 5L Niskin bottles or equivalent, etc. Be sure to scrub the inside of canisters, bottles, etc. (inside and out), threads, cover bucket, etc. Soak stainless steel containers, 5L Niskin bottles or equivalent, etc. for 30 minutes to 1 hour; roll bottle frequently.
5. During the scrubbing process, be sure to bleed Alconox™ solution or equivalent through small passageways/nozzles/vents, etc.
6. Rinse the item with tap water to remove all residual soap. Be sure to bleed tap water through small passageways/nozzles/vents, etc.

7. Rinse the item with 10% nitric acid to remove residual metals. Be sure to bleed 10% nitric acid through small passageways/nozzles/vents, etc.
8. Rinse the item with de-ionized water. Be sure to bleed de-ionized water through small passageways/nozzles/vents, etc.
9. Rinse the item with isopropyl alcohol. Be sure to bleed isopropyl alcohol through small passageways/nozzles/vents, etc.
10. Rinse the item with de-ionized water. Be sure to bleed de-ionized water through small passageways/nozzles/vents, etc.
11. Rinse the item with organic solvent (*e.g.*, hexane or equivalent). Be sure to bleed organic solvent through small passageways/nozzles/vents, etc.
12. Rinse the item with de-ionized or analyte-free water and allow to air dry. Be sure to bleed de-ionized or analyte-free water through small passageways, nozzles, vents, etc.
13. Re-assemble item(s).
14. Wrap the item(s) in aluminum foil or plastic bag to protect it until it is used.

All solvents must be captured and disposed of in appropriate, labeled, aqueous waste containers. All instruments that come into contact with the sample water must be cleaned in the same manner as the sampling device. Liquids collected into the chemical waste container must be discarded in an appropriate waste stream. Staff performing decontamination procedures need to wear appropriate PPE, gloves (*e.g.*, Nitrile) and eye protection. Care must be taken in cleaning not to allow contact of cleaning solutions with clothing as much as possible. If circumstances dictate contact will occur (*e.g.*, splashing, high wind), waterproof outer clothing must be worn (*e.g.*, foul weather gear or rain gear).

Decontamination procedures may vary depending on specific Field Sampling Plan specifications, and unique contaminants of concern at specific locations. The project workplan may designate collection of equipment rinse samples to document effectiveness of cleaning.

This SOP does not address radioactive decontamination, PPE for radioactive waste, or disposal of radioactive contaminated waste material.

V. Reference

American Society for Testing and Materials (ASTM), 1994. Standard Practice for Decontamination of Field Equipment Used at Nonradioactive Waste Sites. Designation: D 5088 – 90.

Title: Management and Disposal of Investigation Derived Waste

I. Introduction

This procedure describes the methods used to manage, store, and dispose of investigation derived waste (IDW) produced during environmental sampling for the Lower Passaic River Restoration Project. The procedures specifically address sediments, soils, water, solvents, and Personal Protective Equipment (PPE) waste generated from collection of sediment, soil and water samples and equipment decontamination.

This SOP does not address radioactive decontamination, PPE for radioactive waste, or disposal of radioactive contaminated waste material.

II. Definitions

PSO: Project Safety Officer
IDW: Investigation Derived Waste
PPE: Personal Protective Equipment

III. Equipment and Supplies

The purchase, maintenance, and use of the supplies and equipment listed below are the responsibility of the Project Safety Officer (PSO) and Processing Facility Manager.

The following equipment and supplies will be used to collect and dispose of investigation derived waste:

1. Waste Storage and Disposal Containers

   A. 30- or 55-gallon drums for solid and liquid wastes, including 30 gallon plastic drums for solids, and sealed top drums with screw-plug openings for liquids. As for liquid storage, steel (6D) drums will be used in the storage of solvent waste. For aqueous organic and acid waste, polylined (17E) drums will be used for storage.

2. Transferring Equipment

   A. Plastic safety funnels with brass or plastic screens and vents.
   B. Hand pump/siphon with Teflon or tygon tubing.
   C. Tools: screwdriver, drum plug wrench, and brass pliers.
   D. Drum dolly.

3. PPE

   A. Disposable Tyvex coveralls and/or lab coats.
   B. Disposable plastic gloves (nitrile, butyl rubber, or Viton).
   C. Respirator and cartridges (consult PSO to determine PPE requirements).
   D. Shoe covers (rubber or Tyvek).

4. Spill Cleanup Equipment and Supplies

   A. Spill absorbent (Vermiculite or Speedidry™).
   B. Broom, foxtail and dustpan.
   C. Shovel.
   D. Paper towels.
   E. 85-gallon overpack drum.
   F. Manual drum pump (same as pump in 'Item 2. Transferring Equipment').

5. Labels and Logs**:** A supply of labels and log sheets that are referred to in this SOP are to be kept on site in an easily accessible location, described in the Work Plan. Additional logs will be obtained from the Processing Facility Manager.

6. Digital camera to document IDW management.

IV. Guidelines

The following procedures will be used to store, manage, and transport IDW:

1. Waste Disposal: IDW is held in the appropriate designated storage area until approval for disposal is granted. After the PSO and Processing Facility Manager receive documentation on the level of contamination in the waste, they will assist the Project Manager in deciding whether the waste is suitable for disposal in a landfill, or must be discarded in a hazardous waste stream.

2. Solid Waste

   A. Solid waste is to be transferred into an air-tight, 30 gallon open top drum.

   B. The lid is to be removed from the collection container and the contents placed into the storage drum.

   C. Once the transfer has been completed, the lid and sealing ring are to be replaced on the storage drum.

   D. The transfer will be recorded on the waste transfer log, and this log will be placed in a location described in the Work Plan for reference.

   Biological solid waste (e.g., fish, crab, tissue, net/trap residue) shall be sealed in double plastic bags, placed in open top drums *(e.g.*, five gallon plastic pails with sealable lids, 30 gallon air-tight open top drum), and segregated for disposal. Containers for these materials shall be appropriately labeled.

3. Liquid Waste

   A. All solvents used for decontamination must be captured and disposed of in appropriate, labeled, aqueous waste containers. Liquids collected into the chemical waste container must be discarded in an appropriate waste stream. Care must be taken not to mix substances that will react with each other. If there is any question concerning compatibility, the PSO or Project Manager should be contacted prior to taking action. A record of the type, relative amount, and hazard associated with each substance added must be kept on the hazardous waste log. This log must be attached to the satellite container. Waste may be temporarily stored, if properly labeled, prior to satellite container introduction. The waste contents in these temporary storage containers must be introduced into an approved satellite container by the end of every working day.

B. Staff performing decontamination procedures need to wear appropriate PPE, gloves (*e.g.*, nitrile) and eye protection. Care must be taken in cleaning not to allow contact of cleaning solutions with clothing as much as possible. If circumstances dictate contact will occur (*e.g.*, high pressure washing, splashing, high wind), waterproof outer clothing must be worn (*e.g.*, foul weather gear or rain gear).

C. Liquid waste is to be transferred into an air-tight, 55-gallon, screw-cap drum. When a new drum is started, the larger cap is unscrewed with the drum plug wrench. The safety vent is screwed in and the cap tightened by hand.

4. PPE

A. PPE are to be transferred into air-tight, 30 gallon open top drums.

B. The lid is to be removed from the collection container and the contents placed into the storage drum.

C. Once the transfer has been completed, the lid and sealing ring will be replaced on the storage drum.

5. Project Safety Officer: Along with the Processing Facility Manager, the PSO is responsible for overseeing IDW collection and management and arranging for IDW to be disposed of off site in accordance with local, state, and federal Regulations. The responsibilities of the PSO and Processing Facility Manager include:

A. Packaging and labeling of containers.

B. Arranging for waste removal.

C. Maintaining manifest records and tracking the manifest until its signed and returned.

D. Conducting weekly inspections of the waste area.

E. Ensuring that the proper waste-handling materials and personal protective equipment are available and adequate (*e.g.*, gloves, coveralls, goggles, respirators and cartridges, boots, funnels, pumps).

F. Maintaining emergency spill response equipment.

Title: Secchi Disk Depth (Transparency) Measurement

I. Introduction

This procedure describes the equipment and methods to be used to collect Secchi Disk depth (transparency) measurements for the Lower Passaic River Restoration Project. Transparency can be measured quickly and easily, but is sensitive to light intensity, reflection, and turbidity.

II. Equipment and Supplies

The following equipment will be needed to collect transparency measurements using the Secchi Disk:

1. Secchi Disk: named after Pietro Secchi, who first used it in 1865 to measure the transparency of the Mediterranean Sea. The disk is made of rigid plastic or metal, but the details of its design are variable. It may be 20 to 30 cm or even larger in diameter and is usually painted white. Alternatively, it may be painted with black and white quadrants. The disk is suspended from a calibrated line, or attached to a calibrated rod. Earlier models, pictured below, have an attached weight. Modern models need no weights and are typically made of acrylic with a center hook eye and rope.

   A 200 mm (7-7/8") plastic Secchi Disk will be used. It will have four quadrants, two white and two black. The disk will be attached via a hook eye to 20 meters of 1/8" diameter line on a Styrofoam form that will float if dropped in the water.

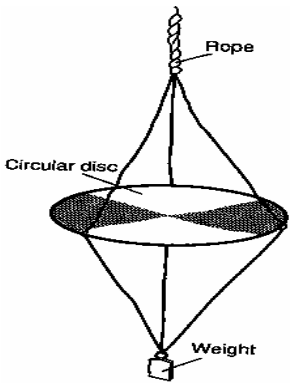


Figure 1: Secchi Disk

2. Boat or waders: to get to the measurement location.

3. Personnel protective equipment (PPE): none (However, PFD required for boat or when wading. HASP PPE required for measurements conducted in contaminated waters.)

4. Miscellaneous Supplies – Garbage bags, decontamination supplies (Paper towels and Alconox), measuring tape, field book, field application equipment, and GPS.

III. Guidelines

1. Try not to not make measurements early in the morning or late in the afternoon because sun glare may distort observations. Wear polarized sunglass if this reduces the surface reflection and improves visibility of the disk.

2. Lower the Secchi Disk through a shaded area of water surface, where possible.

3. As the disk is lowered, note the depth at which it just disappears from view.

4. Lower the disk a little further, then raise it and note the depth at which it reappears.

5. Record the average of the two depth readings as the Secchi Disk transparency. The report must also state the diameter of the disk (200 mm) and the four quadrant pattern on the upper surface of the disk.

IV. References

Lind, O.T. 1979. Handbook of Common Methods in Limnology. C.V. Mosby Co. Saint Louis.190 pp.

Water Quality Monitoring - A Practical Guide to the Design and Implementation of Freshwater Quality Studies and Monitoring Programmes. © 1996 UNEP/WHO. (http://www.who.int/docstore/water_sanitation_health/wqmonitor/ch08.htm#b2-6.2%20Transparency accessed 7-27-05).

Title: Decontamination of Biological Sampling Equipment

I. Introduction

This procedure describes the methods used to decontaminate biological sampling equipment and sample processing tools used at the site. The procedures specifically address equipment used to collect biological samples for chemical analyses.

II. Equipment and Supplies

The following equipment will be used to decontaminate equipment and tools used to collect biological samples:

1. Pump system (intake/pump/hoses) for handling site water
2. Tap water for cleaning and rinsing equipment.
3. De-ionized water for final equipment rinse
4. Non-phosphate detergent (*e.g.* Alconox™) for cleaning equipment.
5. Dishwashing detergent (*e.g.* Joy™ which provides suds in seawater) to remove oily or organic residue.
6. Organic solvent for final equipment cleaning (*e.g.* methanol or hexane)
7. PPE including disposable gloves (nitrile preferred), safety glasses, disposable wipes, eye wash system, first aid kit, and waterproof outerwear if necessary, personal floatation device if necessary.
8. Re-sealable buckets approved for waste collection and transportation.
9. Squirt bottles for water, alcohol, and solvents.
10. Brushes for cleaning equipment.
11. Field notebooks, pens, pencils, and digital camera to document decontamination procedures.

III. Guidelines

The following equipment will be used to collect biological samples and require decontamination:

Gill net
Trawl net
Crab traps
Zooplankton net
Measuring board
Cutting board

Ceramic scissors
Ceramic knives
Ceramic forceps
Other equipment that comes into contact with the sample (*e.g.*, buckets, etc.).

Collection of water for laboratory analysis requires that the equipment be cleaned between sample locations to avoid sample contamination. Generally, the cleaning procedures to be followed between sample locations are as follows:

Decontamination, Sampling Equipment: all sample collection equipment that contacts the organisms of interest will be decontaminated in accordance with the following procedures.

Fish collection nets

1. Remove all inert and organic debris from the net.
2. If a trawl net is extremely fouled, open cod end and tow behind vessel until net is visually clean. Remove any remaining debris by hand.
3. Unfold net and, if possible, hang off of the ground on the vessel or on-shore and rinse the net with site water or tap water.
4. Brush mud from the trawl doors (if using a trawl net).
5. Rinse the trawl doors with site water or tap water.
6. If the net or trawl doors are oiled, or contaminated with material that is not removed with site water or tap water, scrub the soiled area with a brush, site or tap water, and detergent (*e.g.*, Joy™). Collect liquid waste for proper disposal (See SOP 22: Management and Disposal of Investigation Derived Waste).
7. Store the net in a covered container (*e.g.* trash can or plastic bag), protected from contamination from the vessel, atmospheric fallout, and other field operations until the next deployment.
8. Inspect the net prior to the next deployment; confirm the net is clean from debris.

Invertebrate and/ or fish collection traps

1. Remove any bait containers and discard the bait into the trash.
2. Remove all inert and organic debris from the trap.
3. Brush mud from the trap.
4. Rinse the trap with site water or tap water.
5. If the trap is oiled, or contaminated with material that is not removed with site water or tap water, scrub the soiled area with a brush, site or tap water, and detergent (*e.g.*, Joy™). Collect liquid waste for proper disposal (See SOP 22: Management and Disposal of Investigation Derived Waste).
6. If the bait does not completely wash out of the bait container with site or tap water, use a brush to remove the remaining bait and rinse with site or tap water.

7. Store the trap and bait container in a covered container (*e.g.* trash can or plastic bag), protected from contamination from the vessel, atmospheric fallout, and other field operations until the next deployment.
8. Inspect the trap prior to the next deployment; confirm the trap is clean from debris.

Plankton sampling nets

1. Remove all inert and organic debris from the net.
2. Unfold the net and, if possible, hang off of the ground on the vessel or on-shore and rinse the net with site water or tap water.
3. Rinse the net by passing water from the outside of the net through the mesh to the inside of the net. Water should flow out the bottom or out the top of the net depending on which way the net is hung.
4. Use a soft brush to remove any mud or sticky debris from the net, using care not to damage the net.
5. Rinse the trawl doors with site water or tap water.
6. If the net or trawl doors are oiled, or contaminated with material that is not removed with site water or tap water, scrub the soiled area with a brush, site or tap water, and detergent (*e.g.*, Joy™). Collect liquid waste for proper disposal (See SOP 22: Management and Disposal of Investigation Derived Waste).
7. Store the net in covered container (*e.g.* trash can or plastic bag), protected from contamination from the vessel, atmospheric fallout, and other field operations until the next deployment.
8. Inspect the net prior to the next deployment; confirm the net is clean from debris.

Tissue Sample Processing Equipment

Samples may be processed to some level on the vessel, depending on FSP Volume 2 specifications. If processing, occurs and utensils and equipment come in contact with tissue samples, the utensils and equipment will be decontaminated as follows:

1. Rinse each item with tap water to remove tissue, fluids (*e.g.* blood) and/or other visually present material.
2. Scrub the item with a brush and soapy water, using non-phosphate detergent such as Alconox™.
3. Rinse the item with tap water to remove all residual soap
4. Rinse the item with 10% nitric acid to remove residual metals
5. Rinse the item with de-ionized water
6. Rinse the item with organic solvent (*e.g.* methanol, hexane)
7. Rinse the item with de-ionized or analyte-free water and allow to air dry.
8. Wrap the item(s) in aluminum foil or plastic bag to protect it until it is used again.

All solvents must be captured and disposed of in appropriate, labeled, aqueous waste containers. (See SOP 22: Management and Disposal of Investigation Derived Waste). All instruments that come into contact with the sample (*i.e.* cutting tools, forceps, cutting board, measuring board) must be cleaned as described in ***Tissue Sample Processing Equipment***. Liquids collected into the chemical waste container must be discarded in an appropriate waste stream. Staff performing decontamination procedures needs to wear appropriate PPE. As much care as possible must be taken in cleaning to avoid contact of cleaning solutions with clothing. If circumstances dictate contact will occur (*e.g.* high pressure washing, splashing, high wind), waterproof outer clothing must be worn (*e.g.* foul weather gear or rain gear).

Decontamination procedures may vary depending on specific workplan specifications, and unique contaminants of concern at specific locations. FSP Volume 2 and associated SOPs may designate collection of equipment rinse samples to document effectiveness of cleaning.

IV. Reference

American Society for Testing and Materials (ASTM), 1994. Standard Practice for Decontamination of Field Equipment Used at Nonradioactive Waste Sites. Designation: D 5088 – 90.

Title: Habitat and Vegetation Characterization

I. Introduction

This Standard Operating Procedure (SOP) defines the procedures to be followed for conducting a habitat and vegetation characterization of the Lower Passaic River Study Area. These procedures give equipment and field procedure descriptions necessary to quantify the extent of existing habitats and characterize the dominant vegetation within each habitat. This SOP also describes the procedures to collect data on select habitat features (e.g., percent of eroded stream bank, etc.) that are of note within the DQO methodologies.

II. Equipment and Supplies

The following equipment and resources will be used in the field during the habitat and vegetation characterization surveys:

1. Camera, Digital
2. Field Notebook
3. Aerial Photographs
4. Global Positioning System (GPS) unit capable of sub-meter accuracy
5. Vegetation Field Guides
6. Maps Covering the Survey Areas
7. Tide Tables for the Passaic River
8. Survey Vessel, for aquatic habitats
9. 1 m^2 Quadrat for Submerged Aquatic Vegetation (SAV) Survey
10. Personnel Protective Equipment (PPE) – As required in the Passaic River Health and Safety Plan.

III. Survey Procedures

The survey procedure is divided into two sections: Habitats and Vegetation. The Habitat section defines the methodology to be used in determining each habitat's size and classification/cover type (e.g., woodland, grassland, etc.). The Vegetation section defines the methodology(s) to be used to determine the dominant vegetation and frequency of sampling locations within a habitat.

A. HABITATS

Terrestrial habitats will be determined from aerial photographs prior to going into the field and identified as polygons on field maps/figures. The identified polygons will be investigated in the field to determine cover types, dominant vegetation, and key habitat features. Within each habitat, several key features will be measured that include:

- River/Stream bank erosion (or the potential for erosion);
- Percent of vegetation overhanging the shoreline; and
- Amount of vegetative protection afforded to the bank and the near-stream portion of the riparian zone

- In the freshwater portion of the river only, additional habitat features would be measured. These include the percent cover (logs, boulders, cavities, brush, debris, or standing timber) during summer within pools, backwater areas, and littoral areas.

Methodology for Performing the Habitat Characterization Survey:

1. Arrive at the site to be investigated. Confirm site's location by visual reference of landmarks, building, etc. and determine if site has been substantially altered as compared to the aerial photographs. Terrestrial habitats to be investigated are those occurring along the vegetative sampling transects described in FSP Volume 2.

2. Traverse site and determine the cover types within the site. Collect representative photographs of each cover type and locate with GPS following the procedure to obtain sub-meter accuracy.

3. Determine dominant vegetation within investigated site (see Vegetation section, below).

4. Traverse each site's bank area and estimate habitat features (e.g., percent of vegetation overhanging the shoreline, percent cover within pools, littoral areas, etc.).

5. Collect representative photographs of habitat features.

6. The habitat feature analysis should be performed in the summer, when vegetative cover is greatest.

7. For freshwater wetland habitats, establish and map each habitat's boundaries using the GPS. Freshwater wetlands will be identified and mapped in accordance with the 1989 federal manual. (The State of New Jersey has adopted the delineation methodology presented in the 1989 *Federal Manual for Identifying and Delineating Jurisdictional Wetlands* (Federal Manual) in implementing its wetland protection program under the Freshwater Wetlands Protection Act, PL 1987, c.156.). Mapping of freshwater wetlands, if present, will occur along the vegetative sampling transects described in FSP Volume 2.

- **Aquatic Habitats** throughout the study area will be identified through a review of GIS mapping IR photographs, and project documents (e.g., Geochemical Evaluation [Step 2] showing sediment types) prior to performing the field investigation. For intertidal habitats, ecologists will confirm habitat size, bottom conditions (*e.g.*, sediment type, hard bottom, and habitat features), percent coverage of plants and dominant species, and observed sessile and motile fauna. (If fauna are absent, then ecologists will identify likely fauna to use habitat based on substrate, depth, duration of tidal exposure, and floral communities.) For subtidal habitats, information collected during the fish and benthic invertebrate sampling activities will provide information on faunal usage and sediment type. For tidal wetlands, the extent of vegetated area is to be mapped using a GPS.

In the freshwater portion of the river only, additional habitat features would be measured. These include the relative quantity and variety of natural structures in the stream, such as cobble (riffles), large rocks, fallen trees, logs and branches, and undercut banks, available as refugia, feeding, or spawning and nursery sites of aquatic macrofauna.

B. VEGETATION

Terrestrial Vegetation - The terrestrial vegetation transects will be located along the river's bank in areas that may serve as candidate restoration sites, as described in FSP Volume 2. Along the vegetative transects, a random sampling station is selected to identify the composition of the tree (overstory) layer, scrub/shrub layer, and herbaceous (non-woody) vegetation layer. Sampling locations are to be placed at a frequency of one per every 100 feet of transect.

Methodology for Performing the Terrestrial Vegetation Characterization Survey:

1. A permanent position will be selected, marked, and located using a GPS unit. Measurements to landmarks will be used as needed. This position serves as the fixed point for vegetative sampling.

2. Overstory trees will be located and identified within a 30-ft radius of the fixed point. Each tree will be measured with a flexible tape to determine the diameter at breast-height (DBH). All trees over 4 inches DBH will be identified by species and the relative basal area will be calculated.

3. All vegetation within the scrub/shrub layer will be identified within a 30-ft radius of the fixed point. Vegetation comprising the scrub/shrub layer includes: tree saplings (under 4 DBH and over 4.5 feet tall) and shrubs (woody vegetation over 1ft in height. Each individual vegetative organism will be identified to species and enumerated. Percent canopy coverage for each species will also be estimated.

4. All herbaceous vegetation will be identified within two random five-foot radius plots. Herbaceous vegetation consists of all non-woody plants. Herbaceous plants will be estimated for percent coverage and enumerated for density estimates.

5. All basal stalks of woody vines for each species will be counted within the sampling station. Area percent coverage will be estimated for each species. If the basal stalks of the woody vines are not encountered in the sampling station, the percent of area coverage that overlies each sampling station will be estimated.

Submerged Aquatic Vegetation (SAV) – Observations are to be made during low tide cycles in a month when SAV coverage is greatest.

Methodology for Performing the Terrestrial Vegetation Characterization Survey:

1. Access the SAV beds from shore or a boat.

2. Establish one-meter square sample plots in three random locations within the SAV bed.

3. Record the plot location using GPS or note the location on an aerial photo.

4. Visually observe the aerial extent of SAV coverage in the quadrat area.

5. Map the approximate boundaries of the SAV bed using a GPS.

6. Estimate the percent coverage per species within the plots by counting the vegetation (individual shoots) by species.

IV. Reference

State of New Jersey: Adopted Methodology - 1989 *Federal Manual for Identifying and Delineating Jurisdictional Wetlands*

Title: Avian Survey

I. Introduction

This SOP defines the procedures to be followed for conducting a survey of avifauna in the Lower Passaic River study area. These procedures give descriptions of equipment and field procedures necessary to obtain qualitative data of avifauna usage of various habitats (at differing tidal cycles) throughout the study area. The survey also allows for the qualitative assessment of migratory use of the river and immediately adjacent habitats, as well as nesting and year-round resident populations.

II. Equipment and Supplies

The following equipment and resources will be used in the field during the avian surveys:

1. Camera, Digital
2. Field Notebook
3. Aerial Photographs
4. GPS
5. Avifauna Field Guides
6. Binoculars and/or Spotting Scope
7. Maps with Bathymetric Contours Covering the Survey Areas
8. Tide Tables for the Passaic River
9. Survey Vessel, for aquatic habitats
10. Quadrat for Submerged Aquatic Vegetation (SAV) Survey
11. PPE as required in the Passaic River Health and Safety Plan.

III. Guidelines

The following guidelines will be followed when conducting the Avian Surveys:

Ecologists will identify avifauna through visual and/or audible observations. When observed, avifauna will be identified to species and the number of individuals per species will be enumerated. Furthermore, on-site activity of the avifauna would be noted. In this regard, the ecologist will assess whether the organism is passively (i.e., flying over at a high altitude) or actively (e.g., nesting, swimming, breeding/courtship displays, feeding, etc.) utilizing a particular site. Observations will be conducted on days without inclement weather after sunrise, and before and after sunset.

On the Passaic River, avian sampling will include the following procedures.

1. The avian survey will be performed at designated sampling locations, as presented in FSP Volume 2.
2. Arrive at the sampling area 10-15 minutes prior to the sampling period.
3. Anchor and/or secure the vessel in a location providing the optimal viewing of avifauna in the sample area. Note the vessel's location using the GPS. The vessel should not be anchored where it could be stranded during outgoing tide or immediately adjacent to a mudflat. Anchoring the vessel immediately adjacent to the mudflat may reduce the avifauna usage due to human presence.
4. At least two ecologists trained in bird observation will be on each vessel. Ecologists will begin to record each sighting (visual or audio) for the two- hour observation period.
5. The ecologists shall not count the same individual bird more than once during the two-hour sampling period.
6. For each observation, the ecologist will note the time, species, number of individuals, observed behavior, and direction and distance from vessel.

IV. Documentation

The field personnel are responsible for documenting field activities related to the avian survey. Observations and data will be recorded in ink in a field logbook with consecutively numbered pages. The information in the field logbook will include the following as a minimum:

- Responsible person's name
- Dates and times of activities
- Location description and GPS location
- List of all species observed, as well as, location and observed behavior
- Information (e.g., time, date, location) regarding each photograph and video
- Meteorological conditions

Title: Belted Kingfisher Field Monitoring

I. Introduction

This procedure describes the methods used to monitor the Belted Kingfisher population and conduct preliminary surveys of avian species inhabiting the Lower Passaic River and tributaries. This information will provide insight in advance of FSP Volume 2 implementation in Spring 2007. The purpose of the field investigation is to a) identify active kingfisher burrows along the banks and riparian zones; b) characterize the suitability of available habitat for breeding kingfishers (using the USFWS habitat suitability index (HSI) model (Prose 1985); and c) determine reproductive success (clutch size, egg hatchability, fledgling success). This information will aid in the sampling for the ecological risk assessment and future restoration alternatives. This investigation will take place in late April through June 2006. In addition, other avian species that are observed upon visual or audio inspection will be documented.

The investigation will be conducted for each river mile instead of each kilometer of feeding territory as outlined in Prose (1985). HSI parameters will be collected at the mid-point of each river mile from mile 0 to mile 17. Tributaries will also be investigated, with HSI measurements collected 0.5 miles from the confluence with the Passaic River.

II. Definitions- Habitat Suitability Variables (Prose, 1985)

a. Percent of shoreline subject to wave action: The percent of the shoreline that is frequently or constantly subject to wave action that is severe enough to deter foraging.
b. Average water transparency (Secchi Depth): The average depth at which a weighted Secchi disk (8 inches in diameter), disappears from view when measured in a 15-m (49.2 ft) zone from shore during the spring.
c. Percent water surface obstruction: The percent of the water surface in a 15-m zone from shore that is shaded or covered by emergent and floating vegetation, logs, leaves, or overhanging shore vegetation $\leq$ 1.0 m (3.3 ft) above the water during the spring.
d. Percent of the water area that is $\leq$ 60 cm (24 inches) in depth: The percentage of the water area that is $\leq$ 60 cm in depth in a 15-m zone from shore during the spring.
e. Percent riffles: The percent of stream length containing riffles, shallow rapids in an open stream where the water surface is broken in to waves by obstructions wholly or partly submerged.

f. Average number of lentic shoreline or stream sub-sections that contain one or more perches: the average number of 25-m (82.5 ft) lentic shoreline or stream sub-sections within 1-km sections that contain one or more perches (tree or shrub limbs, electrical wires, metal or wooden posts or similar perches, immediately adjacent to or overhanging the water, that provide Kingfishers with unobstructed views of the water).
g. Distance to nearest suitable soil bank from 1-km sections of lentic shoreline or stream: The average distance to the nearest suitable soil bank (vertical to overhanging soil banks that are devoid of excessive vegetation, root masses, rocks, etc., ≥1.3 m (4.3 ft) in height, composed of 70-96% sand and ≤ 15% clay and within 3.0 km (1.9 miles) of the water.

III. Equipment and Supplies

The following supplies are necessary for the field effort:

a. Peeper Probe Video System: Peeper 2000 Video Inspection Probe and Extensions and Sandpiper Sony VCR Kit (Sandpiper Technologies, Manteca, CA). Peeper Probe system contains a video camera attached to the end of an articulated 4 m long gooseneck probe, a head-mounted display, battery, and videocassette recorder and monitor.
b. PPE: Level D protective clothing is required for this sampling effort. Personnel, who have the potential to come in contact with the soil at the burrow location in the lower 7 miles of the river, should wear Tyvek coveralls and disposable glove. Personnel shall read and follow the HASP and implement more stringent PPE levels (Modified D) if clothing is being exposed to sediments and bacteria laden river water. Disposable gloves shall be worn at all times during the survey while wading in the river or tributaries.
c. Field Data Sheets: Each burrow identified should be documented on the data sheet referred to in this SOP.
d. Digital Camera and binoculars.
e. Hand-held Global Positioning System (GPS) Unit.
f. Bird Field Guides
g. Secchi disk

IV. Guidelines

Kingfisher Burrow Identification

a. Prior to the field, inspect Peeper Probe system and verify functionality.
b. Field monitoring via vessel will begin in the downstream segment of the Newark Bay confluence. Shallow tributaries may be accessed via foot.
c. Identification of active burrows along the banks and riparian zones of the river and tributaries.

1. Proceed to fill out the Field Data Sheet with date, location, soil type, burrow attributes, etc. (See Field Data Sheet, at end).
2. Photograph burrows.
3. Map the burrow location using a hand-held Global Positioning System (GPS) unit.
4. Use Peeper Probe system for video documentation of nest status, number of eggs, number of nestlings, parental behavior, etc.

d. Return to nest following fledging of the nestlings to retrieve contents of burrow utilizing a stainless steel ladle. Place remnants in chemically pre-cleaned sample containers, label with date, burrow identification number, sample identification number, and person sampling. These samples, if collected, will be archived for later evaluation and inspection.

Habitat Suitability Index

Each 1- mile river section and tributary will be evaluated. Due to the project mileage designations used within the Passaic River, Prose (1985) was modified to investigate each mile instead of each kilometer. At the center of each section document the following measurements:

a. Average water transparency using a Secchi disk. Record the average Secchi disk depth (inches) using five readings (descend to a depth where it is no longer visible) (Refer to SOP 23);
b. Percent water surface obstruction (i.e., overhanging or emergent vegetation, logs, bridges);
c. Percent water area that is greater than or equal to 60 cm in depth;
d. Percent with riffles (i.e., shallow turbulent reaches with non-laminar flow);
e. Average number of river subsections that contain one or more perches;
f. Number of perches;
g. Distance to nearest suitable soil bank from 1-mile sections of river;

Suitability of individual banks will be determined where an active Kingfisher burrow is identified:

1. Record above data measurements (1-6 in 1-mile sections).
2. Record slope (i.e., vertical or overhanging), presence/absence of vegetation, height and soil texture.
3. Record Percent of shoreline subject to severe wave action.
4. Record soil texture (% silt, clay, sand)

V. References

Prose, B.L. 1985. Habitat Suitability Index Models: Belted Kingfisher, Biological Report 82 (10.87), U.S. Fish and Wildlife Service, Department of Interior.

Kingfisher Monitoring Program – Field Data Sheet

Each Burrow Location (used for multiple visits)

DESCRIPTION	FIELD DATA
Date	
Person Collecting Data	
Burrow Number	
Date of Burrow Discovery	
Burrow	**Characteristics**
Location (River Mile)	
NJ State Plane Northing (Feet)	
NJ State Plane Easting (Feet)	
Tide (record time & consult NOAA)/Location	/
Last Tide / Time of last tide	High/Low (circle one) /
Distance from Water (ft)	
Burrow Height (ft) [from water surface]	
Bank Height (ft) [from water surface]	
Distance from Top of Bank (ft)	
Soil type	
Burrow Diameter (inches)	
Burrow Depth (ft)	
Nest	**Contents**
Clutch Size (Number of Eggs)	
Status of Eggs	
Presence and Number of Young	
Approximate Egg Date	
Approximate Hatch Date	
Approximate Fledge Date	
Signs of Depradation	
Note: Dates estimated from multiple visits and	prediction of minimum ages.
Habitat Suitability Indices (~ 1mile of	**territory upstream/downstream burrow)**
Average Water Transparency (Secchi) (ft)	
% Water Surface Obstruction	
% Water Depth >= 60 cm (2 feet)	
% Riffles	
Number of Perches	
Presence of Vegetation (yes [degree]/no) (% of vegetated bank, % bulkhead)	
% of shoreline subject to severe wave action	

COMMENTS: BIRD ACTIVITY
PHOTO:

Kingfisher Monitoring Program – Field Data Sheet
Habitat Suitability Indices (per river mile)

DESCRIPTION	FIELD DATA
Date	
Person Collecting Data	
Average Water Transparency (Secchi) (ft)	
% Water Surface Obstruction	
% Water Depth >= 60 cm (2 feet)	
% Riffles	
Number of Perches	
Presence of Vegetation (yes [degree]/no) (% of vegetated bank, % bulkhead)	
% of shoreline subject to severe wave action	

COMMENTS: BIRD ACTIVITY
PHOTO:

Title: Fish Surveys, Collection, and Tissue Sampling

I. Introduction

This SOP defines the procedures to be followed when conducting fish surveys, and collecting fish tissue samples, where appropriate, from the study. The fish surveys and collections will be performed, as practicable using gill nets and baited eel/minnow traps. Although the details of sample collection will be influenced by site-specific conditions certain aspects of sample collection can be standardized for fish sampling and collection. These procedures give descriptions of equipment, field procedures, and documentation necessary to conduct fish population surveys and tissue sampling.

Other SOPs will be utilized with this procedure including:

SOP 1: Procedure to Conduct Sample Management for CLP and non-CLP Samples
SOP 4: Locating Sample Points Using a Global Positioning System (GPS)
SOP 6: Decontamination of Soil Sampling Equipment
SOP 22: Management and Disposal of Investigation Derived Waste
SOP 25: Decontamination of Biological Sampling Equipment
SOP 32: Field and Laboratory Processing of Fish and Invertebrate Tissue

II. Preparations for Sampling

The FSP identifies sampling stations, frequency of sampling, sample type and analytical procedures. The field team is responsible for reviewing FSP Volume 2 prior to conducting field activities and ensuring that all field equipment, including sample containers and preservatives are available and in acceptable condition.

III. Equipment and Supplies

Equipment to be used during fish surveys and collecting fish tissue samples may include, but is not limited to the following:

1. Sampling Vessel
2. Gill Nets
3. Seine Nets
4. Eel Traps and Bait
5. Standard Minnow Traps and Bait
6. Weights and Buoys (or floats)
7. Fillet Knives
8. Fish Measuring Board
9. Electronic Scale
10. Anatomical Examination Checklist

11. Field Guides and Taxonomic Keys
12. Plastic Buckets and/or Steel Washtubs
13. Sample Containers
14. Bubble Wrap
15. Ice (wet and dry)
16. Insulated Coolers
17. Sample Identification Labels/Tags
18. Waterproof Marking Pens
19. Plastic Ziploc Bags
20. PPE as required of the HASP (Malcolm Pirnie, January 2005). (*e.g.*, Tyvek, disposable gloves, safety glasses, etc.)
21. Tissue Processing Equipment (See FSP Volume 2 for guidance on field vs. laboratory tissue preparation.)
22. Camera

IV. Equipment Decontamination Procedures

Decontamination of fish tissue sampling equipment will be performed between samples collected from each location/event in accordance with procedures outlined in SOP 6: Decontamination of Soil Sampling Equipment. Personnel decontamination procedures are described in the HASP (Malcolm Pirnie, January 2005). Nets, traps, and other related sampling equipment will be decontaminated following SOP 25: Decontamination of Biological Sampling Equipment.

V. Location of Sampling Stations

The position and depth of the sampling station will be established. The positioning procedures are described in SOP 4: Locating Sample Points Using a Global Positioning System (GPS). The depth of the sampling station will be determined using either a fathometer or weighted demarcated line.

VI. Fish Surveys

The following protocol shall be implemented, as practicable for conducting fish surveys and collecting fish tissue samples from the study area at the appropriate sampling stations as described the FSP Volume 2.

GILL NETTING

Gill nets, approximately 150 feet long and comprised of six 6-foot by 24-foot panels with mesh sizes of 1.0 in, 1.5 in., 2.5 in., 3.0 in., 3.5 in., and 4.0 in., will be used. Each net consists of six different mesh types to capture various fish sizes. Each net is equipped

with lead weights and floats designed to hold the net vertically in the water column *(i.e.*, after deployment, the bottom of the net will be suspended at least one foot above the bottom to avoid contact with bottom debris). The nets will be anchored with appropriate weights, and buoy lines will be rigged within 1-2 feet of taut with respect to the next predicted high tide following deployment. To comply with federal boating regulations for navigable waterways, buoys will not be set in navigation channels. This requirement may influence the actual location of the gill net deployments. These deployment techniques will ensure reasonable net positioning in the water column throughout the tidal cycle. If necessary, alternate sized gill nets may also be utilized.

Gill nets will be deployed perpendicular to shore during the late afternoon -- early evening hours and retrieved the following morning, as practicable. Generally, fish activity increases during the night, and the catch retrieved the following day will be more representative of species movement within the area. Fish caught in the gill nets may be used in the fish community survey and tissue sample collection.

The following protocols will be followed for collecting fish with the gill nets.

1. Position the vessel at the site the gill nets are to be set.

2. Attach floats and anchor weights to surface float lines and bottom lead lines of gill nets.

3. Examine the bow of the vessel. Identify and cover with duct tape any cleats, exposed screws, and irregularities in deck rail where the net might become entangled during deployment.

4. Deploy gill nets perpendicular to shore/current from bow of vessel while vessel is in reverse. Record the time and location of deployment in the field logbook.

5. Retrieve gill nets after the desired interval. Approach the net from the downwind end and slowly pull the net onto the boat.

6. Snake the gill net into a cooler or wash tub in coils or figure eights, carefully removing fish as the net is pulled out of the water.

7. Place fish removed from the gill nets into a clean, labeled, holding container *(e.g.*, insulated cooler).

8. Fish removed from the gill nets will be identified, counted, weighed, measured (total length), and examined for gross pathological conditions including any abnormalities, disease conditions, or missing appendages. Figure 1 is an example fish data sheet for recording this information. Figure 2 is an example data sheet

for recording gross external and internal pathology information. Pathology information will be recorded for a subset of the fish captured. Gross abnormalities will be photographed and described.

NOTE: Due to the debris encountered in the Passaic River it will be necessary, prior to deployment, to assess the feasibility of deploying the nets for extended periods of time.

SEINING

Among the most effective tools used for collecting small native fish species is the seine; however, seines can be difficult to use in areas with considerable amounts of debris and highly vegetated shoreline. As such, seining will be used as a secondary method for capturing small fish (e.g., mummichogs). The seine, commonly referred to as a "minnow seine," will be constructed of synthetic mesh sized to retain small forage fish (~0.2 inches). Depending on shoreline topography and dynamics the length and width of the seine may vary, but a rectangular net measuring 15 feet long and 5 feet high is expected. The seine will be weighted along the bottom (lead line), have a series of small floats across the top, and will be supported on the ends by 1½ inch to 2 inch wooden rods (brails). The seine may also have a bag attached at the center to increase capture efficiency. Seining involves two people working together to corral fish into an area where the fish can be trapped and pulled from the water in the net. Seining will be conducted with the current because there is less drag on the net. Down current seining permits personnel to move more quickly when trapping fish, and creates only a minimal pressure wave in front of the seine, which can cause fish to move away from the net. Fish captured using the seining process will be used to support the ecological risk assessment.

The following procedures will be followed when seining for small fish species.

1. Record beginning time of deployment.
2. Two personnel wearing waders and protective gloves will serially enter the water from the same shore, each holding a brail with the float line on the water surface.
3. Person one: will (beginning at the shore) proceed into the river to approximately waist depth and begin moving down current.
4. Person two: will wait until the float line is taught, enter the water to knee depth and proceed to follow person one down stream and parallel to shore.
5. Care will be taken to prevent fish from escaping under the seine by moving slowly, maintaining tension between the brails and keeping the lead weighted line on the bottom.
6. After proceeding downstream approximately 10m, person one will begin to move shoreward.

7. When pulling the seine to shore, care will be taken to avoid lifting the lead line from the bottom. It may be necessary to get down on hands and knees to slowly work the lead line into the bank to complete the capture process.
8. It may be necessary to lift the lead line quickly and periodically to avoid snags and undercut banks.
9. If fish are observed in the net and an appropriate takeout point along the shore is no available, the seine will be quickly lifted in mid-water to capture the fish.
10. Record termination time of deployment, when fish are brought to shore for processing.
11. Place fish removed from the seine into a clean, labeled holding container (e.g., insulated cooler).
12. Fish removed from the seine will be identified, enumerated, weighed, measured (total length), and examined for gross pathological condition including any abnormalities, or disease conditions. Figure 2 is an example data sheet used to record gross pathology information. Pathology information will be recorded for only a subset of fish captured. Gross abnormalities will be photographed and described.
13. Debris will be removed from the seine and the capture process repeated until sufficient numbers and/or tissue mass has been collected to satisfy program requirements.

BAITED EEL/MINNOW TRAPS

Bait used in traps will not be analyzed for contaminant concentration. To prevent ingested bait from impacting the anticipated tissue-residue analyses, traps will use either indigenous organisms whose contaminant body burdens are similar to the target species' prey or by preventing the captured organisms from ingesting the bait.

Baited minnow traps will be deployed at 3 locations at each of the sampling stations during the late summer/early fall sampling. Baited eel traps will be deployed in conjunction with the gill net sets. The primary goal of using these traps is to catch adult American eel and mummichogs for the tissue-residue analysis, but as a secondary goal, the traps are also likely to catch other small forage fish. Not all fish collected in these traps will be kept for tissue analysis; however, all fish collected will be counted, identified, and examined for external anomalies for the fish community survey in the same manner as those caught in the gill nets. A representative sample of 10-15 fish may be used to generate weight and length (total) data for each species size class. If practicable, sex will be recorded for all fish retained for tissue analysis.

Each trap is made of reinforced aluminum mesh (114 in), and can be buoyed with a small floatation device. Baited minnow traps for collecting mummichogs will be preferentially set during the day on incoming tides as possible based on the schedule of sampling

activities. If sampling activities do not allow for deployment of baited minnow traps during the day, traps will be deployed in the late afternoon - early evening hours and retrieved the following morning in the same manner as the eel traps and gill nets.

1. Place the into the mesh bag or on the hook attached to the center bow of the trap. Attach float or buoy to end of minnow trap line. (See the bait requirement in the first paragraph of this section.)

2. Lower the trap into the water from the side of the boat, making sure that the trap is securely anchored and oriented on the river bottom. A buoy should be clearly visible on the water surface so that the minnow trap can be easily retrieved.

3. Note the time and location of deployment and retrieval and any pertinent sample location and condition descriptions in field logbook.

4. Retrieve traps.

5. Empty each trap into an individual clean holding container *(e.g.*, insulated cooler) by slowly pulling the two ends of the trap apart.

6. A sub-sample of the trapped fish are identified, weighed, measured (total length), and examined for overall condition, including any abnormalities, disease conditions, or missing appendages and measured and weighed. Figure 1 is an example fish data sheet for recording this information, Figure 2 is an example data sheet for recording gross external and internal pathology information. Pathology information will be recorded for a subset of the fish captured, including any individual fish with obvious gross morphological abnormalities. Gross abnormalities will be photographed and described.

VII. Fish Handling and Preservation

Fish collected for identification or population surveys should be identified in the field and released. Fish collected for tissue analysis should be placed in plastic bags labeled by sampling station and sampling time, and placed on wet ice in an insulated cooler until further sample preparation is performed. Fish eggs will be processed as described in SOP 32: Field and Laboratory Processing of Fish and Invertebrate Tissue prior to dispatching the female fish. Collected fish will be dispatched using a fillet knife or scalpel to sever the spinal cord just posterior to the brain. Fish will then be placed on wet ice on the boat, transferred to a freezer at the staging area (or processed if logistically acceptable), refrozen in a standard freezer following resection. Refer to Section IX of this SOP for more detail on sample preservation.

VIII. Fish Sample Preparation

Fish Sample Quantities

The Fish Sample Quantities methods described below are required so that sufficient sample volumes for analyses are assured.

Fish Preparation

Tissue sample and fish egg preparation will be performed at the laboratory as discussed in FSP Volume 2 and as presented in SOP 32: Field and Laboratory Processing of Fish and Invertebrate Sampling.

Methodology for Fish Sample Preparation:

Eel and white perch collected, using eel traps and gill nets, shall be segregated based on sampling station, species, and size class. Eel traps and gill nets will also be used to collect adult and juvenile bass.

The following protocol shall be implemented for preparing fish tissue samples. Composite samples of whole fish (mummichogs) and/or edible fillets (larger fish) will be prepared. The target number of mummichogs per composite sample will be equal to the amount required to achieve the sample volume needed for analysis. At a minimum, a composite sample will consist of two individuals. Effort will be made to collect a sufficient fish quantity to ensure that each composite tissue sample represents the same size, sex, and species of fish. In the event that a sufficient quantity of the same sex and size class of a particular species is not obtained during sampling activities, tissue from either the opposite sex or from a different size class (but never different species) will be added to achieve the desired sample quantity. In the event that target species are not available, substitute species (defined in FSP Volume 2 on Tables 12-1 and 12-3) will be obtained. The determination of whether or not substitute species should be used shall be made during the first sampling event. The target volumes for fish tissue samples will be specified by the laboratory. Fish collected at a particular location will be retained in an individual holding container (*e.g.*, insulated cooler) until sample processing at that location is complete. Once the target tissue volume has been obtained, the sample will be homogenized using a decontaminated glass blender with a stainless steel or titanium blade. Fish collected shall be archived until completion of sampling to ensure that a sufficient number of fish of a given species, size, and sex are obtained.

NYSDEC 1996 procedures, as required, will be followed regarding fillet fish preparation.

Mummichog Preparation

1. Wear appropriate PPE required by the HASP (Malcolm Pirnie, January 2005). Outer gloves should be changed between each composite sample prepared.

2. Rinse any residual sediments or organic material off of the frozen or partially thawed fish using distilled deionized water. Containerize rinsate and follow disposal procedures specified in SOP 22: Management and Disposal of Investigation Derived Waste.

3. Place sufficient numbers of whole fish to approximate the target mass for chemical analysis into decontaminated, dry glass blender equipped with a stainless steel or titanium blade.

4. Cap blender and run for approximately 15 seconds. Remove cap and force any ground tissues on the sides of the blender to the bottom using a decontaminated glass tube or decontaminated stainless steel spatula. Do not add water or other material to the tissue homogenate.

5. Repeat Step 4 as required until a homogenous blend results.

6. Transfer homogenate to appropriate sample bottles using stainless steel spoon or spatula.

7. Label and seal bottles. Wrap with bubble wrap and place in resealable plastic bag.

8. Place bags on dry ice in an insulated cooler. If necessary, wrapped bottles can be placed in a freezer on site for subsequent transfer to shipping cooler containing dry ice.

9. Decontaminate glass blender as specified in SOP 6: Decontamination of Soil Sampling Equipment.

Fish Fillet Preparation

I. Wear appropriate PPE required by the HASP (Malcolm Pirnie, January 2005). Outer gloves should be changed between each composite sample prepared.

2. Place partially thawed fish on a decontaminated glass plate. Rinse any residual sediments or organic material off of the frozen or partially thawed fish using distilled deionized water. Containerize rinsate and follow disposal procedures specified in SOP 22: Management and Disposal of Investigation Derived Waste.

3. Fillet each fish using a decontaminated, clean fillet knife or stainless steel scalpel according to the procedures depicted in Figure 3. A fillet includes the flesh tissue (skinless) from head to tail beginning at the mid-dorsal line and including the belly flap. The fillet should not be trimmed to remove any fat tissue from the lateral line or belly flap. Handle and dispose unused tissues following procedures in SOP 22: Management and Disposal of Investigation Derived Waste.

4. Place sufficient amount of fillet to approximate the target mass for chemical analysis into decontaminated, dry glass blender equipped with a stainless steel or titanium blade. A decontaminated glass pan can be used to pre-weigh the sample on an electric scale.

5. Cap blender and run for approximately 15 seconds. Remove cap and force any ground tissues on the sides of the blender to the bottom using a decontaminated glass tube or decontaminated stainless steel spatula. Do not add water or other material to the tissue homogenate.

6. Repeat Step 5 as required until a homogenous blend results.

7. Transfer homogenate to appropriate sample bottles using stainless steel spoon or spatula.

8. Label and seal bottles. Wrap with bubble wrap and place in resealable plastic bag.

9. Place bags on dry ice in an insulated cooler. If necessary, wrapped bottles can be placed in a freezer on site for subsequent transfer to shipping cooler containing dry ice.

10. Decontaminate glass blender as specified in SOP 6: Decontamination of Soil Sampling Equipment.

Whole (Large) Fish Preparation

1. Wear appropriate PPIE required by the HASP (Malcolm Pirnie, January 2005). Outer gloves should be changed between each composite sample prepared.

2. Place frozen or partially thawed fish on a decontaminated glass plate. Rinse any residual sediments or organic material off of the frozen or partially thawed fish using distilled deionized water. Containerize rinsate and follow disposal procedures specified in SOP 22: Management and Disposal of Investigation Derived Waste.

3. Cut fish into pieces of approximate 2 cm x 2 cm x 2 cm dimensions using a

decontaminated, clean fillet knife or stainless steel scalpel.

4. Place sufficient amount of tissue to approximate the target mass for chemical analysis into decontaminated, dry glass blender equipped with a stainless steel or titanium blade, A decontaminated glass pan can be used to pre-weigh the sample on an electric scale. Handle and dispose unused tissues following procedures in SOP 22: Management and Disposal of Investigation Derived Waste, and as specified in this SOP.

5. Cap blender and run for approximately 15 seconds. Remove cap and force any ground tissues on the sides of the blender to the bottom using a decontaminated glass tube or decontaminated stainless steel spatula. Do not add water or other material to the tissue homogenate.

6. Repeat Step 5 as required until a homogenous blend results.

7. Transfer homogenate to appropriate sample bottles using stainless steel spoon or spatula.

8. Label and seal bottles. Wrap with bubble wrap and place in resealable plastic bag.

9. Place bags on dry ice in an insulated cooler. If necessary, wrapped bottles can be placed in a freezer on site for subsequent transfer to shipping cooler containing dry ice

10. Decontaminate glass blender as specified in SOP 6: Decontamination of Soil Sampling Equipment.

IX. Sample Preservation

Specific instructions regarding sample preservation are described in FSP Volume 2. Generally, fish will be placed on wet ice on the boat, transferred to a freezer at the staging area (or processed if logistically acceptable), refrozen in a standard freezer following resection or homogenized, and shipped on dry ice (to ensure maintenance of temperatures below -~2O degrees Celsius).

X. Quality Control Samples

To help identify potential sample contamination sources and to evaluate potential error introduced by sample collection and handling, field quality control samples (QC samples) will be collected during the fish tissue sample collection and processing. All QC samples will be labeled in accordance with SOP 1: Procedure to Conduct Sample Management for CLP and Non-CLP Samples, and sent to the laboratory with the other samples for

analysis, if fish tissue samples are processed in the field. QC samples for fish tissue collection, wherever done, be it in the field or at the laboratory, will include rinsate samples, field duplicate samples, and matrix spike/matrix spike duplicate samples, and will be collected at the frequency specified in the QAPP (Malcolm Pirnie, August 2005).

Figure 1: Example Fish Data Form

CHECKLIST FOR PHYSICAL EXAMINATION OF FISHES			
Date Collected:	Date Examined:	Sampling Method:	Fish No.:
Location:	Station No.		Length (mm):
Examiner(s):	Species:		Weight (g):
			Sex:
Tissue Samples	Frozen for analysis (Y/N):	Analytical Sample No.:	
	Fixed for Pathology(Y/N):	Fixative:	

EXTERNAL PHYSICAL EXAMINATION					
BODY FORM		ISTHMUS		BRONCHIAL CAVITY	
	Normal		Normal		Normal
	Emaciated		Enlarged		Growths
	Truncate		Hemorrhagic		Parasites
	Scoliosis	EYES		UROGENITAL OPENING	
	Lordosis		Normal		Normal
BODY SURFACE			Popeye		Inflamed
	Normal		Cloudy cornea	ANUS	
	Raised scales		Missing		Normal
	Swollen		Lens deformed		Inflamed
	Lesions		Lens parasites	LESIONS – Location(s)	
	Excess mucous		Lens cataract		Fins
	Reoriented scales	FINS			Head
	Growths		Normal		Eyes
	Parasites		Frayed – eroded		Mouth
	Wounds		Parasites		Peduncle
	Wounds - lamprey		Hemorrhagic		Ventral
LIPS AND JAWS			Gas Bubbles		Dorsal
	Normal	FINS – ERODED			Lateral
	Deformed		Dorsal		
	Growths		Pectoral		
SNOUT			Pelvic		
	Normal		Anal		
	Pugnose (Pughead)		Adipose		
	Growths		Caudal		
	Abrasions				

Figure 1: Example Fish Data Form (cont'd)

EXTERNAL PHYSICAL EXAMINATION – Continued					
BARBELS		GILLS		BEHAVIOR	
	Normal		Normal		Gasping
	Deformed		Bright red		Flashing
	Missing		Brown		Lethargic
OPERCLE			Gas bubbles		Fin twitching
	Normal		Parasites		Convulsions
	Incomplete	PSEUDOBRANCH			Head Up--Tail Down
			Normal		Head-tail whirling
			Enlarged		Pectoral fins folded forward
					Belly up
					Loss of balance
					Long axis whirling
				OTHER OBSERVATIONS	

Figure 2: Example Fish Pathology Form

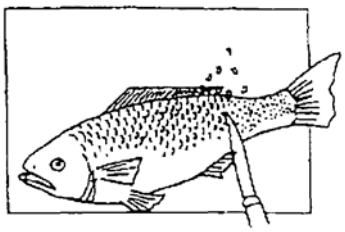
INTERNAL PHYSICAL EXAMINATION					
BODY CAVITY		INTESTINES		OVARIES	
	Normal		Normal		Immature
	Fluid – clear		Flaccid		Mature
	Fluid – bloody		Mucous		Ripe
	Fluid – cloudy		Feces		Reabsorbing
	Adhesions		Fluid		Growth
MESENERIC FAT			Hemorrhagic	MUSCLE	
	Normal		Parasites		Normal
	None	SPLEEN			Soft
	Excessive		Normal		Parasites
LIVER			Enlarged	TUMORS	
	Normal		Shrunken		Liver
	Discolored		Discolored		I Baumann
	Yellowish		Ceroid Pigment Centers		II Scale
	Pale	GAS BLADDER			III
	Enlarged		Normal		Liver wt (g)
	Growths		Fluid	PYLORIC CAECA	
	Parasites		Growths		Normal
GALL BLADDER		KIDNEY			Parasites
	Empty		Normal	TESTIS	
	Full		Pale		Immature
	Yellow		Swollen		Mature
	Green		Soft		Ripe
	Enlarged		Hemorrhagic		Constructed
	Parasites		Stones		Growth
STOMACH			Growths	OTHER OBSERVATIONS	
	Normal		Cysts		
	Empty		Parasites (urinary bladder)		
	Food				
	Mucous				
	Fluid				
	Hemorrhagic				

Figure 3:

Fish Fillet Preparation Procedures

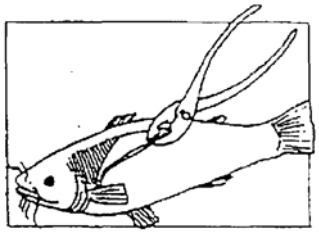
1. Scaled Fish

After removing the scales (by scraping with the edge of a knife) and rinsing the fish:



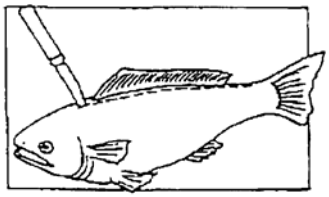
1b. Scaleless Fish

Grasp the skin at the base of the head (preferably with pliers) and pull toward the tail.



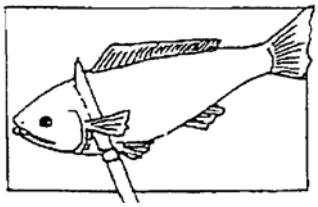
Note: This step applies only for catfish and other scaleless fish.

2



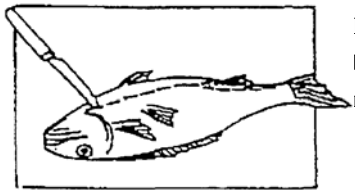
Make a shallow cm through the skin (on either side of the dorsal fin) from the top of the head to the base of the tail.

3



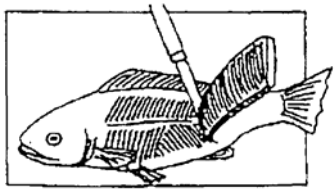
Make a cut behind the entire length of the gill cover, cutting through the skin and flesh to the bone.

4



Make a shallow cur along the belly from the base of the pectoral fin to the tail. A single cut is made from behind the gill to the anus and then a cut is made on both sides of the anal fin. Do not cut into the gut cavity as this may contaminate fillet tissue.

5



Remove the fillet.

Title: Benthic Invertebrate Community Survey and Sampling

I. Introduction

This SOP defines the procedures to be followed for collecting benthic invertebrate samples from surface sediments and hard substrate bottom locations within the study area and reference area(s). Procedures for field counting of organisms within vegetated intertidal areas are also presented. These procedures give descriptions of equipment and field procedures necessary to conduct benthic invertebrate community surveys/sampling.

Other SOPs, found in the FSP Volume 2 attachment, will be utilized with this procedure including:

-SOP 1: Procedure to Conduct Sample Management for CLP and non-CLP Samples
-SOP 4: Locating Sample Points Using a Global Positioning System (GPS)
-SOP 25: Decontamination of Biological Sampling Equipment

II. Preparations for Sampling

FSP Volume 2 identifies sampling stations, frequency of sampling, sample type, and analytical procedures. The field team is responsible for reviewing FSP Volume 2 prior to conducting field activities and ensuring that all field equipment, including sample containers and preservatives are available and in acceptable condition.

III. Field Equipment and Supplies

Equipment to be used when collecting benthic invertebrate samples may include, but is not limited to the following:

1. Sampling vessel
2. Modified Van Veen sampler or equivalent
3. 500 micron mesh sieves
4. Plastic bags
5. Sample containers
6. Small plastic buckets with watertight lids

7. Large plastic pail (5-gallon) with watertight lid
8. Rock baskets
9. Rope
10. Weights
11. Preservative
12. Insulated coolers
13. Sample identification labels/tags
14. Waterproof marking pens
15. 10% solution of buffered formalin or equivalent preservative
16. PPE (*e.g.*, Tyvek, disposable gloves, booties, safety glasses, etc. as required in the HASP (Malcolm Pirnie, January 2005))

IV. Location of Sampling Stations

The sampling schedule for the day will be established prior to vessel departure, and sufficient equipment to complete the work will be on board the sampling vessel. The position and depth of the sampling location will be established. The positioning procedures are described in SOP 4: Locating Sample Points Using a GPS. The depth of the sampling locations at each station will be determined using either a fathometer or weighted demarcated line.

V. Benthic Invertebrate Sample Collection, Counting, and Preparation

A. Procedure for Collecting Benthic Invertebrate Samples from Surface Sediments

The benthic community sample shall consist of a composite sample derived from three sediment grabs from the same area at the central location *(i.e.,* the sediment toxicity and chemistry location) of each station. Benthic samples will be collected from the top six inches.

1. Record the sampling station position, depth (which matches the depth of penetration for sediment chemistry and toxicity test samples), and time of sample in the field logbook.

2. Label the sample containers with the appropriate sample identification labels, pre-printed if available.

3. Slowly lower the sampler into the sediment in a controlled manner.

4. After the sampler reaches the desired six-inch penetration depth, slowly retrieve the sampler to the surface. Care should be taken to retrieve the sampler as smoothly as possible to avoid loosing portions of the sample.

5. Once the sampler has been raised, confirm that the effort was successful. To ensure accurate sampling, only complete six-inch samples should be retained.

6. Once a complete sample has been obtained, empty the sampler into an appropriate clean container *(e.g.,* plastic bucket). Thoroughly remove all sediment from the sampler for inclusion in the sample processing.

7. Remove all large debris *(i.e.,* rocks, leaves, sticks) then pass the entire sediment sample through a standard *500* micron mesh sieve by agitating the sieve in a sieve box containing river water to wash away the sediments.

8. Place organisms and detritus retained on the sieve into a labeled, plastic container and add a 10% solution of buffered formalin or equivalent preservative prepared in advance.

9. Place the container on wet ice in an insulated cooler for storage until shipment to the laboratory.

10. Invertebrate and other related sampling equipment will be decontaminated following SOP 25: Decontamination of Biological Sampling Equipment. SOP 6: Decontamination of Soil Sampling Equipment shall also be followed, where applicable.

B. Procedure for Collecting Benthic Invertebrate Samples from Hard Substrate Areas

For sampling stations that occur on rocky bottoms and hard substrate locations, the use of an artificial substrate sampler (i.e., rock basket) is employed. A rock basket is a cylindrical basket, with ends, that measures approximately 18 inches in length and 10 inches in diameter. Constructed of heavy gage chicken wire, the device is filled with clean rocks. The rock basket is placed on the river bottom for a 4-6 week period. At that time the rock basket is retrieved it is immediately placed in a bucket containing a 10

percent solution of buffered formalin or equivalent preservative, and prepared for shipment to the laboratory. At the lab, the basket is opened and the rocks are carefully removed. Sessile organisms attached to the rocks are identified to the lowest practicable taxa and are enumerated. Motile fauna are also identified and enumerated.

For the Passaic River, rock basket sampling will be performed as follows:

1. Review previous reports, field notes, etc. to determine likely locations for rock baskets.

2. Transit to desired sampling location and verify the bottom composition with a rod probe or other device.

3. Deploy the rock basket using the following steps:

    1. Attach a length of rope to the top of the basket.
    2. Slowly lower the basket over the side of the vessel until it touches the bottom;
    3. Transit to the nearest shoreline and play out enough rope to reach the shoreline. Note: Weight the rope as needed so that it remains on the bottom of the river and will not be caught by debris traveling downstream.
    4. Upon arriving at the shoreline, secure the rope to a tree or other permanent fixture.

4. After a four- to six-week period, return to the site, retrieve the basket, and immediately placed the rock basket in a bucket containing a 10 percent solution of buffered formalin or equivalent preservative.

5. Prepare the bucket for shipment and returned to the laboratory.

4. At the laboratory, cut the basket open with shears and carefully remove the rocks. Sessile organisms attached to the rocks are to be identified, to the lowest practicable taxa, and enumerated. Motile fauna are also identified and enumerated.

C. Procedure for Counting Benthic Invertebrate Samples within Vegetated Intertidal Areas

Note: For this task there will be no physical collection of species in the field. The ecologists performing the survey will have demonstrated experience in identifying marine, intertidal benthic invertebrates.

For vegetated intertidal areas, in-field enumeration of sessile organism will be conducted within a quarter-meter square quadrat. All vegetation within the quadrat will be inspected for the presence of benthic organisms (e.g., snails, mussels, etc.). All benthic invertebrates observed will be identified to the lowest practicable taxa and enumerated. The procedure for conducting the field identification and enumeration of benthic invertebrates from vegetated intertidal areas will be as follows:

1. Upon observing a vegetated bottom, transit to the vegetated area.
2. Randomly select locations to be sampled.
3. In each randomly selected location, place a quarter-meter square quadrat.
4. Inspect all vegetation for the presence of benthic organisms (e.g., snails, mussels, etc.). Upon locating a benthic organism, identify the individual to the lowest practicable taxa, and enumerate the total number of individuals for each taxa. (Due to the limited wetland and SAV resources within the study area no vegetation will be removed.)

VI. Sample Handling and Preservation

Sample containers and handling procedures are described in SOP 1- Procedure to Conduct Sample Management for CLP and Non-CLP Samples. Preservation of samples will be done as specified in this SOP and as may be discussed within FSP Volume 2.

Title: Crab Collection and Tissue Sampling

I. Introduction

This SOP defines the procedures for collecting crab samples and tissues from the Passaic River study area. These procedures describe equipment, field procedures, and documentation necessary to conduct crab tissue sampling.

Other SOPs, located in FSP Volume 2 Attachment, will be utilized with this procedure including:

SOP 1: Procedure to Conduct Sample Management for CLP and Non-CLP Samples
SOP 4: Locating Sample Points Using a Global Positioning System (GPS)
SOP 6: Decontamination of Soil Sampling Equipment
SOP 22: Management and Disposal of Investigation Derived Waste (IDW)
SOP 25: Decontamination of Biological Sampling Equipment
SOP 32: Field and Laboratory Processing of Fish and Invertebrate Tissue

II. Preparations for Sampling

FSP Volume 2 identifies sampling stations, frequency of sampling, sample type, and analytical procedures. The field team is responsible for reviewing the FSP prior to conducting field activities and ensuring that all field equipment are available and in acceptable condition.

III. Equipment and Supplies

Equipment to be used when collecting crabs and crab tissue samples may include, but is not limited to the following:

1. Sampling Vessel
2. Crab Pots and Bait
3. Buoys (or Floats) and Associated Line
4. Shucking Knives
5. Stainless Steel Spoons
6. Wet and Dry Ice
7. Insulated Coolers

8. Sample Identification Labels/Tags
9. Waterproof Marking Pens
10. PPE required by the HASP (Malcolm Pirnie, January 2005). (*e.g.*, Personal Floatation Device, Tyvek coveralls, disposable gloves, safety glasses, etc.)

IV. Equipment Decontamination Procedures

Decontamination of crab tissue sampling equipment will be performed between each sampling location/event in accordance with procedures outlined in SOP 6: Decontamination of Soil Sampling Equipment. Personnel decontamination procedures are contained in the HASP (Malcolm Pirnie, January 2005). Nets, traps, pots, and other related sampling equipment will be decontaminated following SOP 25: Decontamination of Biological Sampling Equipment.

IV. Location of Sampling Stations

The position and depth of the sampling station will be established based on the requirements of FSP Volume 2. (Currently, blue crabs will be collected from 10 sampling locations every 2-mile unit of the river.) The positioning procedures are described in SOP 4: Locating Sample Points Using a Global Positioning System (GPS). The depth of the sampling location will be determined using either a fathometer or weighted, demarcated line.

IV. Crab Tissue Sample Collection

Crab pots, measuring approximately 3’ x 2’ x 1’, are made of coated wire and can be buoyed with a small floatation device. Since blue crabs are generally most active at night, the pots will be deployed during the late afternoon - early evening hours and retrieved the following morning as practicable. However, crab pots may also be deployed and retrieved during a sampling day.

A larger sampling area will be allowed if sufficient crabs cannot be collected within the boundaries of one or more of the sampling stations.

The following protocol shall then be implemented for collecting the crabs:

1. Bait used in traps will not be analyzed for contaminant concentration. To prevent

ingested bait from impacting the anticipated tissue-residue analyses, traps will use either indigenous organisms whose contaminant body burdens are similar to the target species' prey or by preventing the captured organisms from ingesting the bait. Place the bait into the crab pot, accordingly. Attach a float or buoy to the end of the crab pot line.

2. Lower the crab pot into the water from the side of the boat, making sure that the pot is securely anchored and oriented on the river bottom. The buoy should be clearly visible on the surface of the water so that the crab pot can be easily retrieved.

3. Note the time and location of deployment and retrieval and any pertinent location conditions in the field logbook.

4. Retrieve crab pots at desired intervals.

5 Upon retrieval of the pot, place collected crabs on ice in clean, labeled, holding containers *(e.g.,* insulated coolers) designated for the specific sample location.

6 All crabs collected at each location should be examined and the sex, carapace width (horn to horn), and overall condition including the presence of eggs on females, as well as any abnormalities, disease conditions, or missing appendages will be recorded on the field data sheet. The catch per unit effort will also be recorded. Figure 1 is an example blue crab data sheet for recording this information.

Any additional organisms collected should be identified in the field and released. All species collected should be recorded in the field logbook

IV. Sample Preparation and Preservation

Crab Sample Quantities

The Crab Sample Quantities methods described below are required so that sufficient sample volumes for analyses are assured. Whole crab will be placed in Ziploc bags and placed on wet ice. Crab will be placed on dry ice

prior to shipment to the laboratory.

Crab Preparation

Tissue sample preparation will be performed at the laboratory as discussed in FSP Volume 2 and as presented in SOP 32: Field and Laboratory Processing of Fish and Invertebrate Sampling.

Methodology for Crab Sample Preparation:

As possible, separate composite samples of edible muscle (backfin and claw meat), hepatopancreas, and whole body (total soft tissues), of blue crab (Figure 2) will be prepared from crabs collected at each sampling station (as described in the FSP). Preference should be given to compositing male blue crabs of similar relative size, as practicable. A sufficient number of crabs will be utilized to meet the analytical sample volumes for each tissue type specified by the laboratory. Once the target tissue volume has been obtained, and the volatile organics sample has been obtained, the sample will be homogenized using a decontaminated glass blender with a stainless steel blade. The following protocols shall be implemented for preparing crab tissue samples.

Edible Tissue

For each sampling station, the crabs that are collected will be retained. Each crab selected will be examined and the sex and carapace width recorded. Individual crabs will be dissected to obtain separate composites of muscle and hepatopancreas tissues according to the following protocols.

I. Prior to removal of tissues, each crab should be rinsed with de-ionized water to remove any attached sediment. In addition, each crab will be examined for damage to the carapace; crabs exhibiting extensive damage *(i.e.,* cracks or holes) will be discarded.

2. Dispatch the crabs prior to processing, as required.

3. Break off the chelipeds at the carapace and place claws aside for tissue removal. Lift the tail, place fingers into the body cavity of the crab and pull the top

carapace off, exposing the internal organs.

4. Using a clean, decontaminated stainless steel spoon or knife, remove as much of the hepatopaucreas from the upper and lower portions of the carcass as possible, placing the tissue on a decontaminated glass plate. Care should be taken to allow calculation of other tissue types removed with the hepatopancreas.

5. Following removal of the hepatopancreas, remove the muscle tissue from the thoracic cavity, claws, legs, and abdomen portions of the crab using a clean, decontaminated stainless steel spoon or knife, placing it on a separate glass plate or metal sheet. The edible tissue can be removed from the claws by breaking open the cheliped and scraping or pulling out all muscle tissue. Residuals will be disposed of as described in SOP 22: Management and Disposal of Investigation Derived Waste.

6. The composites should be homogenized separately in a glass blender with a stainless steel or titanium blade, transferred to the appropriate sample bottles, wrapped with bubble wrap and placed into a labeled plastic bag.

7. Place the bag on ice in an insulated cooler, or in a freezer for storage until shipment.

8. Complete the appropriate chain-of-custody form for each sample container.

9. Ship sample in cooler containing dry ice.

Whole Body Tissue Samples

Whole body samples will be prepared for each location according to the procedures I through 8 described above for the edible tissue samples with the following exceptions:

- All obtainable soft tissues from the crabs will be combined and homogenized as one composite sample.

V. Sample Preservation

Specific instructions regarding sample preservation are described in SOP 1: Procedure to

Conduct Sample Management for CLP and Non-CLP Samples. Whole crabs are to be placed in Ziploc bags, placed on dry ice and shipped to the laboratory.

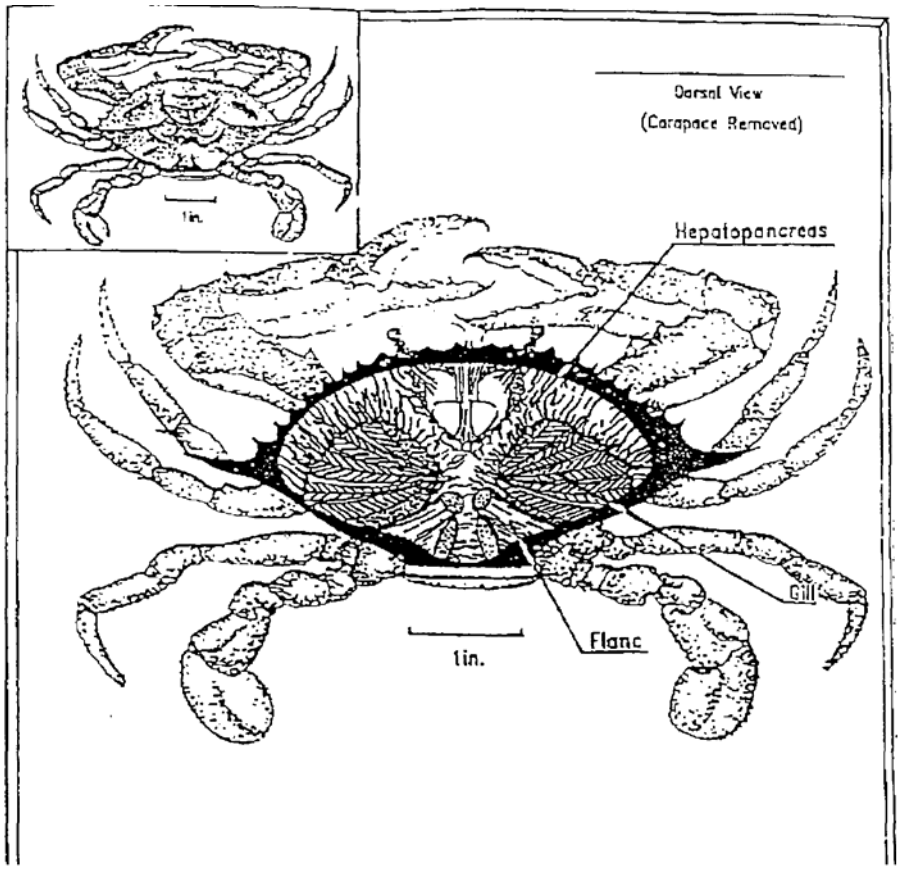
VI. Quality Control Samples

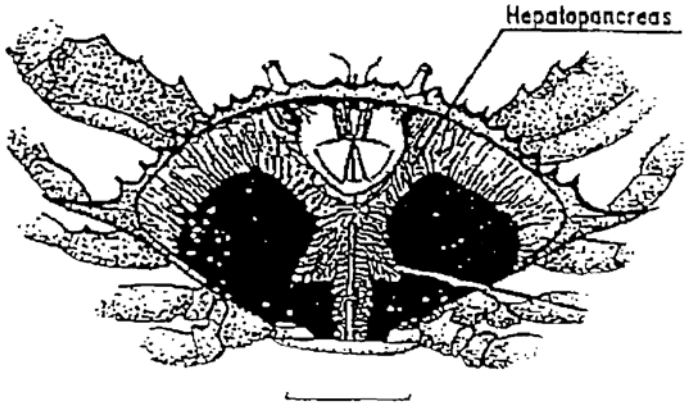
To help identify potential sample contamination sources and evaluate potential error introduced by sample collection and handling, field quality control samples (QC samples) will be collected during the crab tissue sample collection and processing. All QC samples will be labeled in accordance with SOP 1: Procedure to Conduct Sample Management for CLP and Non-CLP Samples and sent to the laboratory with the other samples for analysis. QC samples for crab tissue collection will include rinsate samples, field duplicate samples, and matrix spike samples and will be collected or analyzed at the frequency specified in the QAPP.

Figure 1 Example Blue Crab Data Form

Project Number:				Sampling Date and Time:				
SITE LOCATION								
Site Name / Number:								
County/Parish:		NJ State Plane: Northing:				Easting:		
Waterbody Name / Segment Number:								
Waterbody Type:	□ RIVER		□ LAKE		□ ESTUARY			
Site Description:								
Collection Method:								
Collector Name:								
(print and sign)								
Agency:				Phone:	( )			
Address:								
SHELLFISH COLLECTED								
Species Name:				Replicate Number:				
Composite Sample #:				Number of Individuals:				
Shellfish #	Size (mm)	Sex	Shellfish #	Size (mm)	Sex	Shellfish #	Size (mm)	Sex
001			018			035		
002			019			036		
003			020			037		
004			021			038		
005			022			039		
006			023			040		
007			024			041		
008			025			042		
009			026			043		
010			027			044		
011			028			045		
012			029			046		
013			030			047		
014			031			048		
015			032			049		
016			033			050		
017			034					
$\frac{Minimum_size}{Maximum_size} \times 100 =$_____ $\geq 75\%$				Composite mean size _____mm				
Notes (e.g., morphological anomalies)								

Figure 2
Anatomy of Blue Crab





Source: NJDEP, 1993

Title: Field and Laboratory Processing of Fish and Invertebrate Tissue

I. Introduction

This procedure describes the methods, sampling equipment, and sample processing tools used to process fish and invertebrate tissue samples for the Lower Passaic River Restoration Project. Tissue processing will only be performed at the laboratory facility.

II. Equipment and Supplies

The following equipment may be used to collect and process fish and invertebrate tissue samples on the vessel and/or in the laboratory:

1. Glass and/or plastic sample containers for sample storage and transport as defined in project documents (*e.g.* FSP Volume 2, field SOPs, laboratory SOPs)
2. Pre-cleaned aluminum foil
3. Re-sealable plastic bags (e.g., Ziploc)
4. Pre cleaned Teflon™ sheeting
5. Plastic tubs to hold organisms alive on the vessel or at the laboratory as specified in FSP Volume 2
6. Cutting board (solid Teflon™ or covered with Teflon™ sheeting)
7. Utensils (*e.g.* knives, scissors, forceps) constructed from non-contaminating materials (*e.g.* ceramic, titanium, stainless steel)
    a. The utensil material is chosen based primarily on COCs described in the FSP Volume 2 and laboratory precedent (SOPs)
8. Tissue macerator (*e.g.* Tissuemizer™) constructed from non-contaminating material (*e.g.* titanium)
9. Sitewater pump system (intake/pump/distribution hoses) or collection equipment (*e.g.* Niskin/Go-Flo bottles) for handling site water
10. Tap water for cleaning and rinsing equipment
11. De-ionized (*e.g.* Milli-Q™) water for final rinsing of equipment and organisms
12. Non-phosphate detergent (*e.g.* Alconox™) for cleaning equipment.
13. Dishwashing detergent (*e.g.* Joy™ which provides suds in seawater) to remove oily or organic residue
14. Weak acid (*e.g.* 6% nitric acid) for removing element and organic contaminates
15. Organic solvent for removing water (methanol, ethanol, isopropyl alcohol)
16. Organic solvent for final cleaning of equipment (*e.g.* hexane, DCM, methylene chloride)

17. PPE including disposable gloves (nitrile preferred), safety glasses, disposable wipes, eye wash system, first aid kit, and waterproof outerwear (if necessary)
18. Re-sealable buckets approved for waste collection and transportation.
19. Squirt bottles for water, alcohol, and solvents
20. Brushes for cleaning equipment
21. Length measuring devices (*e.g.* fish measuring board, ruler, tape measure, calipers) as specified in the workplan
22. Weight measuring devices (mechanical scales or electrical balance(s))
23. Magnifying glass for organism documentation activities (*e.g.* taxonomic, parasites, gut contents)
24. Taxonomic reference books for organism identification
25. Field notebooks, pens, pencils, and digital camera to document decontamination procedures.
26. Coolers
27. Ice

III. Guidelines

Organisms are processed as described in the FSP Volume 2 and individual laboratory and field SOPs. Operations will generally follow the methods described below. If significant deviations are planned, a revised SOP should be produced to document the process changes. Collection of organisms will be performed as detailed in the FSP Volume 2 SOPs (e.g., SOP 29 for fish, SOP 30 for benthic invertebrates, and SOP 31 for crab).

WHOLE ORGANISM SAMPLE MANAGEMENT IN THE FIELD

Whole organisms are removed from the collection device (typically net or trap) by hand wearing clean nitrile gloves. Organisms are rinsed with deionized water (*e.g.* Milli-Q™). Organisms are then either:

1. Wrapped in Teflon™ sheeting or clean aluminum foil and double bagged in clean polyethylene zip closure bags, or
2. Placed whole into jars as specified by the laboratory

Sample containers are pre-labeled as specified by the laboratory. Samples are maintained in conditions and shipped according to SOPs specified by FSP Volume 2.

PARTIAL SAMPLE PROCESSING IN THE FIELD

Since it is much more difficult to maintain clean conditions in the field than the laboratory, sample processing in the field is minimized and avoided to reduce contamination. However, field collected organisms may require partial processing based on physical factors (*e.g.* size) or workplan requirements (*e.g.*, sampling bile which is not

possible on dead organism at the laboratory, or fish egg collection from live fish). In general, operations will generally follow the methods described below. Collect decontamination fluids and excess fish/tissue for proper disposal (See SOP 22: Management and Disposal of Investigation Derived Waste).

(Collect fish eggs from live fish following the procedures described in "Collection of Fish Eggs", below, prior to dispatching the female fish.)

1. Organize a processing area in an area that is clean, tidy, well lit, and comfortable as possible.
2. The area should be restricted from mechanical lubricants, exhaust fumes/particles, and vessel chemicals (*e.g.* paint, solvents, soap)
3. Maintain clean cutting board (*e.g.* cover board with disposable Teflon™ sheeting)
4. Dissect organism as specified by FSP Volume 2 with clean ceramic utensils
5. Record required information (*e.g.* length, weight, sex, condition) on field forms
6. Document operations with photography (digital or film)
7. Place resected tissues by hand or with utensils by hand in pre-labeled containers as specified by the laboratory, still wearing clean nitrile gloves
8. Store samples as specified in the workplan (*e.g.* frozen on dry ice, 4° C on wet ice)
9. Clean/decontaminate cutting board and utensils by the following method:
    a. Rinse each item with tap water to remove mud, dirt, or other visually present material
    b. Scrub the item with a brush and soapy water, using non-phosphate detergent such as Alconox™ for non-oily residue, or a detergent (*e.g.* Joy™) for items with oily or other sticky organic residue.
    c. Rinse the item with tap water to remove all residual soap
    d. Rinse the item with de-ionized (*e.g.* Milli-Q™) water three times
    e. Rinse the item with alcohol (methanol, ethanol, isopropyl) or acetone to remove de-ionized water
    f. Rinse the item with organic solvent (*e.g.* hexane, DCM, methylene chloride)
    g. Wrap the item(s) in Teflon sheeting, aluminum foil or polyethylene bag to protect it until it is used again
10. Replace gloves between samples

COLLECTION OF FISH EGGS

Fish eggs will be used to support estimates of dioxin/furan trophic transfer factors relating whole body maternal tissue concentrations to egg exposure concentrations. Efforts will be made to limit egg collection to mature ripe eggs by focusing on large females with obvious gonad enlargement. One of two methods of dry spawning

(stripping) will be used for egg removal. The following procedures will be followed when stripping eggs from fish.

General Process:

1. Wear appropriate PPE required by the HASP (Malcolm Pirnie, January 2005). Outer gloves should be changed between each composite sample.
2. Place appropriately labeled pre-cleaned egg sample container on clean stable working surface.
3. Remove container lid and place closure side up on clean stable work surface.
4. Place appropriately labeled whole fish sample container on clean stable work surface.
5. If possible shield working area from direct sunlight, wind and dust.
6. Obtain individual fish, identify to species level, measure and record length and weight.
7. Rinse fish clean of sediment and organic material with distilled deionized water. Containerize rinsate and follow disposal procedures specified in SOP 22: Management and Disposal of Investigation Derived Waste (IDW).

Large Fish:

1. Large females are always handled by the head and tail, rather than by the tail only, to better control the live animal.
2. Position the vent over the open egg sample container and using a closed finger rocking motion from the tips of the fingers to the back of the hand stripping the eggs from the fish. This technique is thought to be less harmful to the fish, reduces scale loss and mucus production. Personnel with small hands may have difficulty using this technique.
3. Dispatch fish with a clean knife or scalpel by severing the spinal cord just posterior to the brain.
4. Place fish in sample container and transfer to wet ice.
5. Repeat procedure with additional gravid female fish until sufficient egg mass/volume is obtained to meet project requirements.
6. Record time date on labels, close containers and freeze samples for transport to laboratory for further processing.

Small Fish:

1. Small fish are held by firmly with one hand with the head and upper 1/3 of the fish entirely enclosed by the hand.
2. Position the vent over the open egg sample container. Using the free hand, gently press out the eggs with the thumb and forefingers, applying pressure just forward of the genital pore (near vent).
3. Dispatch fish with a clean knife or scalpel by severing the spinal cord just posterior to the brain.
4. Place fish in sample container and transfer to wet ice.

5. Repeat procedure with additional gravid female fish until sufficient egg mass/volume is obtained to meet project requirements.
6. Record time date on labels, close containers and freeze samples for transport to laboratory for further processing.

LABORATORY SAMPLE PROCESSING

Fish and invertebrate samples are processed in the laboratory according to lab specific methods based on the laboratory equipment, the analysis requirements, and specific guidance from FSP Volume 2. In general, operations will generally follow the methods described below.

1. All processing equipment that contacts the sample will be cleaned as follows:
    a. Rinse each item with tap water to remove mud, dirt, or other visually present material
    b. Scrub the item with a brush and soapy water, using non-phosphate detergent such as Alconox™ for non-oily residue, or a detergent (*e.g.* Joy™) for items with oily or other sticky organic residue.
    c. Rinse the item with tap water to remove all residual soap
    d. Rinse the item with de-ionized (*e.g.* Milli-Q™) water three times
    e. Rinse items with dilute (*e.g.* 6%) nitric acid three times
    f. Rinse the item with de-ionized (*e.g.* Milli-Q™) water three times
    g. Rinse the item with alcohol (methanol, ethanol, isopropyl) or acetone to remove de-ionized water
    h. Rinse the item with organic solvent (*e.g.* hexane, DCM, methylene chloride)
    i. Wrap the item(s) in Teflon sheeting, aluminum foil or polyethylene bag to protect it until it is used again
2. The homogenizing device is cleaned as specified in the appropriate laboratory SOP(s), and the manufacturer's manual
3. Tissues are thawed if frozen
4. Either:
    a. Whole organisms are placed in the homogenizing device, or
    b. Samples are resected as specified by FSP Volume 2 and resected portions designated for analysis are placed in the homogenizing device
        i. Resecting may include removing the organism's skin, scales, shell, or exoskeleton
        ii. When organisms are too large to completely homogenize, a representative sub-sample(s) of the tissue(s) of interest are collected
5. Sample specific information is recorded (*e.g.* length, weight, sex, condition) on laboratory forms as required

6. Sample is homogenized
7. Sample is extracted (if required) and analyzed

IV. References

American Society for Testing and Materials (ASTM), 1994. Standard Practice for Decontamination of Field Equipment Used at Nonradioactive Waste Sites. Designation: D 5088 – 90.

Moss Landing Marine Laboratories and SFEI 2000. *Standard Operating Procedures for Field and Laboratory Processing of Fish Tissue Samples*. Part of the Regional Monitoring Program for Trace Substances 2000. DRAFT Document

Title: Measuring Sediment Contaminant Toxicity with Invertebrates

I. Introduction

Measuring the toxicity of sediment-associated contaminants with invertebrates shall be performed following standards established by ASTM International and the U.S. Environmental Protection Agency, referenced below. These methods address the procedures to be followed utilizing freshwater invertebrates, estuarine and marine invertebrates, and the amphipod *Leptocheirus plumulosus*.

II. Equipment and Supplies

The equipment identified in the referenced standards shall be used. Methods identified to decontaminate these materials shall be followed.

III. Specific Invertebrate Testing (including methods references)

Sediment samples, to perform the sediment contaminant toxicity testing, will be obtained from a sub-sample of homogenized sediment (refer to SOP 34: Collection and Processing of Sediment Grab Samples, and FSP Volume 2, Section 13, Toxicity Testing). At a minimum, the following testing shall include:

- 42-day survival, growth, and reproduction test with the epibenthic freshwater amphipod, Hyalella azteca [Measuring Sediment Contaminant Toxicity with Invertebrates, which follows USEPA (2000c) and the American Society for Testing and Materials (ASTM; 2005) standardized methods].

- 20-day life cycle survival and growth test with the infaunal freshwater midge, Chironomus dilutus (formerly C. tentans) [Measuring Sediment Contaminant Toxicity with Invertebrates, which follows USEPA (2000c) and ASTM (2005) standardized methods].

- 28-day survival, growth, and reproduction test with the infaunal estuarine amphipod, Leptocheirus plumulosus [Measuring Sediment Contaminant Toxicity with Invertebrates, which follows USEPA (2001) and ASTM (2004) standardized methods].

IV. Supplemental References

American Society for Testing and Materials (ASTM), 2004. Standard Test Method for Measuring the Toxicity of Sediment-Associated Contaminants with Estuarine and Marine Invertebrates. Designation: E 1376-03.

American Society for Testing and Materials (ASTM), 2005. Standard Test Method for Measuring the Toxicity of Sediment-Associated Contaminants with Freshwater Invertebrates. Designation: E 1706-05.

U.S. Environmental Protection Agency (U.S.EPA), 2001. Office of Research and Development – Western Ecology Division, Newport, Oregon. Method for Assessing the Chronic Toxicity of Marine and Estuarine Sediment-Associated Contaminants with the Amphipod *Leptocheirus plumulosus*. First Edition. Designation: EPA 600/R-01/020.

U.S. Environmental Protection Agency (U.S.EPA), 2000c. "Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates." EPA/600/R-99/064.

TITLE: Collection and Processing of Sediment Grab Samples

I. Introduction

This SOP describes the collection and at-sea processing of sediment grab samples for the Lower Passaic River Restoration Project. Grab samples will be collected for chemical, biological (*i.e.*, benthic), and geophysical analyses.

II. Definitions

No specific terms have been identified as requiring definitions.

III. Supplies and Equipment

The following will be needed to collect sediment grab samples:

1. Grab sampler (type will depend on river bottom conditions and sampling needs); examples include Young-modified Van Veen, Van Veen, Smith-McIntyre, Ponar, Eckman, Shipek, and Petersen.
2. Extra weights for the grab sampler.
3. Sampling vessel capable of deploying grab apparatus with sufficient room for all aspects of grab sampling (*e.g.*, homogenization, sieving, cleaning). Sufficient room must also be available for storage of collected samples.
4. Appropriate winch and cable to deploy grab sampler in deep waters.
5. Wooden base or stand for grab sampler.
6. Bucket with pour spout.
7. 2.54 cm diameter syringe.
8. Sieve table.
9. Sieves, mesh size 0.3 mm, 0.5 mm, 1.0 mm
10. Sample containers: Plastic wide-mouth jars in various sizes for infauna, Whirlpak™ bags for grain size, glass or plastic jars with teflon-lined screw caps for chemistry, sterile specimen cups for microbiology, or as specified in the QAPP
11. Squirt bottles.
12. Funnels.
13. Tape: electrical and teflon tape for sealing sample jar lids, and clear packing tape for securing/protecting the computer generated barcode labels.
14. Grease pencils.
15. Plastic ruler.
16. Reagents
    Formalin (37-40% solution of formaldehyde).
    Borax (to buffer the formalin).

17. Solvents (for cleaning equipment between stations)
    Laboratory Soap, 1% Nitric Acid, Isopropyl Alcohol, Hexane.
    DCM (Dichloromethane).
    EtOH (Ethanol).
18. PPE

IV. Procedures

1. Collection of Benthic Sediment Samples (For benthic invertebrate sampling see SOP 30: Benthic Invertebrate Community Survey and Sampling.)

   The reference sediment stations should be collected first to reduce the chances of contamination between stations. If the sampling stations are located within a short distance of each other, then the most downstream sample, considering tide, should be collected first to avoid contamination from disturbance and resuspension of sediment due to sampling activities. Sampling in areas of aquatic vegetation where macrophyte roots or other vegetation that might inhibit sample collection should be avoided.

   Samples should be collected upstream from the boat's engine or any other machinery that may release exhaust, fumes, or oil into the sample. Once the vessel is on station all engines should be turned off. Station coordinates will be manually recorded on the station log. The sampler must be thoroughly washed with Alconox prior to use at a station, then rinsed with ambient water to ensure no sediments remain from the previous station.

   Attach the sampler to the end of the winch cable with a shackle and tighten the pin. Attach a weight to the grab sampler. Then the grab sampler should be "set" according to the manufacturer's instructions.

   Once the grab sampler is cocked, it should be lowered into the water column such that travel through the last 5 meters is no faster than about 1 m/sec. This minimizes the dispersal of fine material due to a sampler induced shock wave. Grab samplers should never be allowed to free fall into the substrate. In shallow waters, some grab samplers can be pushed directly into the sediment with a minimum penetration of 3 inches, being careful not to overfill the sampling apparatus. For instance, five and ten foot extension handles can be attached to Eckman grabs for sampling in shallow waters.

   When the cable goes slack, the grab sampler is on the bottom. Initiate recovery slowly, until the grab sampler is free from the bottom. After that, retrieve the cable at a steady rate, until the grab sampler is visible near the surface. When the grab sampler is visible, slow the rate of ascent so that it can be steadied as it is brought on-

board. If an insufficient or improper sample is collected, additional weights should be added to the sampler to allow deeper penetration into the sediment.

Set the sampler on the wooden stand, open the lid and inspect the sample for acceptability. An acceptable grab is one that displays the following characteristics:

1. Sampler is not overfilled with sediment, the jaws are fully closed and the top of the sediment is below the level of the open doors.
2. The overlying water is not excessively turbid.
3. The sampler is at least half full, indicating that the desired penetration has been achieved.
4. The sediment is level on at least one side.

In certain locations, slight over-penetration may be accepted, at the discretion of the chief scientist. The chief scientist will make the final decision regarding acceptability of all grab samples. The overall condition of the grab sample (*i.e.*, "slightly sloped on one side") should be noted in the field application. This information will be the same as the information required on the station log (Appendix 1).

Carefully drain overlying water from the grab sample. If the grab sample is used for benthic community analysis, the water must be drained into the container that will receive the sediment to ensure no organisms are lost.

All grab samples taken are recorded on the station log. If the grab sample is rejected, record the reasons on the station log, along with other pertinent station information (See Appendix 1: *Station Log for Benthic Sediment Grab Samples*).

If the sample is rejected, empty the grab sampler, placing the discarded sediment into an appropriately labeled waste container (see SOP 22: Management and Disposal of IDW), then wash the grab sampler thoroughly with seawater and re-cock the sampler. Note that decontamination cleaning procedures are not required when the grab sampler is redeployed at the same station. The sampling procedure is repeated until an acceptable grab sample is obtained.

2. Decontamination Cleaning Procedures

Sediment collection for infaunal analysis requires that the grab sampler be cleaned with at least soap and water between stations. Generally, for other types of sample analyses, the cleaning procedures to be followed between stations are as follows:

Chemistry (organic and inorganic contaminants): Follow SOP 6: Decontamination of Sampling Equipment.

Microbiology (*C. perfringens, enterococcus,* or fecal coliform): Wash the grab with soap and water, follow with an ethanol rinse. Where applicable, follow SOP 25: Decontamination of Biological Sampling Equipment.

Note that all solvents and discarded sediments must be captured and disposed of in appropriately labeled waste containers (See SOP 22: Management and Disposal of IDW). All instruments that come into contact with the sample (*i.e.* syringe, ruler, collection buckets) must be cleaned in the same manner as the grab sampler.

3. Collection of Sediment Sample from the Grab

General

1. Once the grab sample is deemed acceptable, processing can begin. Measure the penetration depth of the grab sampler by inserting a clean ruler into the sediment near the center of the sample. This depth may be compared to a chart of penetration depth versus volumes (Appendix 2), to determine the approximate volume of the grab sample. Record the depth and corresponding volume on the station log (Appendix 1). It is important that all sediment is retained if the grab sample is collected for infaunal analysis (see FSP Volume 2). If the grab sample is going to be analyzed for infauna, then the ruler should be rinsed over the grab so that all of the adhering sediment washes back into the sample.

2. An estimate of the apparent Redox Potential Discontinuity (RPD) will be measured. Insert a 2.54 cm diameter syringe into the sediment and withdraw a core. Estimate the distance from the surface of the sediment to the upper portion of the black subsurface sediment (if visible) to the nearest 0.5 cm and record the distance on the station log (Appendix 1). If the grab sample is collected for infaunal analysis, the contents of the syringe and all adhering sediment must be washed back into the sample as described above. For all other analyses, the core may be properly disposed.

Infaunal Samples

As discussed in the FSP Volume 2, all sediments collected for macrobenthic community analysis must be retained, paying particular attention to organisms visible in overlying water or stuck to the sides of the grab or the lids of the screen. Thorough and gentle washing of the entire grab sample into a clean collection bucket is necessary to ensure a representative sample.

Chemical, Physicochemical, and Microbiological Samples

1. A sub-sample from the biological active zone (*i.e.*, the top 4 inches to 8 inches) of the grab is required for samples collected for chemical, physicochemical, and microbiological analyses. (Refer to FSP Volume 2.) Samples obtained for chemical analyses (organic and inorganic) are collected with a Kynar-coated grab to reduce the possibility of contamination. Once the grab has been deemed acceptable, remove the sediment using a contaminant free (Kynar-coated or teflon) utensil.

2. Samples for Acid Volatile Sulfide/Simultaneously Extracted Metals (AVS/SEM) and volatile organic compounds (VOCs) should be collected first as discrete grabs, prior to homogenization. The sample jar for AVS/SEM must be filled completely, leaving no headspace. The sample must be immediately refrigerated at 4±2°C. Once the AVS/SEM and VOC samples are removed place the remaining sediment in a clean receptacle and gently homogenize for 1-2 minutes.

3. Following homogenization, partition the sediment into the appropriate sample containers and in the amount specified by the selected laboratory. Multiple grabs may be required at some sampling locations in order to achieve the required sample volume as specified by the selected laboratory. If this is the case, the number of grab samples collected for the composite should be recorded. Samples to be analyzed for TOC, organic contaminants, and trace metals can be frozen immediately. Grain size, AVS/SEM, and microbiology samples should be refrigerated at 4±2°C, not frozen (See SOP 2: Procedure to Conduct Sample, Preservation), unless otherwise specified by the laboratory.

4. For field activities requiring the collection of sediment samples for chemistry and toxicity testing refer to FSP Volume 2 Section 13. Sediment samples will be homogenized in the field and then divided into two samples: one for sediment chemistry analysis; the other for sediment contaminant toxicity testing (See SOP 33).

Infaunal Sample Processing

1. Once the entire sample is collected in the bucket, place the bucket on the sieving table, with the spout directed toward the center of the table.

2. Add filtered site water to the bucket while gently decanting the sample onto the screen. When the screen starts to fill up with sediment, direct the water onto the screen and try to remove as much of the fine sediment as possible. While sieving, it is important to make sure that the sediment in the bucket is covered with water,

and that the sides of the bucket have been washed down, to prevent organisms from drying out.

3. The portion of the sample remaining on the screen after sieving is retained for analysis. Wash the contents of the screen to one side of the sieve using a gentle flow of ambient water. Place a funnel in an appropriately sized sample container (the sample material should ideally fill ½ to ¾ of the container) and carefully wash the sample through the funnel into the sample container with water. Be sure to rinse the funnel and to cap the jar to prevent loss from spilling. Continue this process until the bucket is empty.

4. Once the entire sample has been sieved and collected in the sample jar, add buffered formalin to obtain a final concentration of 10% formalin (e.g. 100 mls of formalin in a 1L container), and fill the jar to the threads with water. A heaping tablespoon of Borax is added to the sample to ensure adequate buffering of the slightly acidic formalin. Gently swirl the contents of the jar to ensure complete mixing of the sample and the formalin. Affix the sample label and cover it with clear packing tape. Seal the jar tightly and tape the lid with Teflon and/or electrical tape to prevent leakage and escape of fumes during transport.

5. If the sample is made up of heavy material that will not wash through the sieve (i.e. course sand, rocks, and shell hash) it may be necessary to modify the sieving scheme to avoid injuring the organisms. This is accomplished by an elutriation procedure. The contents of the bucket are flooded with site water and gently swirled to encourage the small infaunal organisms to float to the top. The elutrient is then poured off onto the screen. The procedure is repeated until organisms are no longer visible in the elutrient. The portion of the sample retained on the screen is referred to as the light density fraction; the portion remaining in the bucket is the heavy density fraction. The two fractions are rinsed into separate, labeled sample jars. Whenever a sample is divided into more than one jar, for any reason, the jar label must reflect the number of jars. The number of jars should also be noted on the chain of custody form.

V. Quality Control

Field replicates (collected at a frequency of one replicate for every ten samples) and equipment blanks (once blank for each analytical method) for chemistry analysis will be collected according to SOP 1 – Procedure to Conduct Sample Management for CLP and Non-CLP Samples. Any deviations from this SOP must be documented on the station log in the survey logbook. Careful attention to the procedures described in this SOP by trained, qualified personnel will ensure the quality of the samples collected.

1. Interferences

Interferences that may be encountered during sediment sampling using grab devices should be recorded and every attempt should be made to minimize their impacts. Such interferences include:

Shallow depth of penetration
Shock wave and loss of very fine-grained surface deposits
Potential for water column contamination and nearby downcurrent sediment redeposition
Loss of depth profile
Difficulty of sampling in high current waters
Large debris materials such as twigs and stones may prevent closure of grab

VI. REFERENCES

Ohio EPA. 2001. *Sediment Sampling Guide and Methodologies*. Division of Surface Water, Ohio EPA, Columbus, OH.

Reifsteck, D.R. and C.J. Strobel. 1993. Field Operations and Safety Manual for EMAP- Estuaries 1993 Virginia Province. Environmental Monitoring and Assessment Program, Office of Research and Development. U.S. Environmental Protection Agency. Contract Number 68-C1-0005.

VII. APPENDICES

Appendix 1. Example of Station Log
Appendix 2. Grab Penetration Depth to Sediment Volume Conversion Chart
Appendix 3. Example of Training Certificate

Appendix 1. Example of a Benthic Survey Station Log

STATION LOG For Benthic Sediment Grab Samples Project Name:		
SURVEY: DATE: TIME ON STATION:	STATION DEPTH:	Recorded By:
Comments	Sample ID Label	Field Measurements
		Grab Size:
		Grab Penetration (cm):
		Sediment Texture:
		Redox Depth (cm):
		Analyses: (circle all applicable) Organics Metals TC GR CL EN/FE FA
		Comment:
		Grab Size
		Grab Penetration (cm):
		Sediment Texture:
		Redox Depth (cm):
		Analyses: (circle all applicable) Organics Metals TC GR CL EN/FE FA
		Comment:
		Grab Size
		Grab Penetration (cm):
		Sediment Texture:
		Redox Depth (cm):
		Analyses: (circle all applicable) Organics Metals TC GR CL EN/FE FA
		Comment:
		Grab Size:
		Grab Penetration (cm):
		Sediment Texture:
		Redox Depth (cm):
		Analyses: (circle all applicable) Organics Metals TC GR CL EN/FE FA
		Comment:

TC= total organic carbon, GR = grain size, CL=*C perfringens*, EN/FE= Enterococcus and Fecal Coliform, FA = Infauna

Appendix 2
Example of Penetration to Volume Conversion Chart

Chart Used to Convert Grab Penetration Depth (cm) to Sediment Volume (L) for the 0.1-m^2 van Young-modified Van Veen grab sampler.

Sediment Volume (L)	Grab Penetration Depth (cm)
3.5	5.5
4.0	6.0-6.5
4.5	7.0
5.0	7.0
5.5	7.5
6.0	7.5
6.5	8.5
7.0	8.5
7.5	9.0
8.0	9.5
8.5	10.0
9.0	10.0
9.5	10.5-11.0
10.0	11.5-12.0
10.5	12.5
11.0	13.0
11.0+	13.5 maximum

Appendix 3

Certificate of Training

SOP Title: Collection and At-Sea PROCESSING OF BENTHIC GRAB SAMPLES

Trainee: _____

Instructor: _____

Date SOP Read: _____

Date Training Completed: _____

Approved: _____ **Date:** _____

ATTACHMENT B

DATA QUALITY OBJECTIVES

Table B1. Data Quality Objectives for Ecological Restoration

STEP 1 State the Problem	STEP 2 Identify the Goals of the Study	STEP 3 Identify the Information Inputs	STEP 4 Define Boundaries of the Study	STEP 5 Develop the Analytical Approach	STEP 6 Specify Performance or Acceptance Criteria	STEP 7 Describe the Plan for Obtaining the Data
Problem: Extensive habitat loss and degradation have reduced the functional and structural integrity of the Lower Passaic River ecosystem. Data collection and analysis are needed to assess the level of ecological functioning of the Lower Passaic River and its riparian area; specifically to: • Establish existing ecological conditions. • Evaluate alternative candidate restoration actions. • Determine success following implementation of restoration actions. • Quantify increases in ecological function resulting from implementation of restoration actions. **Planning Team:** U.S. Environmental Protection Agency (USEPA), U.S. Army Corps of Engineers (USACE), New Jersey Department of Transportation – Office of Maritime Resources (NJDOT-OMR), National Oceanic and Atmospheric Administration (NOAA), U.S. Fish and Wildlife Service (USFWS), New Jersey Department of Environmental Protection (NJDEP), local workgroups, and other stakeholders. **Primary Decision Maker:** U.S. Environmental Protection Agency, New Jersey Department of Environmental Protection, U.S. Army Corps of Engineers, and New Jersey Department of Transportation – Office of Maritime Resources. **Conceptual Site Model**: The Lower Passaic River is an	**Principal Questions:** Over the course of the Lower Passaic River Restoration Project, the study will answer the following principal questions: • Which ecological functions of the Lower Passaic River are lower than that of the Mullica River and other, not yet selected, reference areas? • What restoration actions would most effectively increase the ecological functioning of the Lower Passaic River? • To what degree has the ecological functioning of the Lower Passaic River increased due to implementation of the restoration actions? **Alternative Actions:** The following alternative actions could result from resolution of the principal study questions: • Priority ecological functions will be selected for improvement. • Restoration actions will be selected and implemented to increase priority functions. • Implemented restoration actions will be judged effective. • Implemented restoration actions will be modified or supplemented to increase program effectiveness. • Restoration in contaminated locations will be predicated on reducing risk under the Comprehensive Environmental Response, compensation, and Liability Act (CERCLA) program. **Decision Statement:** Define the ecological restoration needs, formulate the	**Information Required:** To resolve the decision statement, draft Ecological Functional Assessment (EFA) metrics have been selected, as documented in the spreadsheet *Draft Restoration Metrics.xls* (Attachment C). Based on the draft metrics, collection of the following data from the Lower Passaic River, the Mullica River, and other not yet selected reference areas are required: • Aquatic Habitat – Aquatic habitat heterogeneity, quantity and variety of natural aquatic structures, and percent aquatic cover. • River Bank – River bank stability and vegetative bank protection. • Benthic Community – Macroinvertebrate species richness and percent perturbation-tolerant macroinvertebrates. • Fish Community – Fish diversity and abundance of perturbation-tolerant fish. • Anadromous/ Catadromous Fish Community – Abundance of anadromous and catadromous fish. • Avian Community – Abundance of wading birds, shore birds, waterfowl, migratory passerines, and belted kingfisher. • Riparian Vegetation – Natural vegetation width and exotic or undesirable plant cover. **Sources of Information:** The principal source of the data will be field sampling in the Lower Passaic River and its riparian area, and in the reference areas. Historical data (*e.g.*, 1999-2000 benthic	**Geographic Area:** The Study Area comprises the Lower Passaic River proper and its riparian area (excluding floodplain) from the Dundee Dam in the north to the River confluence with Newark Bay in the south. Other sites identified in the restoration opportunities report will be evaluated at some future date based on prioritization. Based on the CSM (Malcolm Pirnie, Inc., 2005), the Study Area will be segmented into the following three sections based on available data: • Brackish – River Miles (RM) 0 to ~6 • Transitional – RM ~6 to ~9 • Freshwater – RM ~9 to dam Reference areas will comprise the Mullica River and other not yet selected areas. **Timeframe:** Data collection will address seasonal variation in the biological community assemblages. Data collection will be phased to capture the following: • Current conditions, before implementation of restoration actions. • Conditions after implementation of restoration actions. • Conditions after modifying or supplementing restoration actions. **Scale of Decision Making:** There will be two scales of decision making, as follows: • River section scale – to compare the ecological function of the Lower Passaic River to that of the reference areas, and to assess the overall ecological functioning of the river before and after restoration. • Restoration action scale – to assess the effectiveness of individual restoration actions or	Decision rules will be established for each of the principal study questions based on the metrics selected for incorporation into the EFA. **PRE-RESTORATION ECOLOGICAL FUNCTIONS** The following address Question 1 and Action 1. **Aquatic Habitat Parameters of Interest:** The following parameters characterize the habitat of interest: • Aquatic habitat heterogeneity – HGM-TFW V_{NHC}: A measure of the habitat heterogeneity of a site, based on the comparison of the number of subhabitat types present at a site relative to the number of possible subhabitats known to occur in the appropriate regional reference standard site. • Quantity and variety of natural aquatic structures – RBP Epifaunal substrate/available cover: Relative quantity and variety of natural structures in the stream, such as cobble (riffles), large rocks, fallen trees, logs and branches, and undercut banks, available as refugia, feeding, or sites for spawning and nursery functions of aquatic macrofauna. • Percent aquatic cover – HSI-ChC V2: Percent cover (logs, boulders, cavities, brush, debris, or standing timber) during summer within pools, backwater areas, and littoral areas. Or HSI-WS V9: Percent instream and overhanging shoreline cover. **Action Level:** The action levels for the decision will be the aquatic habitat heterogeneity, quantity and variety of natural aquatic structures, or percent aquatic cover of the reference areas, depending on the specific aquatic habitat being studied. **Decision Rules:** Scoring criteria (relative to the conditions of the reference areas) will form the basis of the decision rule. The following decision rule will be employed: • **If** the Lower Passaic River aquatic habitat heterogeneity is lower than the reference area heterogeneity **or** the quantity and variety of natural aquatic structures is lower than the reference area quantity and variety **or** the percent aquatic cover is lower than the reference area percent aquatic cover, **then**, other things being equal, the improvement of aquatic habitat function will be selected as a priority. • **Otherwise**, other things being equal, the improvement of aquatic habitat function will not be selected as a priority. --- **River Bank Parameters of Interest:** The following parameters characterize the habitat of interest: • River bank stability – RBP Bank stability (condition of banks): Whether the stream banks are eroded (or have the potential for erosion). • Vegetative bank protection – RBP Bank vegetative protection: Amount of vegetative protection afforded to the stream bank and the near-stream portion of the riparian zone. **Action Level:** The action levels for the decision will be the river bank stability and vegetative bank protection of the reference areas.	The first decision error deals with the selection of an inappropriate reference location(s). The consequences of this error lead to sampling error (comparison of different biological communities), data interpretation errors (Lower Passaic River vs. reference), and error to verify restoration success. A second error centers on not providing sufficient data to adequately characterize the existing communities in the Lower Passaic River, and the Mullica River reference area, and other potential reference area(s). The consequences of this error lead primarily to the inability of the project to verify restoration success. For the benthic community, fish, and potentially the avian data, statistical comparisons between the restoration area sample results and the reference area(s) results will be conducted. These comparisons between the Lower Passaic River and the appropriate reference location(s) (Mullica River and others if necessary) will focus on the abundance, diversity, species richness metrics. Statistical comparisons between the Lower Passaic River sample results and the reference area(s) results will be conducted using $\alpha = 0.10$ (statistical confidence level). In addition to a formal statistical analysis of the metric results a comparison of abundance/diversity and richness metrics and function outputs will also be conducted using a qualitative muti-metric comparison.	The field investigation design developed for the restoration process was optimized by developing broad investigation topics subtasks/decision rules and required inputs for the proposed field investigation and data gathering efforts. Aquatic habitat, riparian vegetation, and shoreline stability evaluation will be conducted as a single survey along targeted areas for restoration. (Refer to Section 6.0 "Habitat Delineation"; Section 7 "Terrestrial Vegetation Survey"; Section 9.0 "Aquatic Vegetation Survey.") The avian surveys will be performed quarterly at specific points at 1-mile intervals (18 points) in the river. Both visual sittings and audio calls will be counted. (Refer to Section 8.0 "Avian Community Survey.") For the fish community, samples will be collected every 2 months at specific stations at 2-mile intervals in the Lower Passaic River and at 3 locations in each reference areas. (Refer to Section 10.0 "Fish Community Survey.") For the benthic community, samples will be collected quarterly. One sampling event occurring between May and September will coincide with the toxicity testing program at 90 sampling stations. (6 subtidal and 6 intertidal sampling stations every 2-mile unit of the river) During the other 3 sampling

STEP 1 State the Problem	STEP 2 Identify the Goals of the Study	STEP 3 Identify the Information Inputs	STEP 4 Define Boundaries of the Study	STEP 5 Develop the Analytical Approach	STEP 6 Specify Performance or Acceptance Criteria	STEP 7 Describe the Plan for Obtaining the Data
estuarine system in northern New Jersey. Urban and industrial development around the river has resulted in poor water quality, contaminated sediments, bans on fish and shellfish consumption, lost wetlands, and degraded habitats. The Conceptual Site Model (CSM) for ecological receptors has been developed in the various project documents including the Pathways Analysis Report (PAR) and a technical memorandum (Battelle, 2005, 2006). Malcolm Pirnie, Inc. (2005) presents the overall CSM for the Study Area including geochemistry and fate and transport components. In combination, these documents summarize the current understanding of spatial extent of contamination, potential sources, environmental media of concern, and ecological (and human health) exposure scenarios.	restoration program, and evaluate the effectiveness of the program.	invertebrate, fish community, and avian community data from river mile 1-7) also will be evaluated, primarily to assess temporal trends. **Information Needed to Establish Action Levels:** The action levels will be based on comparison of Lower Passaic River data to reference area data, and comparison of Lower Passaic River data for after restoration action implementation to data for before restoration action implementation. **Existence of Measurement Methods:** Measurement methods that are suitable to providing the necessary data exist.	groups of restoration actions.	**Decision Rules:** Scoring criteria (relative to the conditions of the reference areas) will form the basis of the decision rule. The following decision rule will be employed: • **If** the Lower Passaic River river bank stability is lower than the reference area stability **and** the Lower Passaic River vegetative bank protection is lower than the reference area protection, **then**, other things being equal, the improvement of river bank habitat function will be selected as a primary priority. • **If** the Lower Passaic River river bank stability is lower than the reference area stability **and** the Lower Passaic River vegetative bank protection is equal to or higher than the reference area protection, **then**, other things being equal, the improvement of river bank habitat function will be selected as a secondary priority. • **Otherwise**, other things being equal, the improvement of river bank habitat function will not be selected as a priority. --- **Benthic Community Parameters of Interest:** The following statistical parameters characterize the population of interest: • Benthic community richness – diversity index/indices to be determined. • Abundance of perturbation-tolerant species – perturbation-tolerant species to be determined based on study data. **Action Level:** The action levels for the decision will be the benthic community diversity and abundance of perturbation-tolerant species of the reference areas. **Decision Rules:** Scoring criteria (relative to the conditions of the reference areas) will form the basis of the decision rule. The following decision rule will be employed: • **If** the Lower Passaic River benthic community richness is lower than the reference area richness **and** the Lower Passaic River abundance of perturbation-tolerant species is higher than the reference area abundance, **then**, other things being equal, the improvement of the maintenance of benthic communities function will be selected as a primary priority. • **If** the Lower Passaic River benthic community richness is lower than the reference area richness **and** the Lower Passaic River abundance of perturbation-tolerant species is equal to the reference area abundance, **then**, other things being equal, the improvement of the maintenance of benthic communities function will be selected as a secondary priority. • **If** the Lower Passaic River benthic community richness is equal to the reference area richness **and** the Lower Passaic River abundance of perturbation-tolerant species is higher than the reference area abundance, **then**, other things being equal, the improvement of the maintenance of benthic communities function will be selected as a secondary priority. • **Otherwise**, other things being equal, the improvement of the maintenance of benthic communities function will not be selected as a priority. --- **Fish Community Parameters of Interest:** The following statistical parameters characterize the population of interest:	For the riparian vegetation, and shoreline habitat/cover evaluation will be through a qualitative multi-metric comparison of Lower Passaic River data and reference area(s) data.	events, the benthic survey will occur at 45 of the 90 sampling stations (45 select stations to be determined). Three stations in each reference area will also be sampled. (Refer to Section 11.0 “Benthic Invertebrate Community Survey.”)

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				• Fish diversity – diversity index/indices to be determined. • Abundance of perturbation-tolerant fish – perturbation-tolerant fish species to be determined based on study data. **Action Level:** The action levels for the decision will be the fish diversity and abundance of perturbation-tolerant fish of the reference areas. **Decision Rules:** Scoring criteria (relative to the conditions of the reference areas) will form the basis of the decision rule. The following decision rule will be employed: • **If** the Lower Passaic River fish diversity is lower than the reference area diversity **and** the Lower Passaic River abundance of perturbation-tolerant fish is higher than the reference area abundance, **then**, other things being equal, the improvement of the maintenance of fish communities function will be selected as a primary priority. • **If** the Lower Passaic River fish diversity is lower than the reference area diversity **and** the Lower Passaic River abundance of perturbation-tolerant fish is equal to the reference area abundance, **then**, other things being equal, the improvement of the maintenance of fish communities function will be selected as a secondary priority. • **If** the Lower Passaic River fish diversity is equal to the reference area diversity **and** the Lower Passaic River abundance of perturbation-tolerant fish is higher than the reference area abundance, **then**, other things being equal, the improvement of the maintenance of fish communities function will be selected as a secondary priority. • **Otherwise**, other things being equal, the improvement of the maintenance of fish communities function will not be selected as a priority. --- **Anadromous/Catadromous Fish Community Parameters of Interest:** The following statistical parameters characterize the population of interest: • Anadromous fish abundance – Lower Passaic River $V_{anadromous}$: Abundance of anadromous fish. • Catadromous fish abundance – Lower Passaic River $V_{catadromous}$: Abundance of catadromous fish. **Action Level:** The action levels for the decision will be the anadromous fish abundance and catadromous fish abundance of the reference areas. **Decision Rules:** Scoring criteria (relative to the conditions of the reference areas) will form the basis of the decision rule. The following decision rule will be employed: • **If** the Lower Passaic River anadromous fish abundance is lower than the reference area abundance **and** the Lower Passaic River catadromous fish abundance is lower than the reference area abundance, **then**, other things being equal, the improvement of the maintenance of anadromous/catadromous fish communities function will be selected as a primary priority. • **If** the Lower Passaic River anadromous fish abundance is lower than the reference area abundance **and** the Lower Passaic River catadromous fish abundance is equal to the reference area abundance, **then**, other things being equal, the improvement of the maintenance of anadromous/catadromous fish		

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				communities function will be selected as a secondary priority. • **If** the Lower Passaic River anadromous fish abundance is equal to the reference area abundance **and** the Lower Passaic River catadromous fish abundance is lower than the reference area abundance, **then**, other things being equal, the improvement of the maintenance of anadromous/catadromous fish communities function will be selected as a secondary priority. • **Otherwise**, other things being equal, the improvement of the maintenance of anadromous/catadromous fish communities function will not be selected as a priority. --- **Avian Community Parameters of Interest:** The following statistical parameters characterize the population of interest: • Avian community richness – diversity index/indices to be determined. • Abundance of wading birds, shore birds, waterfowl, migratory passerines, and belted kingfisher to be determined based on study data. **Action Level:** The action levels for the decision will be the avian community richness and the abundance of wading birds, shore birds, waterfowl, migratory passerines, or belted kingfisher of the reference areas. **Decision Rules:** Scoring criteria (relative to the conditions of the reference areas) will form the basis of the decision rule. The following decision rule will be employed: • **If** the Lower Passaic River avian community richness is lower than the reference area richness, **then**, other things being equal, 1) for those avian species or guilds with Lower Passaic River richness lower than reference area richness the improvement of the maintenance of avian communities function will be selected as a primary priority **and** 2) for those avian species or guilds with Lower Passaic River richness equal to reference area richness the improvement of the maintenance of avian communities function will be selected as a secondary priority **and** 3) for those avian species or guilds with Lower Passaic River richness higher than reference area richness the improvement of the maintenance of avian communities function will not be selected as a priority. • **Otherwise**, other things being equal, the improvement of the maintenance of avian communities function will not be selected as a priority. --- **Riparian Vegetation Parameters of Interest:** The following parameters characterize the habitat of interest: • Natural vegetation width – RBP Riparian vegetative zone width: Width of natural vegetation from the edge of the stream bank out through the riparian zone. • Exotic or undesirable plant cover – HGM-TFW V_{EXOTIC}: Proportion of a site covered with exotic or other undesirable plant species. **Action Level:** The action levels for the decision will be the natural vegetation width or the exotic or undesirable plant cover of the reference areas, depending on the specific riparian habitat being studied. **Decision Rules:** Scoring criteria (relative to the conditions of the reference		

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				areas) will form the basis of the decision rule. The following decision rule will be employed: • **If** the Lower Passaic River natural vegetation width is lower than the reference area width **or** the Lower Passaic River exotic or undesirable plant cover is higher than the reference area cover, **then**, other things being equal, the improvement of the riparian habitat function will be selected as a priority. • **Otherwise**, other things being equal, the improvement of the riparian habitat function will not be selected as a priority. --- **RESTORATION ACTIONS AND POST-RESTORATION ECOLOGICAL FUNCTIONS** The following address Questions 2 and 3, and Actions 2, 3, and 4. **Aquatic Habitat Parameters of Interest:** The following parameters characterize the habitat of interest: • Aquatic habitat heterogeneity – HGM-TFW V_{NHC}: A measure of the habitat heterogeneity of a site, based on the comparison of the number of subhabitat types present at a site relative to the number of possible subhabitats known to occur in the appropriate regional reference standard site. • Quantity and variety of natural aquatic structures – RBP Epifaunal substrate/available cover: Relative quantity and variety of natural structures in the stream, such as cobble (riffles), large rocks, fallen trees, logs and branches, and undercut banks, available as refugia, feeding, or sites for spawning and nursery functions of aquatic macrofauna. • Percent aquatic cover – HSI-ChC V2: Percent cover (logs, boulders, cavities, brush, debris, or standing timber) during summer within pools, backwater areas, and littoral areas. Or HSI-WS V9: Percent instream and overhanging shoreline cover. **Action Level:** The action levels for the decision will be the aquatic habitat heterogeneity, quantity and variety of natural aquatic structures, or percent aquatic cover of the restoration site prior to restoration, depending on the specific aquatic habitat being studied. **Decision Rules:** Scoring criteria (relative to the restoration site condition(s)) will form the basis of the decision rule. The following decision rule will be employed: • **If** the projected (Action 2) or actual (Action 3) with restoration aquatic habitat heterogeneity is higher than the without restoration heterogeneity **or** the quantity and variety of natural aquatic structures is higher than the without restoration quantity and variety **or** the percent aquatic cover is higher than the without restoration percent aquatic cover, **then**, other things being equal, the restoration action will be selected or judged effective. • **Otherwise**, other things being equal, the restoration action will not be selected or judged effective. --- **River Bank Parameters of Interest:** The following parameters characterize the habitat of interest: • River bank stability – RBP Bank stability (condition of banks): Whether the stream banks are eroded (or have the potential for erosion).		

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				• Vegetative bank protection – RBP Bank vegetative protection: Amount of vegetative protection afforded to the stream bank and the near-stream portion of the riparian zone. **Action Level:** The action levels for the decision will be the river bank stability and vegetative bank protection of the restoration site prior to restoration. **Decision Rules:** Scoring criteria [relative to the restoration site condition(s)] will form the basis of the decision rule. The following decision rule will be employed: • **If** the projected (Action 2) or actual (Action 3) with restoration river bank stability is higher than the reference area stability, **then**, other things being equal, the restoration action will be selected or judged effective. • **If** the projected (Action 2) or actual (Action 3) with restoration river bank stability is equal to the without restoration stability **and** the projected or actual with restoration vegetative bank protection is higher than the without restoration protection, **then**, other things being equal, modification of the restoration action will be considered or the restoration action will be judged not effective. • **Otherwise**, other things being equal, the restoration action will not be selected or judged effective. ——————— **Benthic Community Parameters of Interest:** The following statistical parameters characterize the population of interest: • Benthic community richness – diversity index/indices to be determined. • Abundance of perturbation-tolerant species – perturbation-tolerant species to be determined based on study data. **Action Level:** The action levels for the decision will be the benthic community diversity and abundance of perturbation-tolerant species of the restoration site prior to restoration. **Decision Rules:** Scoring criteria [relative to the restoration site condition(s)] will form the basis of the decision rule. The following decision rule will be employed: • **If** the projected (Action 2) or actual (Action 3) with restoration benthic community richness is higher than the without restoration richness **and** the projected or actual with restoration abundance of perturbation-tolerant species is lower than the without restoration abundance, **then**, other things being equal, the restoration action will be selected or judged effective. • **If** the projected (Action 2) or actual (Action 3) with restoration benthic community richness is higher than the without restoration richness **and** the projected or actual with restoration abundance of perturbation-tolerant species is equal to the without restoration abundance, **then**, other things being equal, the restoration action may be selected or judged effective. • **If** the projected (Action 2) or actual (Action 3) with restoration benthic community richness is equal to the without restoration richness **and** the projected or actual with restoration abundance of perturbation-tolerant species is lower than the without restoration abundance, **then**, other things being equal, the restoration action may be selected or judged effective.		

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				• **Otherwise**, other things being equal, the restoration action will not be selected or judged effective. --- **Fish Community Parameters of Interest:** The following statistical parameters characterize the population of interest: • Fish diversity – diversity index/indices to be determined. • Abundance of perturbation-tolerant fish – perturbation-tolerant fish species to be determined based on study data. **Action Level:** The action levels for the decision will be the fish diversity and abundance of perturbation-tolerant fish of the restoration site prior to restoration. **Decision Rules:** Scoring criteria (relative to the restoration site condition(s)) will form the basis of the decision rule. The following decision rule will be employed: • **If** the projected (Action 2) or actual (Action 3) with restoration fish diversity is higher than the without restoration diversity **and** the projected or actual with restoration abundance of perturbation-tolerant fish is lower than the without restoration abundance, **then**, other things being equal, the restoration action will be selected or judged effective. • **If** the projected (Action 2) or actual (Action 3) with restoration fish diversity is higher than the without restoration area diversity **and** the projected or actual with restoration abundance of perturbation-tolerant fish is equal to the without restoration abundance, **then**, other things being equal, the restoration action may be selected or judged effective. • **If** the projected (Action 2) or actual (Action 3) with restoration fish diversity is equal to the without restoration area diversity **and** the projected or actual with restoration abundance of perturbation-tolerant fish is lower than the without restoration abundance, **then**, other things being equal, the restoration action may be selected or judged effective. • **Otherwise**, other things being equal, the restoration action will not be selected or judged effective. --- **Anadromous/Catadromous Fish Community Parameters of Interest:** The following statistical parameters characterize the population of interest: • Anadromous fish abundance – Lower Passaic River $V_{anadromous}$: Abundance of anadromous fish. • Catadromous fish abundance – Lower Passaic River $V_{catadromous}$: Abundance of catadromous fish. **Action Level:** The action levels for the decision will be the anadromous fish abundance and catadromous fish abundance of the restoration site prior to restoration. **Decision Rules:** Scoring criteria (relative to the conditions of the reference areas) will form the basis of the decision rule. The following decision rule will be employed: • **If** the projected (Action 2) or actual (Action 3) with restoration		

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				anadromous fish abundance is higher than the without restoration abundance **and** the projected or actual with restoration catadromous fish abundance is equal to or higher than the without restoration abundance, **then**, other things being equal, the restoration action will be selected or judged effective. • **If** the projected (Action 2) or actual (Action 3) with restoration anadromous fish abundance is equal to or higher than the without restoration abundance **and** the projected or actual with restoration catadromous fish abundance is higher than the without restoration abundance, **then**, other things being equal, the restoration action will be selected or judged effective. • **Otherwise**, other things being equal, the restoration action will not be selected or judged effective. --- **Avian Community Parameters of Interest:** The following statistical parameters characterize the population of interest: • Avian community richness – diversity index/indices to be determined. • Abundance of wading birds, shore birds, waterfowl, migratory passerines, and belted kingfisher to be determined based on study data. **Action Level:** The action levels for the decision will be the avaian community abundance of Abundance of wading birds, shore birds, waterfowl, migratory passerines, and belted kingfisher of the restoration site prior to restoration. **Decision Rules:** Scoring criteria (relative to the restoration site condition(s)) will form the basis of the decision rule. The following decision rule will be employed: • **If** the projected (Action 2) or actual (Action 3) with restoration avian community richness is higher than the without restoration richness **and** the projected or actual with restoration abundance of the avian species or guild targeted by the restoration action is higher than the without restoration abundance, **then**, other things being equal, the restoration action will be selected or judged effective. • **If** the projected (Action 2) or actual (Action 3) with restoration avian community richness is higher than the without restoration richness **and** the projected or actual with restoration abundance of the avian species or guild targeted by the restoration action is equal to the without restoration abundance, **then**, other things being equal, the restoration action may be selected or judged effective. • **If** the projected (Action 2) or actual (Action 3) with restoration avian community richness is equal to the without restoration richness **and** the projected or actual with restoration abundance of the avian species or guild targeted by the restoration action is higher than the without restoration abundance, **then**, other things being equal, the restoration action may be selected or judged effective. • **Otherwise**, other things being equal, the restoration action will not be selected or judged effective. --- **Riparian Vegetation Parameters of Interest:** The following parameters characterize the habitat of interest: • Natural vegetation width – RBP Riparian vegetative zone width: Width of		

STEP 1 State the Problem	STEP 2 Identify the Goals of the Study	STEP 3 Identify the Information Inputs	STEP 4 Define Boundaries of the Study	STEP 5 Develop the Analytical Approach	STEP 6 Specify Performance or Acceptance Criteria	STEP 7 Describe the Plan for Obtaining the Data
				natural vegetation from the edge of the stream bank out through the riparian zone. • Exotic or undesirable plant cover – HGM-TFW V_{EXOTIC}: Proportion of a site covered with exotic or other undesirable plant species. **Action Level:** The action levels for the decision will be the natural vegetation width or the exotic or undesirable plant cover of the restoration site prior to restoration, depending on the specific riparian habitat being studied. **Decision Rules:** Scoring criteria (relative to the restoration site condition(s)) will form the basis of the decision rule. The following decision rule will be employed: • **If** the projected (Action 2) or actual (Action 3) with restoration natural vegetation width is higher than the without restoration width **or** the exotic or undesirable plant cover is lower than the without restoration cover, **then**, other things being equal, the restoration action will be selected or judged effective. • **Otherwise**, other things being equal, the restoration action will not be selected or judged effective. _____		

Battelle, 2006. "Conceptual Site Model Technical Memorandum." Lower Passaic River Restoration Project.

Battelle, 2005. "Pathways Analysis Report." Lower Passaic River Restoration Project. Prepared under contract to Malcolm Pirnie, Inc. July 2005.

Malcolm Pirnie, Inc., 2005. "Work Plan." Lower Passaic River Restoration Project. Prepared in conjunction with Battelle and HydroQual, Inc. August 2005.

Metric Legend for Table B1	
Model or Variable	**Description**
RBP Percent sediment tolerant organisms	Percent of infaunal macrobenthos tolerant of perturbation
RBP Total number of taxa	Measures the overall variety of the macroinvertebrate assemblage
LPR $V_{tolerantfish}$	Abundance of fish tolerant of perturbation
LPR $V_{fishdiversity}$	Overall diversity of fish
RBP Bank stability (condition of banks)	Whether the steam banks are eroded (or have the potential for erosion)
HGM-TFW V_{NHC}	A measure of the habitat heterogeneity of a site, based on the comparison of the number of subhabitat types present at a site relative to the number of possible subhabitats known to occur in the appropriate regional reference standard site
RBP Total number of taxa	Measures the overall variety of the macroinvertebrate assemblage
LPR $V_{fishdiversity}$	Overall diversity of fish
RBP Bank stability (condition of banks)	Whether the steam banks are eroded (or have the potential for erosion)
RBP Bank vegetative protection	Amount of vegetative protection afforded to the stream bank and the near-stream portion of the riparian zone
HSI-WS V9	Percent instream and overhanging shoreline cover
LPR $V_{wadingbirds}$	Abundance of wading birds (e.g., herons and egrets)
LPR $V_{shorebirds}$	Abundance of shore birds
LPR $V_{waterfowl}$	Abundance of waterfowl (e.g., ducks and geese)
LPR $V_{migratory}$	Abundance of migratory passerines
LPR $V_{kingfisher}$	Abundance of belted kingfisher
RBP Riparian vegetative zone width	Width of natural vegetation from the edge of the stream bank out through the riparian zone
HGM-TFW V_{EXOTIC}	The proportion of a site covered with exotic or other undesirable plant species
HGM-TFW V_{NHC}	A measure of the habitat heterogeneity of a site, based on the comparison of the number of subhabitat types present at a site relative to the number of possible subhabitats known to occur in the appropriate regional reference standard site
HSI-ChC V2	Percent cover (logs, boulders, cavities, brush, debris, or standing timber) during summer within pools, backwater areas, and littoral areas
RBP Epifaunal substrate / available cover	Relative quantity and variety of natural structures in the stream, such as cobble (riffles), large rocks, fallen trees, logs and branches, and undercut banks, available as refugia, feeding, or sites for spawning and nursery functions of aquatic macrofauna
RBP Total number of taxa	Measures the overall variety of the macroinvertebrate assemblage
LPR $V_{fishdiversity}$	Overall diversity of fish
LPR Vanadromous	Abundance of anadromous fish
LPR Vcatadromous	Abundance of catadromous fish

Table B2. Data Quality Objectives for Ecological Risk Assessment of Fish Populations (Tissue Residue Sampling)

STEP 1 State the Problem	STEP 2 Identify the Goals of the Study	STEP 3 Identify Information Inputs	STEP 4 Define Boundaries of the Study	STEP 5 Develop Analytic Approach	STEP 6 Specify Performance or Acceptance Criteria	STEP 7 Develop the Detailed Plan for Obtaining Data
Problem: Historical and ongoing activities have adversely affected the health of the Lower Passaic River, particularly sediment quality. As a biological resource that is affected by sediment quality via direct contact (*e.g.*, demersal, benthivorous fish) and through trophic interactions (pelagic, piscivorous fish), the fish community has likely been affected by various stressor agents related to historical contaminant releases to the river as well as general urbanization within the watershed. Fish serve an important function as both top predators and prey to other species, including humans, in the aquatic food web and it is necessary to understand the potential risks experienced by this ecological component to determine whether a remedial action is warranted. **Planning Team**: U.S. Environmental Protection Agency (USEPA), U.S. Army Corps of Engineers (USACE), New Jersey Department of Transportation – Office of Maritime Resources (NJDOT-OMR), National Oceanic and Atmospheric Administration (NOAA), U.S. Fish and Wildlife Service (USFWS), New Jersey Department of Environmental Protection (NJDEP), local workgroups, and other stakeholders. **Primary Decision Maker**: USEPA is the lead agency for the CERCLA investigation; however, decision-making will rely on inputs from all team members.	**Primary Question**: Are exposures to site-related chemical stressors throughout the Lower Passaic River posing an unacceptable risk to fish populations? To adequately answer this question, both decision and estimation elements (USEPA, 2006) will need to be addressed. **Secondary Questions**: How will other stressors be differentiated from site-related chemical stressors? **Alternative Actions**: • Consider remedial options if degree of impact (based on a weight of evidence assessment of multiple lines of evidence) to fish populations is determined to be substantial. • Document conditions that support no further action (based on this resource) if no substantial impact is identified. **Estimation Statements**: • Evaluate the spatial extent and variability of COPECs in surface sediment. • Compare COPECs concentrations in surface water to applicable ecotoxicological	**Information Required:** Information necessary to answer the principal study question will include existing, and to be collected data, related to sediment and surface water chemistry, fish tissue residues (including measured and estimated fish egg residues), and fish community health. <u>Sediment and Surface Water Chemistry</u>. Analytical results for surface water will be compared to appropriate National Ambient Water Quality Criteria and NJDEP standards as a measure of effect in the Baseline Ecological Risk Assessment (BERA). Separate DQOs for sediment and surface water chemistry will be provided in the revised FSP Volume 1 document. Sediment and surface water samples will be analyzed using the most appropriate (based on consideration of risk-based effect thresholds) analytical methods as specified in the QAPP (Malcolm Pirnie, Inc, 2005b). The analytical parameter list will include analyses for all types of COPECs identified in the PAR [*e.g.*, metals, VOCs, SVOCs (including PAHs), PCBs, pesticides, and PCDD/Fs]. Miscellaneous analytical measures include grain size and total organic carbon for sediment as well as hardness, salinity, conductivity, pH, and temperature for surface water. A Toxicity Equivalency (TEQ) approach will be used to estimate the combined exposure to compounds (including co-planar PCB congeners) with 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) activity; fish Toxicity Equivalency Factors (TEFs) will be used. At the commencement of the risk assessment, all extant site data will be evaluated for usability in the BERA (USEPA, 1992) and a subset identified for use in the this assessment. <u>Fish Tissue</u>. The following species are targeted for tissue sampling	**Geographical Area**: The Study Area comprises the Lower Passaic River (excluding floodplains) from the Dundee Dam in the north to the River confluence with Newark Bay to the south. Based on the CSM (Malcolm Pirnie, Inc. 2005a), the Study Area will be divided into the following three sections based on available data: • Brackish – River Miles (RM) 0 to ~6 • Transitional – RM ~6 to ~9 • Freshwater – RM ~9 to dam Fish species that occur in estuarine habitat are characterized by relatively low species diversity and broad salinity tolerances. For the purposes of the BERA, the study area will be segregated into a brackish water habitat (Brackish River Section) and a freshwater habitat (Freshwater River Section). Existing salinity and biological data suggest that the Transition River Section is generally located somewhere between RM 6-9 although bathymetric information will need to be considered as well (*i.e.*, salt wedge). Sediment sampling will be limited to the biologically active zone (BAZ), which is most relevant for understanding the relationship between sediment and fish tissue. The selection of reference areas has not yet been completed. Estuarine and freshwater portions of the Mullica River were used during previous tissue-residue	**Appropriate Population Parameters**: The specific estimation parameters will vary depending upon the specific measure of effect evaluated. 1. Comparisons of sediment /surface water to appropriate benchmarks – 95% upper confidence interval (UCL) on median or arithmetic mean to benchmark point estimate. 2. Fish tissue residue to appropriate benchmarks – 95% upper confidence interval (UCL) to benchmark point estimate. Residue values will be based on measured (or derived) whole body tissues and lipid-normalized if necessary for direct comparison with the literature values. 3. Fish community health – (refer to Table B1). 4. Fish tissue concentrations as input to ecological foodweb models 95% upper confidence interval (UCL) on median or arithmetic mean to benchmark point estimate. Incremental risks will be estimated by subtracting the 95% UCL estimator derived from the appropriate reference area from the exposure area in question (see Table B4). The parameter of interest in this portion of the study will be the 95% UCL on either the arithmetic mean or median (depending on whether sample compositing is necessary) chemical concentration of each fish species. Tissue concentrations are expected to vary along the river, so the river will be divided into several segments (based on the salinity gradient and degree of tidal submergence). The statistical analysis will be concerned with each segment, separately. Multiple individuals will be needed to comprise a single mummichogs sample and composite samples of tissue from several fish will be formed (assumed 5 individuals). Because the analytical results of the study will serve as quantitative inputs to risk assessment exposure models, estimates of the means are appropriate rather than hypothesis tests concerning the mean chemical concentrations. Specifically, the statistical analysis will produce confidence intervals for the mean chemical concentrations in tissue samples for each species for each segment of the river. The confidence interval will be based on the normal distribution (Central Limit Theorem), using the mean of the composite sample and an estimate of the variability based on composite sample theory.	The statistical inference that will be performed on the tissue data will be in the form of a confidence interval for the mean or median within various strata of the river. A confidence interval for the entire 17-mile river will also be calculated; however, performance criteria will be based on the individual stratum level. For mummichogs (*i.e.*, composite samples with assumed normal distribution), two performance criteria are required for the confidence interval: (1) the confidence level for the intervals will be 95%, and (2) the width of the confidence intervals will be ±1.5 standard deviations of the estimated mean chemical concentration. For white perch and American eel (*i.e.*, assuming no composites and log normal data distribution), the statistical inference will be in the form of a confidence interval for the median within various strata of the river. A confidence interval for the entire 17-mile river will also be calculated; however, performance criteria will be based on the individual stratum level. Two performance criteria are required for the confidence interval: (1) the confidence level for the intervals will be 95%, and (2) the width of the confidence intervals will be ±20% of the estimated median chemical concentrations. In the event that samples of these species will need to be	Refer to Section 12.0 "Biological Tissue-Residue Sampling." Per the sample design specified in the fish community survey (Table B1), white perch and American eel (or specified alternatives) samples will be collected from 1 station every 2 miles in the Study Area (total of 8 stations) and at 3 locations within each defined reference area type (*e.g.*, freshwater, estuarine). It is estimated that 10 samples per station will be sufficient to achieve the 20% criterion specified in Step 6. The fish community characterization study will be conducted for 4 quarters and the fish tissue collection period will coincide with the fish collection period in the late summer/early fall quarter. A stratified random sampling design (salinity zone, river segment, intertidal/subtidal) will be used to identify sampling stations for each forage fish sample. Stratification will ensure that sufficient samples are obtained for each individual exposure area including all substantial intertidal mudflat areas. Within each 2-mile sampling station, 6 composite mummichog (or alternative forage fish species) samples (consisting of approximately 5-10 individual fish) will be collected. The number of individuals comprising the composite was selected based

STEP 1 State the Problem	STEP 2 Identify the Goals of the Study	STEP 3 Identify Information Inputs	STEP 4 Define Boundaries of the Study	STEP 5 Develop Analytic Approach	STEP 6 Specify Performance or Acceptance Criteria	STEP 7 Develop the Detailed Plan for Obtaining Data
Conceptual Site Model: The Lower Passaic River is an estuarine system in northern New Jersey. Urban and industrial development around the river has resulted in poor water quality, contaminated sediments, bans on fish and shellfish consumption, lost wetlands, and degraded habitats. The Conceptual Site Model (CSM) for ecological receptors has been developed in the various project documents including the Pathways Analysis Report (PAR) and a technical memorandum (Battelle, 2005, 2006). Malcolm Pirnie, Inc. (2005a) presents the overall CSM for the Study Area including geochemistry and fate and transport components. In combination, these documents summarize the current understanding of spatial extent of contamination, potential sources, environmental media of concern, and ecological (and human health) exposure scenarios. Chemicals of potential ecological concern (COPECs) were identified through a risk-based screening process provided in the PAR and include metals, semivolatile organic compounds (SVOCs), including polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), pesticides, and polychlorinated dibenzodioxins/furans (PCDD/Fs). Many of these compounds are hydrophobic and will tend to accumulate in the sediment medium.	standards, criteria, and benchmarks. • Correlate sediment chemistry with fish tissue residues. • Compare COPEC concentrations in fish tissue with literature-based toxicity threshold residues. • Collect tissue concentrations in fish from background or reference areas and compare with Study Area tissues. • Evaluate the current status of important fish populations and the overall fish community (Assessment Question refer to Table B1).	(estuarine/freshwater species respectively): • White perch/sunfish (bluegill, red-breasted, crappie) • American eel/American eel • Mummichog/various freshwater forage fish (including darters, shiners, killifish, or dace) Fish tissue residues will be compared to appropriate sediment concentrations in order to estimate site-specific Biota Sediment Accumulation Factors (BSAFs). Tissue samples will be collected as part of the fish community study (refer to Table B1) and individual or composite, in the case of the *Fundulus* species, samples prepared and tissue residues quantified. Fish tissue samples will be analyzed using appropriate analytical methods with sufficient analytical sensitivity to meet risk-based screening criteria. The analytical parameter list will include analyses for all types of COPECs identified in the PAR [*e.g.*, metals, SVOCs (including PAHs), pesticides, PCBs (Aroclors and congeners), and PCDD/Fs]; in addition, lipid data will be required. Analytical methods as specified in the revised QAPP. Fish samples will need to be as homogeneous as possible and to the extent possible limited to adult females. If gravid females are caught, then the eggs should also be retained for PCDD/Fs and coplanar PCB analysis. Tissue residues will be compared to available residue effects levels (Jarvinen and Ankley, 1999; ERED database, http://el.erdc.usace.army.mil/ered/index.html). <u>Fish Community Health</u>: Data will be evaluated using separately, or in combination, multimetric or multivariate approaches. Community metrics will include abundance, species richness, successional status, and Shannon-Wiener species diversity (refer to Table B1).	studies conducted by TSI in 1999 and 2000. The selection of the reference area must take into account several factors: • Surface water quality (temperature, salinity, dissolved oxygen, depth, and flow) • Sediment attributes (texture, concentrations of naturally occurring contaminants) • Habitat structure (river bottom structure, vertical stratification, river-side cover type, and percent vegetation cover) • Biological components (species present, general trophic structure) • Land use development and degree of urbanization		composited to achieve adequate sample mass, the likelihood of achieving the specified performance criteria will be enhanced.	on analytical mass requirements rather than statistical theory. Review of available mummichog data for the brackish portion of the Study Area indicates that there is little benefit in terms of reducing the confidence interval width associated with increasing the number of samples beyond 5 per exposure unit. Sample locations coincide with the proposed composite surficial sediment sampling and macroinvertebrate toxicity testing (see Table B5). Finally, in order to estimate fish embryo exposures to dioxin-like contaminants, 10 pairs of composite maternal tissue and egg samples will also be collected during the spring sampling period (pre-spawn) in randomly selected intertidal sampling locations within the estuarine zone and analyzed for PCDD/Fs and lipid percent. These data will be used to estimate biotransfer factors (BTFs) that will then be applied to other whole body tissue residue results in the BERA.

Battelle, 2006. “Conceptual Site Model Technical Memorandum.” Lower Passaic River Restoration Project.

Battelle, 2005. “Pathways Analysis Report.” Lower Passaic River Restoration Project. Prepared under contract to Malcolm Pirnie, Inc. July 2005.

Jarvinen and Ankley, 1999. “Linkage of Effects to Tissue Residues: Development of a Comprehensive Database for Aquatic Organisms Exposed to Inorganic and Organic Chemicals.” Society of Environmental Toxicology and Chemistry.

Malcolm Pirnie, Inc., 2005a. “Work Plan.” Lower Passaic River Restoration Project. Prepared in conjunction with Battelle and HydroQual, Inc. August 2005.

Malcolm Pirnie, Inc., 2005b. “Quality Assurance Project Plan” Lower Passaic River Restoration Project. Prepared in conjunction with Battelle and Hydroqual, Inc. August 2005.

USEPA, 2006. “Guidance on Systematic Planning Using the Data Quality Objectives Process.” EPA QA/G-4. Office of Environmental Information, Washington, D.C. EPA/240/B-06/0001.

USEPA, 1992. “Framework for Ecological Risk Assessment.” US Environmental Protection Agency, Risk Assessment Forum, Washington, DC, EPA/630/R-92/001.

Table B3. Data Quality Objectives for Human Health Risk Assessment of Ingestion of Biota (Tissue Residue Sampling)

STEP 1 State the Problem	STEP 2 Identify the Goals of the Study	STEP 3 Identify Information Inputs	STEP 4 Define Boundaries of the Study	STEP 5 Develop Analytic Approach	STEP 6 Specify Performance or Acceptance Criteria	STEP 7 Develop the Detailed Plan for Obtaining Data
Problem: Consumption of biota (fish and crab) is a primary exposure pathway for the angler/sportsman and the homeless resident. It is unclear whether concentrations of chemicals of potential concern (COPCs) in biota tissue pose an unacceptable risk to human receptors. **Planning Team**: U.S. Environmental Protection Agency (USEPA), U.S. Army Corps of Engineers (USACE), New Jersey Department of Transportation – Office of Maritime Resources (NJDOT-OMR), National Oceanic and Atmospheric Administration (NOAA), U.S. Fish and Wildlife Service (USFWS), New Jersey Department of Environmental Protection (NJDEP), local workgroups, and other stakeholders. **Primary Decision Maker**: USEPA is the lead agency for the CERCLA investigation; however, decision-making will rely on inputs from all team members. **Conceptual Site Model:** The Lower Passaic River is an estuarine system in northern New Jersey. Urban and industrial development around the river has resulted in poor water quality, contaminated sediments, bans on fish and shellfish consumption, lost wetlands, and degraded habitats. The Conceptual Site Model (CSM) for human receptors has been developed in the various project documents including the	**Primary Question**: Do COPCs in biota (fish and crab) pose an unacceptable current or future risk to the angler/sportsman and the homeless resident receptors? To adequately answer this question, intake must be estimated for each of the potentially exposed populations. To best understand the conclusions of the risk assessment, these dose estimates must be estimated with an acceptable level of uncertainty (USEPA, 2006). **Alternative Actions**: If COPCs do not pose an unacceptable risk, then no action is required. If COPCs do pose an unacceptable risk then further site evaluation is required or remedial alternatives have to be identified. **Decision Statement**: Determine whether consumption of biota poses an unacceptable risk that requires further data evaluation and remedial action of the sediment within the Lower Passaic River.	**Information Required**: Information necessary to answer the principal study question will include existing, and to be collected data, related to sediment and surface water chemistry, and fish tissue concentrations (Sampling requirements for surface water and sediment will be specified in the revised FSP Volume 1). The following information inputs are necessary to answer the stated problem: • Historical tissue-residue data from USEPA appropriate for use in risk assessment. • Laboratory analysis of additional tissue-residue samples collected during RI/FS and analyzed using appropriate analytical methods with sufficient analytical sensitivity to meet risk-based screening criteria. Fish and shellfish samples will be analyzed using the most appropriate (based on consideration of risk-based effect thresholds) analytical methods as specified in the revised QAPP. The analytical parameter list will include analyses for COPCs identified in the PAR [*e.g.*, certain metals, SVOCs (including PAHs), PCBs, pesticides, 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD), and other compounds with similar mode of action (other PCDD/Fs and co-planar PCB congeners)]. • Only validated and defensible data will be used in the risk assessment. Determination of which data to use and whether to combine historical and recent data will be made based on a thorough review of all the data [*i.e.*, Data Usability Evaluation (USEPA, 1992)]. • Other inputs and assumptions required to calculate risks for the receptors include: exposure assumptions for each receptor, and exposure point concentrations and toxicity data for all COPCs. The methodology that will be used to conduct the risk assessment has been provided in the PAR (Battelle, 2005).	**Geographical Area**: The Study Area comprises the Lower Passaic River (excluding floodplains) from the Dundee Dam in the north to the River confluence with Newark Bay to the south. Based on the CSM (Malcolm Pirnie, Inc., 2005), the Study Area will be divided into the following three sections based on available data: • Brackish – River Miles (RM) 0 to ~6 • Transitional – RM ~6 to ~9 • Freshwater – RM ~9 to dam Fish species that occur in estuarine habitat are characterized by relatively low species diversity and broad salinity tolerances. The Study Area will be segregated into a brackish water habitat (Brackish River Section) and a freshwater habitat (Freshwater River Section). Existing salinity and biological data suggest that the Transition River Section is generally located somewhere between RM 6-9 although bathymetric information will need to be considered as well (*i.e.*, salt wedge). Sediment sampling will be limited to the biologically active zone (BAZ), which is most relevant for understanding the relationship between sediment and fish tissue. The selection of reference areas has not yet been completed. Estuarine and freshwater portions of the Mullica River were used during previous tissue-residue studies conducted by TSI in 1999	**Appropriate Population Parameters**: The parameter of interest in this portion of the study will be the 95% UCL on either the arithmetic mean or median (depending on whether sample compositing is necessary) chemical concentration of each fish species. Tissue concentrations are expected to vary along the river, so the river will be divided into several segments (based on the salinity gradient and degree of tidal submergence). The statistical analysis will be concerned with each segment, separately. Because the analytical results of the study will serve as quantitative inputs to risk assessment exposure models, estimates of the means are appropriate rather than hypothesis tests concerning the mean chemical concentrations. Specifically, the statistical analysis will produce confidence intervals for the mean chemical concentrations in tissue samples for each species for each segment of the river. The confidence interval will be based on the normal distribution (Central Limit Theorem), using the mean of the composite sample and an estimate of the variability based on composite sample theory. Risk for consumption of biota [incremental lifetime cancer risk (ILCR) and hazard indices] will be determined in accordance with USEPA Risk Assessment Guidance for Superfund (RAGS) and associated USEPA guidelines and supplemental guidance. (Chemical specific ILCRs will be determined.) The results of the baseline risk assessment (BRA) will be used to determine the alternative actions for the site. **IF** the calculated ILCR is less than 1×10^{-6} and the calculated hazard indices are less than 1.0, **THEN** it will be concluded that site conditions are	For the specified species (*i.e.*, assuming no composites and log normal data distribution), the statistical inference will be in the form of a confidence interval for the median within various strata of the river. A confidence interval for the entire 17-mile river will also be calculated; however, performance criteria will be based on the individual stratum level. Two performance criteria are required for the confidence interval: (1) the confidence level for the intervals will be 95%, and (2) the width of the confidence intervals will be ±20% of the estimated median chemical concentrations. In the event that samples of these species will need to be composited to achieve adequate sample mass, the likelihood of achieving the specified performance criteria will be enhanced. It is possible that contaminants are present at locations within the Study Area that are not sampled yielding false negative results and possibly leading to incorrect conclusions about COPC and/or COPC concentrations. The sampling design should be designed to minimize the chance of false negatives by using the best available knowledge of the site (*i.e.*, historical data) to focus the sampling collection effort. Risk assessment incorporates many uncertainties which typically are mitigated to a degree through the incorporation of conservative assumptions in exposure parameters used to calculate risk. Therefore, risk estimated from dose modeling may be overestimated and there is a potential for false positives. This uncertainty will be addressed through an analysis of uncertainty in the BRA. Historical data meeting the following criteria were used in the statistical estimation process: • Sampling date • Analytical method (detection levels sufficiently low to meet risk assessment needs)	Refer to Section 12.0 "Biological Tissue-Residue Sampling." The number of biota samples to be collected was determined using statistical estimation based on the mean chemical concentration of historical fish tissue residue data. Because the results of the study are expected to be inputs to risk assessment models, estimates of the means are appropriate rather than hypothesis tests concerning the mean chemical concentrations. Tissue concentrations were expected to vary along the river. Per the sample design specified in the fish community study (Table B1), white perch and American eel samples will be collected from 1 station every 2 miles in the study area (total of 8 stations) and at 3 locations within each defined reference area type (*e.g.*, freshwater, estuarine). It is estimated that 10 samples per stations will be sufficient to achieve the 20% performance criterion specified in Step 6. The fish community characterization study will be conducted for 4 quarters and the fish tissue collection period will coincide with the late summer/early fall quarter per USEPA guidance. Similarly, for crabs, 10 samples are required for every 2-mile length of the river and at 3 locations within each defined reference area. Samples will be collected during the Benthic Invertebrate Community

STEP 1 State the Problem	STEP 2 Identify the Goals of the Study	STEP 3 Identify Information Inputs	STEP 4 Define Boundaries of the Study	STEP 5 Develop Analytic Approach	STEP 6 Specify Performance or Acceptance Criteria	STEP 7 Develop the Detailed Plan for Obtaining Data
Pathways Analysis Report (PAR) and a technical memorandum (Battelle, 2005, 2006). Malcolm Pirnie, Inc. (2005) presents the overall CSM for the Study Area including geochemistry and fate and transport components. In combination, these documents summarize the current understanding of spatial extent of contamination, potential sources, environmental media of concern, and human health exposure scenarios. COPCs were identified through a risk-based screening process provided in the PAR and include metals, semivolatile organic compounds (SVOCs), including polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), pesticides, and polychlorinated dibenzodioxins/furans (PCDD/Fs). Many of these compounds are hydrophobic and will tend to accumulate in either the sediment or biological tissue media.		Target species were selected based on the relative abundance and propensity to be caught and consumed. To the extent possible, fish and shellfish analytical samples should be based on the type of species that are routinely caught from the Lower Passaic River and the analytical results based on typical preparation techniques (*e.g.*, fillet rather than whole body samples) used by these receptors. Other things being equal, resident species are favored over transient species whose tissue residues may be only loosely linked to sediment chemistry. These selected species are: • American eel (*Anguilla rostrata*) • White Perch (*Morone americana*) • Blue crab (*Callinectes sapidus*) Samples should meet applicable size and length catch limits. Also, fish lipids (and sediment TOC) data will also be required in order to develop BSAFs (Biota Sediment Accumulation Factors) necessary to derived Preliminary Remediation Goals (PRGs).	and 2000. The selection of the reference area must take into account several factors: • Surface water quality (temperature, salinity, dissolved oxygen, depth, and flow) • Sediment attributes (texture, concentrations of naturally occurring contaminants) • Habitat structure (river bottom structure, vertical stratification, river-side cover type, and percent vegetation cover) • Biological components (species present, general trophic structure) • Land use development and degree of urbanization	protective of the receptors/scenarios evaluated and no remediation is required. **IF** the calculated ILCR is greater than 1 × 10^{-6}, but less than 1 × 10^{-4} (*i.e.*, within the USEPA risk management range) and/or a segregated HI is greater than 1, **THEN** a site-specific recommendation will be developed regarding the need for further site evaluation or remedial action (*e.g.*, additional site investigation, remediation, evaluation of potential remedies in the Feasibility Study). **IF** the calculated ILCR is greater than 1 × 10^{-4} or a segregated HI is greater than 1, **THEN** it will be concluded that action (*e.g.*, remediation) is required for the site. This conclusion may be overturned if additional lines of evidence indicate that the calculated risks are overestimated. The measured concentrations in the tissue, not the model results, will be used for the development of the EPC. PRO-UCL software will be used to calculate the EPC. The nature of field investigations lends itself to uncertainties. Because these data are being collected on a judgmental basis, not all uncertainties can be quantified. However, potential errors that may be encountered in the field can be mitigated through the use of established sampling procedures. In addition, to ensure usability of laboratory data, appropriate analytical methods have been selected to provide detection limits allowing for comparison of site-specific data to relevant and appropriate risk-based reference levels. It is possible, due to constraints beyond the control of the laboratory or field staff that appropriate detection limits may not be achieved.	• Species • Sample preparation criteria	Survey which will be conducted for 4 quarters and the crab collection period will coincide with the fish collection period in the late summer/early fall quarter. Because the highest level of bioaccumulating compounds in crab tissue are likely to be found in the hepatopancreas, one additional sample will be collected from each 2-mile sampling station and subdivided into a hepatopancreas tissue and other edible tissue (*i.e.*, thoracic, claw, leg, and tail meat) for a total of 16 additional separate analysis. Tissue samples will be analyzed using appropriate analytical methods identified in the revised QAPP. Fish samples will need to be as homogeneous as possible.

Battelle, 2006. “Conceptual Site Model Technical Memorandum.” Lower Passaic River Restoration Project.

Battelle, 2005. “Pathways Analysis Report.” Lower Passaic River Restoration Project. Prepared under contract to Malcolm Pirnie, Inc. July 2005.

Malcolm Pirnie, Inc., 2005. “Work Plan.” Lower Passaic River Restoration Project. Prepared in conjunction with Battelle and HydroQual, Inc. August 2005.

USEPA, 1992. “Framework for Ecological Risk Assessment.” US Environmental Protection Agency, Risk Assessment Forum, Washington, DC, EPA/630/R-92/001.

Table B4. Data Quality Objectives for Ecological Risk Assessment of Ingestion of Biota (Tissue Residue Sampling)

STEP 1 State the Problem	STEP 2 Identify the Goals of the Study	STEP 3 Identify Information Inputs	STEP 4 Define Boundaries of the Study	STEP 5 Develop Analytic Approach	STEP 6 Specify Performance or Acceptance Criteria	STEP 7 Develop the Detailed Plan for Obtaining Data
Problem: Consumption of biota (fish and crab) is a primary exposure pathway for certain categories of ecological wildlife receptors. It is unclear whether concentrations of chemicals of potential ecological concern (COPECs) in biota tissue pose an unacceptable risk to wildlife that may live or routinely forage in the Lower Passaic River. **Planning Team**: U.S. Environmental Protection Agency (USEPA), U.S. Army Corps of Engineers (USACE), New Jersey Department of Transportation – Office of Maritime Resources (NJDOT-OMR), National Oceanic and Atmospheric Administration (NOAA), U.S. Fish and Wildlife Service (USFWS), New Jersey Department of Environmental Protection (NJDEP), local workgroups, and other stakeholders. **Primary Decision Maker**: USEPA is the lead agency for the CERCLA investigation; however, decision-making will rely on inputs from all team members. **Conceptual Site Model**: The Lower Passaic River is an estuarine system in northern New Jersey. Urban and industrial development around the river has resulted in poor water quality, contaminated sediments, bans on fish and shellfish consumption, lost wetlands, and degraded habitats. The Conceptual Site Model (CSM) for ecological receptors has been developed in the various	**Primary Question**: Do COPECs in biota (fish and crab) pose an unacceptable current or future risk to piscivorous and omnivorous wildlife receptors that forage in the Lower Passaic River? To adequately answer this question, both decision and estimation elements (USEPA, 2006) will need to be addressed. **Alternative Actions**: If COPECs do not pose an unacceptable risk, then no action is required. If COPECs do pose an unacceptable risk then further site evaluation is required or remedial alternatives have to be identified. **Decision Statement**: Determine whether consumption of biota poses an unacceptable risk to fish-feeding ecological receptors that requires further data evaluation and remedial action of the sediment within the Lower Passaic River.	**Information Required**: Information necessary to answer the principal study question will include existing, and to be collected data, related to sediment and surface water chemistry, and fish and shellfish tissue residues. The following information inputs are necessary to answer the stated problem: • Historical tissue-residue data from USEPA appropriate for use in risk assessment. • Laboratory analysis of additional tissue-residue samples collected during RI/FS and analyzed using appropriate analytical methods with sufficient analytical sensitivity to meet risk-based screening criteria. Fish and shellfish samples will be analyzed using the most appropriate (based on consideration of risk-based effect thresholds) analytical methods as specified in the revised QAPP. The analytical parameter list will include analyses for bioaccumulating COPECs identified in the PAR [*e.g.*, certain metals, SVOCs (including PAHs), PCBs, pesticides, 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD), and other compounds with similar mode of action (other PCDD/Fs and co-planar PCB congeners)]. • Only validated and defensible data will be used in the risk assessment. Determination of which data to use and whether to combine historical and recent data will be made based on a thorough review of all the data [*i.e.*, Data Usability Evaluation (USEPA, 1992)]. • Other inputs and assumptions required to calculate risks for the receptors include: exposure assumptions for each receptor, and exposure point concentrations and toxicity data for all COPECs. The methodology that will be used to conduct the risk assessment has been provided in the PAR (Battelle, 2005). Target species were selected based on the	**Geographical Area**: The Study Area comprises the Lower Passaic River (excluding floodplains) from the Dundee Dam in the north to the River confluence with Newark Bay to the south. Based on the CSM (Malcolm Pirnie, Inc., 2005), the Study Area will be divided into the following three sections based on available data: • Brackish – River Miles (RM) 0 to ~6 • Transitional – RM ~6 to ~9 • Freshwater – RM ~9 to dam Fish species that occur in estuarine habitat are characterized by relatively low species diversity and broad salinity tolerances. For the purposes of the HHRA, the Study Area will be segregated into a brackish water habitat (Brackish River Section) and a freshwater habitat (Freshwater River Section). Existing salinity and biological data suggest that the Transition River Section is generally located somewhere between RM 6-9 although bathymetric information will need to be considered as well (*i.e.*, salt wedge). Sediment sampling will be limited to the biologically active zone (BAZ), which is most relevant for understanding the relationship between sediment and fish tissue. The selection of reference areas has not yet been completed but will be necessary to estimate incremental risk to wildlife receptors. Estuarine and	**Appropriate Population Parameters**: The parameter of interest in this portion of the study will be the 95% UCL on either the arithmetic mean or median (depending on whether sample compositing is necessary) chemical concentration of each fish species. Tissue concentrations are expected to vary along the river, so the river will be divided into several segments (based on the salinity gradient and degree of tidal submergence). The statistical analysis will be concerned with each segment, separately. Because the analytical results of the study will serve as quantitative inputs to risk assessment exposure models, estimates of the means are appropriate rather than hypothesis tests concerning the mean chemical concentrations. Specifically, the statistical analysis will produce confidence intervals for the mean chemical concentrations in tissue samples for each species for each segment of the river. The confidence interval will be based on the normal distribution (Central Limit Theorem), using the mean of the composite sample and an estimate of the variability based on composite sample theory. Risk to piscivorous and omnivorous wildlife receptors associated with consumption of aquatic biota (hazard indices) will be determined in accordance with USEPA Ecological Risk Assessment Guidance for Superfund (ERAGS) and associated USEPA guidelines and supplemental guidance. The results of the baseline ecological risk assessment (BERA) will be used to determine the alternative actions for the site. **IF** the calculated hazard indices hazard indices are less than 1.0, **THEN** it will be concluded that site conditions are protective of the receptors/scenarios	The statistical inference that will be performed on the tissue data will be in the form of a confidence interval for the mean or median within various strata of the river. A confidence interval for the entire 17-mile river will also be calculated; however, performance criteria will be based on the individual stratum level. For mummichog/forage fish (*i.e.*, composite samples with assumed normal distribution), two performance criteria are required for the confidence interval: (1) the confidence level for the intervals will be 95%, and (2) the width of the confidence intervals will be ±1.5 standard deviations of the estimated mean chemical concentration. For white perch, American eel, and blue crab (*i.e.*, composites may not be required, assumed log normal distribution), the statistical inference that will be performed on the tissue data will be in the form of a confidence interval for the median within various strata of the river. A confidence interval for the entire 17-mile river will also be calculated; however, performance criteria will be based on the individual stratum level. Two performance criteria are required for the confidence interval: (1) the confidence level for the intervals will be 95%, and (2) the width of the confidence intervals will be ±20% of the estimated median chemical concentrations.	Refer to Section 12.0 "Biological Tissue-Residue Sampling." The number of biota samples to be collected was determined using statistical estimation based on the mean chemical concentration of historical fish tissue residue data. Because the results of the study are expected to be inputs to risk assessment models, estimates of the means are appropriate rather than hypothesis tests concerning the mean chemical concentrations. Tissue concentrations were expected to vary along the river. Per the sample design specified in the fish community survey (Table B1), white perch and American eel (or specified alternatives) samples will be collected from 1 station every 2 miles in the study area (total of 8 stations) and at 3 locations within each defined reference area type (*e.g.*, freshwater, estuarine). It is estimated that 10 samples per station unit will be sufficient to achieve the 20% performance criterion specified in Step 6. The fish community characterization study will be conducted for 4 quarters and the fish tissue collection period will coincide with the late summer/early fall quarter per USEPA guidance. Similarly, for crabs, 10 soft body samples are required for every 2-mile station and at 3 locations within each defined reference area. Samples will be collected during the Benthic

STEP 1 State the Problem	STEP 2 Identify the Goals of the Study	STEP 3 Identify Information Inputs	STEP 4 Define Boundaries of the Study	STEP 5 Develop Analytic Approach	STEP 6 Specify Performance or Acceptance Criteria	STEP 7 Develop the Detailed Plan for Obtaining Data
project documents including the Pathways Analysis Report (PAR) and a technical memorandum (Battelle, 2005, 2006). Malcolm Pirnie, Inc. (2005) presents the overall CSM for the Study Area including geochemistry and fate and transport components. In combination, these documents summarize the current understanding of spatial extent of contamination, potential sources, environmental media of concern, and ecological (and human health) exposure scenarios. COPECs were identified through a risk-based screening process provided in the PAR and include metals, semivolatile organic compounds (SVOCs), including polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), pesticides, and polychlorinated dibenzodioxins/furans (PCDD/Fs). Many of these compounds are hydrophobic and will tend to accumulate in the sediment and biological tissue media.		relative abundance and importance in the aquatic food web. Other things being equal, resident species are favored over transient species whose tissue residues may be only loosely linked to sediment chemistry. These selected species are: • American eel (*Anguilla rostrata*) • White Perch (*Morone americana*) • Blue crab (*Callinectes sapidus*) • Mummichog (*Fundulus heteroclitus)* Samples should meet target size and length specifications (see Table 12-4) in order to provide conservative exposure estimates to wildlife receptors as well as to provide data relevant to different type of wildlife receptors (*e.g.*, forage fish – Kingfisher; white perch – cormorant). Also, fish lipids (and sediment TOC) data will also be required in order to develop BSAFs (Biota Sediment Accumulation Factors) necessary to derived Preliminary Remediation Goals (PRGs). Fish samples will need to be as homogeneous as possible and to the extent possible limited to adult females. If gravid females are caught, then the eggs should also be retained for PCDD/Fs and coplanar PCB analysis.	freshwater portions of the Mullica River were used during previous tissue-residue studies conducted by TSI in 1999 and 2000. The selection of the reference area must take into account several factors: • Surface water quality (temperature, salinity, dissolved oxygen, depth, and flow) • Sediment attributes (texture, concentrations of naturally occurring contaminants) • Habitat structure (river bottom structure, vertical stratification, river-side cover type, and percent vegetation cover) • Biological components (species present, general trophic structure) • Land use development and degree of urbanization	evaluated and no remediation is required. **IF** the calculated HI is greater than 1 but less than 10, **THEN** a site-specific recommendation will be developed regarding the need for further site evaluation or remedial action (*e.g.*, additional site investigation, remediation, evaluation of potential remedies in the Feasibility Study). **IF** the calculated HI is greater than 10, **THEN** it will be concluded that action (*e.g.*, remediation) is required for the site. This conclusion may be overturned if additional lines of evidence indicate that the calculated risks are overestimated.		Invertebrate Community Survey which will be conducted for 4 quarters and the crab collection period will coincide with the fish collection period in the late summer/early fall quarter. A stratified random sampling design (salinity zone, river segment, intertidal/subtidal) will be used to identify sampling stations for each forage fish sample. Stratification will ensure that sufficient samples are obtained for each individual exposure area including all substantial intertidal mudflat areas. Within each sampling unit, 6 composite mummichog (or alternative forage fish species) samples (consisting of approximately 5-10 individual fish) will be collected. The number of individuals comprising the composite was selected based on analytical mass requirements rather than statistical theory. Review of available mummichog data for the estuarine portion of the study area indicates that there is little benefit in terms of reducing the confidence interval width associated with increasing the number of samples beyond 5 per exposure unit. Sample locations coincide with the proposed composite surficial sediment sampling and macroinvertebrate toxicity testing (see Table B5). Tissue samples will be analyzed using appropriate analytical methods identified in the revised QAPP.

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Battelle, 2005. “Pathways Analysis Report.” Lower Passaic River Restoration Project. Prepared under contract to Malcolm Pirnie, Inc. July 2005.

Malcolm Pirnie, Inc., 2005a. “Work Plan.” Lower Passaic River Restoration Project. Prepared in conjunction with Battelle and HydroQual, Inc. August 2005.

USEPA, 2006. “Guidance on Systematic Planning Using the Data Quality Objectives Process.” EPA QA/G-4. Office of Environmental Information, Washington, D.C. EPA/240/B-06/0001.

USEPA, 1992. “Framework for Ecological Risk Assessment.” US Environmental Protection Agency, Risk Assessment Forum, Washington, DC, EPA/630/R-92/001.

Table B5. Data Quality Objectives for Ecological Risk Assessment of Benthic Invertebrates (Toxicity Testing)

STEP 1 State the Problem	STEP 2 Identify the Goals of the Study	STEP 3 Identify Information Inputs	STEP 4 Define Boundaries of the Study	STEP 5 Develop Analytic Approach	STEP 6 Specify Performance or Acceptance Criteria	STEP 7 Develop the Detailed Plan for Obtaining Data
Problem: Historical and ongoing activities have adversely affected the health of the Lower Passaic River, particularly sediment quality. As a biological resource that is in direct contact with sediment, the benthic invertebrate community has also been affected by various stressor agents related to historical contaminant releases to the river as well as general urbanization within the watershed. Benthic invertebrates serve an important function in the aquatic food web and it is necessary to understand the potential risks experienced by this ecological component to determine whether a remedial action is warranted. **Planning Team**: U.S. Environmental Protection Agency (USEPA), U.S. Army Corps of Engineers (USACE), New Jersey Department of Transportation – Office of Maritime Resources (NJDOT-OMR), National Oceanic and Atmospheric Administration (NOAA), U.S. Fish and Wildlife Service (USFWS), New Jersey Department of Environmental Protection (NJDEP), local workgroups, and other stakeholders. **Primary Decision Maker**: USEPA is the lead agency for the CERCLA investigation; however, decision-making will rely on inputs from all team members. **Conceptual Site Model**: The Lower Passaic River is an estuarine system in northern New Jersey. Urban and industrial development around the river has resulted in poor water quality, contaminated sediments, bans on fish and shellfish consumption, lost wetlands, and degraded habitats.	**Principal Question**: Are exposures to site-related chemical stressors throughout the Lower Passaic River posing an unacceptable risk to the benthic invertebrate community? To adequately answer this question, both decision and estimation elements (USEPA, 2006) will need to be addressed. **Secondary Questions**: • How will historical data (sediment chemistry, toxicity, and benthic invertebrate community composition) be used to support the current assessment and sampling design? • How will other stressors be differentiated from site-related chemical stressors? **Alternative Actions**: • Consider remedial options if degree of impact to the benthic macroinvertebrate is determined to be substantial. • Document conditions that support a no further action if no substantial impact is identified. **Decision Statements**: • Compare functional elements of the macroinvertebrate community to appropriate reference	**Information Required:** Information necessary to answer the study questions will include existing, and to be collected data, related to sediment chemistry, sediment toxicity, and benthic invertebrate community composition [*i.e.*, a Sediment Triad Approach, involving Multiple Lines of Evidence (MLOE)]. <u>Sediment Chemistry</u>. Analytical results will be compared to appropriate sediment benchmarks to provide a measure of effect; the degree of relationship between contaminant concentration and response (community metrics, laboratory toxicity) will be quantified. Separate DQOs for sediment and porewater chemistry will be provided in the revised FSP Volume 1 document. Sediment and porewater samples will be analyzed using the most appropriate (based on consideration of risk-based effect thresholds) analytical methods as specified in the QAPP (Malcolm Pirnie, Inc., 2005b). The analytical parameter list will include analyses for all types of COPECs identified in the PAR [*e.g.*, metals, VOCs, SVOCs (including PAHs), PCBs, pesticides, and PCDD/Fs]. However, benthic macroinvertebrate community constituents are not believed to be sensitive to 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) or other compounds with similar mode of action (other PCDD/Fs and co-planar PCB congeners), so analysis of these parameters will only be required to address bioaccumulation modeling needs (*i.e.*, as identified by HydroQual). At the commencement of the risk assessment, all extant site data will be evaluated for usability in the Baseline Ecological Risk Assessment [BERA; USEPA (1992)] and a subset identified for use in the this assessment. <u>Whole Sediment Bioassays</u> will be conducted using Lower Passaic River and appropriate reference sediment samples. In addition, chronic survival, growth, and	**Geographical Area**: The Study Area comprises the Lower Passaic River (excluding floodplains) from the Dundee Dam in the north to the River confluence with Newark Bay to the south. Based on the CSM (Malcolm Pirnie, Inc., 2005), the Study Area will be divided into the following three sections based on available data: • Brackish – RM 0 to ~6 • Transitional – RM ~6 to ~9 • Freshwater – RM ~9 to dam Benthic invertebrates that occur in brackish habitat are characterized by relatively low species diversity and broad salinity tolerances. For the purposes of the BERA, the Study Area will be segregated into a brackish water habitat (Brackish River Section) and a freshwater habitat (Freshwater River Section). Existing salinity and biological data suggest that the Transition River Section is generally located somewhere between RM 6-9 although bathymetric information will need to be considered as well (*i.e.*, salt wedge). Sediment samples for the bioassays will be based on the Sediment Profile Imaging (SPI) Survey, conducted in theLower Passaic River by Aqua Survey (2005) and the Biologically Active Zone (BAZ) Report (TSI, 2005) for Newark Bay. The latter report indicates that the top 10-20 cm (4-8 inches) of sediment encompass the majority of the BAZ. Sediment sampling will be limited to the defined BAZ at each sampling location. The selection of reference areas	Sediment Triad Components include sediment chemistry, benthic community analysis, and laboratory toxicity testing. (Specific DQOs for sediment chemistry will be developed and the revised FSP Volume 1, as necessary.) The benthic community assessment component is a restoration activity; risk assessment data quality needs for this Study will be integrated with the DQOs developed under CERCLA. Three different bioassay protocols have been selected to adequately address exposures in the Freshwater and Brackish River Sections of the Study Area. The three test include: • *Leptocheirus plumulosus* 28-day test for survival, growth, and reproduction. • *Hyalella azteca* 42-day test for survival, growth, and reproduction. • *Chironomus dilutus* 20-day test for survival and growth. **Bioassay Decision Rules:** For comparison to laboratory controls, the null and alternative hypotheses may be written for each sediment sample and for the laboratory control sample as: H_o: $\mu_{PRi} < \mu_{Lab}$ H_a: $\mu_{PRi} \geq \mu_{Lab}$ where μ_{PRi} is the biological response (survival, growth, or reproduction) as determined in the bioassay following exposure to the ith Passaic River sample and p_{Lab} is the biological response following exposure to reference area or laboratory (negative) control sediment. The resulting data will be tested for normality and homeoscedasticity (*i.e.*, equality of variances); data transformations applied as appropriate, and statistically tested using either parametric or non-parametric techniques. Where toxicity comparisons to the laboratory control indicate a decreased biological response in the Lower Passaic River sample, the same statistical comparison to the reference area results shall be made. For areas where unacceptable toxicity is found, the correlation between biological response and COPEC concentrations will be evaluated to identify potential concentration-response relationships. Biological response data from laboratory bioassays conducted using sediments from the Lower Passaic River will be interpreted	**Performance Criteria**: The comparison between the mean Lower Passaic River sample locations results will be compared to the mean laboratory control results and laboratory controls. If the p-value from a comparison is less than or equal to 0.1 (α; or other selected Type I error rate), then reject the null hypothesis and conclude that the biological response in the Lower Passaic River sample is less than the laboratory control. If the p-value from the comparison is greater than 0.1, then fail to reject that null hypothesis and conclude that the biological response is not less than the laboratory control. Where toxicity comparisons to the laboratory control indicate a decreased biological response in the Lower Passaic River sample, the same statistical comparison to the reference area results shall be made. For the laboratory bioassay test specific performance criteria are identified in the USEPA Method. These criteria are summarized by test method: ***Leptocheirus plumulosus* 28-day test for survival, growth, and reproduction:** • Laboratory controls > 80% survival. • Measurable growth and reproduction in all control replicates. • Reference Toxicity Test: 90% mean survival and ± 2 SD of the historical mean. • Method performance criteria listed in USEPA (2001) listed for conduct of the test, culturing of test organisms, and additional requirements. ***Hyalella azteca* 42-day test for survival, growth, and reproduction:** • Laboratory controls > 80% survival. • Measurable growth in all control replicates. • Reference Toxicity Test: 90% mean survival and ± 2 SD of the historical mean. • Method performance criteria listed in ASTM (2005) listed for conduct of the test, culturing of test organisms, and additional	Refer to Section 13.0 "Toxicity Testing." A stratified random sampling design will be used with test sediments being comprised of composites collected from within a sampling grid. It will be assumed that the two strata, intertidal and subtidal areas, are of equal ecological significance in supporting the fishery and benthivorous bird populations in the Brackish River Section. As noted previously, there are no toxicity data available for the Freshwater River Section (and only limited data for subtidal portions in the Brackish River Section). Statistical analysis based on the variability of sediment indicator COPECs of concern for this endpoint (*i.e.*, lead, mercury, silver, zinc, LMW-PAHs and HMW PAHs, BEHP, total DDT, and dieldrin) indicated a sample size of n=6 is appropriate for each segment of the river. Statistical analysis were conducted using estimates of mean and variance calculated from laboratory bioassay results published as part of the *L. plumulosus* bioassay protocol by USEPA (2001) to assess the appropriate number of replicates necessary to account for variability in the measurement endpoint. The greatest variability was associated with the reproductive endpoint. The analysis indicated that a replicate size of n=10 is required to meet the DQO specifications. This analysis is based on a α=0.10 (Type I false rejection decision error rate), β=0.20 (Type II false acceptance decision error rate), and Δ= 30% (width of gray region). The mean number of offspring = 7.09 and the variance = 4.769. Similar analyses will be completed for the *H. azteca* and *C. dilutus* to determine an appropriate number of replicates.

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The Conceptual Site Model (CSM) for ecological receptors has been developed in the various project documents including the Pathways Analysis Report (PAR) and a technical memorandum (Battelle, 2005, 2006). Malcolm Pirnie, Inc. (2005a) presents the overall CSM for the Study Area, including geochemistry and fate and transport components. In combination, these documents summarize the current understanding of spatial extent of contamination, potential sources, environmental media of concern, and ecological (and human health) exposure scenarios. Chemicals of potential ecological concern (COPECs) were identified through a risk-based screening process provided in the PAR and include metals, semivolatile organic compounds (SVOCs), including polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), pesticides, and polychlorinated dibenzodioxins/furans (PCDD/Fs). Many of these compounds are hydrophobic and will tend to accumulate in the sediment medium where benthic invertebrates will be exposed.	areas. • Correlate sediment chemistry correlate with the measure of macroinvertebrate toxicity. **Estimation Statements:** • Evaluate the spatial extent and variability of COPECs in surface sediment. • Evaluate the current status of the benthic community.	reproduction endpoints will be evaluated. Relevant toxicity test data for the Lower Passaic River are limited to several studies conducted by TSI (2002, 2004a, 2004b); these studies were limited to intertidal areas within river mile (RM) 1-7. TSI evaluated toxicity to an amphipod (*Ampelisca abdita*) and a polychaete (*Neanthes arenaceodentata*). The selection of specific bioassay protocols will depend upon a variety of factors including: • Biological linkage to study question and applicability of surrogate species • Species sensitivity to primary chemical stressors • Lifestyle and micro exposure considerations • Habitat conditions (*e.g.*, salinity regime, sediment substrate) Based on a review of these factors, the following species were selected: the amphipod *Hyalella azteca*, the midge *Chironomus dilutus* for freshwater; the amphipod *Leptocheirus plumulosus* for estuarine/brackish water. Previous studies with the polychaete, *Neanthes arenaceodentata*, in the river indicate that this species is not appropriate due to its broad tolerance. This combination of species is necessary to provide information regarding benthic invertebrate community condition in freshwater and brackish portions of the Study Area as well as different lifestyles that could affect degree of exposure and impact (*i.e.*, epibenthic versus benthic). Information on toxicity to these species under chronic exposures in the laboratory conditions is sought as a broader array of test endpoints are available (including growth and reproduction) and better approximate field conditions. <u>Benthic Invertebrate Community</u> data will be evaluated using separately, or in combination, multimetric or multivariate approaches. Community metrics will include abundance, species richness, successional status, Shannon Wiener	has not yet been completed. Estuarine and freshwater portions of the Mullica River were used during previous benthic macroinvertebrate studies conducted by TSI in 1999 and 2000. The selection of the reference area must take into account several factors: • Surface water quality (temperature, salinity, dissolved oxygen, depth, and flow) • Sediment attributes (texture, concentrations of naturally occurring contaminants) • Habitat structure (river bottom structure, vertical stratification, river-side cover type, and percent vegetation cover) • Biological components (species present, general trophic structure) • Land use development and degree of urbanization	using both the laboratory control data and the reference area data. **Integration of Sediment Triad Components:** The integration of the multiple lines of evidence may be done either quantitatively or qualitatively. The Sediment Quality Triad is typically evaluated using a binary response assignation for each leg of the triad; there are interpretive guidelines established for each of the 8 possible combinations of individual outcomes. An evaluation of the relative merits of the quantitative and qualitative approaches will be made as part of the next phase of DQO development. Consideration will also be given to the relative merits of the three triad components in evaluating this assessment endpoint (primary study question). Based on degree of site-specificity and review of previous study results for the study area, it is anticipated that the laboratory toxicity component will be assigned the greatest weight.	requirements. ***Chironomus dilutus* 28-day test for survival and growth:** • Laboratory controls > 70% at day 20 and > 65% at the end of the test. • Minimum average size of *C. dilutus* in the control sediment at 20 days must be at least 0.6 mg/surviving organism dry weight or 0.48 mg/surviving organism as ash-free dry weight (AFDW). • Emergence should > 50%. • Time to death after emergence < 6.5 days for males, and 5.1 days for females. Measurable growth in all control replicates. • Mean number of eggs/egg case > 800 and hatch > 80%. • Method performance criteria listed in ASTM (2005) listed for conduct of the test, culturing of test organisms, and additional requirements. **Acceptance Criteria**: The TSI study results were evaluated with respect to study design, species selection, and spatial and temporal relevance. While a rigorous sampling design was employed, the following limitations were identified: • Biological responses observed in the selected species may underestimate the toxicity of study area sediments to sensitive organisms. • Study limited to intertidal areas within RM 1-7 and no subtidal or freshwater sediments were tested. • Testing occurred in 1999 and 2000 and test results may not accurately characterize current toxicity of the intertidal sediments.	

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		species diversity (refer to Table B1). Although not necessary to answer the principal study question, it may be determined that a Toxicity Identification Evaluation (TIE) is warranted to attempt to distinguish non-chemical from chemical stressors or among classes of site-related compounds. Preliminary data for RM 1-7 have been previously collected and would be used to focus the additional study if determined to be warranted.				

ASTM, 2005. "Standard Test Method for Measuring the Toxicity of Sediment-associated Contaminants with Freshwater Invertebrates." E 1706-05

Battelle, 2006. "Conceptual Site Model Technical Memorandum." Lower Passaic River Restoration Project.

Battelle, 2005. "Pathways Analysis Report." Lower Passaic River Restoration Project. Prepared under contract to Malcolm Pirnie, Inc. July 2005.

Malcolm Pirnie, Inc., 2005. "Work Plan." Lower Passaic River Restoration Project. Prepared in conjunction with Battelle and HydroQual, Inc. August 2005.

TSI 2005. "Biologically Active Zone (BAZ) Report for Newark Bay."

TSI, 2004a. "Amphipods (Ampelisca abdita) and polychaete (Neanthes arenaceodentata) bioassay results." Data collected in 2000 from the lower six miles of the Passaic River.

TSI, 2004b. "Amphipods (Ampelisca abdita) bioassay results." Data collected in 2000 from the lower six miles of the Passaic River.

TSI, 2002. "Amphipod (Ampelisca abdita) and polychaete (Neanthes arenaceodentata) bioassay results." Data collected in 1999 from the lower six miles of the Passaic River.

USEPA, 2006. "Guidance on Systematic Planning Using the Data Quality Objectives Process." EPA QA/G-4. Office of Environmental Information, Washington, D.C. EPA/240/B-06/0001.

USEPA, 2001. "Method for Assessing the Chronic Toxicity of Marine and Estuarine Sediment-associated Contaminants with the Amphipod Leptocheirus plumulosus." EPA 600/R-01/020.

USEPA, 1992. "Framework for Ecological Risk Assessment." US Environmental Protection Agency, Risk Assessment Forum, Washington, DC, EPA/630/R-92/001.

ATTACHMENT C

ENVIRONMENTAL FUNCTIONAL ASSESSMENT METRICS

Attachment C: Selected Metrics for Use in River and Riparian Habitats in Lower Passaic River Brackish, Transitional, and Freshwater River Sections

Habitat	Brackish River Section						Transitional River Section						Freshwater River Section						Model or Variable	Description
	Benthic		Fish		Riparian		Benthic		Fish		Riparian		Benthic		Fish		Riparian			
Action/Sampling Domain	**Su**	**Fa**	**Wa**	**Fa**	**Fl**	**Fa**	**Su**	**Fa**	**Wa**	**Fa**	**Fl**	**Fa**	**Su**	**Fa**	**Wa**	**Fa**	**Fl**	**Fa**		
Restoration Action																				
Remediate contaminated sediment [1]	I	D	I				I	D	I										RBP Percent sediment tolerant organisms	Percent of infaunal macrobenthos tolerant of perturbation
	I	D	I				I	D	I										RBP Total number of taxa	Measures the overall variety of the macroinvertebrate assemblage
	I	D	I	D			I	D	I	D									LPR $V_{tolerantfish}$	Abundance of fish tolerant of perturbation
	I	D	I	D			I	D	I	D									LPR $V_{fishdiversity}$	Overall diversity of fish
Remove manmade structures	D						D						D						RBP Bank stability (condition of banks)	Whether the steam banks are eroded (or have the potential for erosion)
	D	I	D	I			D	I	D	I			D	I	D	I			HGM-TFW V_{NHC}	A measure of the habitat heterogeneity of a site, based on the comparison of the number of subhabitat types present at a site relative to the number of possible subhabitats known to occur in the appropriate regional reference standard site
	I	D	I				I	D	I				I	D	I				RBP Total number of taxa	Measures the overall variety of the macroinvertebrate assemblage
	I	D	I	D	I		I	D	I	D	I		I	D	I	D	I		LPR $V_{fishdiversity}$	Overall diversity of fish
Re-grade and bio-stabilize shoreline	D						D						D						RBP Bank stability (condition of banks)	Whether the steam banks are eroded (or have the potential for erosion)
	I				D		I				D		I				D		RBP Bank vegetative protection	Amount of vegetative protection afforded to the stream bank and the near-stream portion of the riparian zone
	I				D		I				D		I				D		HSI-WS V9	Percent instream and overhanging shoreline cover
				D I	I					D I	I					D I	I		LPR $V_{wadingbirds}$	Abundance of wading birds (e.g., herons and egrets)
				D I	I					D I	I					D I	I		LPR $V_{shorebirds}$	Abundance of shore birds
				D I	I					D I	I					D I	I		LPR $V_{waterfowl}$	Abundance of waterfowl (e.g., ducks and geese)
					I	D					I	D					I	D	LPR $V_{migratory}$	Abundance of migratory passerines
										I	I	D				I	I	D	LPR $V_{kingfisher}$	Abundance of belted kingfisher
Remove invasive flora and plant native flora					D	I					D	I					D	I	RBP Riparian vegetative zone width	Width of natural vegetation from the edge of the stream bank out through the riparian zone
					D	I					D	I					D	I	HGM-TFW V_{EXOTIC}	The proportion of a site covered with exotic or other undesirable plant species
Remove debris and trash [2]																			LPR V_{Refuse}	Tons/Cubic yards of refuse removed
Enhance fish/benthic habitat and aquatic structure													D	I	D	I			HGM-TFW V_{NHC}	A measure of the habitat heterogeneity of a site, based on the comparison of the number of subhabitat types present at a site relative to the number of possible subhabitats known to occur in the appropriate regional reference standard site
													D	I	I	I			HSI-ChC V2	Percent cover (logs, boulders, cavities, brush, debris, or standing timber) during summer within pools, backwater areas, and littoral areas
													D	I	I	I			RBP Epifaunal substrate / available cover	Relative quantity and variety of natural structures in the stream, such as cobble (riffles), large rocks, fallen trees, logs and branches, and undercut banks, available as refugia, feeding, or sites for spawning and nursery functions of aquatic macrofauna
													I	D	I	I			RBP Total number of taxa	Measures the overall variety of the macroinvertebrate assemblage
													I	D	I	D			LPR $V_{fishdiversity}$	Overall diversity of fish
Promote fish passage [3]													I	D	I	D			LPR Vanadromous	Abundance of anadromous fish
													I	D	I	D			LPR Vcatadromous	Abundance of catadromous fish

Notes

1. The presence of contaminated sediment in the freshwater river section has not been determined; therefore, remediation of sediments in this river section currently is not planned.

2. As debris and trash are expected to accumulate again after they are removed, a metric that directly measures the quantity of debris and trash removed was selected rather than one that measures the abundance of trash in or along the river.

3. Anadromous and catadromous fish abundance would be measured in other river sections; however, the metrics would be used only in the freshwater section where implementation of the promote fish passage restoration action is planned.

Legend

Su - Substrate: broadly defined as sediment, hard bottom, and structures.
Fa - Fauna.
Wa - Water.
Fl - Flora.
- Hatching indicates that the restoration action is not planned for the river section.
D - Direct: metric directly measures the effect of the restoration action on the action/sampling domain.
I - Indirect: metric indirectly measures the effect of the restoration action on the action/sampling domain.

HGM-TFW - Hydrogeomorphic Assessment for Tidal Fringe Wetlands.
HSI-ChC - Habitat Suitability Index Channel Catfish Model.
HSI-WS - Habitat Suitability Index White Sucker Model.
LPR - Lower Passaic River Restoration Project.
RBP - Rapid Bioassessment Protocols.

ATTACHMENT D

GEOGRAPHICAL COORDINATES FOR SAMPLING STATIONS

Table D1: Coordinates Associated with Benthic Invertebrate Survey and Toxicity Test Sampling Stations (Presented in Figure 11-1)

Sample ID [a]	X-Coordinate (Feet) [b]	Y-Coordinate (Feet) [b]
BS-1-01	597264.28	687069.96
BS-1-02	597814.27	688022.56
BS-1-03	597264.28	688975.16
BS-1-04	597814.27	689927.76
BS-1-05	597814.27	691832.96
BS-1-06	598364.25	692785.56
BS-2-01	597966.45	695040.85
BS-2-02	595663.10	695838.75
BS-2-03	592438.42	695040.85
BS-2-04	591056.41	694242.95
BS-2-05	590595.74	693445.05
BS-2-06	590135.08	692647.15
BS-3-01	589333.27	692589.56
BS-3-02	588507.64	692589.56
BS-3-03	585617.94	693304.57
BS-3-04	585205.13	695449.61
BS-3-05	584792.31	696164.63
BS-3-06	584792.31	697594.66
BS-4-01	584987.94	700101.91
BS-4-02	585361.41	702042.51
BS-4-03	585734.88	702689.38
BS-4-04	587228.75	705276.85
BS-4-05	588349.16	707217.46
BS-4-06	588722.63	707864.33
BS-5-01	589740.64	711611.40
BS-5-02	590311.44	712600.05
BS-5-03	590882.24	713588.71
BS-5-04	591453.04	714577.36
BS-5-05	592023.84	715566.01
BS-5-06	592023.84	717543.31
BS-6-01	592134.01	719699.29
BS-6-02	592134.01	720733.50
BS-6-03	592432.55	722284.81
BS-6-04	593029.65	723319.01
BS-6-05	594522.40	723836.12
BS-6-06	596313.70	724870.32
BS-7-01	596977.17	727718.50
BS-7-02	596679.93	729262.99
BS-7-03	596382.69	729777.83
BS-7-04	596679.93	732351.99
BS-7-05	596977.17	733896.49
BS-7-06	597274.41	736470.66
BS-8-01	597602.53	738225.44
BS-8-02	600655.00	739547.21
BS-8-03	598747.21	742851.61
BS-8-04	597984.09	744173.37
BS-8-05	596839.41	746156.01
BS-8-06	595694.73	746816.89
BI-2-01	597897.31	693196.58

Table D1 (continued)		
BI-2-02	595681.27	695281.74
BI-2-03	595297.16	695281.74
BI-2-04	592409.85	695341.74
BI-2-05	590554.65	693822.67
BI-2-06	590170.53	693157.37
BI-3-01	589151.47	692115.37
BI-3-02	588957.28	692115.37
BI-3-03	588674.25	692801.93
BI-3-04	587994.58	692633.75
BI-3-05	586757.12	692713.70
BI-3-06	586465.83	692881.88
BI-4-01	585396.58	701219.86
BI-4-02	586112.85	703303.88
BI-4-03	586311.52	703647.99
BI-4-04	587503.69	705232.53
BI-4-05	587702.35	705576.64
BI-4-06	588276.27	707475.23
BI-5-01	589937.65	711719.15
BI-5-02	590506.44	712725.05
BI-5-03	591315.35	713925.78
BI-5-04	591842.03	715013.05
BI-5-05	592571.11	716564.85
BI-5-06	592053.11	718359.23
BI-6-01	592332.22	719184.92
BI-6-02	592335.78	721038.10
BI-6-03	592499.18	721887.17
BI-6-04	593405.10	723644.91
BI-6-05	594524.38	723990.02
BI-6-06	596543.21	725186.41
BI-7-01	596998.33	727062.97
BI-7-02	596434.49	729394.96
BI-7-03	596397.94	730181.78
BI-7-04	596476.98	730044.87
BI-7-05	596722.62	731886.47
BI-7-06	596801.66	732023.38
BI-8-01	597455.60	737318.41
BI-8-02	598028.65	738253.49
BI-8-03	599422.16	737532.25
BI-8-04	600809.52	737316.71
BI-8-05	600942.71	737547.40
BI-8-06	600872.20	739214.93

a: Sample ID corresponds to sampling stations in Figure 11-1. The label BI-x-07 represents BI = Benthic Intertidal or BS = Benthic Subtidal, x = each 2-mile length of the river, and y = sample number within the 2-mile-long unit of the river.

b: All coordinates in New Jersey State Plane NAD83.

Table D2: Coordinates Associated with Tissue-Residue Sampling Stations Presented in Figure 12-1

Sample ID [a]	X-Coordinate (Feet) [b]	Y-Coordinate (Feet) [b]
FF-2-01	597897.3	693196.6
FF-2-02	595681.3	695281.7
FF-2-03	595297.2	695281.7
FF-2-04	592409.9	695341.7
FF-2-05	590554.7	693822.7
FF-2-06	590170.5	693157.4
FF-3-01	589151.5	692115.4
FF-3-02	588957.3	692115.4
FF-3-03	588674.3	692801.9
FF-3-04	587994.6	692633.8
FF-3-05	586757.1	692713.7
FF-3-06	586465.8	692881.9
FF-4-01	585396.6	701219.9
FF-4-02	586112.9	703303.9
FF-4-03	586311.5	703648.0
FF-4-04	587503.7	705232.5
FF-4-05	587702.4	705576.6
FF-4-06	588276.3	707475.2
FF-5-01	589937.7	711719.2
FF-5-02	590506.4	712725.1
FF-5-03	591315.4	713925.8
FF-5-04	591842.0	715013.1
FF-5-05	592571.1	716564.9
FF-5-06	592053.1	718359.2
FF-6-01	592332.2	719184.9
FF-6-02	592335.8	721038.1
FF-6-03	592499.2	721887.2
FF-6-04	593405.1	723644.9
FF-6-05	594524.4	723990.0
FF-6-06	596543.2	725186.4
FF-7-01	596998.3	727063.0
FF-7-02	596434.5	729395.0
FF-7-03	596397.9	730181.8
FF-7-04	596477.0	730044.9
FF-7-05	596722.6	731886.5
FF-7-06	596801.7	732023.4
FF-8-01	597455.6	737318.4
FF-8-02	598028.7	738253.5
FF-8-03	599422.2	737532.3
FF-8-04	600809.5	737316.7
FF-8-05	600942.7	737547.4
FF-8-06	600872.2	739214.9

a: Sample ID corresponds to sampling locations in Figure 12-1. The label FF-x-07 represents FF = Forage Fish, x = each 2-mile length of the river, and y = sample number within the 2-mile length.
b: All coordinates in New Jersey State Plane NAD83.