BASF Corporation
Rensselaer, New York

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Work Plan
Hudson River Operable Unit 2 Investigation

Operable Unit 2
BASF Rensselaer
Rensselaer, New York

ENSR Corporation
September 2005
Document Number 00760 171 202

Certification

This submission has been subjected to internal review in accordance with ENSR's review and coordination procedures to ensure:

(a) completeness for each discipline commensurate with the level of effort required for the submission

(b) elimination of conflicts, errors and omissions, and

(c) the overall professional and technical accuracy of the submission.

Signed for ENSR

Signature	John A. Bleiler
Name	John A. Bleiler
Title	Project Manager
Date	12 Sept. 2005

Signature	
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Title	Technical Reviewer
Date	12 Sept. 2005

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1.0 INTRODUCTION

This Work Plan outlines the proposed approach for characterizing surface water and sediment quality in the Hudson River adjacent to the BASF Corporation (BASF) facility in Rensselaer, New York (Figure 1-1). This Work Plan has been prepared by ENSR International (ENSR) on behalf of BASF.

The BASF Rensselaer facility (the "site") is the subject of an ongoing environmental investigation under New York State Department of Environmental Conservation (NYSDEC) regulatory authority. The Hudson River adjacent to the Rensselaer facility is part of Operable Unit 2 (OU-2), which was designated by NYSDEC to include offsite areas not evaluated under the Remedial Investigation (RI) of the BASF Rensselaer Main Plant (OU-1). The offsite OU-2 RI at the BASF Rensselaer facility also included investigations of offsite soil gas and groundwater; findings from these elements of the OU-2 RI are reported elsewhere (e.g., Roux Associates [Roux], 2000; Roux, 2001).

1.1 Program Objectives

This Work Plan has been developed to present an approach for characterizing the Hudson River adjacent to the site relative to constituents which may have emanated from the BASF Main Plant (i.e. OU-1). A review of the sediment quality data from the recently completed BASF Rensselaer OU-2 *Offsite Investigation Report for Hudson River Sediment* (Roux, 2004a) indicates that:

1) Selected volatile organic compounds (VOCs) are present in sediment in near-shore environments adjacent to the BASF facility production sewer outfalls; and

2) Selected inorganic compounds (i.e., metals) are present in sediment in both the near-shore environments (proximate to the production sewer outfalls) as well as in downstream locations within the river.

The reach of the Hudson River estuary adjacent to the site is a complex and dynamic system. In order to understand sediment chemistry dynamics as they relate to the BASF Rensselaer OU-2 investigation, it is critical to develop a better understanding of the riverine, tidal, and benthic conditions in the vicinity of the site. Therefore, the proposed characterization of the Hudson River in the vicinity of the BASF facility relies on an approach that uses field and laboratory data to provide an assessment of constituent fate and transport in the river adjacent to the site, and to provide a preliminary evaluation of the potential for risks to human health and ecological receptors.

Based on the results of the OU-1 investigation, the recently completed OU-2 sediment sampling program, and the review of information contained in this Work Plan, the proposed sampling effort focuses on:

1) Delineating the extent of selected metals and VOCs within the sediments adjacent to the facility;

2) Evaluating Hudson River surface water quality in the vicinity of and downstream of production sewer outfalls; and

3) Providing a preliminary analysis of the benthic community in the Hudson River in the vicinity of the site.

↘ river bottom organisms

This Work Plan has been designed to articulate the study design and data quality objectives, and includes a description of the scope and nature of investigative and sampling programs which will be undertaken to further characterize the potential risks of harm to the environment. Specifically, this Work Plan presents a scope of work for the following investigative and data analysis activities:

- Focused geophysical investigation;
- Sampling and analysis of surficial and sub-surficial sediment;
- Sampling and analysis of surface water;
- Sampling and reconnaissance level analysis of benthic macroinvertebrate communities; and
- Preparation of a river characterization report.

Characterization of the Hudson River adjacent to the facility will be conducted to determine the level and presence of constituents potentially attributable to site sources reaching the Hudson River via historic waste disposal activities (i.e., outfalls, spills) or surface water discharge(s) from the site. Based on historic site activities, the sampling efforts within the river will focus on delineating the extent of site-related metals and VOCs. The VOC delineation effort will focus on the near-shore sediments adjacent to historic outfalls, while the metals delineation effort will include the near-shore areas as well as main channel and upstream sampling.

1.2 Site History

BASF is the current owner of a former industrial manufacturing site in the City of Rensselaer, Rensselaer County, New York (Figure 1-1). The site is zoned for heavy industry and includes several unused facilities: a manufacturing plant, water intake and treatment system, wastewater pre-treatment system, lagoons, parking areas, and a closed landfill. In addition, there is an undeveloped parcel at the southern end of the property. The former manufacturing portion of the site (Main Plant) has been occupied by industrial manufacturers (principally dyestuffs and pharmaceuticals) for more than a century.

The 88-acre site is situated on the east bank of the Hudson River across and south of Albany. The property currently contains approximately 42 acres of developed areas, 23 acres of brushland, 11 acres of poor quality wetlands, 10 acres of unvegetated area, and 2 acres of closed man-made lagoons. It is bordered by Riverside Avenue and the Hudson River on the west, a truck access road (Irwin Stewart Port Expressway, also known as the Port Access Highway) on the east and south, and by another industrial facility on the north. An 80 MW (nominal) electrical cogeneration plant and a vehicle reclamation facility lie just south and west of site between Riverside Avenue and the Hudson River (ENSR, 2001).

The majority of the site currently lies within the floodplain of the Hudson River, and the majority of the site is situated below the 100-year flood elevation (approximately 20.5 feet above mean sea level).

1.3 Previous Site Studies

The Hudson River in the vicinity of the BASF site has been the subject of several investigations during the past decade, including the major programs described in this sub-section. The data collected from these various programs are further evaluated in Section 2 of this Work Plan (Conceptual Site Model).

1.3.1 Empire State Newsprint Project

A comprehensive characterization of local river conditions immediately adjacent to the BASF site was performed by ENSR in March 2001 to support the design of a proposed water intake and discharge structure as part of the planned Empire State Newsprint Project power plant and newspaper recycling facility (ENSR, 2001) (also known as the Bessicorp-Empire Development Company project). The focused field survey provided characterization of local instream and river bottom conditions, and included bathymetric, river current and water quality data collection, side-scan and sub-bottom imaging, and sediment grab samples. The survey area spanned approximately 1,600 linear feet of river adjacent to the site. As part of this effort, three surface sediment grab samples and nine sediment cores were collected and analyzed for grain size, moisture content, total organic carbon (TOC), Total Petroleum Hydrocarbons (gasoline range organics and diesel range organics), benzene, toluene, ethylbenzene, and xylenes (BTEX), polychlorinated biphenyls (PCBs), pesticides, and metals (Figure 1-2).

1.3.2 BASF Remedial Investigation

BASF has, since the early 1990's, been conducting RI/FS efforts at the Rensselaer facility. The following reports summarize previous investigations that were conducted at the Main Plant and Lagoon Area:

- "Wastewater Equalization Lagoon Reconstruction Study and Preliminary Design," March 1993, Clough, Harbour & Associates (1993).

- "BASF/Sterling Organics Wastewater Lagoons Baseline Assessment Rensselaer, New York," June 1994, Malcolm Pirnie, Inc (1994).
- "Remedial Investigation (RI) and Supplemental Remedial Investigation (SRI) Report, BASF Rensselaer, Rensselaer, New York," November 2000, Roux (2000).
- "Additional Remedial Investigation Activities, BASF Rensselaer, Rensselaer, New York," August 3, 2001, Roux (2001a).

Additional investigations have been performed in the Closed Landfill and South 40 under two separate Voluntary Cleanup Agreements with the NYSDEC. Investigations of these areas are described in the following reports:

- "Voluntary Cleanup Program Application, Closed Landfill" (Roux, 2002a).
- "Site Investigation Report, Closed Landfill" (Roux, 2002b).
- "Voluntary Cleanup Program Application, South 40 Parcel" (Roux, 2001b).
- "Site Investigation Report, South 40 Parcel" (Roux, 2001c).

The following text provides a brief summary of the groundwater and sediment investigations as they relate to the Hudson River OU-2 investigation.

On-site Groundwater

Hydrogeologic conditions at the BASF site were evaluated based on three synoptic rounds of water level data collected in support of the RI, Supplemental RI and Additional RI activities, and summarized in the Work Plan developed by Roux in support of the preliminary OU-2 Investigation (Roux, 2004a).

Offsite Groundwater

A review of data obtained during an offsite (OU-2) groundwater investigation indicated that there are no offsite groundwater transport pathways between the BASF Main Plant and the residential area to the north, or offsite areas to the south of the Main Plant (Roux, 2004b).

Sediment Screening Study

A screening level assessment of sediments in the immediate vicinity of the facility was performed in May 2004 (Roux, 2004a). Historical maps and records were reviewed to identify all outfall locations to determine selection of river sediment sampling locations. Through this program, BASF identified five sewer outfalls to the Hudson River in the vicinity of the site.

- One 18-inch cast iron sewer in the northern part of the Lagoon Area, probably related to storm water;
- Two outfalls in the northern part of the Lagoon Area related to past operations at the plant;

- The Town of East Greenbush Storm Sewer; and
- The City of Rensselaer Storm Sewer.

The two outfalls related to past plant operations were both used before the lagoons went into operation and include an abandoned 30-inch tile sewer that was used before lagoon construction, and a 30-inch diameter cast iron temporary effluent line that was apparently used only during lagoon construction. The abandoned 30-inch tile sewer was also used by Sterling Drug, which was a prior owner of the site now occupied by Albany Molecular.

The Town of East Greenbush and City of Rensselaer storm sewers are not related to past plant operations. The bedding outside of these sewers was identified during the RI as a potential migration route for dissolved VOCs in groundwater – primarily chlorobenzene – and was evaluated using water-quality samples obtained from piezometers in the sewer bedding. The City of Rensselaer storm sewer originates east of the Main Plant, and may represent a conduit for constituents originating east of the Site to be transported to the Hudson River.

In order to evaluate the potential contribution of these sewers to Hudson River sediment, a total of 18 Hudson River sediment samples were sampled and analyzed (Figure 1-3). Two sediment samples were collected in the immediate vicinity of the each of the five outfalls as well as additional samples upstream (north), downstream (south) of the site and adjacent to the site across the river. These samples were analyzed for TOC, Target Analyte List (TAL) metals, and semi-volatile organic carbons (SVOCs). Sediment samples collected in the vicinity of the municipal outfalls were analyzed for TOC, TAL metals, and VOCs. In addition to sediment samples, sludge samples were collected from manholes in the storm sewers near the outfalls, where possible. Analytical results were compared to NYSDEC regulatory screening criteria to provide a general understanding of sediment quality adjacent to the site.

1.3.3 NYSDEC Benthic Survey Program

An extensive mapping survey of the entire 240 km tidal reach of the Hudson River, including swath bathymetry, side-scan sonar, sub-bottom profiling, sediment-profile imaging, and collection of grab samples was performed by NYSDEC in 2003 (http://benthic.info). These data have been analyzed to develop reach-wide bathymetry, substrate and sediment environment maps and were made available to researchers for additional, detailed analysis. In July 2005, on behalf of BASF and under confidentially agreement, ENSR obtained an electronic copy of the NYSDEC data for review relative to the Hudson River sampling program.

As part of this Work Plan development, a critical review of the NYSDEC study was conducted to evaluate whether these existing geophysical data support bottom classifications and sediment transport regimes assigned by NYSDEC, and to determine whether or not the existing geophysical data were of adequate resolution to support the design of a sediment sampling and analysis program in the vicinity of the BASF site. This review is presented in Appendix A of this work plan, and is further discussed in Section 2 (Conceptual Site Model).

1.4 Regulatory Authority

This Work Plan has been prepared in accordance with the following relevant state guidance:

- Draft Voluntary Cleanup Program Guide (NYSDEC, 2002a); and
- Draft DER-10 Technical Guidance for Site Investigation and Remediation (NYSDEC, 2002b).

1.5 Project Organization and Responsibilities

Key personnel and their specific responsibilities are discussed below. Table 1-1 includes names of individual personnel, telephone numbers, and e-mail addresses.

BASF Project Manager

The BASF Project Manager, Mr. J. Douglas Reid-Green, is responsible for project direction and decisions concerning technical issues and strategies, including technical, financial, and scheduling matters.

ENSR Project Manager

The ENSR Project Manager, Mr. John Bleiler, has responsibility for sub-contracted technical, financial, and scheduling matters. Other duties, as necessary, include

- Subcontractor procurement,
- Assignment of duties to project staff and orientation of the staff to the specific needs and requirements of the project,
- Ensuring that data assessment activities are conducted in accordance with the Quality Assurance Project Plan (QAPP),
- Approval of project-specific procedures and internally prepared plans, drawings, and reports,
- Serving as the focus for coordination of all field and laboratory task activities, communications, reports, and technical reviews, and other support functions, and facilitating site activities with the technical requirements of the project, and
- Maintenance of the project files.

ENSR Technical Leader

ENSR's project manager will be assisted by a Technical Lead, whose duties, as necessary, include:

- Ensuring that data assessment activities are conducted in accordance with the QAPP,
- Approval of project-specific procedures and internally prepared plans, drawings, and reports,
- Serving as the focus for coordination of all field and laboratory task activities, communications, reports, and technical reviews, and other support functions, and facilitating sampling activities with the technical requirements of the project, and
- Maintenance of the project files.

ENSR Technical Reviewer

ENSR's technical reviewer(s) will provide added technical guidance to ENSR's Project Manager and Technical Lead as needed, and review all reports.

ENSR Health and Safety Officer

The ENSR Project Health and Safety Officer, Ms. Kathy Harvey will serve as a health and safety advisor to the Project Manager and ENSR staff including:

- Recommending appropriate personal protective equipment (PPE) to protect ENSR personnel from potential hazards,
- Conducting accident investigations.

ENSR Project QA Officer

- The ENSR Project QA Officer, Debra McGrath, has overall responsibility for quality assurance oversight. The ENSR Project QA Officer communicates directly to the ENSR Project Manager. Specific responsibilities include:
- Preparing the QAPP,
- Reviewing and approving QA procedures, including any modifications to existing approved procedures,
- Ensuring that QA audits of the various phases of the project are conducted as required,
- Providing QA technical assistance to project staff,

- Ensuring that data validation/data assessment is conducted in accordance with the QAPP, and
- Reporting on the adequacy, status, and effectiveness of the QA program to the ENSR Project Manager.

ENSR Analytical Task Manager

The ENSR Project Chemist/Laboratory Coordinator, Lori Herberich, will be responsible for managing the subcontractor laboratories, serving as the liaison between field and laboratory personnel, and assessing the quality of the analytical data.

ENSR Field Team Leader

The ENSR Field Team Leader will be responsible for implementing the field program, including management of field services subcontractors.

ENSR Data Manager

The ENSR Data Manager will be responsible for managing the project data.

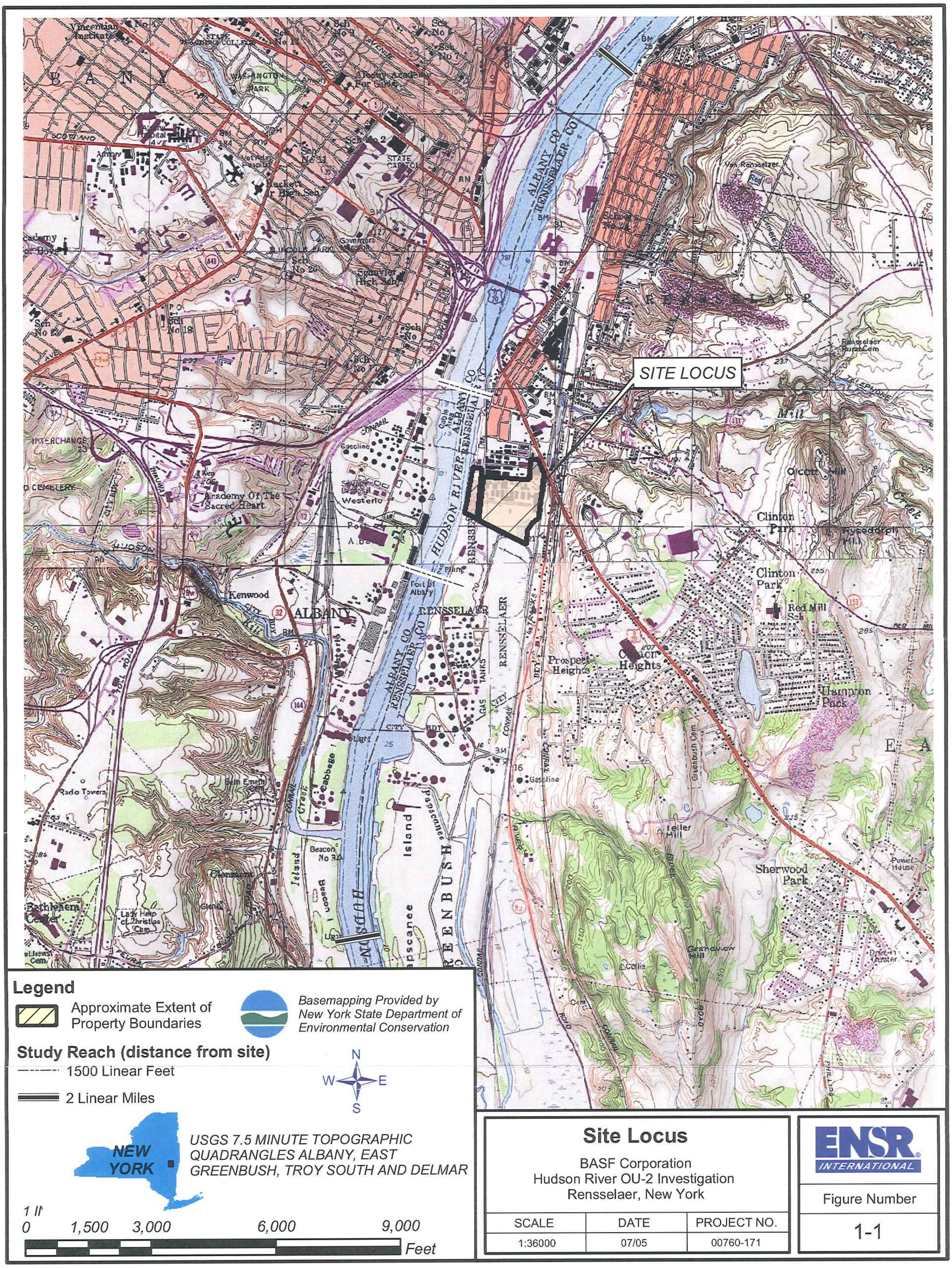
1.6 Document Organization

The remainder of this Work Plan is organized in the following manner:

- Section 2.0 Conceptual Site Model
- Section 3.0 Field Sampling Scope of Work
- Section 4.0 Reporting
- Section 5.0 Schedule
- Section 6.0 List of Commonly Used Acronyms
- Section 7.0 References

Table 1-1
Proposed Project Team
BASF Corporation
Hudson River OU-2 Investigation
Rensselaer, New York

Title	Name	Telephone Number	Email
BASF Project Manager	J. Douglas Reid-Green	908 806-6472	reidgrj@basf.com
ENSR Project Manager	John Bleiler	978-589-3000 ext 3056	jbleiler@ensr.com
ENSR Technical Leader	John Bleiler Mark Gerath	978 589 3000 ext 3056 978 589 3000 ext 3189	Jbleiler@ensr.com MGerath@ensr.com
ENSR Technical Reviewer	To be determined	To be determined	To be determined
ENSR Project QA Officer	Debra McGrath	978 589 3000 ext. 3358	dmcgrath@ensr.com
ENSR Analytical Task Manager	Lori Herberich	978-589-3000 ext 3383	lherberich@ensr.com
ENSR Health and Safety	Kathy Harvey	978-589-3000 ext 3325	kharvey@ensr.com
Field Team Leader	To be determined	To be determined	To be determined
Data Manager	To be determined	To be determined	To be determined



Legend

▨ Approximate Extent of Property Boundaries

Basemapping Provided by New York State Department of Environmental Conservation

Study Reach (distance from site)

- 1500 Linear Feet
- 2 Linear Miles

USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLES ALBANY, EAST GREENBUSH, TROY SOUTH AND DELMAR

NEW YORK

1 In

0 1,500 3,000 6,000 9,000 Feet

Site Locus

BASF Corporation
Hudson River OU-2 Investigation
Rensselaer, New York

SCALE	DATE	PROJECT NO.
1:36000	07/05	00760-171

ENSR INTERNATIONAL

Figure Number

1-1

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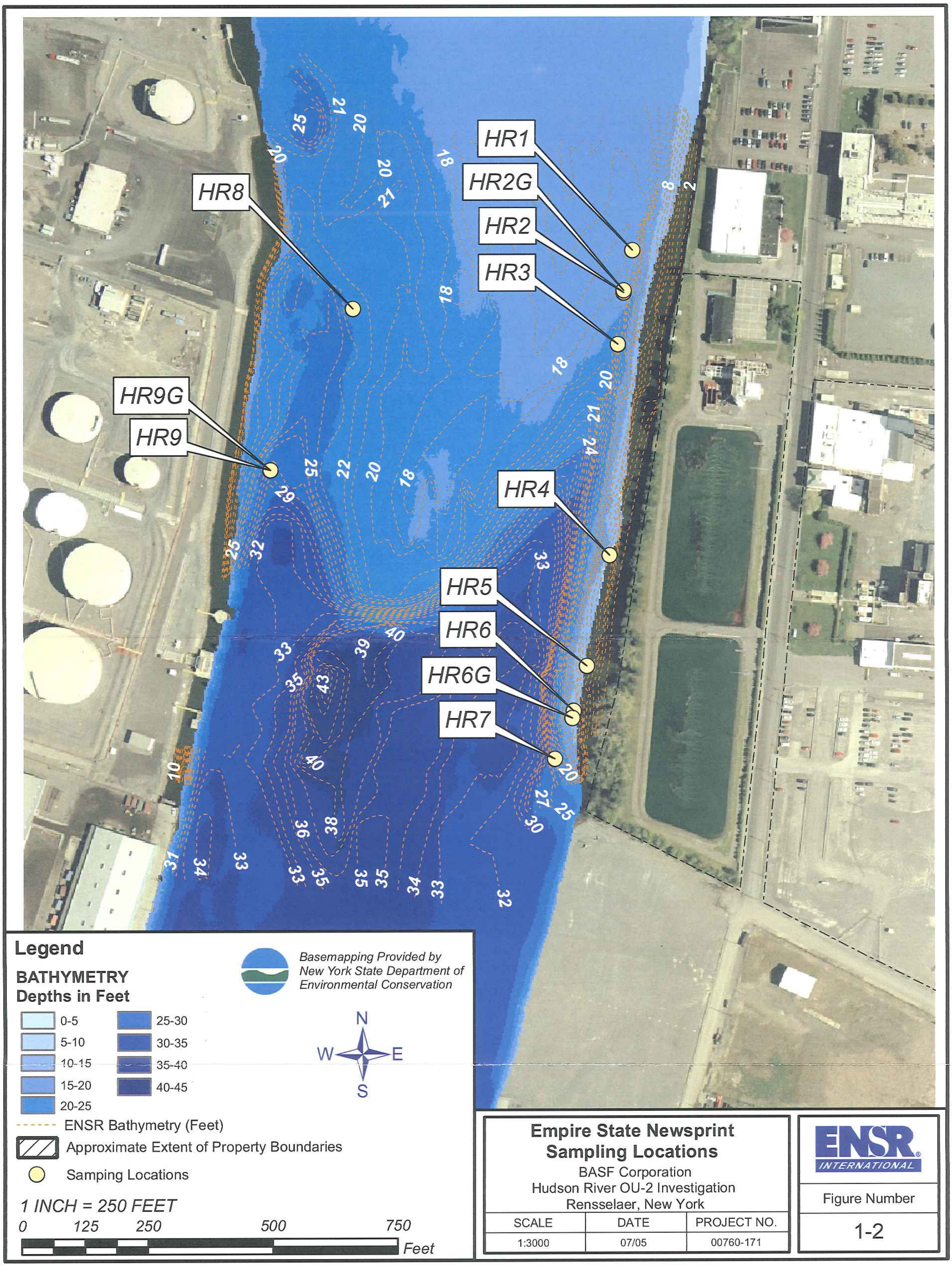

Empire State Newsprint
Sampling Locations
BASF Corporation
Hudson River OU-2 Investigation
Rensselaer, New York

SCALE	DATE	PROJECT NO.
1:3000	07/05	00760-171

ENSR INTERNATIONAL

Figure Number
1-2

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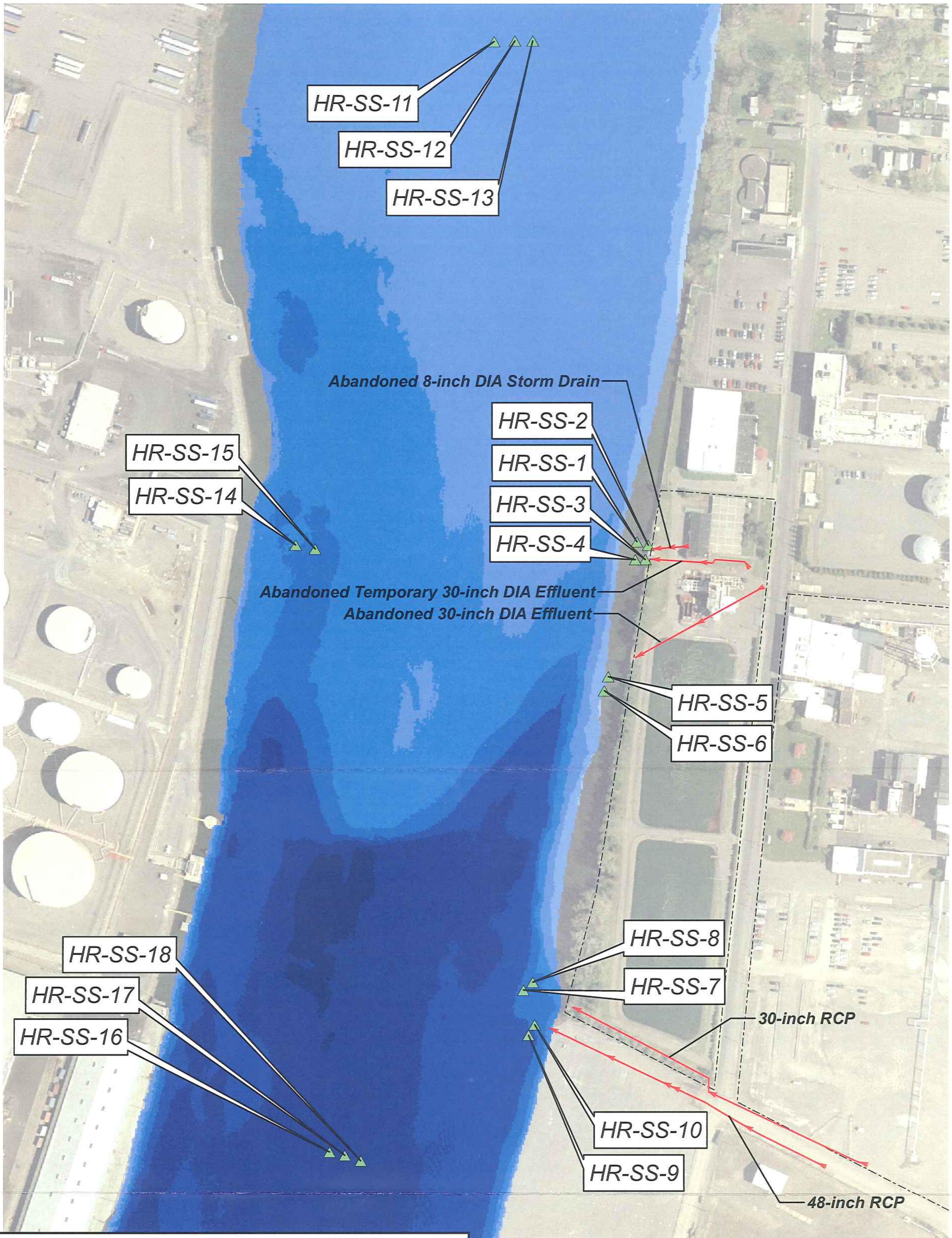

Legend

BATHYMETRY
Depths in Feet

0-5	25-30
5-10	30-35
10-15	35-40
15-20	40-45
20-25	

Approximate Extent of Property Boundaries
Approximate Locations of Outfall Pipes

Sample Locations

△ Roux 2004 Locations

N W E S

Basemapping Provided by New York State Department of Environmental Conservation

1 INCH = 200 FEET
0 100 200 400 600 800 Feet

Hudson River OU-2
Sampling Locations
BASF Corporation
Hudson River OU-2 Investigation
Rensselaer, New York

SCALE	DATE	PROJECT NO.
1:24000	07/05	00760-171

ENSR INTERNATIONAL

Figure Number
1-3

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2.0 CONCEPTUAL SITE MODEL

The conceptual site model (CSM) provides an important basis for the conceptualization and investigation of constituent fate, transport, and potential impacts. Notably, the CSM is critical for defining the nature and extent of site-related constituents and observed concentrations relative to background conditions. It is also important for understanding the effects of anthropogenic factors (e.g., releases) as well as natural factors (e.g., effects of grain size, carbon content, etc.) on constituent concentration patterns in sediment. The Hudson River OU-2 CSM discusses the apparent mechanisms of constituent movement from the site into the river as well as the distribution of various sediment environments/habitats in the river as they might affect constituent distribution. Background information on the river is also summarized in this CSM.

This section provides a preliminary CSM based on the available data. This CSM was developed in order to support the design of the field sampling program that considers the various complex physical, hydrological, and geological conditions which may affect sediment composition in the upper Hudson River estuary. It is envisioned that this preliminary CSM will be a "living document", and will be refined in an iterative manner as new information becomes available.

2.1 Physical Description of the Hudson River

The following section provides a discussion of the physical setting of the Hudson River including hydrology, tidal flows, and geology, with a focus on the relevant reach of river adjacent to the BASF site.

2.1.1 Hydrology

The Hudson River watershed lies predominantly in New York (93%), with small areas in Vermont, Massachusetts, New Jersey and Connecticut. The 13,300 mi^2 watershed is typically divided into the upper and lower Hudson River basins and the Mohawk River basin. The headwaters of the upper Hudson basin (4,590 mi^2) begin at Lake Tear of the Clouds in the Adirondack Mountains. The Mohawk River basin (3,500 mi^2) joins the Hudson River just upstream of the Federal Dam at Troy, NY. The lower Hudson basin (5,200 mi^2) begins below the Federal Dam and flows 154 miles to New York Harbor. The lower Hudson River is tidal for its entire 154 mile reach, and flows reverse direction, up to four times per day in the lower portions of the tidal reach of the river. The river adjacent to the site is located in the very upper reaches of the lower Hudson River, just downstream of the Federal Dam.

Typical average rainfall in the Hudson River basin is 40 to 48 in/yr (United States Geological Survey, [USGS], 1991), with substantial variation throughout the basin. The largest rainfall amount (greater than 50 in/yr) occurs in the high elevations of the basin and near the Atlantic Ocean at the mouth of the river (USGS, 1996). In the low-lying areas adjacent to the Hudson and Mohawk Rivers, rainfall

Bedrock underlying the upper Hudson River basin is predominantly igneous and metamorphic rock, while bedrock in the Mohawk River basin is composed of limestone, shale, and shaley sandstone (USGS 1991). The lower Hudson River basin bedrock is similar to that of the Mohawk River basin, containing predominantly shale and sandstone with some metamorphic and igneous rock.

2.1.4 Geomorphology

The sediment bed of the lower Hudson River transitions from sandy from the mouth to 9 miles upstream to muddy for 90 miles from the inner harbor to Kingston. From Kingston to Troy (50 miles), where fluvial processes dominate the river, estuarine muddy sands are being buried by fluvial sands (McHugh et al., 2004). The Hudson River is characterized by loading of sediments in the upper watershed that are transported over the Federal Dam at Troy. The sediment load in the tidal portion of the Hudson River ranges from 1.2 to 2.6 x 10^5 metric tons/year (McHugh et al., 2004). These sediments are generally transported as suspended sediments through most reaches of tidal Hudson River. Radiocarbon dating of oyster shells and the presence of coal burning relicts found on the estuary floor indicate that there has been little sediment accumulation for several hundreds of years (McHugh et al., 2004). Sediment rates has been estimated from less than 0.05 in/year (correlated to a sea level rise of ~0.05 in/year) to 0.4 in/year along narrow reaches in the vicinity of the estuarine turbidity maximum, about 15 miles from the mouth to more than 4 in/year in New York Harbor (Bopp and Simpson, 1998; McHugh et al 2004).

During the flood tide, sediments may be moved a short distance upriver, but the net transport direction is downriver, towards the Harbor, as downstream velocities are generally higher than upstream velocities (Gary Wall, USGS Pers. Comm.). During large storm events, the dominant sediment transport can be reversed, however these reversals generally have a short temporal duration (on the order of a day), and are followed by transport back in the downstream direction.

2.1.5 Dredging Operations

The Hudson River is maintained for commercial navigation from New York City to the Port of Albany, at river mile (rm) 148 (The BASF site is located at approximately rm 148.) A ship channel with a minimum depth of 32 feet and width of 400 feet runs up the Hudson River, originally dredged in the 1960s. At the Port of Albany, located approximately 1200 linear feet from the southern property boundary, a turning basin of 1,100 feet allows ships with overall length of 700 feet, maximum beam of 110 feet and a maximum air draft of 135 feet to navigate the Hudson River to Albany (www.portofalbany.com). The Turning Basin is dredged on a five to seven year cycle. Maintenance dredging is not required in the ship channel in the vicinity of Albany, although dredging is required in the vicinity of Germantown, approximately 40 miles downstream of Albany.

2.2 Local Conditions

For the purposes of this Work Plan, the following sections provide additional detail regarding the reach of the river immediately adjacent to the BASF Rensselaer Site, including the portion of the river extending approximately 10,000 lineal feet upstream and downstream of the site.

2.2.1 Bathymetry

Bathymetry in the vicinity of the BASF site was collected in 2001 (ENSR, 2001) and in 2003 (NYSDEC). The high resolution multibeam survey was performed by NYSDEC as part of the Hudson River Benthic Mapping Project. These data show that water depths range from 18 to 40 feet MLLW (Figure 2-2). The upstream limit of the dredged section, just upstream from the Albany turning basin, is located adjacent to the center of the BASF site. Dredged water depths range from 35 to 40 feet MLLW, while water depths in the undredged area range form 18 to 24 feet MLLW. A very steep gradient was observed in water depth, transitioning from 20 to 40 feet depth MLLW over a distance of 60 feet along the channel.

In March 2001, as part of the Besicorp-Empire Development Company project (ENSR, 2001), a single-beam bathymetric survey over 1,600 feet of the river was conducted; this survey extended from the southern edge of the lagoon to the northern fence line along the BASF property. These data clearly indicated the sharp transition from the upstream limit of the Hudson River ship channel to the undredged river bottom (Figure 2-3). The sharp bathymetric transition located at the BASF site, and the Albany Turning Basin, located approximately 2,000 feet downstream, could affect both local hydrodynamics and sediment transport. The results were very consistent with those of the 2003 large-scale survey, indicating that there has been no significant change in channel bathymetry (i.e., little net scour or deposition) between the two surveys.

2.2.2 Hydrology

A current study was performed at the site in March 2001 as part of the Besicorp-Empire Development Company project (ENSR, 2001) to characterize local flow velocities. A vessel-mounted Acoustic Doppler Current Profiles (ADCP) repeatedly navigated four cross-river transects every hour for 11.4 hours (approximately one tidal cycle), with two additional transects lines surveys during peak ebb and flood tides. During this survey, the tidal range was 5.3 feet, and water levels ranged from -1.2 feet NGVD to 4.1 feet NGVD. Mean daily freshwater inflow measured at Green Island was 17,900 cfs (considerably above the daily average discharge for the period of record).

Measured flow rates over the survey period ranged from 32,000 cfs (peak ebb) to -11,000 cfs (peak flood). Note that due to channel geometry and elevation, the tidal flow is much less at Albany than downstream at Poughkeepsie. In fact, given the relatively high importance of runoff flows, the daily periods of net upstream flow are likely to be less at Albany. In the 2001 survey, in which runoff flows were well above average, net upstream flows were observed only during one set of the flow measurements, approximately one hour after low tide. Peak ebb velocities were measured at 2 ft/s with fairly uniform currents across the channel. Flow reversal was observed on the ebb tide, near shore on the eastern side of the river where steep bathymetric gradients mark the upstream limit of the ship channel. During flood tide, upstream currents in the main channel approached zero, while maximum upstream currents observed during flood tide were 0.85 ft/s along the east bank of the channel. The reverse flow eddy observed during ebb tide was not observed during the flood tide. At the peak flood velocity, a 0.6 mile upstream tidal excursion could occur over the hour that upstream currents were observed. During this survey, downstream flow was observed approximately 95% of the time.

2.2.3 Groundwater

Groundwater flow patterns beneath the site were inferred based on three rounds of synoptic water level sampling events performed in support of the RI investigations. Groundwater generally flows across the site from east to west, towards the Hudson River. Observed perturbations in this pattern were assumed to be the influence of subsurface sewers. In the vicinity of the sewers, groundwater flow is towards the sewers, and potentially discharging to the bedding of the utilities.

To the north of the BASF site is the Sterling site, a chemical manufacturing facility. Water level measurements indicated that an east-west groundwater divide runs through the center of this property. South of this divide, groundwater flows towards the sewers on the BASF property. Groundwater level data indicated that groundwater from both the Sterling site and the BASF site discharge to the bedding of the BASF sanitary sewer and subsequently to the bedding of the City of Rensselaer storm water sewer.

A steel bulkhead runs the length of the BASF property along the shoreline. This bulkhead is driven into underlying silt and clay, and likely isolates onsite groundwater from seeping into the river. Water levels gages in the river and in the water table on site indicated that water levels in the river fluctuated over five feet, and groundwater fluctuated less than 0.2 feet 28 feet east of the river which has been interpreted to indicate little hydraulic connectivity between the river and the on-site groundwater (N. Epler, Pers. Comm.). The presence of the bulkhead suggests that any groundwater discharge to the river is likely from the sewer bedding and/or the sewers.

2.2.4 Biology

The biological resources of the Hudson River have been studied by a variety of government agencies, industries, academic institutions, and interest groups. The information presented in the following sub-sections summarizes some of the data currently available to describe aquatic vegetation, fish, and benthic communities within the Hudson River adjacent to the site.

2.2.4.1 Aquatic Vegetation

Submerged aquatic vegetation has been mapped in a joint effort by NYSDEC, Cornell University, the Institute for Ecosystem Studies, New York SeaGrant and others. Beds of vegetation were identified and mapped using true color aerial photographs from 1997 (NYSDEC, 2000a), then large-scale maps were created, and data verified with sampling and visual observation vegetation. According to this study, submerged aquatic vegetation beds in the vicinity of the site tend to be limited, and are dominated by water celery (*Vallisnaria americana*). Lesser amounts of pondweed (*Potomogeton* sp.) are also found throughout the beds. Distribution of plants is light-limited, with the highest abundance in water less than 3 feet deep at lowtide (NYSDEC, 2000a). The area where water depth is less than 3 feet at low tide is very limited adjacent to the site, thus limiting the development of submerged aquatic vegetation.

2.2.4.2 Fish Community

The Hudson River in the vicinity of the site is designated as a Class C water. NYSDEC regulations indicate that the best usage of Class C waters is fishing and that Class C waters shall be suitable for fish propagation and survival, as well as primary and secondary contact recreation.

Due to the tidal nature of the Hudson River adjacent to the site, the fish community is composed of estuarine species, diadromous species (those that migrate from the sea), and a few euryhaline species (those able to travel between freshwater and saltwater environments)(Odum, 1971).

In a report on the fish species composition of the Hudson River estuary, Beebe and Savidge (1988) determined that the fish fauna of the Hudson River estuary was typical of that found in Atlantic Coast temperate zone drowned-river valley estuaries. However, the 140 species recorded in the Hudson River constituted one of the most diverse fish assemblages of any Atlantic Coast river. The report listed a total of 58 fish species representing 26 families in the Albany area of the Hudson River (Beebe and Savidge, 1988).

An additional 16 species have been recorded during various Albany Steam Station sampling programs which, when combined with the Beebe and Savidge inventory, results in a total of 74 fish species representing 28 families utilizing the Albany area of the Lower Hudson River estuary (NMPC, 1999).Of those species, approximately 60% are classified as freshwater, 25% are classifies as diadromous, and 15% are classified as marine. The large percentage of freshwater species reflects the water conditions prevalent at the site throughout the year. The relatively large number of marine species collected in the Albany area is attributable to the Hudson River's low stream gradient, seasonal upstream penetration of marine waters, and the free-flowing nature of the Hudson River between the Troy Dam and the Battery (Smith and Lake, 1990).

Shortnose sturgeon (*Acipenser brevirostrum*), a federally-listed endangered species, and the Atlantic sturgeon (*Acipenser oxyrhynchus*), a species of concern, may be present in the Hudson River near the site. Bridle shiner (*Notropis bifrenatus*), central mudminnow (*Umbra limi*), and northern hogsucker (*Hypentelium nigricans*) are regionally rare species that may be present in the Hudson River near the site. Alewife (*Alosa pseudoharengus*), American eel (*Anguilla rostrata*), Atlantic shad (*Alosa sapidissima)*, blueback herring (*Alosa aestivali*), and striped bass (*Morone saxatilis*) are commercially and/or recreationally important species likely present in the area (ENSR, 2001).

2.2.4.3 Benthic Community

The benthic macroinvertebrate community associated with the Hudson River near the site was investigated in 2001 as part of the Besicorp-Empire Development Company project (ENSR, 2001). The investigation was aimed at identifying the general habitat characteristics of this segment of the Hudson River, and to provide additional supporting qualitative data to supplement existing data collected by others. The 2001 field study included collection of nine sediment samples from various locations adjacent to the site and three additional samples from the opposite side of the river for comparison. Observations at that time indicated that the substrate type and water depth varied considerably across the river. Based on species richness, there was an apparent difference in the diversity of organisms corresponding to substrate type. Those sampling locations with more heterogeneous substrate composition, including sand, rocks, or cobble tended to have a greater diversity of organisms present. The samples collected on the western side of the river (opposite from the site) were represented by nine primary taxa, while the samples collected on the eastern side of the river (adjacent to the site) were represented by only six primary taxa. Chironomids were not identified to the species level in this survey, and therefore this group may include multiple taxa (ENSR, 2001).

Previous studies indicated that the benthic community in the reach nearest the site was generally dominated by oligochaetes (primarily tubificid worms) (Simpson et al., 1986). Simpson et al. (1986) also indicated that the benthic community in the south Albany area exhibited the lowest diversity from Troy to Albany. Benthic macroinvertebrate data collected downstream of the site by New York State Department of Health (NYSDOH) for use in the Revised Baseline Ecological Risk Assessment Hudson River PCB Reassessment (TAMS and MCA, 2000) also documented a benthic community dominated by oligochaetes and chironomids at Stockport Flats (rm120) as well as other stations downstream of that location (TAMS and MCA, 2000). Those studies also concluded that there was evidence of adverse impacts to the benthic macroinvertebrate community associated with PCBs in the river and sediment down as far as rm 89.

Zebra mussels were first observed in the Hudson River in May 1991 and a decrease in the abundance of macroinvertebrates in deeper areas of the Hudson River and an increase in the abundance in shallow waters following the invasion of the area by the zebra mussels has been observed (Strayer et al., 1999). Researchers have suggested that the decline in deep water areas may be associated with a decline in the flux of edible suspended particles into the deep water caused by the efficient filtering of water by the zebra mussels. Zebra mussels were found in samples collected near the site in March 2001.

The results of these historic studies of the benthic macroinvertebrate community near the site document a community dominated primarily by oligochaetes and chironomids. These results are consistent with the results of prior studies of the freshwater tidal portions of the Hudson River, and are typical for benthic communities in a large river system. Based on the available data, the benthic community in the Hudson River near the site is characterized by low diversity (ENSR, 2001).

2.3 Physical Description of Sediments

Two sets of survey data were available to physically characterize sediment in the Hudson River in the vicinity of the BASF site: a survey performed by ENSR (2001) as part of the Besicorp-Empire Development Company project and the 2003 survey under the NYSDEC Benthic Mapping Program.

In 2001, ENSR collected bathymetric, side-scan and sub-bottom profile data in the immediate vicinity of the site. NYSDEC performed high-resolution surveys of the entire tidal stretch of the Hudson River in 2003. The surveys included multibeam bathymetry, side-scan sonar to characterize surface sediments and sub-bottom profiling to gather information about sediment structure with depth. In addition, 410 sediment cores and 600 grab samples were collected to ground-truth the acoustic surveys. Analysis of these data was performed by NYSDEC, and data from the vicinity of the BASF site were evaluated for this CSM.

As part of this Work Plan development, a critical review of the NYSDEC and ENSR (2001) study was conducted to evaluate whether these existing geophysical data support bottom classifications and sediment transport regimes assigned by NYSDEC, and to determine whether or not the existing geophysical data were of adequate resolution to support the design of a sediment sampling and analysis program in the vicinity of the BASF Site. This review is presented in Appendix A of this work plan. In general, this review indicated that the NYSDEC and Besicorp studies were well conducted studies that met their overall project objectives; however, neither of the data sets were of sufficient resolution for any site-specific evaluation of benthic characteristics or sediment transport.

- The NYSDEC side scan data were collected to allow regional-scale evaluation of the entire Hudson River estuarine riverbed, and employed a sonar range outside of the acceptable limits for investigations at an industrial waste site. Given the wide swath widths and processing techniques employed by NYSDEC, the data are less than optimal for site-specific evaluation of benthic conditions along the relatively short river reach of concern for the BASF Rensselaer investigation.
- The Besicorp side scan sonar system was not of survey-grade, and data artifacts and electrical noise obscure much of the data. The data for this program were collected using side scan system that is best suited to object detection rather than benthic mapping, and is

frequently used by police, archaeologists and treasure-hunters because of it's high frequency (i.e., better discrimination capabilities for small objects) and low cost relative to professional survey systems. While these data may be of use for the identification of submerged structures (i.e., culverts, pipes etc.), they are of limited value relative to the overall project objectives (i.e., they do not provide sufficient resolution for the design of a sediment sampling program).

2.3.1 Grain Size

Analysis of the three sets of NYSDEC survey data along with the grain size analysis of the sediment samples resulted in a map of bottom sediment types (Figure 2-4). The mapped sediment types closely follow the local bathymetry (Figure 2-5). Coarse-grained sediments are mapped in the northern section of the reach, corresponding to the undredged river bottom. Sediments in the center two-thirds of the channel were classified as sandy gravel, and along the banks the sediments were slightly finer, and classified as gravelly sand. Downstream, in the dredged ship channel, sediments are predominantly sand, with finer sediments along the banks and in the Albany Turning Basin.

Sediment samples (nine cores and three grabs) collected by ENSR (2001) as part of the Besicorp-Empire Development Company project were analyzed for grain size. In general, the grain size results are consistent with the NYSDEC mapping. At a few locations, located near the transitions between sediment type classifications, the grain size results were inconsistent with the sediment type mapping (Table 2-2 and Figure 2-6). Sample HR01 falls within the sandy gravel classification, but only contains 10.4% sand and gravel. Similarly, HR09 falls within the muddy sand classification, but contains 98.2% sand and gravel in the core and 98.8% in the grab sample. It is expected that the NYSDEC mapping is less accurate along the banks of the river, where steep bathymetric gradients make collection of acoustic data more difficult. As importantly, the goals of the NYSDEC program were development of wide-scale map of sediment quality: the scale of the program and its methods are very likely to lead to failure to resolve local changes in sediment texture.

An earlier side-scan sonar survey was performed in 2001 in the vicinity of the site (ENSR 2001). Survey results indicated fine-grained silty material along the eastern bank adjacent to the BASF site. Towards mid-channel, sediments were silty, grading to coarser sediments and hard, coarse-grained sediments were observed from mid-channel to the western shore. Observations of coarse-grained sediments in the center of the channel and finer grained materials along the margins were consistent with those of the NYSDEC survey.

2.3.2 Erosional/Depositional Characteristics

Sediment environments were mapped based on analysis of the three sets of NYSDEC survey data and sediment grab sample results (Figure 2-7). The river bed in the vicinity of the BASF site was classified as predominantly a dynamic-scour environment, indicative of a rough and/or hard surface.

This region corresponds to regions of relatively coarse-grained sediments on the river bed. Along the east bank, the sediment bed was classified as erosion-non-deposition adjacent to the northern portion of the site and depositional adjacent to the southern portion of the site. Along the east bank from the Turning Basin to the upstream limit of the dredged channel a transition from erosional to depositional was mapped. However, a close inspection of these data in the vicinity of the BASF site indicated that this mapped transition may be an artifact of the scale of the data and data interpretation (see Appendix A).

Sub-bottom profiling and side-scan sonar were performed in 2001 in the vicinity of the site to characterize bottom sediment composition and stratigraphy (ENSR, 2001). Along the east river bank, sub-bottom profiling indicated a predominantly depositional environment with occasional erosional events. In the deep portion of the river, the sub-bottom profiling indicated a thin surficial layer (<2 meters) of mixed sediments, mostly sand and silt interbedded with coarse sand and gravel that was an active erosional/depositional environment. Below was more than 7 meters of relatively homogeneous sediments, mostly silt and sand with thin lag deposits of gravel. These results and interpretations of the 2001 study are generally consistent with those from the NYSDEC study.

The side-scan sonar survey indicated a mound of sediment adjacent to the bulkhead and possibly sub-aqueous holes in the steel sheeting of the bulkhead, likely the northernmost discharge location identified in the Roux (2004a) study. Approximately 50 feet to the north, a structure was observed that was thought to be an historic structure, consisting of two parallel pipes extending 30 to 50 feet offshore from the bulkhead and surrounded by scattered debris.

2.4 Sediment Quality

This section discusses the quality of sediments with respect to chemical constituents. This includes reference to potential variation in constituent concentration with physical quality as well as regional and local trends in sediment quality. This discussion focuses on a set of metals (cadmium, chromium, copper, lead, mercury, and zinc, i.e., the metals of interest) and organic compounds (benzene and a set of chlorobenznes) that have been found on the BASF site and at some sediment sample locations within the river.

2.4.1 Relationship Between Sediment Physical, Chemical, and Toxicological Properties

Concentrations of contaminants in sediments have often been observed to be closely correlated to sediment type and sediment organic carbon content (Michelson and Bragdon-Cook, 1993). Organic contaminants, such as VOCs and PAHs are hydrophobic, and have limited solubility in water, but preferentially partition to oils, fats, non-polar organic solvents and organic material in sediments (Hemond and Fechner, 1994). The toxicity of organic contaminants has also been correlated to organic carbon fraction of sediments, while it is poorly correlated to overall dry weight concentration.

Because hydrophobic organic contaminants are well correlated to organic content, sediment concentrations of these contaminants are often normalized to organic carbon content. Normalization to organic carbon can help discern patterns in chemical concentrations when sediments with varying physical properties are present.

Metals do not partition as strongly to organic material as hydrophobic organic constituents. However, some correlation has been observed between metals and grain size[1]. Large grained sediments tend to have lower metals concentrations due to relatively low surface area available for metals sorption. Conversely, silts and clays, which have smaller particles, have more surface area and tend to have higher metals concentrations. Additionally, when weathering breaks down minerals into clay particles, this fine fraction has higher metals concentrations in mineral matrices associated with naturally occurring background concentrations. In an estuarine or riverine environment, both naturally occurring background metals and metals associated with anthropogenic sources tend to be found in low energy depositional areas, where fine sediments accumulate.

2.4.2 Regional Trends in Sediment Quality

Sediment cores and grab samples have been collected throughout the Hudson River and typically analyzed for metals, pesticides and PCBs. While much of the focus of these studies has been PCBs, the discussion presented here will focus on constituents observed regionally that have also been observed on the BASF site.

Bopp and Simpson (1998) used radionuclides to trace sediment accumulation combined with analytical measurements of several contaminants to develop information on sources, fate and transport and depositional history in eight cores throughout the lower Hudson River. In upstream tidal cores (RM 46, 88.6 and 91.8), surficial copper and lead concentrations were much lower than deeper concentrations, and indicated a 50% drop in these metals in between 1976 and 1986. This decline was attributed to decreases in industrial discharge of trace metals and/or the recent implementation of secondary sewage treatment by the city of Albany.

The metals of interest (e.g., cadmium, chromium, copper, lead, mercury, and zinc) are generally found in sediments analyzed throughout the lower Hudson River, typical of urban estuarine environments. In the USGS National Water-Quality Assessment Program (NAWQA) Study (Wall et al., 1998), metals of interest were detected in 100% of the Hudson River surficial sediment samples (with the exception of mercury, detected in 98% of the samples), compared with a national data set, where detection of metals ranged from 24% to 100% of all sediment samples. The highest metals concentrations were correlated to areas with urban land use (Wall et al., 1998). Paired sediment cores collected at six locations from rm 42 (Peekskill) to rm 140.5 (Albany) found metals concentrations at concentrations

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[1] http://web.ead.anl.gov/ecorisk/related/documents/Appendix_B_-_Geochemical_Analysis_Overview.pdf

sufficient to potentially cause adverse biological effects at all locations (NYSDEC 2000b). At the Turning Basin in Albany, the highest metals concentrations were found in the deeper core segments (27 to 45 in). The range of surficial metals concentrations from the NYSDEC and the USGS study are presented in Table 2-3.

Little historical or regional data are available characterizing the VOCs that have been observed in the vicinity of the BASF property. In a few samples collected for the NAWQA study, 1,2-dichlorobenzene (3%), 1,3-dichlorobenzene (3%), and 1,4-dichlorobenzene (12%) were detected. Other organic contaminants were observed at a much higher rate of detection throughout the Hudson River watershed (Wall et al., 1998).

2.4.3 Local Trends in Sediment Quality

During the past decade, sediment samples were collected by ENSR (2001) and Roux (2004a) in the vicinity of the BASF site (Figure 2-8). The complete set of results can be found in the summary reports of the individual investigations. This discussion is focused on constituents observed in the screening sediment study above the selected screening criteria (Roux, 2004a).

2.4.3.1 Distribution of Metals of Interest

Sediment samples analyzed for metals were collected by ENSR (2001) and Roux (2004a) in the vicinity of the BASF site. Metals observed to exceed the NYSDEC severe effects level in both studies are summarized in Table 2-4 and Table 2- 5, and a summary of selected concentration data is presented in Figure 2-9.

Metals are seen in sediments at several locations adjacent to and downstream of the site. The 2001 Bessicorp samples were composites of the upper three feet of sediment (except for the samples with a "G" in the location name, which are co-located surficial grab samples). The 2004 BASF RI OU-2 sediment samples are composites of the upper two feet of sediment. None of the surficial grab samples showed metals exceedences, while at two locations (03 and 06) there were exceedences in the co-located cores, suggesting that metals concentrations may increase with depth.

A summary of the range of observed metals concentrations grouped by location relative to the BASF site is presented in Table 2-6. In general, these concentrations are within the range observed within the Hudson River watershed (see Table 2-3) and are not atypical of sediments in urban areas. Despite this, some samples are highly elevated relative to NYSDEC guidelines (e.g., lead in HR-SS-17) and sediments adjacent to and downstream of the site appear to be elevated relative to those upstream and on the western bank; however, it is possible that these apparent trends may also be explained differences in sediment texture and depositional characteristics.

Sediment data were compared to NYSDEC screening criteria (NYSDEC, 1999). The Severe Effect Level was previously established for the metals criteria because the site is located in an urban, highly industrialized location (Roux, 2004a). Metals concentrations observed to exceed the established criteria are presented in bold in Tables 2-4 and 2-5. The ranges of observed metals concentrations, grouped by location, are summarized in Table 2-6. Metals concentrations were generally highest adjacent to and downstream of the site. These locations tend to correspond to depositional areas or areas where grain size is finer (see discussion in Section 2.5).

2.4.3.2 Distribution of VOCs

Several VOCs were observed above the NYSDEC screening criteria in sediments adjacent to the BASF property: benzene, chlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, and 1,4-dichlorobenzene (Table 2-7); concentrations normalized to organic carbon content are presented in this table for ease of comparison to NYSDEC sediment quality screening values. Figure 2-9 presents the distribution of chlorobenzene, observed in several of the sediment samples. The highest concentrations are generally located closest to the shoreline, in the vicinity of the historic outfalls. VOC concentrations were highly variable in the sediments, as evidenced by samples HR-SS-5 and HR-SS-6, located approximately 30 feet apart. All five VOCs of potential concern were observed at HR-SS-5, while three of the five VOCs of concern were not detected at HR-SS-6.

In several of the samples collected at the outfall locations, sediment staining and a hydrocarbon odor were observed. At two locations sampled in 2001 (HR03 and HR06G) a blue, oily sheen was observed in the upper six inches of the sediment column. At HR07, black oil was observed in the core at 29 inches and 46 inches. Although VOCs were not measured in these samples, they were generally located in the vicinity of the 2004 samples where VOCs were detected.

Sediment data were compared to NYSDEC screening criteria (NYSDEC, 1999). The selected VOCs screening criteria were Benthic Aquatic Life Acute Toxicity Criteria, normalized to TOC content of the sediment (Roux, 2004a). The observed VOC concentrations which exceed the established criteria are presented in bold in Table 2-7. All exceedences were observed at near-shore locations, and VOCs were not detected in off-shore environments. Exceedences were observed in the vicinity of the historic outfalls on the BASF property and in the vicinity of the active municipal outfalls.

2.5 Relationships between Constituent Concentration and Other Factors

The observed concentrations of the metals of interest are generally correlated with sediment grain size. Higher concentrations were observed in finer-grained areas of muddy sand and sand, and lower concentrations were observed in gravelly sand and dandy gravel substrates. Figure 2-11 presents several examples of how metals concentrations vary with grain size in the 2001 sediment cores and grab samples. In these examples, sediment size was characterized as the sum of percent gravel and percent sand, representing the coarse fraction. In general, the observed metals concentrations decrease with an increased coarse grain size fraction. For all metals, sample HR01 (located along the eastern shoreline) had a low sand and gravel content and also low metals concentrations, which resulted in fairly low correlation coefficients (without data from HR01, correlation coefficients were 0.8 to 0.95).

Grain size data were not collected in 2004; however, TOC data were collected and applied to normalize VOC concentrations. While VOCs were generally not detected in areas with low TOC (Table 2-7), the organic carbon normalized VOC concentration is higher near historic outfalls.

2.6 CSM Summary

The review of available data provides a consistent conceptual site model of the Hudson River in the vicinity of the BASF site, both in terms of physical processes and contaminant distribution. An understanding of the historical and existing conditions of the site allows for identification of data gaps and for the development of a sampling plan to fill these data gaps. A summary of the CSM is provided below.

2.6.1 Summary of Critical Processes

The channel of the Hudson River in this area and immediately upstream is quite stable: it is not subject to meander or to major rework of the river bed. While a significant amount of sediment transport occurs in the reach of interest, the CSM suggests little net deposition and scour.

The flows in the Hudson River are generally dominated by tidal influence, with a four-foot tidal range at the BASF site, 148 miles upriver from the mouth. Net flow is in the downstream direction the majority of the time, with periodic flow reversals, depending on the tide and the freshwater inflow. A hydrographic survey at the site indicated upstream flow for less than one hour during a twelve hour tidal cycle, with upstream flow velocities lower than those observed in the downstream direction over the survey. During this survey, when freshwater inflow was above average, the upstream tidal excursion was approximately 0.6 miles. Although this survey represents only one set of flow conditions, flows are predominantly in the downstream direction and the maximum upstream excursion under certain flow conditions is likely on the order of one to two miles and peak downstream velocities are generally always higher than upstream velocities.

The existing benthic surveys were generally not conducted with sufficiently high resolution in the immediate site area to accurately select sampling locations for future sampling activities. However, these surveys do provide valuable input for the CSM. These surveys, which included bathymetry, side-scan and sub-bottom profiling, indicated a stable river channel in the vicinity of the BASF site. Although no regular dredging is performed, the sharp bathymetric transition at the head of the dredged shipping channel persists in the near-site environment. The river bottom in the upstream portion of this reach is coarse-grained, and dynamic, suggesting episodes of erosion and deposition with no net change in bathymetry. Downstream, below the bathymetric transition, materials are finer, generally sand-sized particles and also non-depositional. Along the shoreline, sediments are silty sand, indicating potential areas of deposition. Some depositional areas may be associated with discharge from process water or stormwater outfalls. Fine-grained areas along the banks coincide with observed flow eddys due to the sharp change in bathymetry and the lobe-shaped feature in the center of the channel.

The flow and bed material data and mapping together indicate that the river is non-depositional in the vicinity of the BASF site, as well as upstream and downstream of the site. Observed downstream velocities (0.85 to 2.0 ft/s) are indicative of an erosional regime for sand grain size (>0.1 mm) (Graf, 1971). Along the shoreline of the river there is evidence of at least periodic deposition, both from the eddys in the flow and possibly from episodic landslide events.

The distribution of metals throughout the study area is variable. Metals appear to be highest adjacent to the site and downstream of the site; however a fairly strong correlation between metals and sediment type is apparent, which may account for some of the observed variation. A sharp spatial variation is observed downstream, where samples 30 feet apart range in lead concentrations by an order of magnitude, illustrating the high variability in metals in riverine environments. Comparison with other metals concentrations observed throughout the Hudson River Basin generally indicates that the concentrations observed at the site could generally be typical of urban ambient concentrations. Comparison with background data is complicated by two factors: 1) some available data (the NAWQA data set) are surface grabs, while most site data are composited cores, and there is evidence that metals concentrations increase with depth in depositional areas; 2) background samples are collected from a variety of land use regions, and not limited to urban areas.

The VOCs of concern are localized along the eastern shore, adjacent to the BASF facility and apparently concentrated around the outfalls (both the historic BASF outfalls and the active municipal outfalls). Data are not available to characterize either the lateral or vertical extent of the VOCs, nor are data available to compare with other locations along the Hudson River.

Given the magnitude of water and sediment discharge in the river and the relatively low flux of groundwater and surface runoff from the site, it is anticipated that any site-associated effects should be relatively localized. Few site-related solids are likely to deposit in the relatively fast water of the main river channel; they are likely to have deposited only in the relatively quiet water along the margins of the river.

Based on this CSM, the field sampling plan (Section 3) has been developed to consider the variations in sediment texture, grain size, deposition, scouring, and ultimately habitat type.

2.6.2 Potential Data Gaps

Following the data review and development of the CSM, several significant data gaps remain:

- What are the sources of the constituents of potential concern? Possible constituent sources on the site include historic discharge at the location of the outfalls, groundwater leaking through or under the bulkhead along the BASF property, or overland flow. Earlier studies indicated that if any groundwater is leaking through the bulkhead, it is only at a very small flow rate. Most runoff would likely be collected in the storm water system and is not likely a significant source of constituents. Elevated levels of VOCs were observed adjacent to both active and historic outfalls, although utility bedding on the site could provide connections throughout the site as well as with the property to the north.

- What is the extent (horizontal and vertical) of the VOCs? Too few VOC samples were collected in the previous surveys to map their distribution laterally or with depth in the sediment. The delineation of the extent of VOCs in sediments should help identify a likely source as well as provide insight into the fate and transport of these constituents, including potential migration from the source.

- Are the metals of interest associated with the Site or are they related to ambient urban background conditions in the Hudson River? Sufficient data do not exist to establish if the metals of interest observed adjacent to the site are related to ambient conditions or are related to the BASF facility, or if the distribution of metals observed in the vicinity of the site is largely a function of grain size distribution and other geophysical properties of the river.

The sampling plan (Section 3) provides a scope of work for collection of the following additional data regarding the nature and extent of the selected VOCs and metals in the vicinity of the BASF facility:

- A focused geophysical study is recommended to generate a higher resolution sediment grain size and substrate composition data set which would permit the most efficient design of a sediment sampling and analysis program. A review of the existing data suggests that, given the non-depositional nature of the river, any influence of the site is likely to be limited to, or at least significantly stronger, along the eastern shore of the river.

- Additional samples along the property boundary will serve to delineate the vertical and horizontal extent of the VOCs.

- Sediment cores will be used to infer changes in concentration with depth as well as potential source locations.

- Additional samples in the different grain size regions will further establish the relationship between observed metals concentrations and grain size, and provide a more extensive set of urban ambient measurements.

- Because of the observed relationships between contaminant concentrations and other factors (e.g., TOC and grain size), it is clearly necessary to collect these ancillary parameters to be able to properly interpret observed concentration data. Additional sampling will provide additional data to gain a better understanding of the data gaps identified above.

Table 2-1
Hudson River at Green Island Summary Flow Statistics (1946-2003)
BASF Corporation
Hudson River OU-2 Investigation
Rensselaer, New York

Statistic	**Value (cfs)**
Annual Mean	13,810
Highest Annual Mean (1976)	22,100
Lowest Annual Mean (1965)	6,386
Highest Daily Mean (3/14/77)	152,000
Lowest Daily Mean (9/2/68)	882
Annual 7-day Minimum (8/23/95)	2,110
10% Exceedence	28,800
50% Exceedence	9,480
90% Exceedence	4,280

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Table 2-2
Comparison of Observed Grain Size and NYSDEC Benthic Mapping
BASF Corporation
Hudson River OU-2 Investigation
Rensselaer, New York

ENSR (2001) Sediment Samples					NYSDEC Classification
Location	**Gravel**	**Sand**	**Silt**	**Clay**	
HR01	1.2	9.2	44.6	45	Sandy Gravel
HR02	2.8	58.5	23.5	15.1	Sandy Gravel
HR03	0.2	49.9	28.6	21.4	Sandy Gravel/Gravelly Sand
HR02G	6.9	83.5	6.1	3.5	Sandy Gravel
HR05	1.2	43.4	34.7	20.7	Muddy Sand
HR06	0.4	32	40.1	27.6	Muddy Sand
HR07	0.2	28.8	42.6	28.4	Sand/Muddy Sand
HR06G	0.1	69	22.9	8	Muddy Sand
HR04	1.4	23	46.8	28.8	Muddy Sand
HR08	32.1	66.1	1.2	0.6	Gravelly Sand
HR09	50.1	48.1	1.25	0.6	Muddy Sand
HR09G	59.5	39.4	0.8	0.4	Muddy Sand

Table 2-3
Summary of Metals of Interest Results for Hudson River Watershed Sediment Samples
BASF Corporation
Hudson River OU-2 Investigation
Rensselaer, New York

	NYSDEC (2000)			USGS (1998)	
Analyte	**Minimum (mg/kg)**	**Surficial Maximum (mg/kg)**	**Core Maximum (mg/kg)**	**Minimum (mg/kg)**	**Surficial Maximum (mg/kg)**
Cadmium	0.59	34.5	170	0.2	6.9
Chromium	29.8	55.8	175	40	160
Copper	33.6	171	171	9	410
Lead	27.8	890	1440	20	450
Mercury	0.15	0.87	3.5	0.03	1.4
Zinc	115	493	493	110	980

INCREASING WITH DEPTH.

Table 2-4
Summary of 2001 Sediment Metals Data
BASF Corporation
Hudson River OU-2 Investigation
Rensselaer, New York

Analyte	**Screening Values (mg/kg) (a)**	HR01	HR02	HR03	HR02G	HR05	HR06	HR07	HR06G	HR04	HR08	HR09	HR09G
Cadmium (mg/kg)	9	0.2	**12**	2.2	0.2	2.9	5.4	3.5	0.5	**11**	0.1	0.2	0.1
Chromium (mg/kg)	110	17	**170**	**140**	15	70	110	83	26	**200**	7.4	11	6.5
Copper (mg/kg)	110	28	74	86	24	70	**120**	100	29	**150**	12	11	19
Lead (mg/kg)	110	18	**190**	**160**	23	**220**	**210**	**220**	30	**330**	19	55	16
Mercury (mg/kg)	1.3	0.06	**1.4**	**1.6**	0.09	**1.9**	**2.2**	**2.1**	0.11	**2.6**	0.1	0.05	--
Zinc (mg/kg)	270	63	**280**	**280**	87	190	250	250	110	**330**	51	59	47
TOC (%)	-	0.48	3.0	0.78	1.31	3.36	4.73	3.87	1.69	4.86	0.99	0.27	0.77

(a) NYSDEC Severe Effect Level screening values obtained from NYSDEC (1999)

Note: Samples exceeding NYSDEC Severe Effects Level are presented in bold font.

Table 2-5
Summary of 2004 Sediment Metals Data
BASF Corporation
Hudson River OU-2 Investigation
Rensselaer, New York

Analyte	Screening Value (a) (mg/kg)	HR-SS-1	HR-SS-2	HR-SS-3	HR-SS-4	HR-SS-5	HR-SS-6	HR-SS-7	HR-SS-8	HR-SS-9	HR-SS-10	HR-SS-11	HR-SS-12
Cadmium (mg/kg)	9	5.1	**14**	3.7	**12**	6	3.2	1 U	4.6	0.92 U	1.8	0.69 U	0.71 U
Chromium (mg/kg)	110	**180**	**230**	**120**	**260**	**120**	**160**	40	**150**	23	66	5.7 U	6 U
Copper (mg/kg)	110	110	**150**	**120**	**230**	80	100	57	78	37	77	5.7 U	6 U
Lead (mg/kg)	110	**190**	**300**	**130**	**290**	97	**120**	49	**150**	99	**160**	5.7 U	6 U
Mercury (mg/kg)	1.3	0.78	**1.4**	**1.8**	**1.4**	0.41	0.91	0.15	0.49	0.13 U	0.36	0.096 U	0.099 U
Zinc (mg/kg)	270	**290**	**390**	**280**	**440**	230	**310**	180	**250**	170	210	44	42
TOC (%)		1.3	2.3	2	1.8	1.9	1.4	1.5	1.3	1.7	0.7	0.029	0.036

Analyte	Screening Value (a) (mg/kg)	HR-SS-13	HR-SS-14	HR-SS-15	HR-SS-16	HR-SS-17	HR-SS-18	LF-RST-4	LG-RST-2
Cadmium (mg/kg)	9	0.72 U	0.7 U	0.71 U	7.5	7.9	4.1	0.92 U	0.81 U
Chromium (mg/kg)	110	6.5	7.9	8.6	**240**	**260**	**180**	31	25
Copper (mg/kg)	110	6 U	7.5	15	**170**	**160**	**130**	47	63
Lead (mg/kg)	110	6 U	20	16	**250**	**1,400**	**210**	**120**	**130**
Mercury (mg/kg)	1.3	0.1 U	0.097 U	0.099 U	0.93	0.74	0.91	0.3	0.12
Zinc (mg/kg)	270	53	49	73	**500**	**520**	**360**	230	**350**
TOC (%)		0.03	0.048	0.13	2.1	2	1.7	--	--

(a) NYSDEC Severe Effect Level screening values obtained from NYSDEC (1999)

U = Analyte not detected at reported detection limit.

Note: Samples exceeding NYSDEC Severe Effects Level are presented in bold font.

Table 2-6
Minimum and Maximum Metals Concentration in the Near-Site River Reach
BASF Corporation
Hudson River OU-2 Investigation
Rensselaer, New York

Analyte	Screening Value (a) (mg/kg)	Site Vicinity Range (mg/kg)	Downstream Range (mg/kg)	Upstream Range (mg/kg)	Western Shore Range (mg/kg)
Cadmium	9	0.2-14	4.1-7.9	0.69-0.72	0.1-0.71
Chromium	110	15-260	180-260	5.7-6.5	6.5-11
Copper	110	24-230	130-170	5.7-6	7.5-19
Lead	110	18-330	210-1400	5.7-6	16-55
Mercury	1.3	0.06-2.6	0.74-0.93	0.096-0.1	0.05-0.1
Zinc	270	63-440	360-520	42-53	47-73

(a) NYSDEC Severe Effect Level screening values obtained from NYSDEC (1999)

Table 2-7
Summary of 2004 Sediment VOC Data
BASF Corporation
Hudson River OU-2 Investigation
Rensselaer, New York

Analyte	Acute Benthic Aquatic Life Criteria (ug/gOC)	HR-SS-1	HR-SS-2	HR-SS-3	HR-SS-4	HR-SS-5	HR-SS-6
		μg/gOC	μg/gOC	μg/gOC	μg/gOC	μg/gOC	μg/gOC
Sample TOC (g/kg):		13	23	20	18	19	14
1,2-Dichlorobenzene	120	47 J	33 J	1.9 U	37 J	**5,263**	79 U
1,3-Dichlorobenzene	120	77 U	48 U	1.9 U	53 U	**484**	79 U
1,4-Dichlorobenzene	120	77 U	48 U	1.9 U	53 U	**363**	79 U
Benzene	103	**323**	**248**	14	23	**216**	25
Chlorobenzene	34.6	**1,077**	**1,174**	**95**	**428**	**4,789**	**1,143**

Analyte	Acute Benthic Aquatic Life Criteria (ug/gOC)	HR-SS-7	HR-SS-8	HR-SS-9	HR-SS-10	HR-SS-11	HR-SS-12
		μg/gOC	μg/gOC	μg/gOC	μg/gOC	μg/gOC	μg/gOC
Sample TOC (g/kg):		15	13	17	7	0.29 U	0.36
1,2-Dichlorobenzene	120	0.6 U	0.6 U	6.5	4.7 U	20 U	17 U
1,3-Dichlorobenzene	120	0.6 U	0.6 U	1.3 J	4.7 U	20 U	17 U
1,4-Dichlorobenzene	120	0.6 U	0.6 U	11	4.7 U	20 U	17 U
Benzene	103	0.6 U	0.6 U	12	2.1 J	20 U	17 U
Chlorobenzene	34.6	0.6 U	0.6 U	**100**	**43**	20 U	17 U

Analyte	Acute Benthic Aquatic Life Criteria (ug/gOC)	HR-SS-13	HR-SS-14	HR-SS-15	HR-SS-16	HR-SS-17	HR-SS-18
		μg/gOC	μg/gOC	μg/gOC	μg/gOC	μg/gOC	μg/gOC
Sample TOC (g/kg):		0.3 U	0.48	1.3	21	20	17
1,2-Dichlorobenzene	120	20 U	12 U	4.6 U	2.1 U	2.2 U	0.6 U
1,3-Dichlorobenzene	120	20 U	12 U	4.6 U	2.1 U	2.2 U	0.6 U
1,4-Dichlorobenzene	120	20 U	12 U	4.6 U	2.1 U	2.2 U	0.6 U
Benzene	103	20 U	12 U	4.6 U	2.1 U	2.2 U	0.6 U
Chlorobenzene	34.6	20 U	12 U	4.6 U	0.8 J	0.7 J	0.6 U

(a) NYSDEC Benthic Aquatic Life Acute Toxicity Criteria obtained from NYSDEC (1999)

J = Estimated concentration.

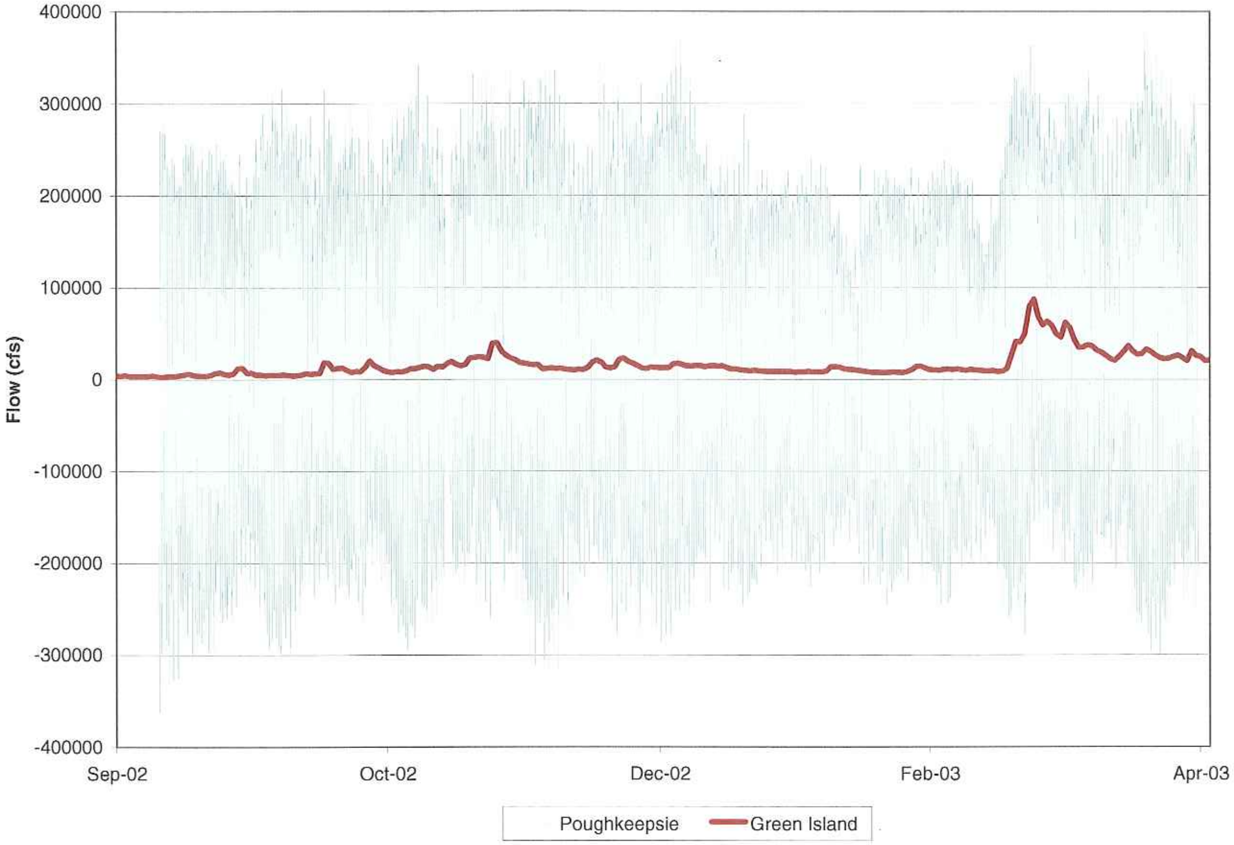
U = Analyte not detected at reported detection limit.

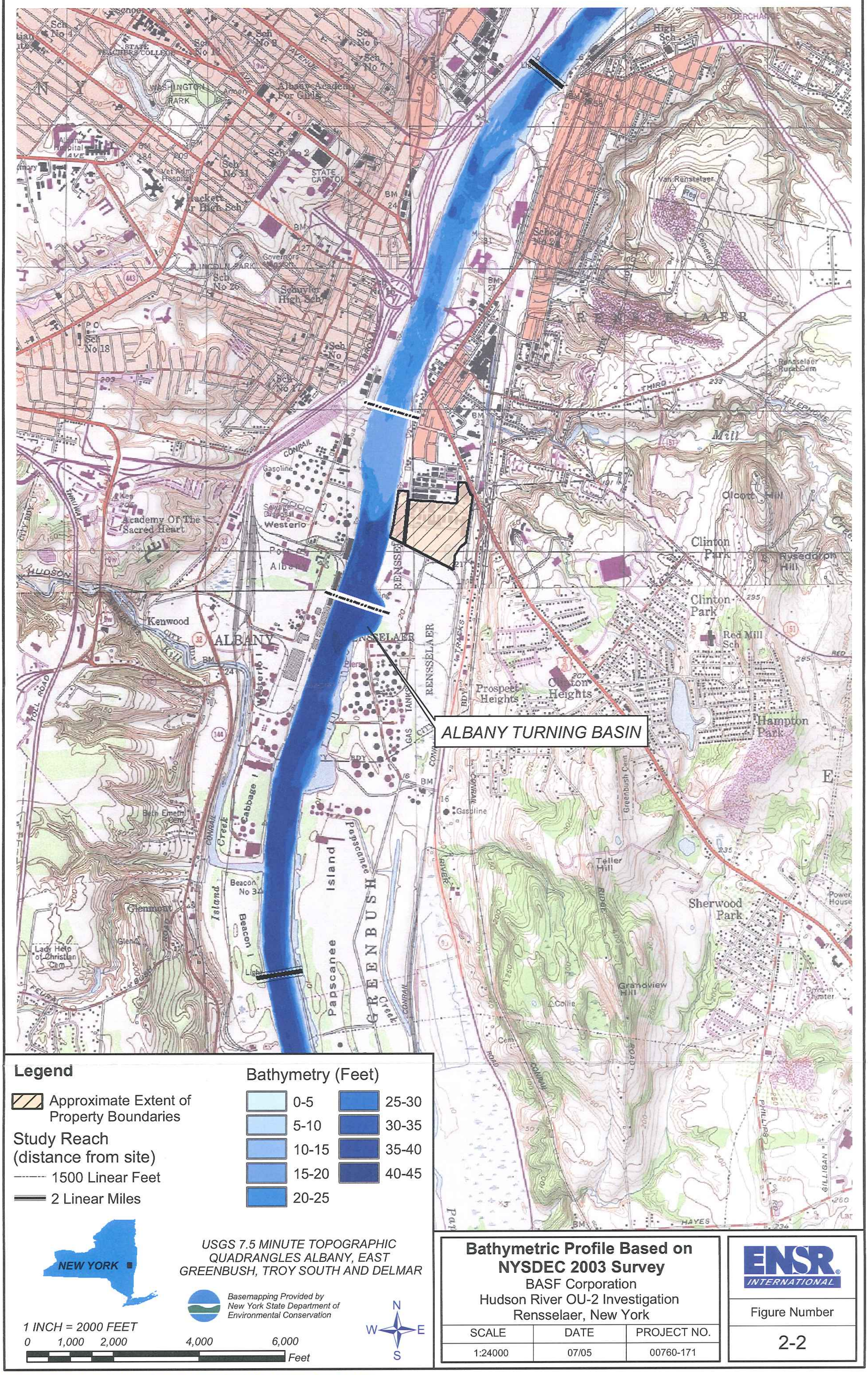
Note: Samples exceeding Acute Benthic Aquatic Life Criteria are presented in bold font.

Figure 2-1

Hudson River Flow at Poughkeepsie and Green Island

BASF Corporation
Hudson River OU-2 Investigation
Rensselaer, New York





Bathymetric Profile Based on NYSDEC 2003 Survey
BASF Corporation
Hudson River OU-2 Investigation
Rensselaer, New York

SCALE	DATE	PROJECT NO.
1:24000	07/05	00760-171

ENSR INTERNATIONAL

Figure Number

2-2

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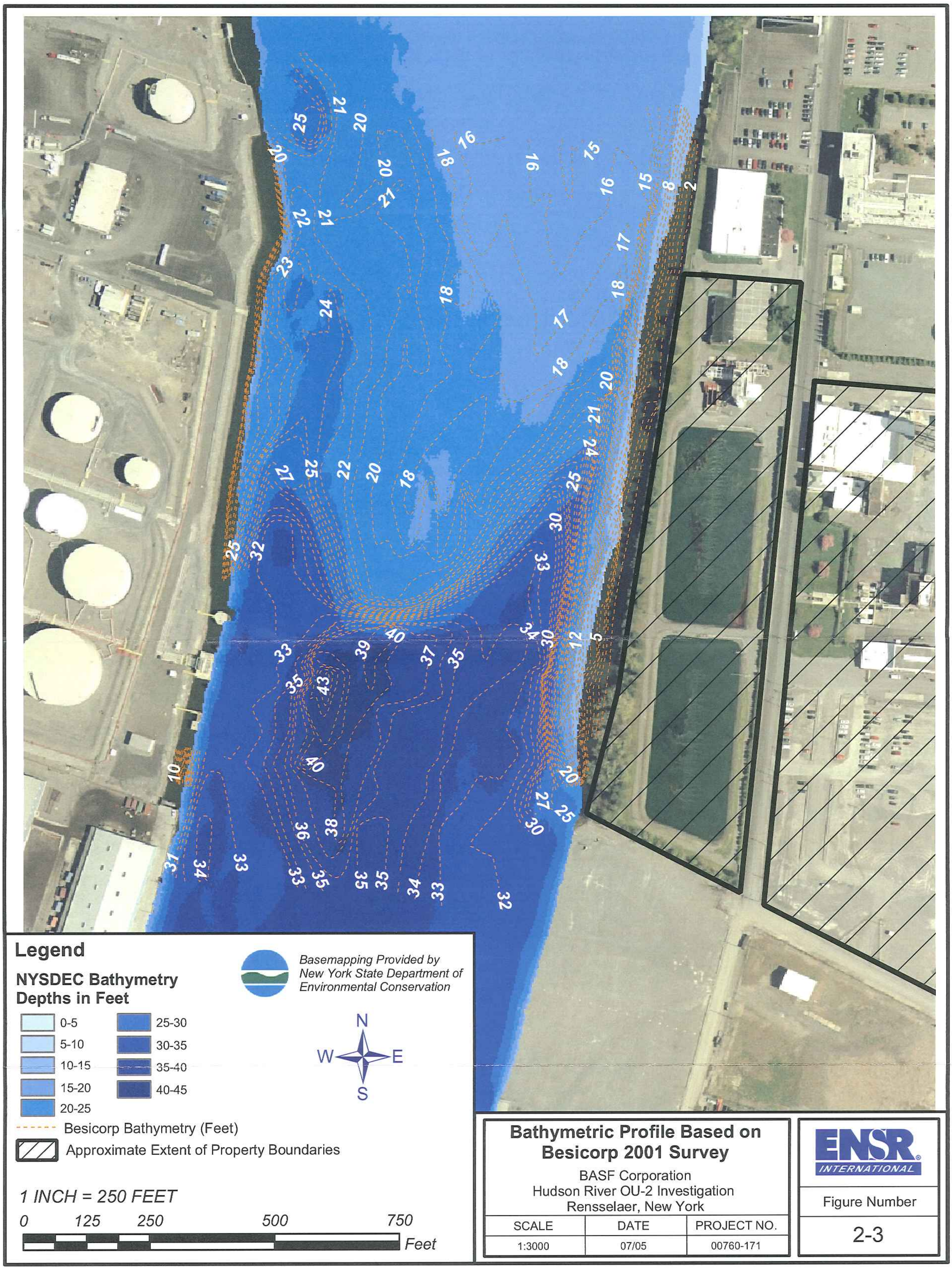

Bathymetric Profile Based on Besicorp 2001 Survey

BASF Corporation
Hudson River OU-2 Investigation
Rensselaer, New York

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ENSR INTERNATIONAL

Figure Number

2-3

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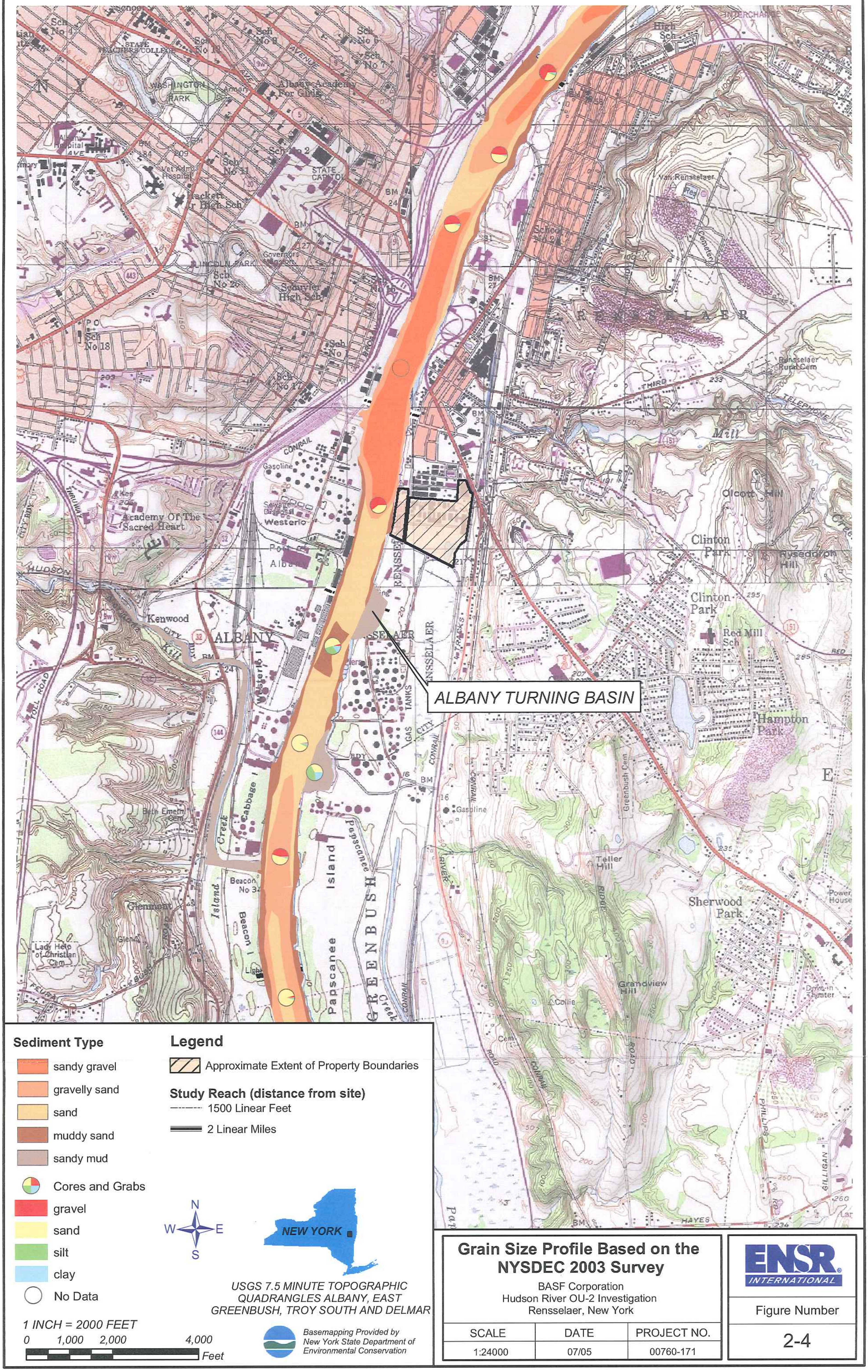

Grain Size Profile Based on the NYSDEC 2003 Survey

BASF Corporation
Hudson River OU-2 Investigation
Rensselaer, New York

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ENSR INTERNATIONAL

Figure Number

2-4

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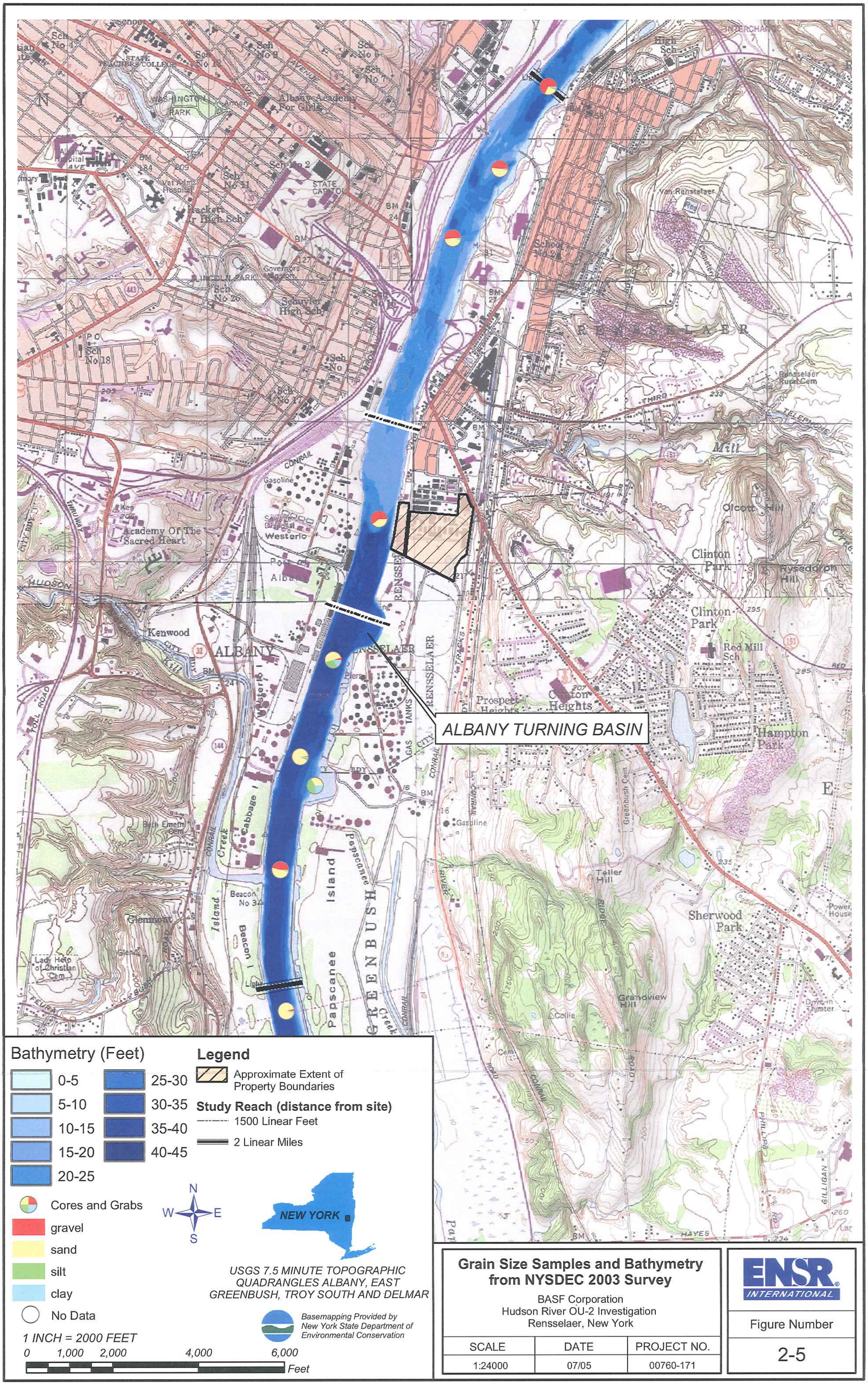

Grain Size Samples and Bathymetry from NYSDEC 2003 Survey

BASF Corporation
Hudson River OU-2 Investigation
Rensselaer, New York

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Figure Number

2-5

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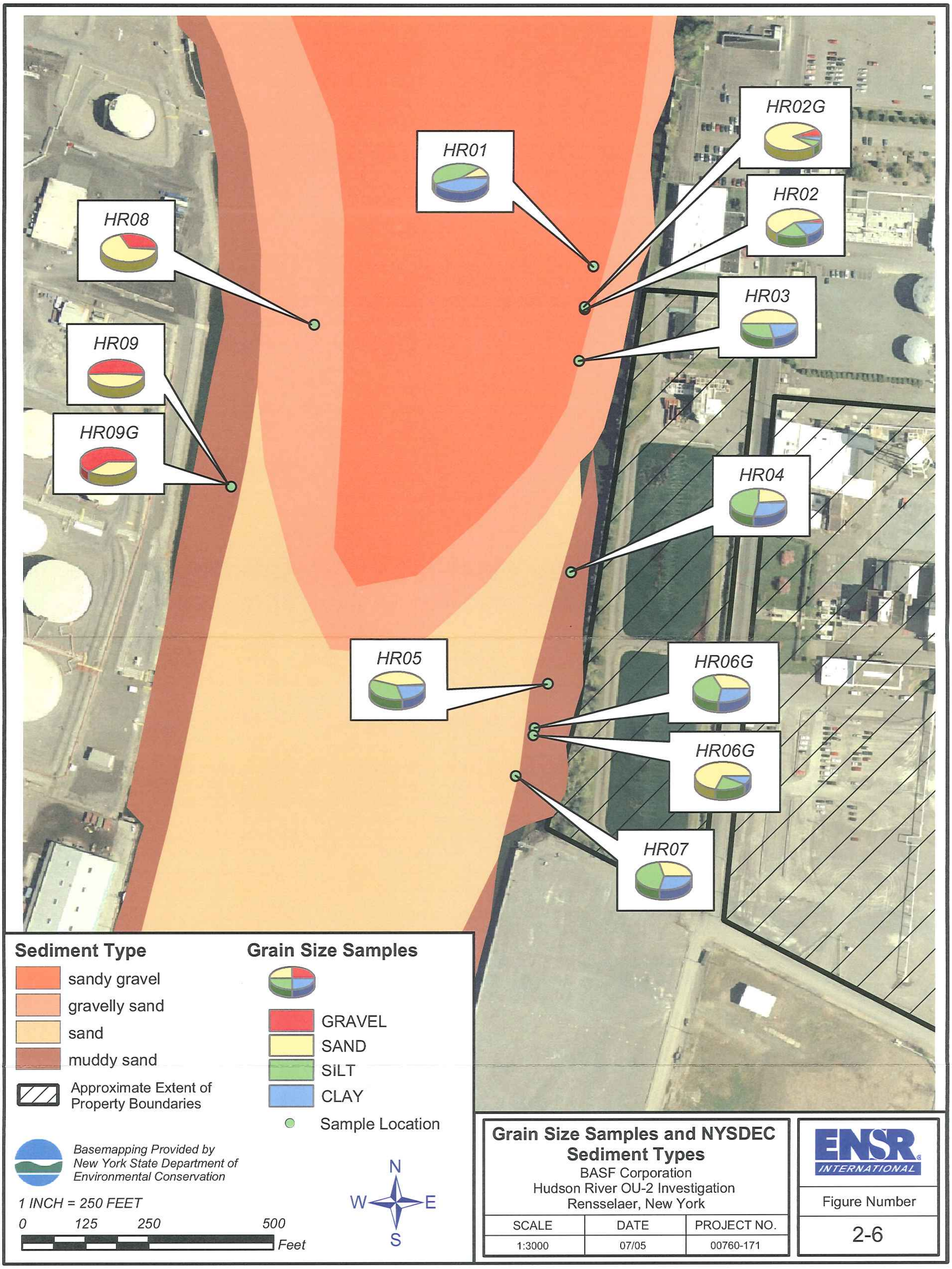

Grain Size Samples and NYSDEC Sediment Types

BASF Corporation
Hudson River OU-2 Investigation
Rensselaer, New York

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Figure Number
2-6

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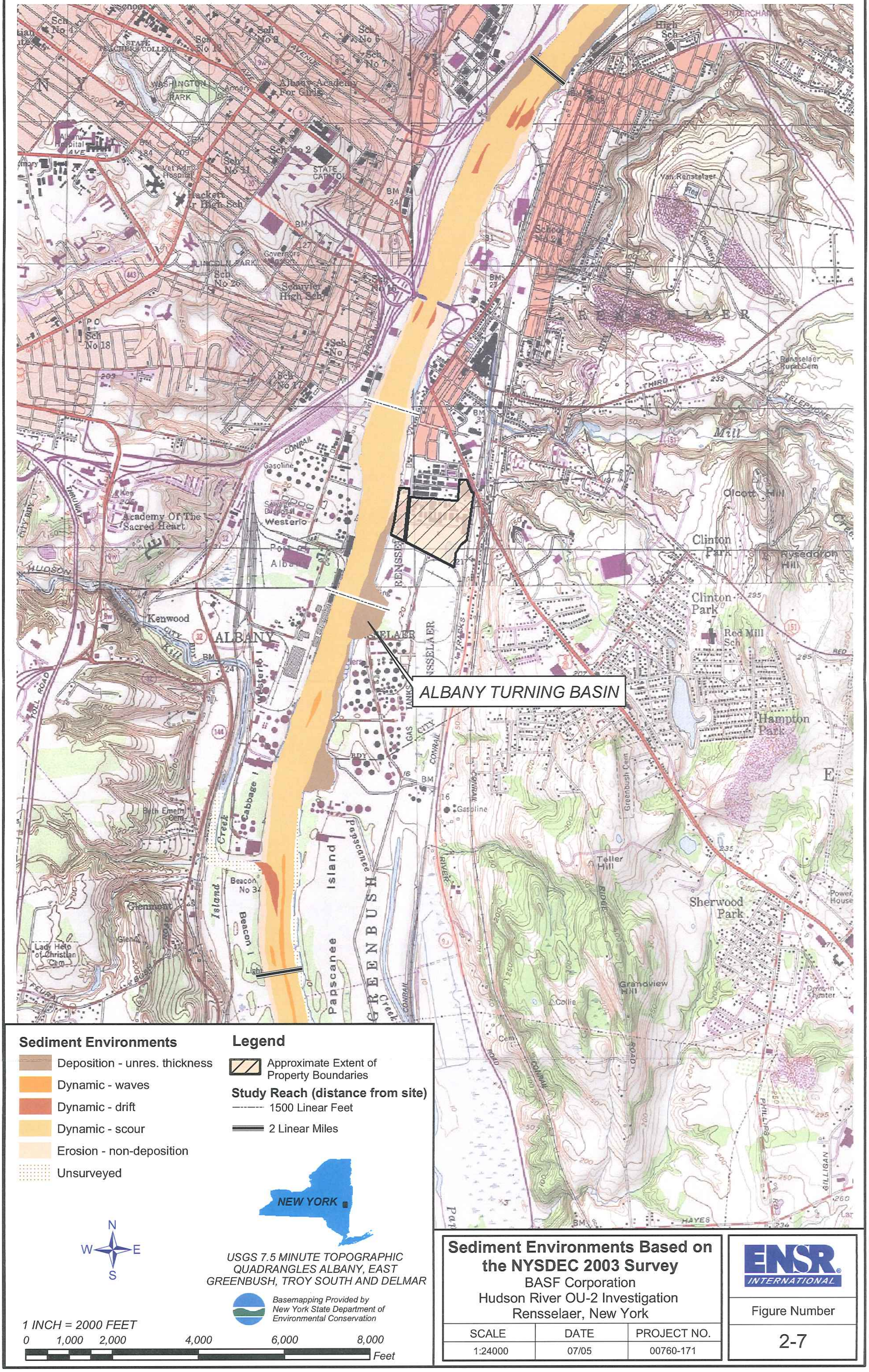

USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLES ALBANY, EAST GREENBUSH, TROY SOUTH AND DELMAR

Basemapping Provided by New York State Department of Environmental Conservation

Sediment Environments Based on the NYSDEC 2003 Survey

BASF Corporation
Hudson River OU-2 Investigation
Rensselaer, New York

SCALE	DATE	PROJECT NO.
1:24000	07/05	00760-171

ENSR INTERNATIONAL

Figure Number

2-7

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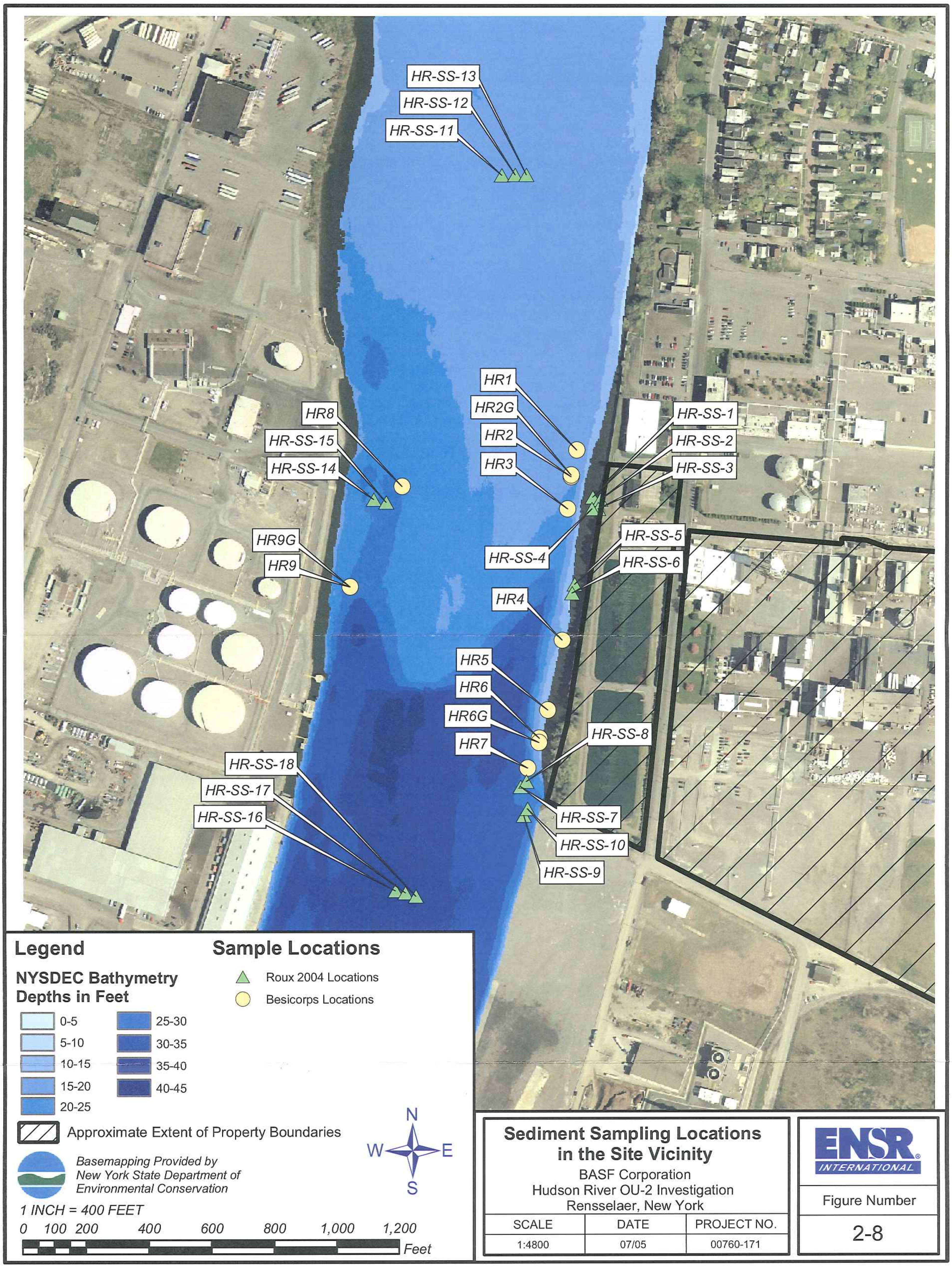

Sediment Sampling Locations in the Site Vicinity

BASF Corporation
Hudson River OU-2 Investigation
Rensselaer, New York

SCALE	DATE	PROJECT NO.
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Figure Number
2-8

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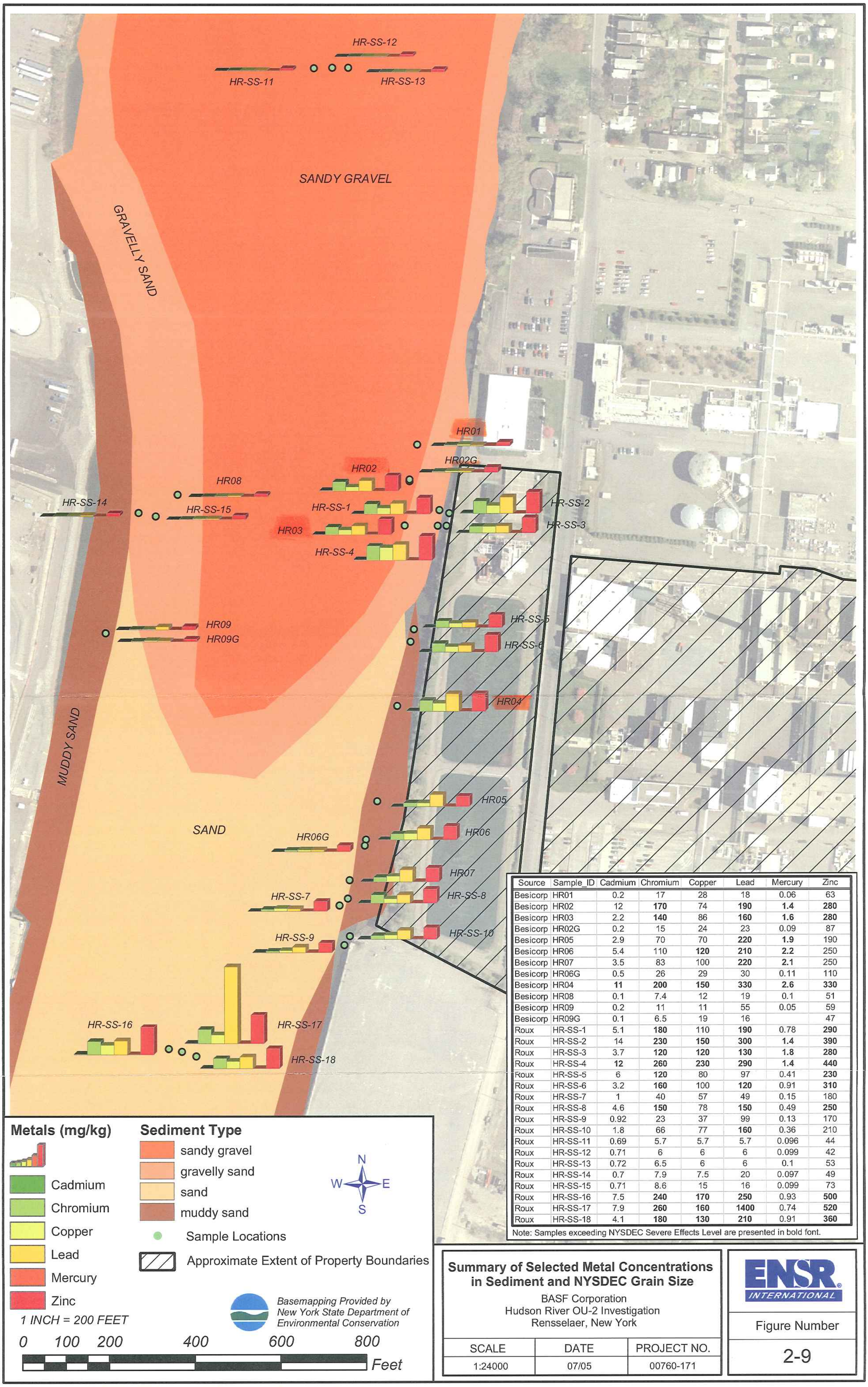

Source	Sample_ID	Cadmium	Chromium	Copper	Lead	Mercury	Zinc
Besicorp	HR01	0.2	17	28	18	0.06	63
Besicorp	HR02	12	**170**	74	**190**	**1.4**	**280**
Besicorp	HR03	2.2	**140**	86	**160**	**1.6**	**280**
Besicorp	HR02G	0.2	15	24	23	0.09	87
Besicorp	HR05	2.9	70	70	**220**	**1.9**	190
Besicorp	HR06	5.4	110	**120**	**210**	**2.2**	250
Besicorp	HR07	3.5	83	100	**220**	**2.1**	250
Besicorp	HR06G	0.5	26	29	30	0.11	110
Besicorp	HR04	**11**	**200**	**150**	**330**	**2.6**	**330**
Besicorp	HR08	0.1	7.4	12	19	0.1	51
Besicorp	HR09	0.2	11	11	55	0.05	59
Besicorp	HR09G	0.1	6.5	19	16		47
Roux	HR-SS-1	5.1	**180**	110	**190**	0.78	**290**
Roux	HR-SS-2	14	**230**	**150**	**300**	**1.4**	**390**
Roux	HR-SS-3	3.7	**120**	**120**	**130**	**1.8**	**280**
Roux	HR-SS-4	**12**	**260**	**230**	**290**	**1.4**	**440**
Roux	HR-SS-5	6	**120**	80	97	0.41	**230**
Roux	HR-SS-6	3.2	**160**	100	**120**	0.91	**310**
Roux	HR-SS-7	1	40	57	49	0.15	180
Roux	HR-SS-8	4.6	**150**	78	**150**	0.49	**250**
Roux	HR-SS-9	0.92	23	37	99	0.13	170
Roux	HR-SS-10	1.8	66	77	**160**	0.36	210
Roux	HR-SS-11	0.69	5.7	5.7	5.7	0.096	44
Roux	HR-SS-12	0.71	6	6	6	0.099	42
Roux	HR-SS-13	0.72	6.5	6	6	0.1	53
Roux	HR-SS-14	0.7	7.9	7.5	20	0.097	49
Roux	HR-SS-15	0.71	8.6	15	16	0.099	73
Roux	HR-SS-16	7.5	**240**	**170**	**250**	0.93	**500**
Roux	HR-SS-17	7.9	**260**	**160**	**1400**	0.74	**520**
Roux	HR-SS-18	4.1	**180**	**130**	**210**	0.91	**360**

Note: Samples exceeding NYSDEC Severe Effects Level are presented in bold font.

Summary of Selected Metal Concentrations in Sediment and NYSDEC Grain Size

BASF Corporation
Hudson River OU-2 Investigation
Rensselaer, New York

SCALE	DATE	PROJECT NO.
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ENSR INTERNATIONAL

Figure Number

2-9

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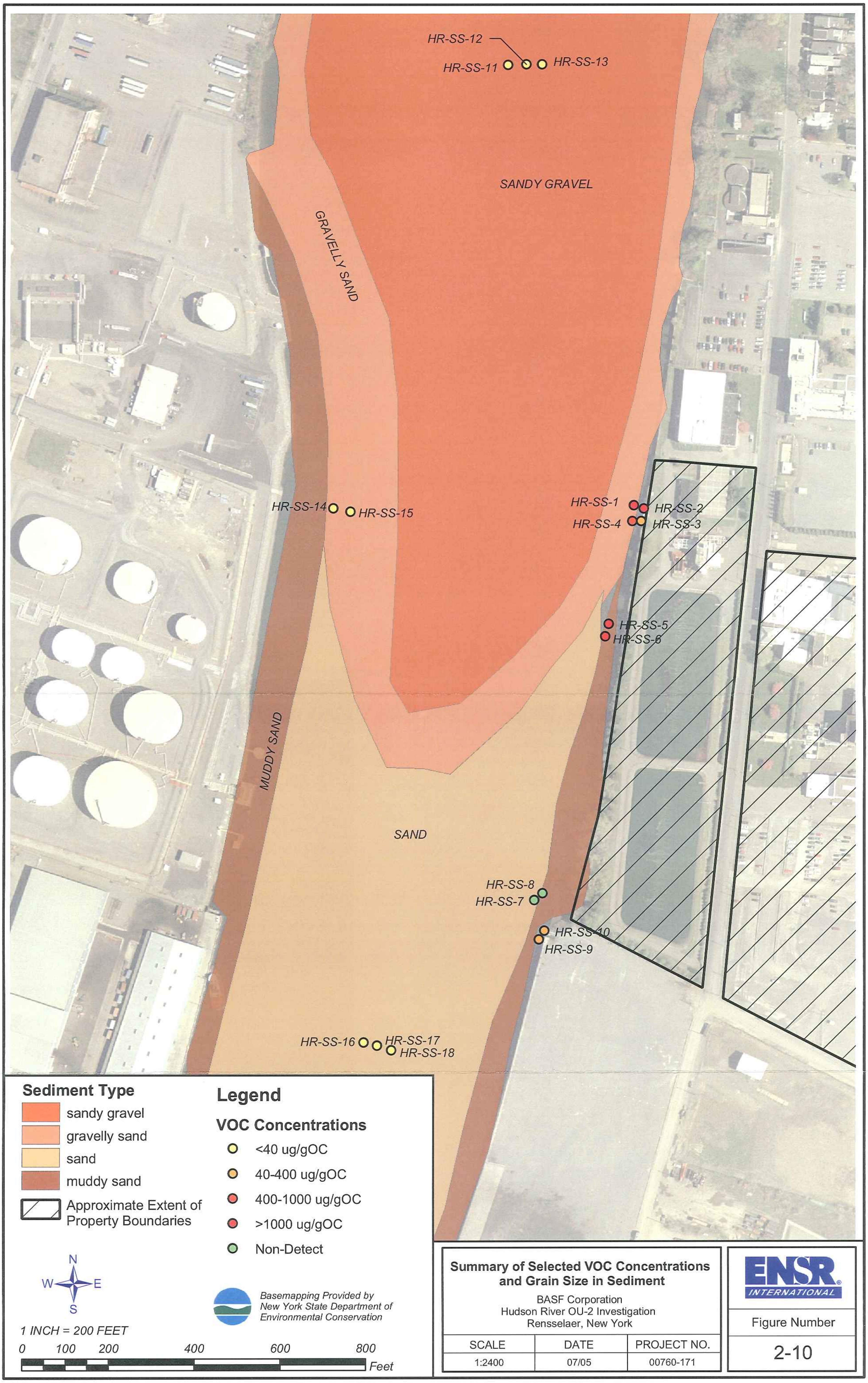

Basemapping Provided by
New York State Department of
Environmental Conservation

**Summary of Selected VOC Concentrations
and Grain Size in Sediment**

BASF Corporation
Hudson River OU-2 Investigation
Rensselaer, New York

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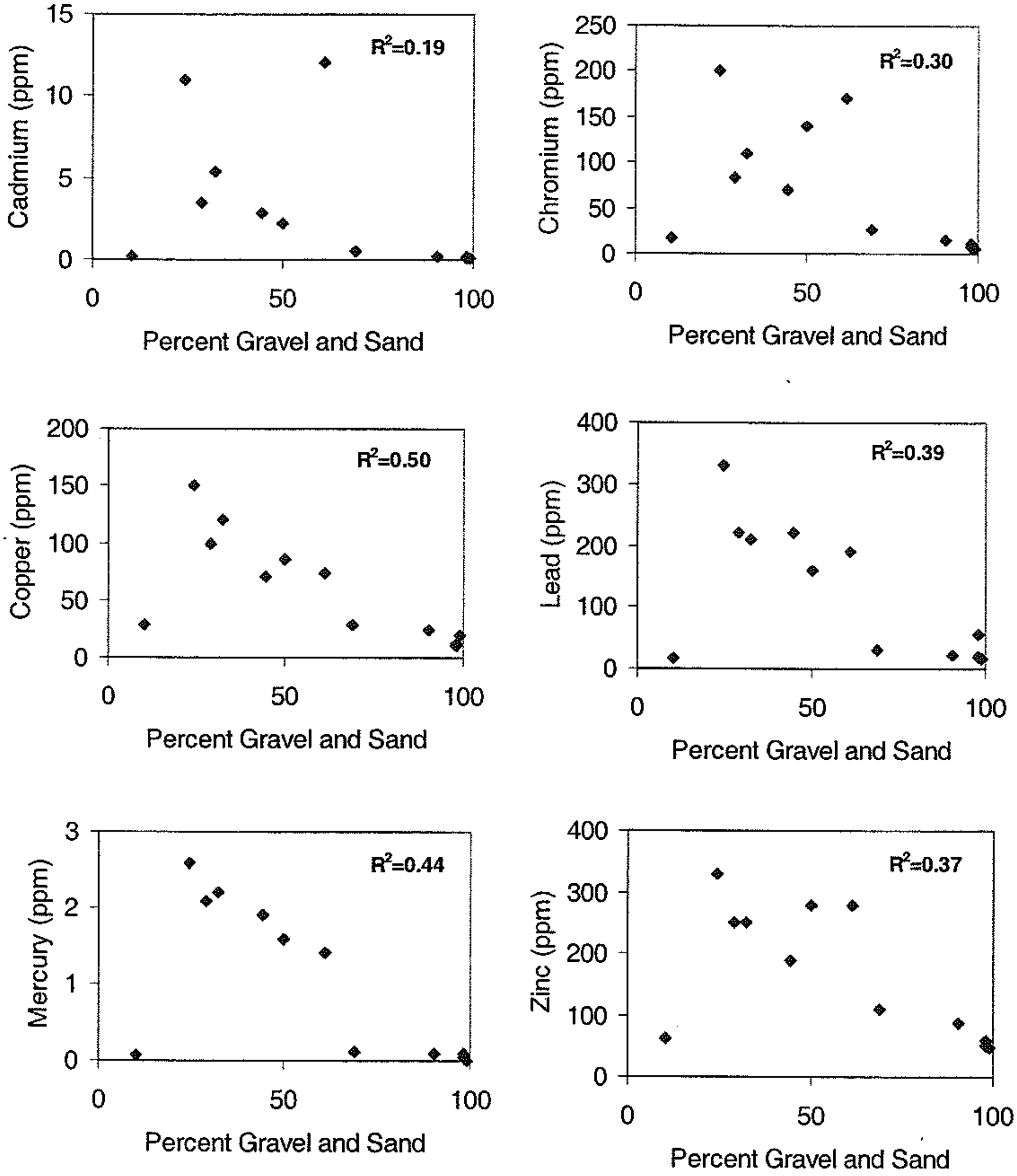
1:2400	07/05	00760-171

ENSR INTERNATIONAL

Figure Number

2-10

Figure 2-11
Correlation of Metals with Grain Size
BASF Corporation
Hudson River OU-2 Investigation
Rensselaer, New York



3.0 FIELD SAMPLING SCOPE OF WORK

This section of the Work Plan describes the procedures that will be implemented for the field sampling activities at the site. The field program includes the following activities:

- Focused geophysical survey;
- Sediment sampling and analysis;
- Surface water sampling and analysis; and
- Benthic macroinvertebrate reconnaissance level survey.

This section describes the field and laboratory investigations that will be conducted to meet project objectives for the river characterization. The tasks described in these sections are supported by the Quality Assurance Program Plan (QAPP), which is attached as Appendix B to this work plan. All work will be performed in strict conformance with OSHA standard 1910.120 as detailed in the Project Health and Safety Plan (HASP; Appendix C). The HASP describes the level of personal protective equipment (PPE) required for this field program. In general, field program personnel will be required to wear OSHA Level D ensembles of PPE.

Preliminary sediment sampling station locations to support the river characterization are depicted on Figure 3-1 and 3-2; surface water and benthic community survey sampling locations are shown on Figure 3-3. The actual sampling locations may be slightly modified based on site conditions encountered in the field, the results of the focused geophysical survey, and based on the recommendations of NYSDEC upon field program initiation.

3.1 Data Quality Objectives

The Data Quality Objectives (DQOs) for the river characterization were developed using the EPA's DQO process, a multi-step, iterative process that ensures that the type, quantity, and quality of environmental data used in the decision making process are appropriate for its intended application. Specific analytical chemistry DQOs are presented in the QAPP. Table 3-1 presents the general DQOs for this evaluation, and Table 3-2 presents a summary of the rationale for the proposed sampling program.

3.1.1 Sediment Sampling and Analysis Objectives

With regard to the sediment sampling effort, the proposed program was designed to: (1) acquire sufficient data to evaluate the nature and extent of potentially site-related VOCs and metals in the context of site-specific riverine geophysical and substrate characteristics; (2) acquire sufficient data to conduct a screening level ecological risk assessment in accordance with NYSDEC requirements; and (3) evaluate the relationship between anthropogenic background concentrations of inorganic constituents in an upstream reach of the river relative to the concentrations of these constituents in the near-site (Adjacent) reach of the river, including consideration of sediment texture.

3.1.2 VOC Sediment Sampling Objectives

As described in Section 2, the available data suggest that the VOC concerns at this site are present in the nearshore environment, in the vicinity of the bulkhead and in the vicinity of historic discharge locations (e.g., sewer outfalls). While transport of VOCs is possible beyond the nearshore environment, the volume of water and sediment movement in the river suggests that such transport will not affect sediment or water quality in the main stem of the river. Therefore, the primary objective relative to the VOC sampling effort is to delineate the extent of the VOCs in this nearshore environment through collection of the following analytical data, as depicted in Figure 3-1:

<u>Surficial Sediment Sampling</u>

A total of 33 surficial sediment samples (0 to 6 inches) will be collected for evaluation of VOCs at the site. The surficial sampling effort for VOCs includes the following numbers of samples (additional rationale is included in Table 3-2).

- 27 surficial sediment samples will be collected from three palmate transects centered on the three outfall locations (3 outfalls, 3 transects, 3 samples per transect = 27 samples). The sampling locations within each transect have been placed within 25 linear feet of the bulkhead, 75 linear feet of the bulkhead, and 150 linear feet of the bulkhead, with a slight southerly angle to account for the predominance of downstream flow;
- 4 surficial sediment samples will be collected from locations along the bulkhead in between the outfalls; and
- 2 surficial sediment samples will be collected from locations upstream (both samples will be collected in Muddy Sand substrate to approximate nearshore conditions)

<u>Sub-Surficial Sediment Sampling</u>

A total of 18 sub-surficial samples will be collected for evaluation of VOCs in the sub-surface sediments at this site.

- 18 sub-surface samples will be collected from nine cores located on the above-described palmate transects centered on the three outfall locations (1 core per transect, 9 transects, 2 intervals per core);

- Sub-surficial samples will be collected from approximately the 2 to 4 ft and 4 to 6 ft sampling horizon; and
- The core sampling locations will be co-located with nine of the 33 surficial sampling locations

All surficial and sub-surficial sediment samples will be evaluated for VOCs, total organic carbon (TOC), and grain size. Specific detail regarding analytical methodologies and analytical DQOs are contained in the QAPP.

3.1.3 Inorganic Sediment Sampling Objectives

As described in Section 2, the inorganic constituents detected in the near-site and downstream sediment in historic sampling efforts may be attributable to BASF or may, at least in part, be attributable to ambient anthropogenic background conditions. With regard to these metals, evaluating the nature, extent, potential risks associated with exposure to the sediments, and relationship to upstream conditions requires a detailed understanding of the grain size distribution, bathymetry, depositional characteristics, and other geophysical properties of the river. Based on the NYSDEC (2003) and ENSR (2001) geophysical surveys, four major environmental substrates (e.g., benthic habitat types) have been identified in the immediate vicinity of the BASF Site:

- Sandy Gravel;
- Gravelly Sand;
- Sand; and
- Muddy Sand.

A fifth substrate (sandy mud) is also found within the general area of the BASF facility, but is generally limited to the downstream navigational turning basins. The proposed sediment sampling program considers these substrates as they relate to the overall sampling objective of obtaining sufficient data for conducting a statistical analysis of upstream versus near-site conditions. Namely, within each of these four major substrate types, implementation of the proposed sampling program will result in collection of sufficient surficial sediment samples for evaluating the statistical relationships between and among upstream and adjacent reaches of the river within each of the major substrate types. Likewise, with regard to the screening level ecological risk assessment, the reconnaissance level macroinvertebrate sampling program has been designed to provide broad spatial coverage (including reference conditions upstream of the site), as well as to obtain samples from each of the major substrate types.

Collection of the following analytical data, as depicted in Figure 3-2, will permit BASF to achieve project objectives relative to the substrate types, bathymetry, and statistical needs:

Surficial Sediment Sampling

A total of 96 surficial sediment samples (0 to 6 inches) will be collected for evaluation of inorganic constituents at the site. As depicted in Figures 3-1 and 3-2, whenever possible sampling locations for the VOC analysis and inorganic analysis are co-located.

- 27 surficial sediment samples will be collected from three palmate transects centered on the three outfall locations (3 outfalls, 3 transects, 3 samples per transect = 27 samples). The sampling locations within each transect have been placed within 25 linear feet of the bulkhead, 75 linear feet of the bulkhead, and 150 linear feet of the bulkhead, with a slight southerly angle to account for downstream flow;
- 4 surficial sediment samples will be collected from locations along the bulkhead in between the outfalls;
- 4 surficial sediment samples will be collected from locations in muddy sand on the far (western) side of river;
- 15 samples will be collected in sand immediately downstream of site, surrounding HR-SS-17, and providing spatial coverage of sand wedge;
- 6 samples will be collected in gravelly sand in immediate vicinity and immediately downstream of site;
- 10 samples will be collected in sandy gravel in immediate vicinity and immediately downstream of site; and
- 30 Upstream samples: 10 samples each in 2 matrices (muddy sand and sand); 5 samples each in two matrices (sandy gravel, gravelly sand).

Sub-Surficial Sediment Sampling

A total of 24 sub-surficial samples will be collected for evaluation of inorganic constituents in the sub-surface sediments at this site.

- 18 sub-surface samples will be collected from nine cores located on the palmate transects centered on the three outfall locations (1 core per transect, 9 transects, 2 intervals per core);
- 3 additional cores (1 per substrate type) will be collected in the adjacent reach of river; 2 samples per core;

- Sub-surficial samples will be collected from approximately the 2 to 4 ft and 4 to 6 ft sampling horizon; and
- The core sampling locations will be co-located with 12 of the 96 surficial sampling locations.

All inorganic samples will be evaluated for selected metals and grain size. A sub-set of approximately 50 percent of the samples will be analyzed for TOC, SEM, and AVS. Specific detail regarding analytical methodologies and analytical DQOs are contained in the QAPP.

3.2 Mobilization/Demobilization

Mobilization for the field effort will include a kick-off meeting for the field team, subcontracting all required laboratories, purchasing/renting field equipment, coordinating receipt of sample bottles from the laboratory and volume requirements, obtaining site security passes for the field team (if required), location of all sampling stations with Global Positioning System (GPS), and coordinating with NYSDEC and BASF personnel during the field investigation. Field data sheets will be prepared during project mobilization; selected sample data sheets are included in the QAPP. Prior to the mobilization/demobilization, a field reconnaissance trip may be held with NYSDEC to select sampling locations.

Equipment requirements will be finalized by the Field Team Leader (FTL) following the acceptance of the work plan. The FTL will review the scope of work and assemble equipment (e.g., vehicles, sampling, personal protection, and decontamination equipment) to implement and complete the field investigations.

This list will be reviewed by the project team and by the ENSR Project Manager. The FTL will be responsible for packaging and loading of equipment, and ensuring that all equipment is operable and calibrated.

The FTL will be responsible for tracking equipment used in the field. It is anticipated that the following services will be subcontracted: boat operator; analytical laboratory services; and benthic community taxonomy and enumeration. Following the procurement of these services, the FTL will be responsible for coordinating these activities. The Project Chemist/Laboratory Coordinator will be responsible for coordinating the analytical services, as well as, the acquisition and delivery of sample bottles to the site.

During mobilization, the FTL will review the roles and responsibilities of each member, and review the requirements of the various field activities. Upon mobilization, an on-site meeting will be conducted to review health and safety requirements. The Site Safety Officer (SSO) will be responsible for reviewing the HASP with the field team members and subcontractors.

3.3 Field Team Responsibilities

The FTL will have overall responsibility and authority for the various field activities. The FTL will be responsible for coordinating and managing the field sampling team and subcontractors. The FTL will report directly to the Project Manager.

A field team consisting of at least two people will be used during the field activities. The team will coordinate directly with the FTL and Project Manager.

The SSO will be responsible for training and monitoring site conditions. The SSO will report directly to the Project Manager and work closely with the FTL.

A Quality Assurance/Quality Control (QA/QC) Officer will be responsible for ensuring that all field work performed by ENSR or their subcontractors is being conducted in accordance with this FSP. The QA/QC Officer will be responsible for conducting on-site and laboratory audit(s) and reporting of deficiencies. The QA/QC Officer will report directly to the Project Manager.

3.4 Focused Geophysical Survey

In order to obtain a higher resolution data set which would permit the final design of a sediment sampling and analysis program, a two-day hydrographic survey(s) using a survey grade side scan sonar system (e.g. Edgetech 272-TD) and a CW low-frequency sub-bottom profiling system (e.g., SyQwest 10-kHz Stratabox) is proposed. Given the likely goals of such a survey and the relatively short river reach of interest, 25-m to 50-m range side scan sonar and a 100-kHz signal will provide adequate resolution for meeting project objectives. Survey lines will be spaced to allow 100-percent overlap. Sub-bottom sonar data will be collected simultaneously with the side scan sonar survey. Gains for both sonar systems will be properly adjusted during acquisition, and data processing shall include TVG and BAC corrections. Side scan mosaics will be produced using the finest resolution possible, allowing accurate identification of substrate composition. Substrate composition will be verified using a small benthic grab. All data will be georeferenced to the same grid and datum as other site plans, allowing incorporation into the site GIS project.

Once the focused geophysical survey is complete, the final sampling locations will be selected and geo-positioned. It is anticipated that preliminary mapping can be conducted as part of the two-day geophysical field effort, and that selection of final sampling stations will occur without any temporal delay. It is recognized that the preliminary locations depicted in Figure 3-1 may be slightly modified based on the results of the focused geophysical survey.

3.5 Sediment Sampling

Sediment sampling will be conducted in order to obtain a more comprehensive analytical chemistry data set for the Hudson River adjacent to the site, as well as to evaluate the spatial variability in the system. Additional sediment data will be collected to further delineate the chemical stressor distribution in the sediment in the vicinity of the site and will include collection of sediment from upstream and downstream sampling locations. Sediment data will be used to support future risk assessment activities and to further refine the conceptual site model.

Based on historic site activities, the sampling efforts within the river will focus on delineating the extent of site-related metals and VOCs as they relate to grain size and depositional environments (see Table 3-2 for sampling rationale). Both surficial and sub-surficial samples will be collected to assess the vertical delineation of potential constituents. In addition, simultaneously extracted metals (SEM) and acid volatile sulfides (AVS) analyses will be collected to evaluate the potential bioavailability of selected divalent metals within the metals delineation area. SEM and AVS data will be collected from approximately 25% of the sediment sampling locations.

As described in the USEPA's (2001) Method for Collection, Storage, and Manipulation of Sediments for Chemical and Toxicological Analysis: Technical Manual, the sampling station locations were selected following a "Targeted Sampling Design" where prior knowledge of site-related factors are incorporated into the process of selected station locations. The targeting sampling design was selected to minimize sampling error attributable to selecting sampling stations that may not represent the defined area of interest. Sampling station locations were targeted to represent "worst case" conditions by selecting sampling locations in depositional areas.

Sediment sampling within the Hudson River will be conducted in order to identify the presence and extent of potential site related constituents. Proposed locations of the sediment sampling stations are presented in Table 3-2, Figures 3-1 and 3-2. As indicated in these figures, sampling to delineate VOC contamination will be focused on the near-shore study area near the three historic BASF outfalls. Sampling for metals will include the near-shore study area as well as additional samples collected from the upstream and adjacent reaches. As described below, both surficial and sub-surficial sediment samples will be collected to evaluate both the horizontal and the vertical distribution of contaminants.

3.5.1 Surficial Sediment Sampling Procedures

Discrete surficial sediment samples will be collected using a petit ponar dredge, pole-mounted Ekman grab sampler, vibracore barrel, a gravity-corer, or stainless steel spoon or equivalent depending upon specific sampling-station characteristics in accordance with Section 3.2 of the USEPA's (2001) Method for Collection, Storage, and Manipulation of Sediments for Chemical and Toxicological Analysis: Technical Manual.

Surficial sediment will be collected from the upper 0 to 15 cm horizon. Generally, this is the sediment horizon of interest as it contains the most recently deposited sediments and the most epifaunal and infaunal organisms are found within this horizon (USEPA, 2001).

The top 0 to 4 cm horizon will be collected and placed in the appropriate sample container for SEM and AVS analyses prior to the homogenization of the remaining sample. Only the top 0 to 4 cm of sediment will be collected for analysis of SEM and AVS because the AVS concentration increases dramatically below the top few centimeters, whereas sampling at greater depths may fail to indicate the toxicity of the top few centimeters (van der Berg et. al 1998).

3.5.2 Sub-Surficial Sediment Sampling Procedures

Sub-surficial sediment samples will also be collected from a sub-set of the surficial sediment sampling locations in order to characterize the vertical distribution of contaminants and the potential for groundwater discharge to the sediments. Sub-surface samples will be collected using a vibracore sampling device and will target cores from the 2 to 4 foot and 4 to 6 foot horizon at each station. These depth horizons are well below the bioactive zone, but were selected to provide data on the vertical distribution of VOCs and metals.

3.5.3 General Sediment Sampling Procedures

The appropriate sediment horizon (surficial or sub-surficial) will be removed from the appropriate sampling device using a stainless steel spoon/scoop and placed in a decontaminated 1-gallon stainless steel or pyrex glass mixing bowl. Each sample will be visually examined for physical characteristics such as composition, layering, odor, and discoloration. Samples for VOC, SEM, and AVS analyses will be collected prior to sediment homogenization. The remaining sample will be homogenized in the mixing bowl and placed in appropriate sample containers. Sediment sampling equipment such as bowls, spoons, augers, and dredges will be decontaminated prior to and following sample collection as described below.

The sample containers will be pre-labeled by the sampling task manager at the beginning of each day using the label code described in the QAPP. Field notebooks and sample collection forms will be used to record pertinent data while sampling. The time of sampling will be recorded on each pre-labeled bottle. All samples will be stored on ice (at 4°C), packed in coolers, and shipped under chain of custody for laboratory analysis as described in the QAPP. All laboratories used for sediment analyses are listed in the QAPP.

Water quality field measurements will be collected at each sediment station with a YSI 600 XL or equivalent. Water quality measurements will be collected from the surface and near-bottom prior to the collection of sediment. Water quality parameters to be measured in the field include temperature, specific conductivity, dissolved oxygen, and pH. Field parameters will be measured by submerging the instrument probe in the surface water and recording the measurements after stabilization. Visual observations including color and turbidity will also be recorded in the field logbook. The field instrument will be pre- and post calibrated for quality assurance purposes.

The collection of sample duplicates will be consistent with the procedures outlined above for sediment analysis. Sample depth will be recorded for each sampling location along with sample station positioning using global positioning system (GPS). Tier II data validation will be performed as specified in the QAPP.

3.5.4 Sediment Dewatering

The majority of sediment samples collected under this field effort are expected to contain less than 30% solids. Moisture content of this magnitude has a substantial impact on analytical sensitivity, causing significant increases in laboratory practical quantitation limits (PQLs). The severity of the impact can be lessened by increasing sample aliquot size and/or dewatering the samples prior to analysis. A combination of these procedures will be used to optimize sensitivity while maintaining the integrity of the environmental sample.

- Sample aliquots used for chemical tests (except VOCs) will be homogenized in the field, allowed to settle, and standing water will be decanted to the extent possible. The remaining sediment will be placed into appropriate sampling containers and shipped to the laboratories.
- Analytical laboratories will be requested to decant any standing water from the sample jars prior to analysis.
- Analytical laboratories may analyze percent moisture of samples prior to analysis. Samples containing less than 30% solids may require additional dewatering using filter paper or decanting.

3.5.5 Decontamination

Sampling equipment (e.g., petit ponar, stainless spoons, stainless bowls, etc.) will be decontaminated prior to sampling and between samples. Cleaning of equipment is performed to prevent cross-contamination between samples and to maintain a clean working environment for all personnel. Decontamination will generally consist of a station river water rinse to remove gross contamination (if needed), followed by a non-phosphate detergent (e.g., Alconox) water rinse, a rinse with deionized water, and followed by another a river station water rinse. If equipment is to be stored or transported, it should be wrapped in aluminum foil after air-drying. Water generated during decontamination of sampling equipment will be returned downstream of sampling stations.

Personnel decontamination is discussed in the HASP.

3.6 Surface Water Sampling

Surface water will be collected from the Hudson River in order to identify the presence and extent of potential contaminants. Proposed locations of the surface water sampling stations are presented in Figure 3-3. Seven surface water sampling locations will be co-located with a sub-set of the sediment sampling locations. Surface water data will be used to support the risk assessment activities and to further refine the conceptual site model.

3.6.1 Surface Water Sampling Procedures

Surface water samples will be collected at approximately mid-depth at each sampling location. Samples will be obtained using a teflon-lined alpha bottle or similar apparatus. Samples for dissolved inorganics analyses will be filtered prior to sample preservation. At each of the sampling locations, water depth, dissolved oxygen (DO), temperature, conductivity, and pH will be measured and recorded. Surface water samples will be collected prior to sediment sampling at a location.

The sample containers will be pre-labeled by the sampling task manager at the beginning of each day using the label code described in the QAPP. Field notebooks and sample collection forms will be used to record pertinent data while sampling. The time of sampling will be recorded on each pre-labeled bottle. All samples will be stored on ice (at 4°C), packed in coolers, and shipped under chain of custody for the laboratory analyses described in the QAPP. Tier II data validation will be performed as specified in the QAPP.

3.7 Macroinvertebrate Community Survey

To provide a direct assessment of the integrity of the benthic community, a reconnaissance level macroinvertebrate community survey is proposed. Benthic macroinvertebrate sampling stations will be co-located with a sub-set of the sediment analytical chemistry sampling stations, thereby allowing for detailed evaluation of the co-occurring data in the ecological risk assessment. The results of the macroinvertebrate community survey program will provide a direct measure of the sustainability of the site-specific benthic invertebrate community in support of the ecological risk assessment. Objectives of this task include:

- Determining the abundance of macroinvertebrate infauna at selected Adjacent, Upstream,and Downstream sampling stations;
- Assessing the level of taxonomic diversity and evenness at selected Adjacent, Upstream and Downstream sampling locations;
- Evaluating the macroinvertebrate community structure Adjacent, Upstream and Downstream from the site.

- Biological impairment may be indicated by the absence of pollution-sensitive macroinvertebrate taxa, excess dominance by one taxon, low overall taxa richness, or reduced community composition relative to reference conditions.

3.7.1 Macroinvertebrate Community Survey Station Locations

Macroinvertebrate community survey stations will be co-located with a sub-set of the analytical sediment chemistry stations in an attempt to relate the results of the benthic community survey with measured concentrations of target chemicals. Preliminary station locations are depicted on Figure 3-3.

Sampling locations were preliminarily selected to spatially represent the study area of interest, while limiting stations to similar habitat type (e.g., cover, grain size) to reduce the variability associated with external environmental factors. Sampling locations may be refined based on substrate type and other local modifications (e.g., obstructions) which may affect the availability of suitable habitat. An effort will be made to select homogenous sampling stations with regard to habitat conditions. Sampling locations will be finalized following the planned agency site reconnaissance.

3.7.2 Field Macroinvertebrate Sampling Procedures

The macroinvertebrate sampling technique is designed after a modified version of the USEPA (1999) Rapid Bioassessment Protocols (RBP) and will incorporate sampling method aspects from the USEPA (2000) Estuarine and Coastal Marine Waters: Bioassessment and Biocriteria Technical Guidance. The depth of the Hudson River limits the selection of gear type to conduct a macroinvertebrate survey to grab samplers. Therefore, a Ted Young grab, petite Ponar or equivalent will be used to collect the benthic invertebrate samples from each location. This method will permit sampling of deep habitats that preclude the use of shallow water sampling techniques such as Kick nets or Dip nets. Prior to sampling, a physical/chemical field data sheet will be completed to document supplementary information including water quality, depth, etc. A field sketch of the sampling reach will be drawn to document major habitats, riparian habitat, and other instream attributes and weather conditions will be documented. Sampling will begin at downstream stations and continue to upstream stations.

Sampling techniques to collect the benthic macroinvertebrate will be consistent with the technique used to collect sediment. Once the sample is collected, the top of the grab sampler will be opened to determine whether the sample collected is acceptable for analysis. In accordance with USEPA (2000) guidance, an acceptable grab is one having relatively level, intact sediment over the entire area of the grab, and a sediment depth at the center of at least 7 centimeters. Samples deemed unacceptable may result form inadequate penetration, angle of closure, completeness of closure of the jaws, and potential loss of sample material during retrieval.

Duplicate samples will be collected at each sampling location. Samples will emptied into a collection bucket and any sediment remaining in the grab will be washed directly into the bucket. The bucket will be transferred to a sample-processing table where be sieved through a 500 micron sieve bucket to remove fine material. Large debris (e.g., rocks) will be removed from the sample; however, no attempt will be made to remove small debris. All matter retained on the sieve will be transferred to labeled storage bottles and preserved in 95 percent ethanol to cover the sample. Sample bottles will be labeled with the site name, the station number, a unique sample identification number, date and time of collection, depth of collection, preservative use, and name of collectors. Detailed field notes will be kept to document the macroinvertebrate community survey.

The preserved samples will be sent to the contract laboratory under chain-of-custody for identification and enumeration.

3.8 Field Operations/Documentation

This section discusses field custody and documentation procedures. Laboratory and project file custody is discussed in the QAPP.

3.8.1 Field Log Book and/or Sample Field Sheets

The FTL will be responsible for maintaining a detailed log of field activities within a bound field notebook. The field notebook will contain a chronological description of sample collection activities. The notebook will include information such as names and times for which all project-related personnel (consultant, subcontractors, client) who are on-site, health and safety information, work-area assignments and goals, general notation of time and weather conditions, description of work-related problems and their solutions, any specific scope of work deviations, among other information. Each page of this notebook will identify the project name and the date and location of each activity described on a specific page. Individual notebook pages will be numbered sequentially and signed by the individual making the entry.

Other field records such as sampling logs will be organized in a loose-leaf notebook for each field investigation. The notebook will be assembled prior to each field investigation including the appropriate logs, as presented below. The notebook will include loose-leaf plastic pockets for collection of documents generated in the field (e.g., shipping records). For convenience in the field (as well as neatness), clipboards may be used on a daily basis during completion of specific field activities. At the end of each day, all completed field records will be returned to the loose-leaf notebook. The notebook will be kept by the FTL in an accessible location for use as a reference by project personnel as needed. At the completion of each field investigation, the notebooks will be returned to the office, and the logs separated and filed into the appropriate project files. Logs which are relevant to several different tasks (or units), such as calibration logs or photographic logs, will be copied and filed in each of the relevant project files.

Field records will be recorded in black waterproof ink, or in pencil if weather prevents use of ink. Logs will include entries in every blank, with appropriate use of the abbreviations NA (not available) and NR (not recorded). Field record corrections will include a single line crossing out the incorrect data, such that the incorrect data remains legible, and initialed by the field staff member.

Field measurements will be made by geologists, engineers, or other scientists and technicians. Field measurements will be recorded to the level of precision indicated in the QAPP and the relevant SOP. The appropriate logs for this project will be employed, including site-specific media sampling logs.

3.8.2 Photographic Records

Photographs from the site investigations and from site visits will be included in the reporting process. Photographs will be numbered and documented sequentially. The numbering system will include date and location for each photograph taken.

3.8.3 Sample Documentation

3.8.3.1 Sample Numbering System

Each field sample will be assigned a unique six-digit sample identifier as discussed in the QAPP. This identifier will be used throughout collection, analysis, and reporting activities. The sample identifier will be clearly shown on the chain-of-custody form and sample container labels and tags. The sample identifier will be cross-referenced to the field identification of the sample point in both field notebooks and the project database management system.

3.8.3.2 Sample Labels

Immediately upon collection, each sample will be labeled with a pre-printed adhesive label, which includes test to be performed, preservation conditions and a unique identifier. Field personnel will mark the date and time of collection and sampler's initials once the label is affixed to the sampling container with a permanent marker.

3.8.3.3 Chain-of-Custody Records

Samples will be accompanied by a properly completed chain-of-custody form. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents the transfer of custody of samples from the sampler, to another person, to a mobile laboratory, to the permanent laboratory, or to/from a secure storage location. An example chain-of-custody form is included as Figure 3-4.

Minimum information recorded on the chain-of-custody record in addition to the signatures and dates of all custodians will include:

- Client/project name,
- Project location,
- Project number,
- Field logbook number,
- Chain-of-custody tape numbers,
- The person to whom results should be reported,
- Field sampling number/identification,
- Sampling date and time,
- Type of sample (grab or composite),
- Identification of sample collector and his/her affiliation,
- Sample container number, size, and material,
- Sample description (matrix),
- Sample preservative,
- The performance of field filtration, and
- Analyses to be performed.

The field sampler will be personally responsible for the care and custody of the samples until the samples are transferred or dispatched properly. As few people as possible should handle the samples.

Each sample container will have a pre-affixed label. This label will be completed in the field with a unique sample identifier, the site name, sample collection date and time, analysis requested, and preservative and will be signed by the sampler. The FTL will review field activities to determine whether proper custody procedures were followed during the field work and will decide if additional samples are required.

3.8.4 Sample Packaging and Shipping Requirements

Samples will be packaged properly for shipment and dispatched to the laboratories for analysis with a separate signed custody record enclosed in each sample cooler. Shipping containers will be locked or secured with strapping tape and sealed with custody seals. The preferred procedure is to attach a custody seal to the front right and back left of the cooler. The cooler will be taped closed with fiberglass tape covering the chain-of-custody seals.

Samples will be shipped daily from the field to the laboratory using an overnight courier or onsite pickup by the laboratory. All shipments will be accompanied by the chain-of-custody record identifying the contents. The back copy will be detached and kept as part of the field records. The original record and remaining copies will accompany the shipment.

Laboratory Custody Procedures are described in the QAPP.

3.8.5 Investigation Derived Wastes

The purpose of this section is to ensure that the guidance specified in the April 1992 EPA Publication 9345.3-03FS titled Guide to Management of Investigation-Derived Wastes is followed when performing investigative activities at the site. Methods for collection and handling of Investigation-Derived Wastes (IDW) will be consistent with this document.

Given the nature of the Hudson River field sampling effort (e.g., primarily sediment, surface water, and potentially biota sampling), it is anticipated that only very limited waste materials will be generated during the field investigation. These materials include:

- Decontamination fluid;
- Used PPE;
- Used sampling equipment;

These wastes will be handled in the following manner:

- River water used for rinsing sampling equipment will be released back to the River in the immediate vicinity of its point of generation. Phosphate-free detergent wash water and deionized rinsate water used for decontamination will be contained in 55-gallon drums or bulk containers.
- Used PPE, such as sampling gloves, paper towels, or other materials will be bagged and sealed prior to disposal as general refuse. If PPE becomes grossly contaminated, it will be segregated from other PPE, labeled and staged as "contaminated material". Contaminated material will be drummed and staged in the IDW area designated by BASF personnel. The field team will arrange for off-site disposal of drums by a licensed waste hauler at an approved facility.

- Used sampling equipment, which generally has minor contamination, will be disposed of with the PPE as general refuse. Contaminated disposable equipment will require segregation from other equipment and proper disposal.
- The field team will be responsible for arranging the removal and proper disposal of all accumulated waste materials following completion of the field program. Disposal will be arranged with licensed waste haulers at approved receiving facilities.

3.9 Analytical Program

Based on previous sediment sampling in the river and analytes of interest discharged by the BASF facility, the focus of the analytical program is on metals and VOCs.

3.9.1 Sediment

As indicated in the QAPP, the sediment samples will be analyzed for the following parameters:

- Target Compound List (TCL) Volatile Organics;
- Target Analyte List (TAL) Metals;
- SEM and AVS;
- Percent moisture;
- Grain size; and
- TOC.

Not all samples will be analyzed for the full list of parameters. Table 3-2 presents a summary of the proposed sampling program and the rationale for the sampling effort.

3.9.2 Surface Water

As indicated in the QAPP, all surface water samples will be analyzed for the following parameters:

- TCL Volatile Organics;
- Dissolved and total recoverable TAL Metals;
- Total Suspended Solids;
- TOC; and
- Hardness.

3.9.3 QA/QC

The QAPP summarizes sediment and surface water laboratory analytical methods. Frequency of sediment and aqueous field QA/QC samples will be submitted for analysis as specified in the QAPP. Additional samples will be collected to satisfy field duplicate requirements. Certain QA/QC samples (e.g., MS/MSD and duplicates) are not required for grain size and TOC analyses.

3.9.4 Macroinvertebrate Data Analysis

All preserved samples will be sent under chain-of-custody to a taxonomic laboratory for sample processing and identification. The duplicate samples from each sampling station will be analyzed in accordance with the USEPA guidance (1999).

All organisms will be identified to the lowest practical taxon (e.g., genus or species) by a qualified macroinvertebrate taxonomist, as described in USEPA (1999). If the preponderance of samples are found to contain gross quantities of invertebrate organisms, then each sample analyzed will be separated into 100-organism sub-samples and will be sorted and preserved separately from the remaining sample. Sorting techniques are described in detail in USEPA (1999) and include thoroughly rinsing the sample in a No. 35 mesh (500-micron) screen to remove preservative and fine sediment and spreading the washed sample evenly in a gridded pan with a light colored bottom. Grids will be randomly selected and all organisms within these grids will be collected until a 100-organism sub-sample is obtained.

Samples will be labeled and voucher specimens of all taxa will be archived in denatured 70 percent ethanol for a minimum of three years. The numbers of each taxon will be recorded on an RBP Laboratory Bench Sheet. Quality control for taxonomy will be conducted as outlined by USEPA (1999).

The data analysis of the biological samples will integrate several community, population, and functional parameters into a qualitative evaluation of biological integrity. Metrics to be evaluated include richness measures, diversity indices, percent similarity measures, and trophic measures. The exact metrics to be used at the site will be dependent upon the data generated through the field sampling program. Examples of the metrics that may be used in addition to those mentioned above are listed in the RBP Manual (USEPA 1999) and in the USEPA (2000) Estuarine and Coastal Marine Waters: Bioassessment and Biocriteria Technical Guidance. Metrics that have relevancy to the assemblage of organisms found in the Hudson River watershed will initially be considered for use in the macroinvertebrate data analysis. After the initial screening of candidate metrics, key metrics will be selected for further evaluation. Ideally, the site-specific data will permit selection of core metrics which represent diverse measurements of community structure, composition, trophic status, and pollution-sensitivity. Metrics will be eliminated from consideration in the Hudson River data analysis if there are too many zero values to calculate the metric at a large proportion of sampling locations, or if the metric is so variable that it will not serve to help discriminate among sampling stations.

As described in USEPA (1999), an attempt will be made to determine the association and/or linkages between biological, habitat condition, and physicochemical metrics. As appropriate, metric values will be plotted against analytical chemical data, and an inferential statistical evaluation (e.g., multivariate ordination) of the raw data may be conducted to elucidate relationships between metrics and the raw data from the various sampling stations. The application of inferential statistics will be used to determine if significant differences exist between Upstream, Adjacent and Downstream sampling stations and try to measure the relative importance of environmental variables and chemical concentrations influence on the observed patterns.

Table 3-1

Data Quality Objectives

BASF Corporation
Hudson River OU-2 Investigation
Rensselaer, New York

DQO Step	Site-Specific Information
Step 1: State the Problems	Based on previous limited sediment sampling, metals and VOCs were detected at elevated levels in the Hudson River in the vicinity of the BASF facility. Additional sediment and surface water sampling is necessary to evaluate the horizontal and vertical extent of metals and VOCs in the river adjacent to the site, to evaluate the relationship of these constituents to factors such as grain size and bathymetry, and to evaluate the potential for risk to human health and the environment.
Step 2: Identify the Decisions	1) Has the extent of sediment contamination been adequately delineated vertically and horizontally? 2) Can relationships be established between sediment constituent burden and factors such as grain size, sample depth, depositional patterns, etc. 3) Are the target chemical concentrations in surface sediments adjacent to the site greater than upstream from the site? 4) Are the target chemical concentrations in sub-surface sediments adjacent to the site greater than upstream from the site? 5) Are the target chemical concentrations in surface water adjacent to the site greater than upstream from the site? 6) Are detected concentrations in surface water or sediment present at levels that indicate the potential for risk to human health or the environment?
Step 3: Identify Inputs to the Decision	The key inputs for making the required decisions are briefly summarized as follows: VOCs - Surface water and sediment (surface and sub-surface) samples will be collected from the near-shore study area and submitted for laboratory analysis of VOCs. Inorganics - Surface water and sediment (surface and sub-surface) samples will be collected from the near-shore study area, upstream reach and downstream reach and submitted for laboratory analysis of inorganics, grain size and TOC. Approximately 25% of the sediment samples will also be analyzed for SEM/AVS.

DQO Step	Site-Specific Information
Step 4: Define the Study Boundaries	The BASF site is located on Riverside Avenue in Rensselaer, NY. The study area within the Hudson River has been defined as the portion of the river within 1500 feet upstream and downstream of the facility boundary. Although this extent of the river is likely to include background areas (i.e., upstream) not impacted by the site, in order to achieve similar upstream conditions regarding sediment composition and deposition, a reach of the river approximately 2 miles upstream has been selected as the background or reference condition reach.
Step 5: Develop a Decision Rule	1) A benchmark comparison will be conducted to determine whether the sediment and surface water concentrations of VOCs and inorganics adjacent to the site are above human health and ecological benchmarks, indicating the potential for risk. a. If the benchmark comparison indicates that adjacent concentrations are below human health and/or ecological benchmarks, then this suggests no unacceptable risk attributable to the site. b. If the benchmark comparison indicates that adjacent concentrations are below human health and/or ecological benchmarks, then additional investigation may be necessary. If the constituent concentrations are less than the sediment quality benchmarks, then those constituents are not expected to contribute to total site risk. If the constituent concentrations are greater than the sediment quality benchmarks, then further evaluation may be required. 2) A statistical evaluation will be conducted to determine whether the sediment and surface water concentrations of inorganics adjacent to the site are consistent with upstream conditions. This evaluation will consider modifying factors such as grain size, TOC, and riverine geophysical characteristics. a. If the statistical evaluation indicates that adjacent concentrations are less than or consistent with upstream concentrations, then this suggests no unacceptable risk attributable to the site. b. If the statistical evaluation indicates that adjacent concentrations are greater than upstream concentrations, then additional investigation may be necessary. 3) Total concentrations of metals in sediment may overstate the risk to ecological receptors. An assessment of constituent bioavailability using SEM and AVS is necessary to refine the risk assessment. a. If the SEM/AVS ratio is less than one, it is unlikely that the metals are bioavailable; therefore, further study is not warranted. b. An SEM/AVS ratio greater than one indicates a possibility of bioavailabilty to ecological receptors; therefore, further investigation may be warranted.

DQO Step	Site-Specific Information
Step 6: Specify Tolerable Limits of Decision Errors	The data quality indicators for screening and definitive data are defined in terms of the precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters. The assessment of the data quality indicators is necessary to determine data usability and involves the evaluation of the PARCC parameters: precision, accuracy, representativeness, completeness, and comparability. To ensure the quality and integrity of the project data, the precision and accuracy of the analysis, the representativeness of the results the completeness of the data, and the comparability of the data to existing data will be evaluated. Data that meet the DQOs and fulfill project goals will be deemed acceptable. Data that do not meet objectives and goals will be reviewed on a case-by-case basis to ascertain its usefulness. To limit errors made based upon analytical data, the reporting limits (practical quantitation limits) for target analytes have been established at a level at least three times less than the action limit whenever technically feasible. In general, statistical analysis will not be used to determine decision error tolerance limits. Generally each sample will be used to make a decision.
Step 7: Optimize the Design	The variability of data will have an effect on the sampling design. If necessary, the sample frequency and the analytical procedures may undergo changes to optimize the design. The design options, such as sample collection design, sample size and analytical procedures will be evaluated based on cost and ability to meet the DQOs.

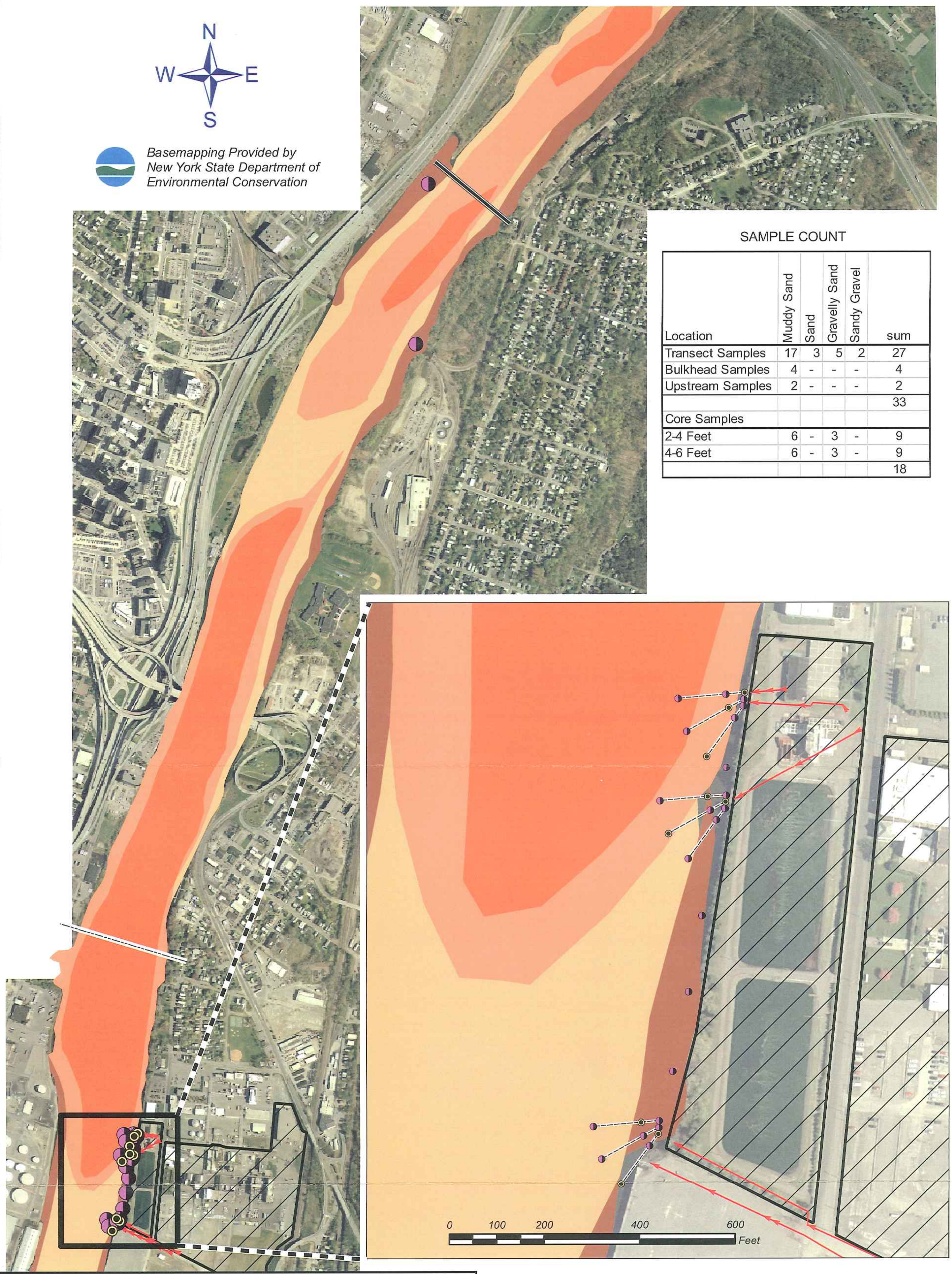
Table 3-2
Sediment Sampling Program Rationale
BASF Corporation
Hudson River OU-2 Investigation
Rensselaer, New York

		Number of Samples in Each Surficial Substrate Type				Number of Analyses					
Number of Samples	Location Description	Sand	Sandy gravel	Gravelly sand	Muddy sand	Metals	VOCs	SEM/AVS (b)	TOC (b)	Grain size	Rationale
Volatile Organic Constituents											
Surficial Sediment Sampling (0 to 6 in sampling horizon)											
27	Adjacent OU-2 Near-Shore (Production Sewers)	3	2	5	17		27		27	27	Twenty-seven samples are located in immediate association with each of the three former outfalls. Within each outfall area, three transects containing three samplingl locations have been established. These samples will help to: (1) delineate the horizontal extent of the VOCs in the nearshore environment potentially associated with historic discharge from the sewers; (2) represent the major substrates identified within the study reach; and (3) provide information on grain size distribution, bathymetry, depositional characteristics, and other geophysical properties of the nearshore environment
4	Adjacent OU-2 Near-Shore (Bulkhead)				4		4		4	4	Four sampling locations have been selected along the BASF bulkhead. These samples will help to: (1) delineate the horizontal extent of the VOCs in the nearshore environment potentially associated with leakage through the bulkhead or deposition from historic sewer discharges; (2) represent the muddy sand substrate that dominates the nearshore environment; (3) provide information on grain size distribution, bathymetry, depositional characteristics, and other geophysical properties of the nearshore environment as they relate to constituent concentrations.
2	Upstream (Reference Conditions)				2		2		2	2	Two upstream sampling locations have been selected to represent upstream conditions unimpacted by the site. These stations will: (1) provide an indication of upstream, anthropogenic levels of VOCs associated with a large river in an urbanized environment; represent the muddy sand substrate and allow for comparison with samples collected from the nearshore environment; (3) provide information on grain size distribution, bathymetry, depositional characteristics, and other geophysical properties of the upstream environment
Sub-Surficial Sediment Sampling (2 to 4 ft and 4 to 6 ft sampling horizons)											
18	Adjacent OU-2 Near-Shore (Production Sewers)			6	12		18		18	18	Within each of the nine transects associated with the former outfalls, a sediment boring is proposed. Two sampling intervals will be collected from each of the nine borings to represent sub-surface sediment (i.e., 18 samples to be collected from 9 borings). These borings will help to: (1) delineate the vertical extent of the VOCs in the nearshore environment potentially associated with historic discharge from the sewers; (2) represent the major substrates identified within the nearshore environment; and (3) provide information on grain size distribution, bathymetry, depositional characteristics, and other geophysical properties of samples at depth in the nearshore environment

Table 3-2
Sediment Sampling Program Rationale
BASF Corporation
Hudson River OU-2 Investigation
Rensselaer, New York

		Number of Samples in Each Surficial Substrate Type				Number of Analyses					
Number of Samples	**Location Description**	**Sand**	**Sandy gravel**	**Gravelly sand**	**Muddy sand**	**Metals**	**VOCs**	**SEM/AVS (b)**	**TOC (b)**	**Grain size**	**Rationale**
						Inorganic Constituents					
Surficial Sediment Sampling (0 to 6 in sampling horizon)											
27	Adjacent OU-2 Near-Shore (Production Sewers)	3	2	5	17	27		14	[a]	[a]	Twenty-seven samples are located in immediate association with each of the three former outfalls. Within each outfall area, three transects containing three sampling locations have been established. These samples will: (1) delineate the horizontal extent and spatial variability of the metals in the nearshore environment potentially associated with historic discharge from the sewers; (2) represent the major substrates identified within the study reach and allow for statistical comparison with similar substrates in the upstream environment; and (3) provide information on metals bioavailablility, grain size distribution, bathymetry, depositional characteristics, and other geophysical properties of the nearshore environment
4	Adjacent OU-2 Near-Shore (Bulkhead)				4	4		2	[a]	[a]	Four sampling locations have been selected along the BASF bulkhead. These sampling locations will help to: (1) delineate the horizontal extent and spatial variability of the metals in the nearshore environment potentially associated with leakage through the bulkhead; (2) represent the muddy sand substrate that dominates the nearshore environment and allow for statistical comparison with similar substrate in the upstream environment; and (3) provide information on metals bioavailablility, grain size distribution, bathymetry, depositional characteristics, and other geophysical properties of the nearshore environment
4	Adjacent OU-2 Far-Shore Reach (Western Bank)				4	4		2	2	4	Four sampling locations are proposed in Muddy Sand on the opposite (western) side of the river. These stations will help to: (1) provide an indication of the spatial variability of the metals in the nearshore environment on the opposite side of the river representing anthropogenic levels of metals associated with a large river in an urbanized environment; (2) represent the muddy sand substrate that dominates the nearshore environment and allow for statistical comparison with samples collected from the nearshore and upstream environment; and (3) provide information on metals bioavailablility, grain size distribution, bathymetry, depositional characteristics, and other geophysical properties of the nearshore environment
15	Downstream OU-2 (Around HR-SS-17)	15				15		8	8	15	Fifteen surficial sediment samples are proposed in the vicinity of a station with historically high lead concentrations. These samples will help to: (1) delineate the spatial variability of the metals in the sandy substrate surrounding HR-SS-17; (2) allow for statistical comparison with similar substrates in the upstream environment; and (3) provide information on metals bioavailablility, grain size distribution, bathymetry, depositional characteristics, and other geophysical properties of the nearshore environment
16	Adjacent OU-2 (Main Stem of River)		10	6		16		8	8	16	Sixteen sampling locations have been selected to represent the sandy gravel and gravelly sand in the vicinity of the Site. These stations will: (1) provide an indication of the metals in the main channel representing anthropogenic levels associated with a large river in an urbanized environment; (2) represent the sandy gravel and gravelly sand substrates in the channel and allow for statistical comparison with samples collected from similar substrates in the upstream environment; (3) provide information on metals bioavailablility, grain size distribution, bathymetry, depositional characteristics, and other geophysical properties of the nearshore environment
30	Upstream (Reference Conditions)	10	5	5	10	30		15	13 [a]	28 [a]	Thirty upstream sampling locations were selected to represent unimpacted, upstream reference conditions. These stations will: (1) provide an indication of upstream, anthropogenic levels of metals associated with a large river in an urbanized environment; (2) represent the muddy sand substrate and allows for statistical comparison with samples collected from the nearshore environment; and (3) provide information on grain size distribution, bathymetry, depositional characteristics, and other geophysical properties of the upstream environment
Sub-Surficial Sediment Sampling (2 to 4 ft and 4 to 6 ft sampling horizons)											
18	Adjacent OU-2 Near-Shore (Production Sewers)			6	12	18			[a]	[a]	Within each of the nine transects associated with the former outfalls, a sediment boring is proposed. Two sampling intervals will be collected from each of the nine borings to represent sub-surface sediment (i.e., 18 samples to be collected from 9 borings). These samples will help to: (1) delineate the vertical extent and spatial variability of the metals in the nearshore environment potentially associated with historic discharge from the sewers; (2) represent the major substrates identified within the nearshore environment; (3) allow for statistical comparison with similar substrates in the farshore reach (assumed to represent urbanized river conditions); and (4) provide information on bioavailability, grain size distribution, bathymetry, depositional characteristics, and other geophysical properties of samples at depth in the nearshore environment
6	Adjacent OU-2 (Main Stem of River)	2	2	2		6			3	6	Three additional borings are proposed in the main stem of the river (one in each of the main stem substrate types). Two sampling intervals will be evaluated per boring (i.e., 6 samples to be collected from 3 borings). These stations will: (1) provide an indication of the spatial variability of the metals in the nearshore environment on the opposite side of the river representing anthropogenic levels of metals associated with a large river in an urbanized environment; (2) represent the muddy sand substrate that dominates the nearshore environment and allow for statistical comparison with samples collected from the nearshore and upstream environment; (3) provide information on metals bioavailablility, grain size distribution, bathymetry, depositional characteristics, and other geophysical properties of the nearshore environment

[a] - analysis co-located with VOC samples
[b] TOC, SEM, and AVS to be evaluated in approximately 50% of samples selected for inorganic constituents.



Basemapping Provided by New York State Department of Environmental Conservation

SAMPLE COUNT

Location	Muddy Sand	Sand	Gravelly Sand	Sandy Gravel	sum
Transect Samples	17	3	5	2	27
Bulkhead Samples	4	-	-	-	4
Upstream Samples	2	-	-	-	2
					33
Core Samples					
2-4 Feet	6	-	3	-	9
4-6 Feet	6	-	3	-	9
					18

Legend

Sample Locations

- ◐ Surface Sample
- ◉ Core Sample (Surface, 2-4 Feet, 4-6 Feet)
- ------ Palmate Transects
- ➝ Approximate Locations of Outfall Pipes
- ▨ Approximate Property Boundaries

Study Reach

(Distance from Site)

- -------- 1500 Linear Feet
- ═ 2 Linear Miles

Sediment Type

- 🟫 muddy sand
- 🟨 sand
- 🟧 gravelly sand
- 🟥 sandy gravel

See Table 3-2 for additional information on sampling rationale.

1 INCH = 1000 FEET

0 500 1,000 2,000 3,000 Feet

Proposed Sampling Locations for VOCs in Sediment

BASF Corporation
Hudson River OU-2 Investigation
Rensselaer, New York

SCALE	DATE	PROJECT NO.
1:12000	07/05	00760-171

ENSR INTERNATIONAL

Figure Number

3-1

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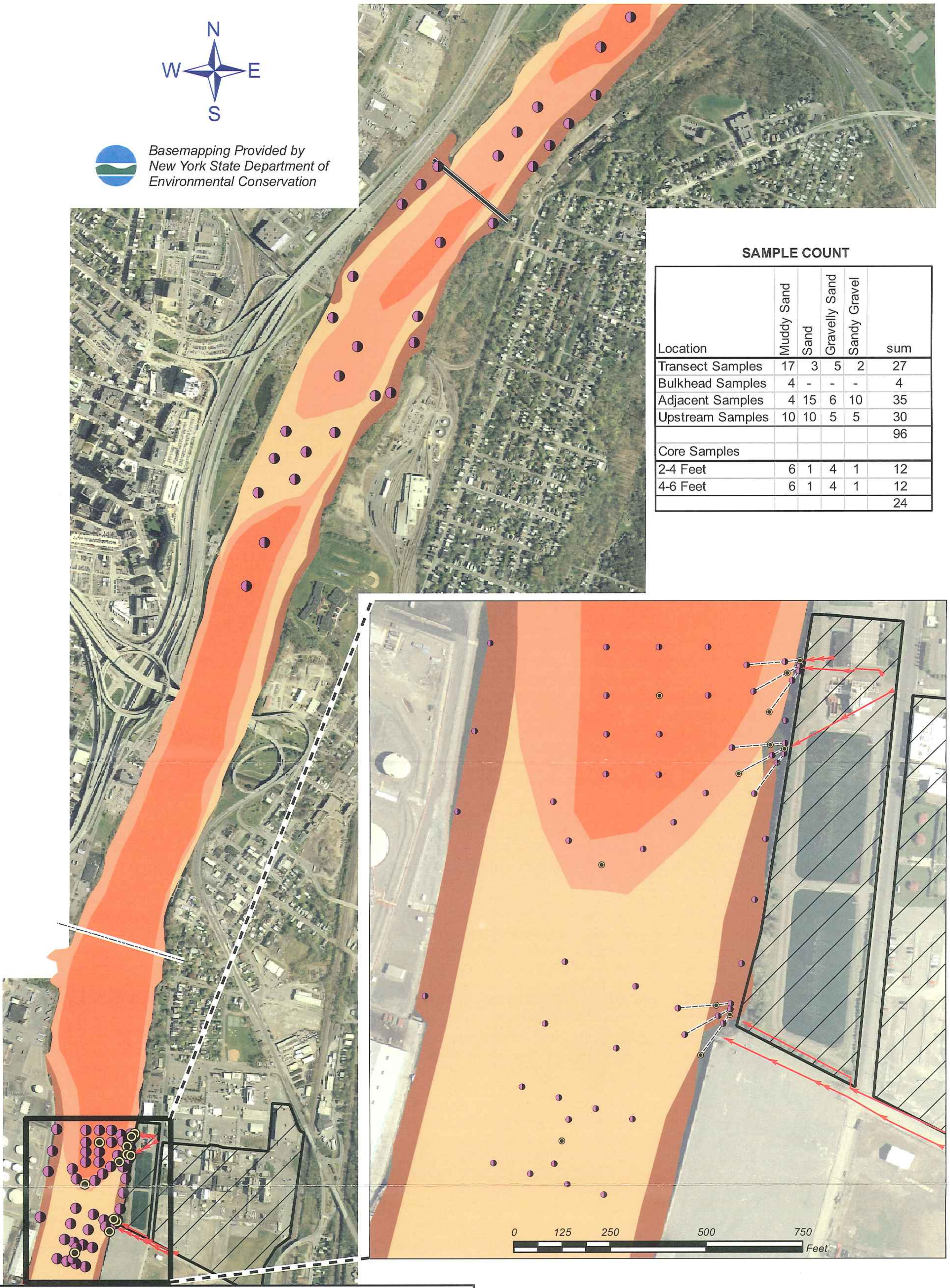

Basemapping Provided by New York State Department of Environmental Conservation

SAMPLE COUNT

Location	Muddy Sand	Sand	Gravelly Sand	Sandy Gravel	sum
Transect Samples	17	3	5	2	27
Bulkhead Samples	4	-	-	-	4
Adjacent Samples	4	15	6	10	35
Upstream Samples	10	10	5	5	30
					96
Core Samples					
2-4 Feet	6	1	4	1	12
4-6 Feet	6	1	4	1	12
					24

Legend

Sample Locations

- ◐ Surface Sample
- ◉ Core Sample (Surface, 2-4 Feet, 4-6 Feet)
- ------ Palmate Transects
- ➝ Approximate Locations of Outfall Pipes
- ▨ Approximate Property Boundaries

Study Reach

(Distance from Site)

- -------- 1500 Linear Feet
- ═ 2 Linear Miles

Sediment Type

🟫	muddy sand
🟨	sand
🟧	gravelly sand
🟥	sandy gravel

✱ *See Table 3-2 for additional information on sampling rationale.*

1 INCH = 1000 FEET

0 500 1,000 2,000 3,000 Feet

Proposed Sampling Locations for Inorganics in Sediment

BASF Corporation

Hudson River OU-2 Investigation

Rensselaer, New York

SCALE	DATE	PROJECT NO.
1:12000	07/05	00760-171

ENSR INTERNATIONAL

Figure Number

3-2

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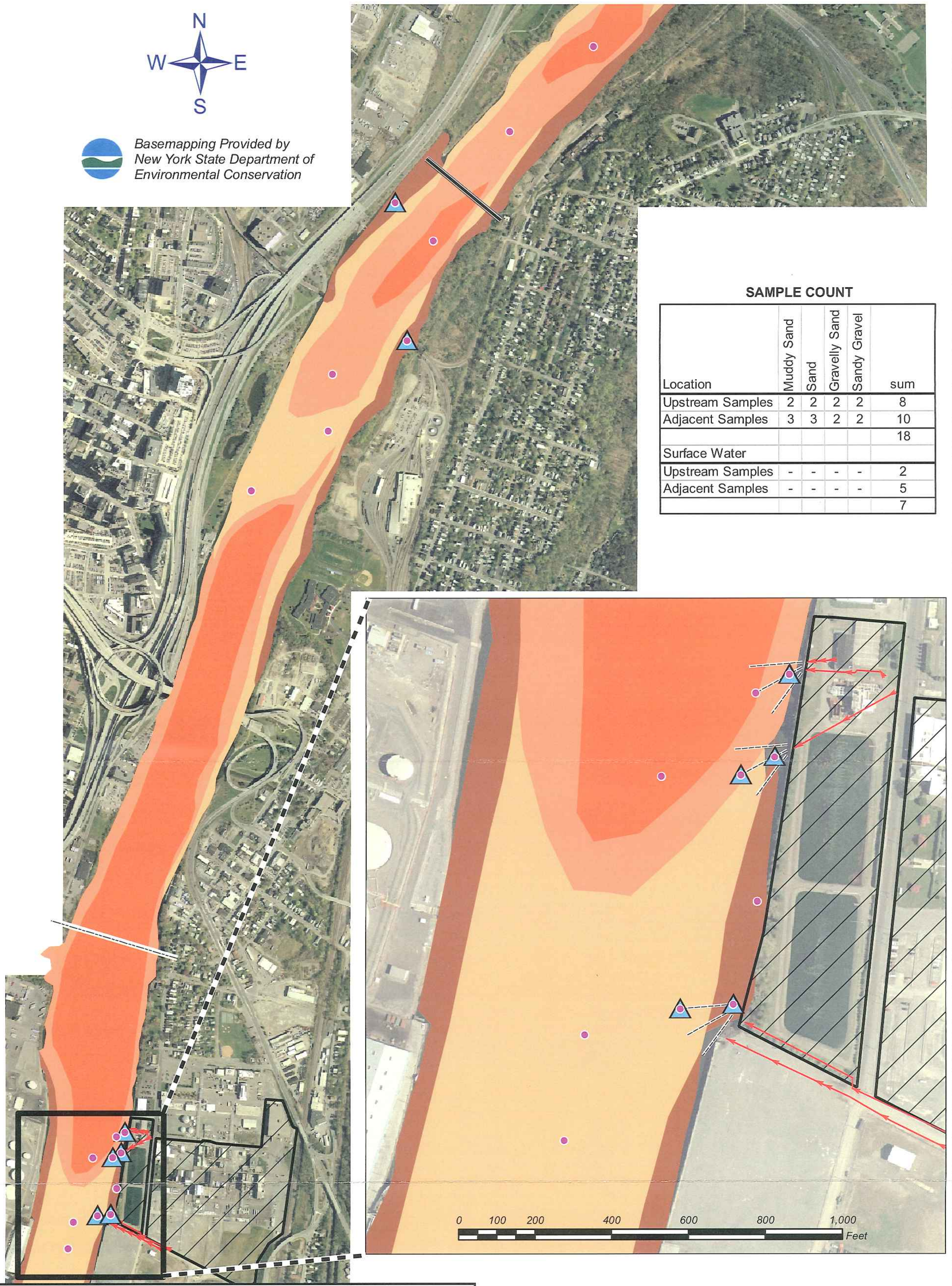

Basemapping Provided by
New York State Department of
Environmental Conservation

SAMPLE COUNT

Location	Muddy Sand	Sand	Gravelly Sand	Sandy Gravel	sum
Upstream Samples	2	2	2	2	8
Adjacent Samples	3	3	2	2	10
					18
Surface Water					
Upstream Samples	-	-	-	-	2
Adjacent Samples	-	-	-	-	5
					7

Legend

Sample Locations

- ● Macroinvertebrates
- ▲ Surface Water
- → Approximate Locations of Outfall Pipes
- ▨ Approximate Property Boundaries

Study Reach

(Distance from Site)

- ---- 1500 Linear Feet
- ═ 2 Linear Miles

Sediment Type

- ■ muddy sand
- ■ sand
- ■ gravelly sand
- ■ sandy gravel

See Table 3-2 for additional information on sampling rational.

1 INCH = 1000 FEET

0 500 1,000 2,000 3,000 Feet

Proposed Surface Water and Marcoinvertebrate Sampling Locations

BASF Corporation
Hudson River OU-2 Investigation
Rensselaer, New York

SCALE	DATE	PROJECT NO.
1:12000	07/05	00760-171

ENSR INTERNATIONAL

Figure Number

3-3

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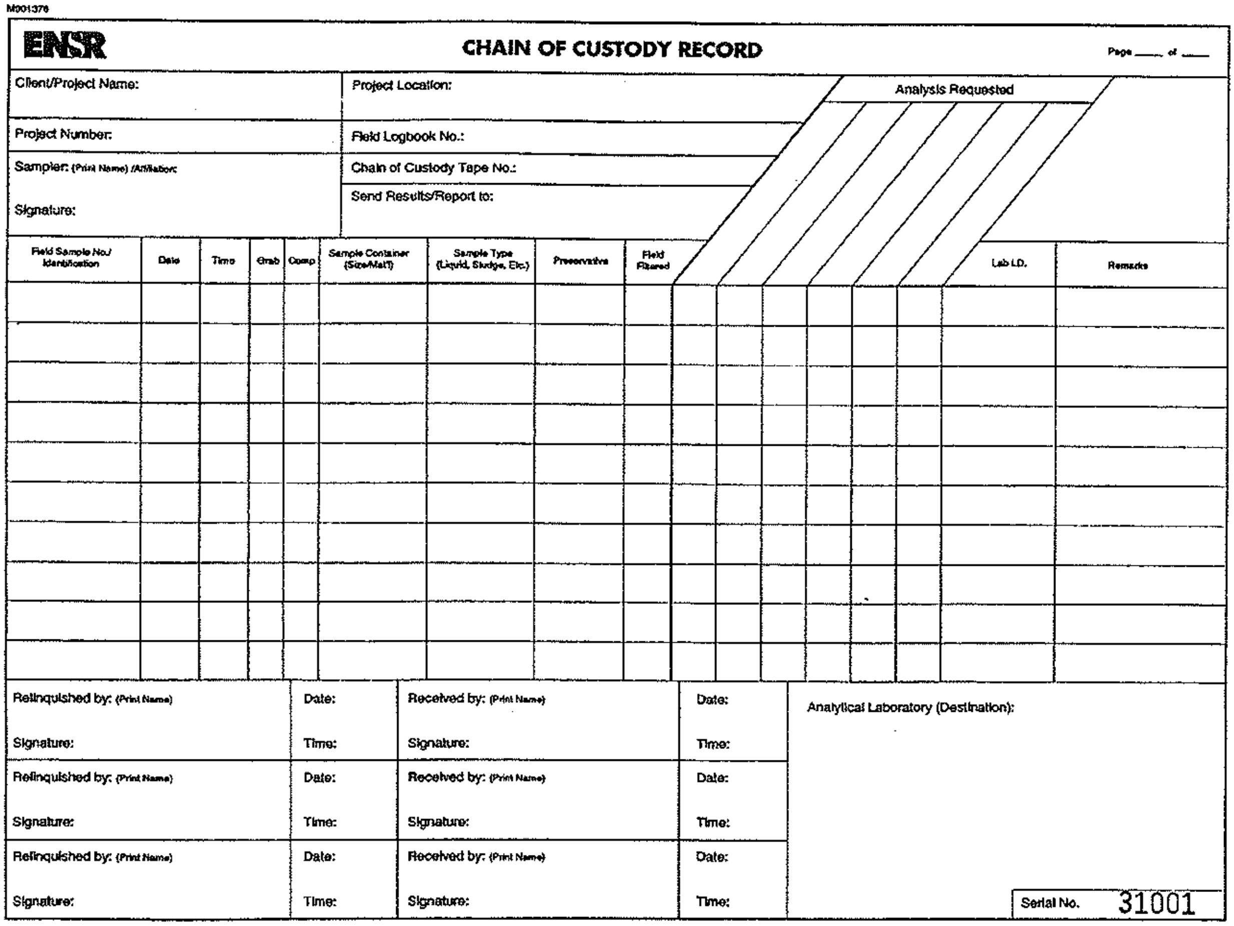
Figure 3-4 Example Copy of Chain-of-Custody Form



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ENSR **CHAIN OF CUSTODY RECORD** Page ____ of ____

Client/Project Name:

Project Location:

Project Number:

Field Logbook No.:

Sampler: (Print Name) /Affiliation:

Signature:

Chain of Custody Tape No.:

Send Results/Report to:

Analysis Requested

Field Sample No./ Identification	Date	Time	Grab	Comp	Sample Container (Size/Mat'l)	Sample Type (Liquid, Sludge, Etc.)	Preservative	Field Filtered							Lab I.D.	Remarks

Relinquished by: (Print Name) Signature:	Date: Time:	Received by: (Print Name) Signature:	Date: Time:	Analytical Laboratory (Destination):
Relinquished by: (Print Name) Signature:	Date: Time:	Received by: (Print Name) Signature:	Date: Time:	
Relinquished by: (Print Name) Signature:	Date: Time:	Received by: (Print Name) Signature:	Date: Time:	Serial No. 31001

4.0 REPORTING

The report for this investigation will include several components designed to address the objectives of the investigation and conform to NYSDEC requirements. These objectives were presented in Section 1.1 and included the following:

- Delineating the extent of selected metals and VOCs within the sediments adjacent to the facility;
- Evaluating Hudson River surface water quality in the vicinity of and downstream of production sewer outfalls; and
- Providing a preliminary analysis of the benthic community in the Hudson River in the vicinity of the site.

The report will include the following:

- Summary of the results of previous sampling activities;
- Discussion of investigation activities including sediment and surface water sampling, macroinvertebrate surveys, and geophysical evaluations, as appropriate;
- Tabular presentation of analytical results for all media sampled during the field effort;
- Comparison of analytical results for surface water and sediment to appropriate human health and/or ecological screening levels;
- Discussion of the nature and extent of any contaminants identified, in the context of riverine bathymetric and geophysical conditions;
- Evaluation of the vertical and horizontal distribution of metals and VOCs in the near-shore areas near the outfalls;
- Discussion of the distribution of metals in the Upstream and Adjacent reaches. The sampling plan has been designed to allow for a statistical evaluation of inorganic contaminants in the various substrates upstream and downstream of the site. It is anticipated that statistical Background Test Form 2 from the *Guidance for Comparing Background and Chemical Concentrations in Soil at CERCLA Sites* (U.S. EPA, 2002) will be used to evaluate the data. Background Test Form 2 requires a strict burden of proof by selecting the null hypothesis that the chemical concentration in potentially contaminated areas exceeds background (upstream) by more than a substantial difference (identified as S). This approach favors the protection of the environment (U.S. EPA, 2002).

- Discussion of the findings of the benthic macroinvertebrate community survey results, in the context of the site chemistry, and riverine bathymetric and geophysical conditions;
- Discussion of the geophysical survey results, including relevant mapping;
- Conclusions and recommendations drawn from interpretation of the data, including a discussion of the CSM and the potential for any risks to human health or the environment; and
- Supporting data including any analytical data packages, statistical support, and/or photographs.

If additional phases of investigation are necessary, BASF will discuss with NYSDEC options for future evaluations and/or sampling plans.

5.0 SCHEDULE

Field activities are anticipated to commence in the fall of 2005, depending on weather conditions and NYSDEC approval of the final Work Plan. The field program is projected to be complete within 30 days of mobilization.

Activity	Duration (days)	Anticipated Start Date*	Anticipated Finish Date
Mobilize (subcontract procurement equipment rental etc.)	15	September 30, 2005	October 15, 2005
Field Effort	30	October 15, 2005	November 15, 2005
Laboratory Analysis	30	November 15, 2005	December 15, 2005
Data Validation	30	December 15, 2005	January 15, 2006
Database Development	15	January 15, 2006	January 30, 2006
Report Preparation	60	January 30, 2006	March 30, 2006
Submission of Draft Characterization Report to NYSDEC	0	April 1, 2006	
* Anticipated start date is dependent upon final Work Plan approval			

6.0 LIST OF COMMONLY USED ACRONYMS

ADCP	Acoustic Doppler Current Profiles
AHA	Activity Hazard Analysis
ASTM	American Society of Testing Methods
AVS	Acid Volatile Sulfides
C	Centigrade
cfs	Cubic Feet per Second
COC	Chain-of-Custody
CSM	Conceptual Site Model
DCQCR	Daily Chemical Quality Control Reports
DO	Dissolved Oxygen
DQO	Data Quality Objective
FSP	Field Sampling Plan
FTL	Field Team Leader
GPS	Global Positioning System
HASP	Health and Safety Plan
IDW	Investigation Derived Waste
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NGVD	National Geodetic Vertical Datum
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OU	Operable Unit
PAH	Polycyclic Aromatic Hydrocarbon
PARCC	Precision, Accuracy, Representativeness, Completeness, and Comparability
PCB	Polychlorinated Biphenyl
PPE	Personal Protective Equipment
PQL	Practical Quantitation Limit
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Program Plan
QC	Quality Control
RBP	Rapid Bioassessment Protocol
RI	Remedial Investigation
RM	River Mile
SSO	Site Safety Officer
SEM	Simultaneously Extracted Metals

SVOC	Semi- Volatile Organic Compound
TAL	Target Analyte List
TCL	Target Compound List
TOC	Total Organic Carbon
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VOC	Volatile Organic Compound

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APPENDIX

A

APPENDIX A

REVIEW OF AVAILABLE GEOPHYSICS DATA

REVIEW OF GEOPHYSICAL DATA – HUDSON RIVER ADJACENT TO THE BASF SITE IN RENSSELAER, NEW YORK

CR Environmental Inc., (CR) was tasked, under sub-contract to ENSR Corporation (ENSR), with reviewing and commenting on the quality and utility of existing geophysical data for the Hudson River adjacent to the BASF Site in Rensselaer, New York. Specifically, CR evaluated whether existing geophysical data collected by the New York State Department of Environmental Conservation (NYSDEC) support bottom classifications and sediment transport regimes assigned by NYSDEC. The primary objective of the CR review was to evaluate the existing geophysical data to determine if they were of adequate resolution to support the design of a sediment sampling and analysis program in the vicinity of the BASF Site.

In order to facilitate this review, ENSR provided CR with the following materials: (1) georeferenced digital side scan sonar (SSS) mosaics generated by NYSDEC (100-kHz and 384-kHz); (2) a shapefile developed by NYSDEC depicting bottom classifications and sediment transport regimes; a shapefile depicting the approximate Site property boundary; and (3) bathymetric polygons generated from NYSDEC multibeam bathymetry. These data were previously provided to ENSR from NYSDEC under confidentiality agreement. CR also reviewed the geophysical portions of an Environmental Impact Assessment report prepared to evaluate the Proposed Empire State Newsprint Project (ENSR, 2001). This report contained high frequency SSS data as raw "waterfall" imagery, the results of a magnetometer survey, and profile imagery generated by an acoustic sub-bottom profiling system.

1.0 Review of NYSDEC Data

The side scan sonar mosaics provided for review were 1.0-meter pixel resolution grayscale files. The 100-kHz data appear to have been collected using a 200-meter range and the 384-kHz (nominally 500-kHz) data were collected using a 100-meter range. Based on previous NYSDEC survey work in the region, it is likely that the SSS system employed was the Edgetech DF-1000 dual-frequency digital side scan. Note that the applied signal frequencies and sonar ranges would support processing to 10.0 – 20.0 cm per pixel. Based on comparisons between shoreline features visible on orthophotos and depiction of these features on sonar data, there appears to be "along-track" offsets of between 0-80 feet.

The mosaics clearly show that the NYSDEC survey consisted of two passes along the river: one upstream and one downstream. The strong dark banding along the towpath on some data segments suggests that neither Time Varied Gain (TVG) or Beam Angle Corrections (BAC) were applied during acquisition or processing. These data adjustments are commonly employed to reduce or eliminate data artifacts associated with signal attenuation and angle of incidence.

Given the wide swath widths and processing techniques employed by NYSDEC, the SSS data are less than optimal for site-specific evaluation of benthic conditions along the relatively short river reach of concern for the BASF investigation. Nonetheless, a review of these data provides some information concerning approximate riverbed geology and sediment transport regimes. The data do not consistently support the riverbed classifications generated by NYSDEC. For instance, consider the two small figures below (Figures 1A and 1B), which represent the riverbed in the a reach of the river at and immediately to the south (downstream) of the BASF Rensselaer facility.

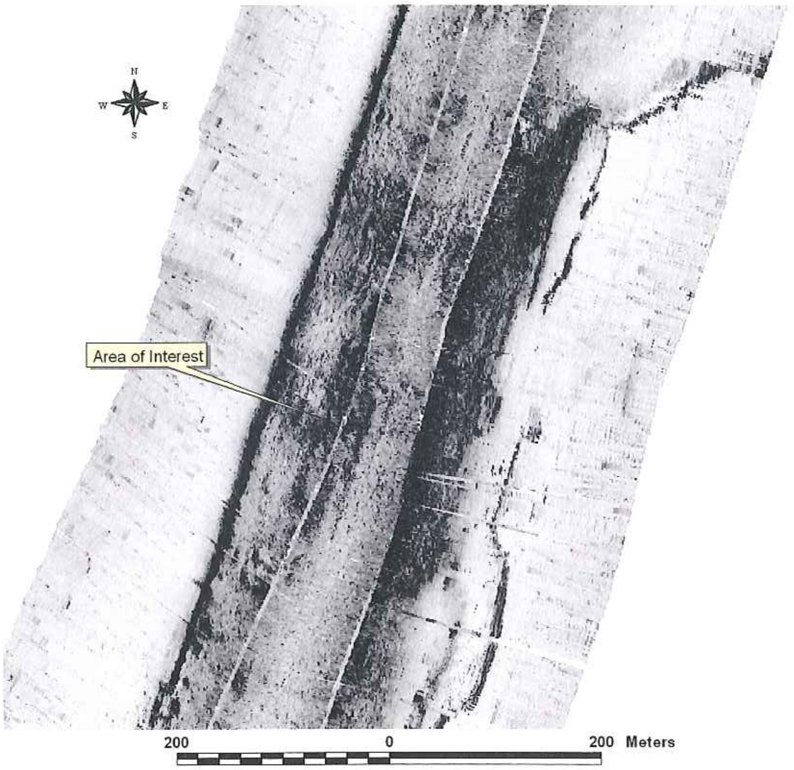


Figure 1A – 100-kHz SSS mosaic. River reach south of Site

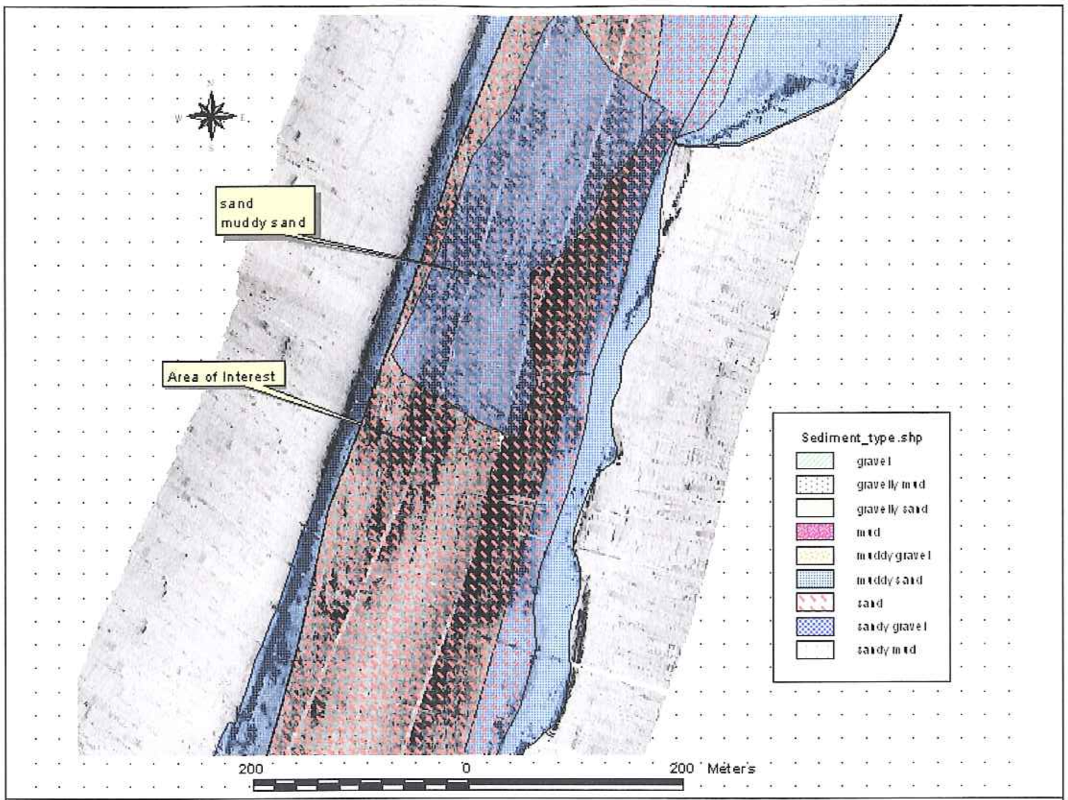
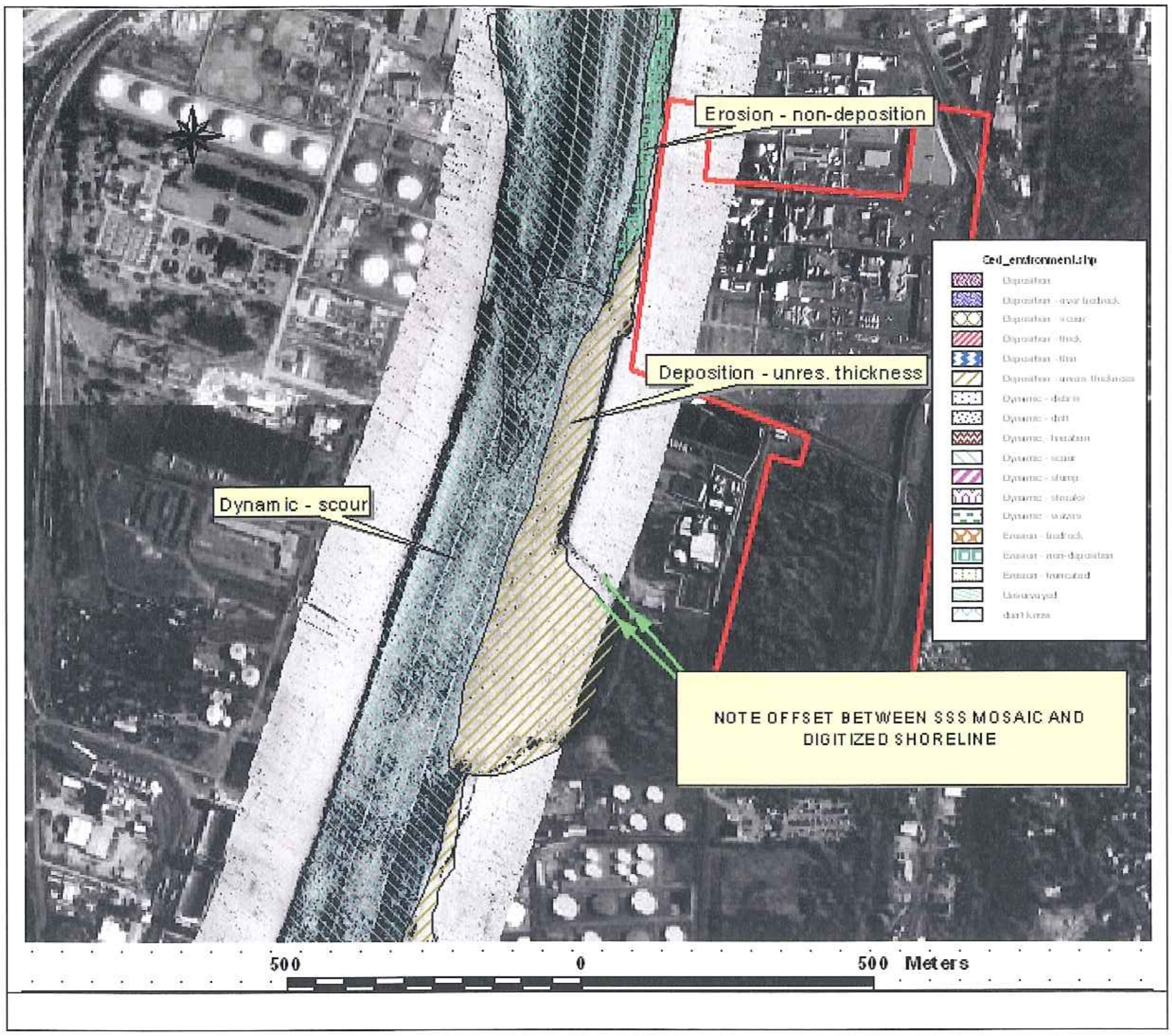


Figure 1B – 100-kHz SSS mosaic with NYSDEC sediment classification layer.

The 100-kHz sonar data shown on Figure 1A (top), suggests a relatively extensive (>100-m long) region of higher reflectivity, likely caused by coarser sediment. The multibeam bathymetry indicates that this region is relatively flat. The NYSDEC classification shapefile does not identify this area of likely coarser material. Instead, portions of the area are identified as *finer* sediment (muddy sand). Figure 2 below shows the 100-kHz SSS mosaic & the NYSDEC sedimentary environment classifications. The DEC shapefile identifies this area of interest as a "Dynamic Scour" sedimentary environment. Thus, there is a potential disparity between the "scouring" and "muddy" classifications in the reach of the river nearest the BASF Site.



In addition, our review of these data suggest that neither the multibeam bathymetry or SSS mosaics suggest substantial differences between the easterly and westerly banks (with the exception of the eastern cove), yet the DEC classification segregates much of the easterly bank as depositional.

The SSS data suggest the presence of bedforms and morphological features not identified by the DEC shapefile or the multibeam bathymetry. In particular, we noted several coarse circular features which may indicate disposal events. The data also suggests migratory current-induced sand waves and several large mounded features.

2.0 Review of 2001 Data

CR briefly reviewed the geophysical portions of the Empire State Newsprint Project Report (ENSR, 2001). With regard to the project objectives (i.e., using the geophysical data to focus a sediment investigation) several potential shortcomings were observed. First, the side scan sonar system used for this survey was not of survey-grade. Severe data artifacts caused by the side-lobes of inferior transducers obscure much of the data. Data were collected using a 600-kHz Marine Sonics side scan system. This type of sonar is best suited to object detection rather than benthic mapping, and is frequently used by police, archaeologists and treasure-hunters because of it's high frequency (i.e., better discrimination capabilities for small objects) and low cost relative to professional survey systems. Inspection of the data was also confounded by the presence of rather severe electrical noise caused by poor or lacking sea-ground during acquisition. As with the NYSDEC data, neither TVG nor BAC corrections were applied. Mosaics were not prepared from the data, limiting its value for incorporation with other GIS information. SSS records were presented as reverse-intensity orange/brown scale waterfalls, including the water column. While these data may be of use for the identification of submerged structures (i.e., culverts, pipes etc.), they are of limited value relative to the overall project objectives (i.e., they do not provide sufficient resolution for the design of a sediment sampling program).

CR briefly reviewed the sub-bottom sonar data presented in this report. The system employed was the Edgetech GeoStar, a CHIRP 4-24 kHz acoustic profiler. Data were presented as annotated seismic profiles. In several instances, the interpretation of the data (based on the annotations on the profiles) may warrant additional evaluation. For example, one profile depicted a thick series of sand/silt strata located at the toe of the riverbank slope. The horizontal extent of this feature was quite narrow, and data were quickly obscured further from the bank. We have commonly observed similar features in the Hudson River as well as at the edges of CAD-cell excavations and utility crossings. The likely cause of these narrow windows of superior penetration is the instability of the material at the toe of slope/edge of excavation. This instability allows biogenic gases to escape which would otherwise have been entrained and completely obscured subsurface strata. Therefore it is possible that this relatively thick series extends a substantial distance towards the river thalweg, rather than forming a narrow band as annotated by NYSDEC.

3.0 Conclusions and Recommendations

It is CR's professional opinion that the data sets provided for our review are not of sufficient resolution for any site-specific evaluation of benthic characteristics or sediment transport. The NYSDEC side scan data were collected to allow regional-scale evaluation of the riverbed, and employed a sonar range outside of the acceptable limits for investigations at an industrial waste site.

In order to obtain a higher resolution data set which would permit the design of a sediment sampling and analysis program, the potential benefits of additional hydrographic survey(s) using a survey grade side scan sonar system (e.g. Edgetech 272-TD) and a CW low-frequency sub-bottom profiling system (e.g., SyQwest 10-kHz Stratabox) should be considered. Given the likely goals of such a survey and the relatively short river reach of interest, 25-m to 50-m range side scan sonar and a 100-kHz signal would provide adequate resolution for meeting project objectives. Survey lines should be spaced to allow 100-percent overlap. Sub-bottom sonar data could be collected simultaneously with the side scan sonar survey. Gains for both sonar systems should be properly adjusted during acquisition, and processing should include TVG and BAC corrections. Side scan mosaics should be produced using the finest resolution possible, allowing accurate identification of substrate composition. Substrate composition should be verified using a small benthic grab. All data should be georeferenced to the same grid and datum as other Site plans, allowing incorporation into the Site GIS project.

Prepared by:

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B

APPENDIX B

QUALITY ASSURANCE PROGRAM PLAN

DISTRIBUTION LIST

BASF Corporation Project Manager, J. Douglas Reid-Green
ENSR Project Manager, John Bleiler
ENSR Technical Leader, Mark Gerath/John Bleiler
ENSR Technical Reviewer, *To Be Determined*
ENSR Project QA Officer, Debra McGrath
ENSR Analytical Task Manager, Lori Herberich
ENSR Field Team Leader, *To Be Determined*
ENSR Data Manager, Caryn Spiak
Laboratory Project Manager, *To Be Determined*

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A.0 PROJECT MANAGEMENT

A.1 Introduction

This Quality Assurance Project Plan (QAPP) presents the organization, objectives, planned activities, and specific quality assurance/quality control (QA/QC) procedures associated with the Hudson River OU-2 Investigation at the BASF Corporation (BASF) facility in Rensselaer, NY. Specific protocols for sampling, sample handling and storage, chain-of-custody, and laboratory and field analyses are described herein. All QA/QC procedures have been structured in accordance with applicable technical standards, New York State Department of Environmental Conservation (NYSDEC) requirements, regulations, guidance, and technical standards. This QAPP has been prepared in accordance with the U.S. EPA QAPP policy as presented in EPA Requirements for Quality Assurance Project Plans (EPA QA/R-5, March 2001), and contains the information required for QAPPs in New York State Department of Environmental Conservation Technical Guidance for Site Investigation and Remediation, Draft DER-10.

This QAPP has been prepared as Appendix B to the Work Plan and incorporates that document by reference.

A.2 Distribution List

The QAPP, and any subsequent revisions, will be distributed to the personnel shown on the Distribution List that immediately follows the approval page.

A.3 Project/Task Organization

The lines of authority and communication specific to this investigation are described below along with the responsibilities of key personnel.

A.3.1 Management Responsibilities

<u>BASF Project Manager</u>

The BASF Project Manager, Mr. J. Douglas Reid-Green, is responsible for project direction and decisions concerning technical issues and strategies, including technical, financial, and scheduling matters.

ENSR Project Manager

The ENSR Project Manager, Mr. John Bleiler, has responsibility for technical, financial, and scheduling matters. Other duties, as necessary, include

- Subcontractor procurement,
- Assignment of duties to project staff and orientation of the staff to the specific needs and requirements of the project,

ENSR Technical Leader

ENSR's Project Manager will be assisted by Mr. Mark Gerath as ENSR's Co-Technical Leader. His duties, as necessary, include:

- Ensuring that data assessment activities are conducted in accordance with the QAPP,
- Approval of project-specific procedures and internally prepared plans, drawings, and reports,
- Serving as the focus for coordination of all field and laboratory task activities, communications, reports, and technical reviews, and other support functions, and facilitating sampling activities with the technical requirements of the project, and
- Maintenance of the project files.

ENSR Technical Reviewer

ENSR's Technical Reviewer, *To Be Determined*, will provide added technical guidance to ENSR's Project Manager and Technical Leader as needed, and review all reports.

ENSR Task Managers

Each ENSR Task Manager is responsible for overseeing the day-to-day activities associated with his/her task and for communicating progress, problems, and any data quality issues to the ENSR Project Manager. The Task Managers will also participate in report preparation. The Task Leaders are as follows:

- *To Be Determined*, Field Team Leader – The Field Team Leader will be responsible for implementing the field program, including management of field services subcontractors.

- Lori Herberich, Analytical Task Manager – Ms. Herberich will be responsible for managing the subcontractor laboratories, serving as liaison between field and laboratory personnel, and assessing the quality of the analytical data.

- Caryn Spiak, Data Manager – Ms. Spiak will be responsible for managing the project data.

A.3.2 Quality Assurance Responsibilities

ENSR Project QA Officer

The ENSR Project QA Officer, Debra McGrath, has overall responsibility for quality assurance oversight. The ENSR Project QA Officer communicates directly to the ENSR Project Manager. Specific responsibilities include:

- Preparing the QAPP,
- Reviewing and approving QA procedures, including any modifications to existing approved procedures,
- Ensuring that QA audits of the various phases of the project are conducted as required,
- Providing QA technical assistance to project staff,
- Ensuring that data validation/data assessment is conducted in accordance with the QAPP, and
- Reporting on the adequacy, status, and effectiveness of the QA program to the ENSR Project Manager.

ENSR Data Validator

The ENSR Data Validator reports to the ENSR Project QA Officer. The Data Validator is responsible for validating the analytical data in accordance with the QAPP.

A.3.3 Laboratory Responsibilities

A laboratory will perform chemical analyses of sediment and surface water samples. The laboratory that will be performing the analyses is identified in Section B. 4.

Laboratory Manager

The Laboratory Manager is ultimately responsible for the data produced by the laboratory. Specific responsibilities include:

- Implementing and adhering to the laboratory QA manual and all corporate policies and procedures within the laboratory,
- Approving the standard operating procedures (SOPs),
- Maintaining adequate staffing documented on organization charts
- Implementing internal/external audit findings corrective actions

Laboratory QA Coordinator

The Laboratory QA Coordinator reports to the Laboratory Manager. Specific responsibilities include:

- Approving SOPs,
- Assessing and maintaining the laboratory QA manual implementation within the facility operations,
- Recommending resolutions for ongoing or recurrent nonconformances within the laboratory,
- Performing QA assessments,
- Reviewing and approving corrective action plans for nonconformances, tracking trends of nonconformances to detect systematic problems, and initiating additional corrective actions as needed.

Laboratory Project Manager

The Laboratory Project Manager is the primary point of contact between the laboratory and ENSR. Specific responsibilities of the Laboratory Project Manager include:

- Monitoring analytical and QA project requirements for a specified project,
- Acting as a liaison between the client and the laboratory staff,

- Reviewing project data packages for completeness and compliance to client needs, and

- Monitoring, reviewing, and evaluating the progress and performance of projects.

A.3.4 Field Responsibilities

ENSR Field Team Leader

The ENSR Field Team Leader, *To Be Determined*, has overall responsibility for completion of all field activities in accordance with the Work Plan and QAPP and is the communication link between ENSR project management and the field team. Specific responsibilities of the ENSR Field Team Leader include:

- Coordinating activities at the site,

- Assigning specific duties to field team members,

- Mobilizing and demobilizing of the field team and subcontractors to and from the site,

- Directing the activities of subcontractors on site,

- Resolving any logistical problems that could potentially hinder field activities, such as equipment malfunctions or availability, personnel conflicts, or weather dependent working conditions, and

- Implementing field QC including issuance and tracking of measurement and test equipment; the proper labeling, handling, storage, shipping, and chain-of-custody procedures used at the time of sampling; and control and collection of all field documentation.

ENSR Field Staff

The field staff reports directly to the ENSR Field Team Leader. The responsibilities of the field team include:

- Collecting samples, conducting field measurements, and decontaminating equipment according to documented procedures stated in the Work Plan,

- Ensuring that field instruments are properly operated, calibrated, and maintained, and that adequate documentation is kept for all instruments,

- Collecting the required QC samples and thoroughly documenting QC sample collection,
- Ensuring that field documentation and data are complete and accurate, and
- Communicating any nonconformance or potential data quality issues to the ENSR Field Team Leader.

A.4 Problem Definition and Background

A.4.1 Site Background and Description

BASF is the current owner of a former industrial manufacturing site in the City of Rensselaer, Rensselaer County, New York. The site is zoned for heavy industry and includes several unused facilities: a manufacturing plant, water intake and treatment system, wastewater pre-treatment system, closed lagoons, parking areas, and a closed landfill. In addition, there is an undeveloped parcel at the southern end of the property. The former manufacturing portion of the site (north parcel) has been occupied by industrial manufacturers (principally dyestuffs and pharmaceuticals) for more than a century.

The 88-acre site is situated on the east bank of the Hudson River. The property currently contains approximately 42 acres of developed areas, 23 acres of brushland, 11 acres of poor quality wetlands, 10 acres of unvegetated area, and 2 acres of closed man-made lagoons. It is bordered by Riverside Avenue and the Hudson River on the west, a truck access road (Irwin Stewart Port Expressway, also known as the Port Access Highway) on the east and south, and by another industrial facility on the north. An 80 MW (nominal) electrical cogeneration plant and a vehicle reclamation facility lie just south and west of site between Riverside Avenue and the Hudson River (ENSR, 2001).

The majority of the site currently lies within the floodplain of the Hudson River, and the majority of the site is situated below the 100-year flood elevation (approximately 20.5 feet above mean sea level).

A.4.2 Problem Definition

A review of the sediment quality data from the recently completed BASF Rensselaer OU-2 *Offsite Investigation Report for Hudson River Sediment* (Roux Associates, 2004) indicates that:

1) The reach of the Hudson River estuary adjacent to the Site is a complex and dynamic system. In order to understand sediment chemistry dynamics as they relate to the BASF Rensselaer OU-2 investigation, it is critical to develop a better understanding of the riverine, tidal, and benthic conditions in the vicinity of the Site;

2) Selected volatile organic compounds (VOCs) are present in sediment in near-shore environments adjacent to the BASF facility production sewer outfalls; and

3) Selected inorganic compounds (i.e., metals) are present in sediment in both the near-shore environments (proximate to the production sewer outfalls) as well as in downstream locations within the river.

The proposed characterization of the Hudson River in the vicinity of the BASF facility relies on an approach that uses field and laboratory data to provide an assessment of constituent fate and transport in the river adjacent to the site, and to provide a preliminary evaluation of the potential for risks to human health and ecological receptors.

Based on the results of the OU-1 investigation, the recently completed OU-2 sediment sampling program, and the review of information contained in the Work Plan, the proposed sampling effort focuses on:

1) Delineating the extent of selected metals and VOCs within the sediments adjacent to the facility;

2) Evaluating Hudson River surface water quality in the vicinity of and downstream of production sewer outfalls; and

3) Providing a preliminary analysis of the benthic community in the Hudson River in the vicinity of the Site.

A.5 Project/Task Description and Schedule

A.5.1 Project Description

Characterization of the Hudson River adjacent to the facility will be conducted to determine the level and presence of constituents potentially attributable to Site sources reaching the Hudson River via historic waste disposal activities (i.e., outfalls, spills) or surface water discharge(s) from the Site. Based on historic site activities, the sampling efforts within the river will focus on delineating the extent of site-related metals and VOCs. The VOC delineation effort will focus on the near-shore sediments adjacent to historic outfalls, while the metals delineation effort will include the near-shore areas as well as main channel and upstream sampling.

Specific tasks associated with field program are:

- Sampling and analysis of surficial sediment for metals, volatile organic compounds (VOCs), grain size, total organic carbon (TOC), and simultaneously extracted metals/acid volatile sulfide (SEM/AVS);

- Sampling and analysis of subsurficial sediment for metals, VOCs, grain size, and TOC;

- Sampling and analysis of surface water for total recoverable and dissolved metals, VOCs, total suspended solids (TSS), TOC, dissolved organic carbon (DOC), and hardness; and

- Sampling and reconnaissance level analysis of benthic macroinvertebrate communities.

A.5.2 Project Schedule

The project schedule is presented in Section 5.0 of the Work Plan.

A.6 Quality Objectives and Criteria for Measurement Data

A.6.1 Project Quality Objectives

The objective of the Hudson River OU-2 Investigation is to characterize the Hudson River adjacent to the BASF Rensselaer facility relative to the constituents which may have emanated from the BASF Main Plant (i.e., OU-1). Therefore, the sampling and analysis program has been based on:

- A sampling protocol designed to obtain sufficient data to characterize the constituents adjacent to, and upstream and downstream of the BASF facility,
- The use of sample collection and handling procedures that will ensure the representativeness and integrity of the samples, and
- An analytical program designed to generate definitive data of sufficient quality and sensitivity to meet the project objectives. Data deliverables will allow validation of the data and reproduction of the reported results.

The design of the Hudson River OU-2 Investigation was based on the EPA data quality objectives (DQO) process, a multi-step, iterative process that ensures that the type, quantity, and quality of environmental data used in decision making is appropriate for its intended application. This process is summarized in Section 3.0 of the Work Plan.

A.6.2 Data Quality Objectives for Measurement Data

DQOs, as target detection limits, are summarized in Table A-1. QC samples are described in Sections B.5.1 and B.5.2.

Precision

Precision is a measure of the degree to which two or more measurements are in agreement. Field precision is assessed through the collection and measurement of field duplicates at a rate of one duplicate per ten analytical samples. Precision will be measured through the calculation of relative percent difference (RPD). The objectives for field precision RPDs are 30% RPD for aqueous samples and 50% RPD for solid samples.

Precision in the laboratory is assessed through the calculation of RPD for duplicate samples, either as matrix spike/matrix spike duplicates (MS/MSDs), Laboratory Control Sample (LCS) duplicates, or as laboratory duplicates, depending on the method. The control limits generated by the laboratory that are current at the time of analyses will be utilized.

Accuracy

Accuracy is the degree of agreement between the observed value and an accepted reference or true value. Accuracy in the field is assessed through the use of trip blanks and equipment blanks and through the adherence to all sample handling, preservation, and holding time requirements. The objective for trip blanks and equipment blanks is that no target compounds are present above the reporting limit.

Laboratory accuracy is assessed through the analysis of laboratory method blanks, and spiked samples such as MS/MSDs, laboratory control samples (LCSs), and surrogate compounds. Method blanks will not contain any target compounds above the reporting limit. For spiked samples, the accuracy objectives, as measured by percent recoveries (%Rs), will be the laboratory control limits that are current at the time of analyses.

Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions. "Normal conditions" are defined as the conditions expected if the sampling plan was implemented as planned.

Field completeness is a measure of the amount of valid samples obtained during all sampling for the project. The field completeness objective is greater than 90 percent.

Laboratory completeness is a measure of the amount of valid measurements obtained from all the measurements taken in the project. The laboratory completeness objective is greater than 95 percent.

Sensitivity

Sensitivity of analytical data is demonstrated by reporting limits or practical quantitation limits. The reporting limits for the parameters to be analyzed are presented in Table A-1. To maximize the usability of the data, any detected compounds below the reporting limit and above the method detection limit (MDL) will be reported by the laboratory as estimated ("J") values.

A.7 Special Training/Certification

A.7.1 Training

Prior to starting work, personnel will be given instruction specific to the project, covering the following areas:

- Organization and lines of communication and authority,
- Overview of the Work Plan,
- QA/QC requirements,
- Documentation requirements, and
- Health and safety requirements.

Instructions will be provided by the ENSR Project Manager, ENSR Field Team Leader, and ENSR Project QA Officer.

A.7.2 Certifications

The laboratory utilized for chemical testing of sediment and surface water will be certified by New York State Department of Health (NYSDOH). In the absence of NYSDOH certification for selected media or parameters, the laboratory performing the analyses will hold National Environmental Laboratory Accreditation Program (NELAP) accreditation.

A.8 Documents and Records

A.8.1 Project Files

The project files will be the central repository for all documents which constitute evidence relevant to sampling and analysis activities as described in this QAPP. ENSR is the custodian of the project files and will maintain the contents of the project files for the investigation, including all relevant records, reports, logs, field notebooks, pictures, subcontractor reports, and data reviews in a secured, limited access area and under custody of the ENSR Project Manager.

The project files will include at a minimum:

- Field logbooks,
- Field data and data deliverables,
- Photographs,
- Drawings,
- Sample collection logs,
- Laboratory data deliverables,
- Data validation reports,
- Data assessment reports,
- Progress reports, QA reports, interim project reports, etc.,
- All custody documentation (tags, forms, airbills, etc.)

A.8.2 Field Records

Field logbooks will provide the means of recording the data collecting activities performed during the investigation. As such, entries will be described in as much detail as possible so that persons going to the facility could reconstruct a particular situation without reliance on memory.

Field logbooks will be bound field survey books or notebooks. Logbooks will be assigned to field personnel, but will be stored in the project files when not in use. Each logbook will be identified by the project-specific document number.

The title page of each logbook will contain the following:

- Person to whom the logbook is assigned,
- The logbook number,
- Project name and number,
- Project start date, and
- End date.

Entries into the logbook will contain a variety of information. At the beginning of each entry, the date, start time, weather, names of all sampling team members present, and the signature of the person making the entry will be entered. The names of visitors to the site, field sampling or investigation team personnel, and the purpose of their visit, will also be recorded in the field logbook.

Field logbooks will be supplemented by standardized field measurement and sample collection forms. All measurements made and samples collected will be recorded. All entries will be made in permanent ink, signed, and dated and no erasures or obliterations will be made. If an incorrect entry is made, the information will be crossed out with a single strike mark which is signed and dated by the sampler. Whenever a sample is collected, or a measurement is made, a detailed description of the sampling location, which includes compass and distance measurements, or, latitude and longitude information (e.g., obtained by using a global positioning system) will be recorded. The number of photographs taken of the sampling location, if any, will be noted. All equipment used to make measurements will be identified, along with the date of calibration.

A.8.3 Laboratory Records and Deliverables

Laboratory data reduction procedures will be performed according to the following protocol. All information related to analysis will be documented in controlled laboratory logbooks, instrument printouts, or other approved forms. All entries that are not generated by an automated data system will be made neatly and legibly in permanent, waterproof ink. Information will not be erased or obliterated. Corrections will be made by drawing a single line through the error and entering the correct information adjacent to the cross-out. All changes will be initialed, dated, and, if appropriate, accompanied by a brief explanation. Unused pages or portions of pages will be crossed out to prevent future data entry. Analytical laboratory records will be reviewed by the supervisory personnel on a regular basis, and by the Laboratory QA Coordinator periodically, to verify adherence to documentation requirements.

Analytical data deliverables will be provided to ENSR within 21 days from the date of sample receipt at the laboratory. The EDD will be provided as text files EQuIS® format. The hard copy data package will be a New York State Analytical Services Protocol Category B deliverable and will include, at a minimum, the following:

- Case narrative (see description below)
- Cross reference of field sample IDs and laboratory IDs
- Method summary
- Chain-of-custody documentation
- Sample receipt checklist
- Dates of sample extraction and analysis
- Description of any data qualifiers used

- Sample results, including units
- Sample preparation information
- Summaries of MS/MSDs (recoveries and RPDs), method blanks, LCS recoveries, internal standard areas, initial and continuing calibrations, tunes, laboratory duplicates, and surrogate spike recoveries.

The case narrative will include the client name, project name and number, date of issuance, and a discussion of any deviations from analytical strategy, technical problems, and QC failures or nonconformances. The report will be signed by the Laboratory Project Manager.

A.9 References

This QAPP was prepared using the following documents:

ENSR. 2001. Draft Environmental Impact Statement. Empire State Newsprint Project. Article X Case No. 00-F-2057. NYSDEC Project No. 4-3814-00052. December 2001.

New York State Department of Environmental Conservation. Draft DER-10. Technical Guidance for Site Investigation and Remediation. December 2002.

Roux, 2004. Offsite Investigation Report for Hudson River Sediments, BASF Rensselaer, Rensselaer, New York," August 2004.

United States Environmental Protection Agency, Quality Staff. *EPA Requirements for Quality Assurance Project Plans*, EPA QA/R-5. March 2001.

United States Environmental Protection Agency. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, SW-846. Third Edition. May 1986, revised June 1997.

United States Environmental Protection Agency, Region II. SOP HW-24 (Revision 1, June 1999), *Standard Operating Procedure for the Validation of Organic Data Acquired using SW-846 Method 8260B* (Revision 2, December 1996).

United States Environmental Protection Agency, Region II. SOP HW-2, Evaluation of Metals Data for the CLP Program" (Revision 11, January 1992).

B.0 MEASUREMENT/DATA ACQUISITION

B.1 Sampling Process Design

The rationale for sample design is provided in Section 3.0 of the Work Plan.

B.2 Sampling Methods

B.2.1 Field Measurements

Field measurements will be taken during sediment and surface water sampling. These measurements include temperature, specific conductivity, dissolved oxygen (DO), and pH of surface water at sediment sampling locations and water depth, DO, temperature, conductivity, and pH of surface water at surface water sampling locations. These measurements will be taken according to the procedures described in Section 3.0 of the Work Plan.

B.2.2 Sampling Procedures

During the Hudson River OU-2 Investigation, sediment and surface water will be sampled. Sampling will be conducted in accordance with the procedures described in Section 3.0 of the Work Plan.

B.2.3 QC Sample Collection

QC samples will include trip blanks, equipment field blanks, field duplicates, MS/MSDs and laboratory duplicates. These samples will be collected as described below:

Trip blanks – Trip blanks will be included with each shipment of VOC samples. Trip blanks associated with aqueous VOC samples will originate in the laboratory and will be prepared by filling two 40-mL VOA vials with laboratory VOA-free water and sealing the vials with septum-lined caps (allowing no headspace). Trip blanks will accompany the sample bottles to the site and will remain (unopened) in the shipping container until the sample bottles are received back at the laboratory. Trip blanks will be analyzed for VOCs only.

Equipment blanks – Equipment blanks will be prepared by routing laboratory grade water (provided by the laboratory) through non-dedicated sampling equipment after equipment decontamination and before field sample collection. Equipment blanks will be collected for all aqueous and solid samples collected with non-dedicated equipment (at a frequency of one per day per media sampled), and will be analyzed for the same parameters as their associated samples.

Field duplicates – Field duplicates will be collected at a frequency of one field duplicate for every 10 or less investigative samples submitted for analysis. Sample containers for VOC field duplicates will be filled consecutively. All field duplicates will be analyzed for the same parameters as their associated samples.

MS/MSDs – MS/MSD samples will be collected at a frequency of one for every 20 or less investigative samples submitted for analysis. For those samples designated as MS/MSDs, sufficient additional volume (based on the individual laboratory's requirements) will be collected.

B.2.4 Equipment Decontamination

Decontamination of equipment in the field is described in Section 3.0 of the Work Plan.

B.3 Sample Handling and Custody

B.3.1 Sample Containers, Preservation, and Holding Times

Sample bottles and chemical preservatives will be provided by the laboratory. The containers will be cleaned by the manufacturer to meet or exceed all analyte specifications established in the latest U.S. EPA's *Specifications and Guidance for Contaminant-Free Sample Containers*. Certificates of analysis will be provided with each lot of containers and maintained on file to document conformance to EPA specifications.

A summary of sample container, preservation, and holding time requirements is presented in Table B-1.

B.3.2 Sample Labeling

Immediately upon collection, each sample will be labeled with an adhesive label. Samples will be assigned unique sample identifications as described below:

The first two characters will define the sampling round and will be followed by a dash (e.g., 01-)

The third and fourth characters will define the matrix type:

SD – sediment
SW – surface water

The fifth and sixth characters will be a two digit number that will correspond to a specific location on a map and will be followed by a dash (e.g., 01-, 02-, 038-, etc.)

The seventh character will indicate the station area and will be followed by a dash:

A – Adjacent to the facility
D – Downstream from the facility
U – Upstream from the facility

The eighth character will be a letter representing depth. An "A" will represent the first sample collected and letter assignment will proceed sequentially (B, C, etc.) as samples from increasing depth are collected. The cross-reference between the letter assigned and the actual depth at which the sample was colleted will be recorded in the field records.

The last character of the sample ID will represent the sample type:

1 – Field sample
2 – Field duplicate
3 – Equipment blank

Samples being designated for MS/MSD analysis will not include an identifier as part of the sample code, but will be identified as such on the chain-of-custody form.

B.3.3 Custody Procedures

Custody is one of several factors that are necessary for the admissibility of environmental data as evidence in a court of law. Custody procedures help to satisfy the two major requirements for admissibility: relevance and authenticity. Sample custody is addressed in two parts: field sample collection and laboratory analysis.

A sample is considered to be under a person's custody if

- the item is in the actual possession of a person;
- the item is in the view of the person after being in actual possession of the person;
- the item was in the actual physical possession of the person but is locked up to prevent tampering;
- the item is in a designated and identified secure area.

<u>Field Custody Procedures</u>

The field sampler is personally responsible for the care and custody of the samples until they are transferred or dispatched properly. Field procedures have been designed such that as few people as possible will handle the samples.

All sample containers will be identified by the use of sample labels with sample numbers, sampling locations, date/time of collection, and type of analysis. The sample numbering system is presented in Section B.3.2 of the QAPP. Sample labels will be completed for each sample using waterproof ink unless prohibited by weather conditions. For example, a logbook notation would explain that a pencil was used to fill out the sample tag because the pen would not function in freezing weather.

Samples will be accompanied by a properly completed chain-of-custody form. The sample numbers and locations will be listed on the chain-of-custody form. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents the transfer of custody of samples from the sampler to another person, to a mobile laboratory, to the permanent laboratory, or to/from a secure storage location. An example chain-of-custody form is presented as Figure B-1.

If split samples are collocated with a government agency, a separate sample receipt will be prepared for those samples and marked to indicate with whom the samples are being collocated. The person relinquishing the samples to the facility or agency should obtain the representative's signature acknowledging sample receipt. If the representative is unavailable or refuses to sign, this is noted in the "Received By" space.

All sample shipments will be accompanied by the chain-of-custody record identifying the contents. The original record will accompany the shipment, and the pink and yellow copies will be retained by the sampler and placed in the project files.

Samples will be packaged on ice at 4°C (if thermal preservation is required) for shipment and dispatched to the appropriate laboratory for analysis, with a separate signed custody record enclosed in and secured to the inside top of each sample box or cooler. Shipping containers will be locked and secured with strapping tape and custody seals for shipment to the laboratory. The custody seals will be attached to the front right and back left of the cooler and covered with clear plastic tape after being signed by field personnel. The cooler will be strapped shut with strapping tape in at least two locations.

If the samples are sent by common carrier, the waybill will be used. Waybills will be retained as part of the permanent documentation. Commercial carriers are not required to sign off on the custody forms since the custody forms will be sealed inside the sample cooler and the custody seals will remain intact.

Samples are expected to be transported to the laboratory the same day the samples are collected in the field. Samples will be shipped by overnight commercial carrier or will be transported by same-day courier.

Laboratory Custody Procedures

Samples will be received and logged in by a designated sample custodian or his/her designee. Upon sample receipt, the sample custodian will

- Examine the shipping containers to verify that the custody tape is intact,
- Examine all sample containers for damage,
- Determine if the temperature required for the requested testing program has been maintained during shipment and document the temperature on the chain-of-custody form,
- Compare samples received against those listed on the chain-of-custody,
- Verify that sample holding times have not been exceeded,
- Examine all shipping records for accuracy and completeness,
- Determine sample pH (if applicable) and record on chain-of-custody,
- Sign and date the chain-of-custody immediately (if shipment is accepted) and attach the waybill,
- Note any problems associated with the coolers and/or samples on the cooler receipt form and notify the Laboratory Project Manager, who will be responsible for contacting the client,
- Attach laboratory sample container labels with unique laboratory identification and test,
- Place the samples in the proper laboratory storage.

Following receipt, samples will be logged in according to the following procedure:

- The samples will be entered into the laboratory information management system (LIMS). At a minimum, the following information will be entered: project name or identification, unique sample numbers (both client and internal laboratory, type of sample, required tests, date and time of laboratory receipt of samples, and field ID provided by field personnel.

- The appropriate laboratory personnel will be notified of sample arrival.
- The completed chain-of-custody, waybills, and any additional documentation will be placed in the project file.

Specific details of laboratory custody procedures for sample receiving, sample identification, sample control, and record retention are described in the laboratory SOPs.

B.4 Analytical Methods

Samples of sediment and surface water will be submitted to

Laboratory To Be Determined

The methods to be used are summarized in Table B-2. Target analytes and reporting limits are provided in Table A-1. Laboratory turnaround time is described in Section A.8.3.

B.5 Quality Control

B.5.1 Field

QC measurements for field measurements will be limited to the calibrations described in Section B.7.

Field QC samples will be collected during sediment and surface water sampling to assess the accuracy and precision of the data. These samples will include field duplicates, MS/MSDs, trip blanks, and equipment blanks, as appropriate for the media and/or parameters being sampled. The collection of QC samples is described in Section B.2. Frequency of collection and acceptance criteria are described in Section A.6.2.

B.5.2 Laboratory

Each analytical laboratory has a QC program in place to ensure the reliability and validity of the analysis performed at the laboratory. All analytical procedures are documented in writing as SOPs and each SOP includes the minimum requirements for the procedure. The internal QC checks differ slightly for each individual procedure but in general the QC requirements include the following:

- Blanks (method, reagent/preparation, instrument)
- MS/MSDs
- Surrogate spikes (GC/MS analysis)

- Laboratory duplicates
- LCSs
- Internal standard areas (GC/MS analysis)
- Interference checks (ICP analysis)
- Serial dilutions (ICP analysis)

The laboratory SOPs for each analyses define the type, frequency, and corrective action for the applicable QC checks. Acceptance criteria will be the control limits generated by the laboratory for each analyses, or, in their absence, the QC limits specified in the method.

B.6 Instrument/Equipment Testing, Inspection, and Maintenance

The field equipment for this project is limited to water quality meters. The ENSR Field Team Leader will be responsible for ensuring that the instruments are functioning properly. At a minimum, this will entail checking the instruments prior to shipment to the field and performing daily operational checks and calibration as described in Section B.7. Routine maintenance and trouble-shooting procedures will be performed as described in the manufacturer's instructions.

Routine testing and preventive maintenance is performed by the laboratory as part of their QA program. Details on the type of checks, frequencies, and corrective actions are included in the laboratory QA manual.

B.7 Instrument/Equipment Calibration and Frequency

The field instrumentation for this project is limited to water quality meters. Calibration of these instruments will be performed according to the manufacturer's instructions and will be consistent with the procedures and frequencies specified in the applicable SOPs. A summary of calibration procedures and frequencies is provided as Table B-3. All calibration procedures will be documented in the field records. Calibration records will include the date/time of calibration, name of the person performing the calibration, reference standard used, and the results of the calibration.

Calibration procedures for laboratory instruments will consist of initial calibrations, initial calibration verifications, and continuing calibration verification. The SOP for each analysis performed in the laboratory describes the calibration procedures, their frequency, acceptance criteria, and the conditions that will require recalibration.

The laboratory maintains documentation for each instrument which includes the following information: instrument identification, serial number, date of calibration, analyst, calibration solutions, and the samples associated with these calibrations.

B.8 Inspection/Acceptance of Supplies and Consumables

For this project, critical supplies for field activities will be tracked through ENSR's system in the following manner.

Critical Supplies and Consumables	Inspection Requirements and Acceptance Criteria	Responsible Individual
Sample bottles	Visually inspected upon receipt for cracks, breakage, and cleanliness. Must be accompanied by certificate of analysis.	Field Team Leader
Chemicals and reagents	Visually inspected for proper labeling, expiration dates, appropriate grade	Field Team Leader
Field measurement equipment	Functional checks to ensure proper calibration and operating capacity	Field Team Leader
Sampling equipment	Visually inspected for obvious defects, damage, and contamination	Field Team Leader

Supplies and consumables not meeting acceptance criteria will initiate the appropriate corrective action. Corrective measures may include repair or replacement of measurement equipment, and/or notification of vendor and subsequent replacement of defective or inappropriate materials. All actions will be documented in the project files.

The laboratory system of inspection and acceptance of supplies and consumable is documented in the laboratory QA Manual.

B.9 Non-Direct Measurements

The use of non-direct data such as historical reports, maps, and literature searches will be limited to the design of the sampling program and will not be used for characterization purposes. Previously collected data, if determined to be of known quality that meets the quality objectives established for this program, may be used for characterization.

B.10 Data Management

Data management operations include data recording, validation, transformation, transmittal, reduction, analysis, tracking, storage and retrieval.

All data will be entered into an EQuIS® database system. EQuIS® is a software product of Earthsoft, is widely used in the industry, and has proven to be a reliable and robust data management tool. EDDs provided by the laboratories will be in an EQuIS-compatible format that will minimize manipulation of the data.

Upon receipt from the laboratory, hard copy and EDD will be assigned a unique identifier, which allows the data to be tracked from receipt, through validation, to data loading. The electronic data will be imported into the EQuIS® database system concurrent with the data validation process. Data qualifiers generated during data validation will be entered manually. Data collected in the field will also be entered into the system and integrated with laboratory data.

As data is loaded into the system, a variety of quality checks are performed to ensure data integrity. These checks include

- Audits to ensure that laboratories reported all requested analyses;
- Checks that all analytes are consistently and correctly identified;
- Reviews to ensure that units of measurement are provided and are consistent;
- Queries to determine that any codes used in the database are documented properly;
- Reports to review sample definitions (depths, dates, locations);
- Proofing manually entered data against the hard-copy original, and
- Reports to review groupings of sampling locations and coordinate systems.

Records of the checks are maintained on file.

At a minimum, the database will contain the following fields:

Sample identifier,
Sample location,
Sample media type,
Sampling date,
Analysis date,
Laboratory analysis identifier,
Analyte name,
Concentration value,
Measurement units,
Data qualifiers.

Data will be loaded into a "temporary" database until data validation is complete, at which time the database will be finalized. Any changes made to the database after finalization will be documented, including a description of the change, date of change, person responsible, and reason for change.

Once all data quality checks are performed, the data will be exported to a variety of formats to meet project needs. Cross-tab tables showing concentrations by sample location will be prepared.

Statistical analyses will be performed as required. Data can be accessed by a variety of mapping and visualization tools.

The project database will be maintained on a secure network drive which is backed up regularly. Access to the database will be limited to authorized users and will be controlled by password access. Data will be retained in accordance with the requirements stated in Section A.8.1 of this QAPP.

C.0 ASSESSMENT/OVERSIGHT

C.1 Assessment and Response Actions

C.1.1 Assessments

The types of planned assessments pertinent to this program include technical surveillance audits (TSAs) of field and laboratory activities, data package audits, and data validation audits.

Field Activity TSA

A TSA of field activities will be conducted by the ENSR Project QA Officer or his/her designate. The TSA will include examination of the records associated with sample collection, field measurements, field instrument operating and calibration records, and chain-of-custody. Any deficiencies will be communicated to the ENSR Field Team Leader and to the ENSR Project Manager, who will be responsible for ensuring that corrective measures are implemented and documented (Section C.1.2).

Laboratory TSA

Laboratory TSAs are conducted periodically by ENSR as part of their analytical subcontractor monitoring program. The laboratory TSA will include a review of the following areas:

- QA organization and procedures,
- Personnel training and qualifications,
- Sample log-in procedures,
- Sample storage facilities,
- Analyst technique
- Adherence to laboratory SOPs and project QAPP,
- Compliance with QA/QC objectives,
- Instrument calibration and maintenance,
- Data recording, reduction, review, and reporting, and
- Cleanliness and housekeeping.

Preliminary results of the systems audit will be discussed with the Laboratory Manager, Laboratory Project Manager, and Laboratory QA Coordinator. A written report that summarizes audit findings and recommends corrective actions will be prepared and submitted to the Laboratory Manager for response, and to the ENSR Project Manager. The results of the audit, including resolution of any deficiencies, will be included in the QA reports to management, as described in Section C.2.

Data Package Audits

Audits of analytical data packages will be conducted for 100% of the packages received as part of the data validation process (Section D.1). The review will include an evaluation of the package to ensure that all required deliverables are provided. Any deficiencies will be communicated to the laboratory so that the missing information can be provided.

Data Validation Audits

Each analytical data package will be validated as described in Section D.2. As part of the validation process, a review of each completed validation package will be conducted by a validator other than the one performing the validation. The review will verify that the analytical deliverable package was complete and that any missing information requested from the laboratory was supplied, that validation worksheets were filled out accurately and completely, that validation actions were consistent with the validation guidelines established for this program and/or best professional judgment, and that the validation reports and data qualifiers accurately reflect the validation actions as documented on the worksheets.

C.1.2 Response Actions

Corrective action is the process of identifying, recommending, approving, and implementing measures to counter unacceptable procedures or out-of-limit QC performance that can affect data quality. Corrective action can occur during field activities, laboratory analyses, data validation, and data assessment. All corrective action proposed and implemented should be documented in the QA reports to management (Section C.2). Corrective action should only be implemented after approval by the ENSR Project Manager, or his designee.

Field Corrective Action

Corrective action in the field may be needed when the sample network is changed (i.e., more/less samples, sampling locations other than those specified in the QAPP, etc.), or when sampling procedures and/or field analytical procedures require modification, etc. due to unexpected conditions. The field team may identify the need for corrective action. The ENSR Field Team Leader will approve the corrective action and notify the ENSR Project Manager. The ENSR Project Manager, in consultation with the ENSR Project QA Officer, will approve the corrective measure. The ENSR Field Team Leader will ensure that the corrective measure is implemented by the field team.

Corrective action resulting from internal field audits will be implemented immediately if data may be adversely affected due to unapproved or improper use of approved methods. The ENSR Project QA

Officer will identify deficiencies and recommend corrective action to the ENSR Project Manager. Implementation of corrective actions will be performed by the ENSR Field Team Leader and field team. Corrective action will be documented in QA reports to the project management team (Section C.2).

Corrective actions will be implemented and documented in the field record book. Documentation will include:

- A description of the circumstances that initiated the corrective action,
- The action taken in response,
- The final resolution, and
- Any necessary approvals.

No staff member will initiate corrective action without prior communication of findings through the proper channels.

Laboratory Corrective Action

Corrective action in the laboratory may occur prior to, during, and after initial analyses. A number of conditions such as broken sample containers, multiple phases, low/high pH readings, and potentially high concentration samples may be identified during sample log-in or analysis. Following consultation with laboratory analysts and supervisory personnel, it may be necessary for the Laboratory QA Coordinator to approve the implementation of corrective action. If the nonconformance causes project objectives not to be achieved, the ENSR Project Manager will be notified.

These corrective actions are performed prior to release of the data from the laboratory. The corrective action will be documented in both the laboratory's corrective action files, and in the narrative data report sent from the laboratory to the ENSR Project Manager. If the corrective action does not rectify the situation, the laboratory will contact the ENSR Project Manager, who will determine the action to be taken and inform the appropriate personnel.

Corrective Action During Data Validation and Data Assessment

The need for corrective action may be identified during either data validation or data assessment. Potential types of corrective action may include resampling by the field team or reinjection/reanalysis of samples by the laboratory. These actions are dependent upon the ability to mobilize the field team and whether the data to be collected is necessary to meet the required QA objectives. If the ENSR data validator or data assessor identifies a corrective action situation, the ENSR Project Manager will be responsible for informing the appropriate personnel.

C.2 Reports to Management

QA reports will be submitted to the ENSR Project Manager to ensure that any problems identified during the sampling and analysis programs are investigated and the proper corrective measures taken in response. The QA reports will include:

- All results of field and laboratory audits,
- Problems noted during data validation and assessment, and
- Significant QA/QC problems, recommended corrective actions, and the outcome of corrective actions.

QA reports will be prepared by the ENSR Project QA Officer and submitted on an as-needed basis.

D.0 DATA VALIDATION/DATA USABILITY

D.1 Data Review, Verification, and Validation

D.1.1 Field Data

Field data will be reviewed daily by the ENSR Field Team Leader to ensure that the records are complete, accurate, and legible and to verify that the sampling procedures are in accordance with the protocols specified in the Work Plan and QAPP.

D.1.2 Internal Laboratory Review

Prior to the release of any data from the laboratory, the data will be reviewed and approved by laboratory personnel. The review will consist of a tiered approach that will include reviews by the person performing the work, by a qualified peer, and by supervisory and/or QA personnel.

D.1.3 Validation of Analytical Data

Validation of the laboratory deliverables for sediment and surface water samples analyzed for chemical parameters will be performed by ENSR. The analytical data will be evaluated using the EPA validation guidelines cited in Section D.2 and the QC summary forms provided in the data package. At a minimum, the data will be reviewed for the following, as appropriate to the method:

- Completeness of deliverable,
- Technical holding times,
- Laboratory and field blank contamination,
- Surrogate spike recoveries,
- MS/MSD recoveries and relative percent differences (RPDs),
- Laboratory duplicate RPDs,
- LCS recoveries,
- Field duplicates,
- Initial and continuing calibrations,
- Instrument tuning, and
- Internal standard performance.

Equations that will be used to evaluate the data quality are presented in Section D.3.1.

D.2 Verification and Validation Methods

D.2.1 Field Data Verification

Field records will be reviewed by the ENSR Field Team Leader to ensure that:

- Logbooks and standardized forms have been filled out completely and that the information recorded accurately reflects the activities that were performed.
- Records are legible and in accordance with good recordkeeping practices, i.e., entries are signed and dated, data are not obliterated, changes are initialed, dated, and explained.
- Sample collection, handling, preservation, and storage procedures were conducted in accordance with the protocols described in the QAPP, and that any deviations were documented and approved by the appropriate personnel.

D.2.2 Laboratory Data Verification

Prior to being released as final, laboratory data will proceed through a tiered review process. Data verification starts with the analyst who performs a 100 percent review of the data to ensure the work was done correctly the first time. The data reduction and initial verification process must ensure that:

- Sample preparation and analysis information is correct and complete,
- Analytical results are correct and complete,
- The appropriate SOPs have been followed and are identified in the project records,
- Proper documentation procedures have been followed, and
- All nonconformances have been documented.

Following the completion of the initial verification by the analyst performing the data reduction, a systematic check of the data will be performed by an experienced peer or supervisor. This check will be performed to ensure that initial review has been completed correctly and thoroughly and will include a review of

- Adherence to the requested analytical method SOP,
- Correct interpretation of chromatograms, mass spectra, etc.,

- Correctness of numerical input when computer programs are used (checked randomly),
- Correct identification and quantitation of constituents with appropriate qualifiers,
- Numerical correctness of calculations and formulas (checked randomly)
- Acceptability of QC data,
- Documentation that instruments were operating according to method specifications (calibrations, performance checks, etc.),
- Documentation of dilution factors, standard concentrations, etc.,
- Sample holding time assessment.

A third-level review will be performed by the Laboratory Project Manager before results are submitted to clients. This review serves to verify the completeness of the data report and to ensure that project requirements are met for the analyses performed. A narrative to accompany the final report will be prepared by the Laboratory Project Manager.

D.2.3 Validation of Analytical Deliverables

Validation of the chemical data will be performed as described in Section D.1.3 of the QAPP using the U.S. EPA Region II SOP HW-24 (Revision 1, June 1999), Standard Operating Procedure for the Validation of Organic Data Acquired using SW-846 Method 8260B (Revision 2, December 1996) and SOP HW-2, Evaluation of Metals Data for the CLP Program" (Revision 11, January 1992). Data validation protocols based on SW-846 analytical methodologies will be used in conjunction with the project-specific acceptance criteria defined in Section A.6.2 of this QAPP to accept, reject, or qualify data.

Upon completion of the validation, a report will be prepared. This report will summarize the samples reviewed, elements reviewed, any nonconformances with the established criteria, and validation actions (including application of data qualifiers). Data qualifiers will be consistent with the U.S EPA guidelines.

D.2.4 Verification during Data Management

All manually entered data (e.g., field data) will be proofed 100 percent against the original. Electronic data will be checked 100 percent after loading against laboratory data sheets for completeness and spot checked for accuracy.

D.3 Reconciliation with User Requirements

D.3.1 Comparison to Measurement Objectives

The field and laboratory data collected during this investigation will be used to achieve the objectives identified in Section A.6 of this QAPP. The QC results associated with each analytical parameter for each matrix will be compared to the measurement objectives presented in Section A.6.2 of this QAPP. Only data generated in association with QC results meeting the stated acceptance criteria (i.e., data determined to be valid) will be considered usable for decision making purposes.

D.3.1.1 Accuracy Assessment

One measure of accuracy will be percent recovery (%Rs), which is calculated for matrix spikes, surrogates, and laboratory control samples (LCSs). Percent recoveries for MS/MSD results will be determined according to the following equation:

$$\%R = \frac{(Amount\ in\ Spiked\ Sample - Amount\ in\ Sample)}{Known\ Amount\ Added} x100$$

Percent recoveries for LCS and surrogate compound results will be determined according to the following equation:

$$\%R = \frac{Experimental\ Concentration}{Known\ Amount\ Added} x100$$

An additional measure of accuracy is blank contamination. The blanks associated with this project include laboratory method blanks and field blanks (e.g., equipment blanks and trip blanks). The results of the laboratory and field blanks will be compared to the objectives in stated Section A.7.2 of the QAPP. Failure to meet these objectives may indicate a systematic laboratory or field problem that should be investigated and resolved immediately. Associated data may be qualified and limitations placed on its use, depending on the magnitude of the problem.

D.3.1.2 Precision Assessment

The RPD between the matrix spike and matrix spike duplicate, or sample and sample duplicate in the case of some of the inorganic parameters, and field duplicate pair is calculated to compare to precision objectives (Section A.6.2 of this QAPP). The RPD will be calculated according to the following formula.

$$RPD = \frac{(Amount\ in\ Sample\ 1 - Amount\ in\ Sample\ 2)}{0.5\,(Amount\ in\ Sample\ 1 + Amount\ in\ Sample\ 2)} x\,100$$

Failure to achieve precision objectives may result in the associated data be qualified (Section D.2.3) and limitations placed upon its use.

D.3.1.3 Completeness Assessment

Completeness is the ratio of the number of valid sample results to the total number of samples analyzed with a specific matrix and/or analysis. Following completion of the analytical testing, the percent completeness will be calculated by the following equation:

$$Completeness = \frac{(number\ of\ valid\ measurements)}{(number\ of\ measurements\ planned)} x\,100$$

Failure to meet the completeness objective will require an assessment to determine if the missing or invalid data are critical to achieving the project objectives. Corrective actions may include resampling or re-analysis, depending on the type of problem, logistical constraints, etc.

D.3.2 Comparison to Project Objectives

In addition to the comparison described in Section D.3.1, the data obtained will be both qualitatively and quantitatively assessed on a project-wide, matrix-specific, and parameter-specific basis. Factors to be considered in this assessment of field and laboratory data will include, but not necessarily be limited to, the following.

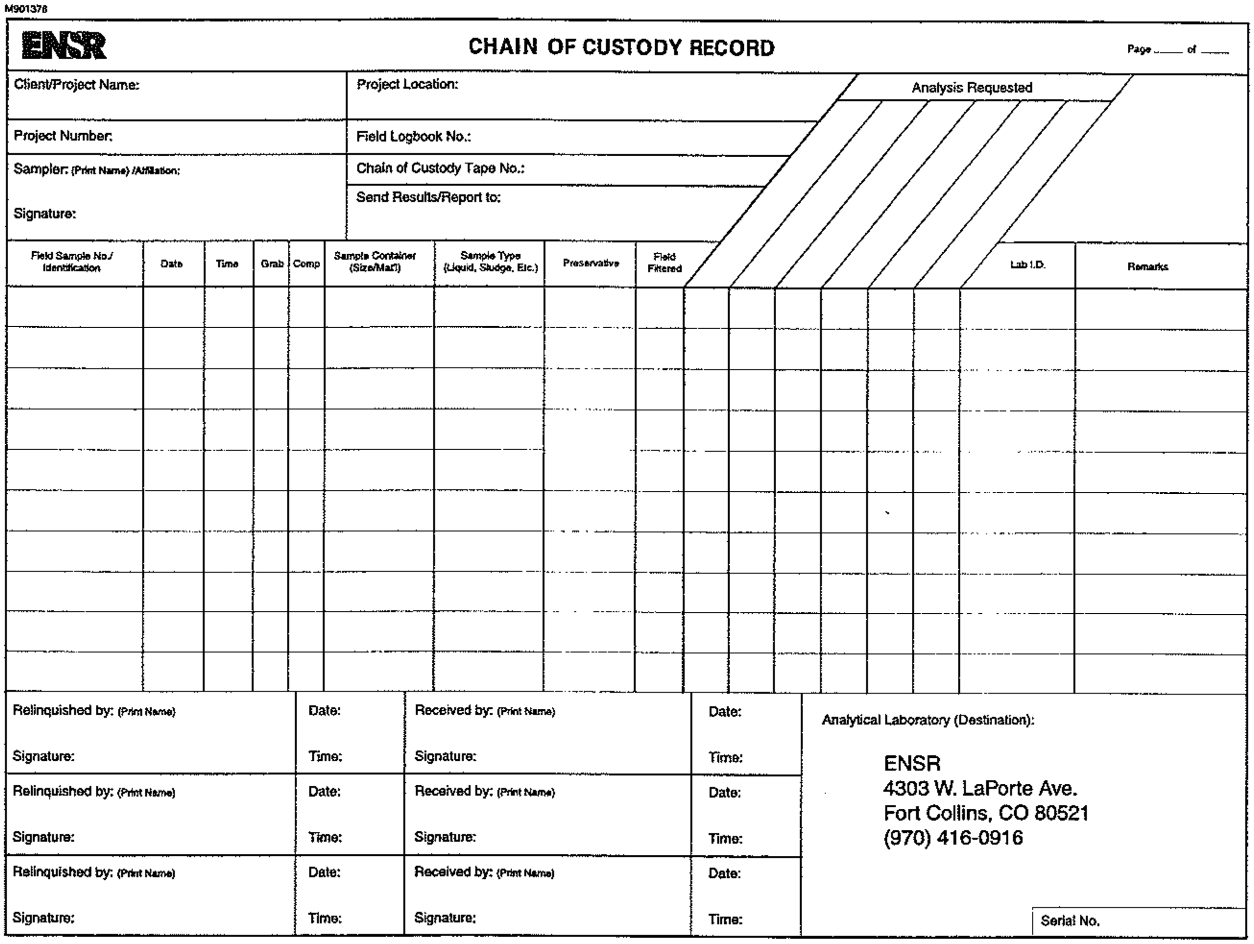
- Conformance to the field methodologies and SOPs proposed in the GIWP and QAPP,
- Conformance to the analytical methodologies provided in the QAPP,
- Adherence to proposed sampling strategy,

- Presence of elevated detection limits due to matrix interferences or contaminants present at high concentrations,
- Unusable data sets (qualified as "R") based on the data validation results,
- Data sets identified as usable for limited purposes (qualified as "J") based on the data validation results,
- Effect of qualifiers applied as a result of data validation on the ability to implement the project decision rules, and
- Status of all issues requiring corrective action, as presented in the QA reports to management.

The effect of nonconformance (procedures or requirements) or noncompliant data on project objectives will be evaluated. Minor deviations from approved field and laboratory procedures and sampling approach will likely not effect the adequacy of the data as a whole in meeting the project objectives. Data that are estimated ("J" qualified) during the validation process will generally be considered usable, although any instances of extreme bias will be evaluated on a case-by-case basis to determine the limitations, if any, of the data usability. Missing or rejected data will be reviewed to determine whether the data is critical to attaining the project objectives. The assessment will also entail the identification of any remaining data gaps and need to reevaluate project decision rules.

This assessment will be performed by the ENSR technical team, in conjunction with the ENSR Project QA Officer, and the results presented and discussed in detail in the final report.

Figure B-1 Example of Chain of Custody Form



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ENSR CHAIN OF CUSTODY RECORD Page ___ of ___

Client/Project Name:
Project Location:
Analysis Requested
Project Number:
Field Logbook No.:
Sampler: (Print Name) /Affiliation:
Signature:
Chain of Custody Tape No.:
Send Results/Report to:

Field Sample No./ Identification	Date	Time	Grab	Comp	Sample Container (Size/Mat'l)	Sample Type (Liquid, Sludge, Etc.)	Preservative	Field Filtered							Lab I.D.	Remarks

Relinquished by: (Print Name) Signature:	Date: Time:	Received by: (Print Name) Signature:	Date: Time:	Analytical Laboratory (Destination): ENSR 4303 W. LaPorte Ave. Fort Collins, CO 80521 (970) 416-0916
Relinquished by: (Print Name) Signature:	Date: Time:	Received by: (Print Name) Signature:	Date: Time:	
Relinquished by: (Print Name) Signature:	Date: Time:	Received by: (Print Name) Signature:	Date: Time:	Serial No.

Table A-1 Analyte List, Project Required Detection Limits, and Reporting Limits

CAS No.	Parameter	Surface Water PRDL µg/L	Note	Sediment PRDL mg/Kg	Note	Surface Water* RL µg/L	Sediment* RL mg/Kg
TCL VOCs							
79-34-5	1,1,2,2-Tetrachloroethane	0.2	1	1.4	2	TBD	TBD
71-55-6	1,1,1-Trichloroethane	5	1	0.030	2	TBD	TBD
79-00-5	1,1,2-Trichloroethane	1	1	1.2	2	TBD	TBD
96-12-8	1,2-Dibromo-3-chloropropane	0.04	1	NV, **	--	TBD	TBD
106-93-4	1,2-Dibromoethane	0.0006	1	NV, **	--	TBD	TBD
75-34-3	1,1-Dichloroethane	5	1	0.027	2	TBD	TBD
107-06-2	1,2-Dichloroethane	0.6	1	0.250	2	TBD	TBD
75-35-4	1,1-Dichloroethene	0.07	1	0.031	2	TBD	TBD
156-59-4	cis-1,2-Dichloroethene	5	1	0.400	2	TBD	TBD
156-60-5	trans-1,2-Dichloroethene	5	1	0.400	2	TBD	TBD
78-87-5	1,2-Dichloropropane	1	1	0.333	6	TBD	TBD
10061-01-5	cis-1,3-Dichloropropene	0.055	2	0.000051	2	TBD	TBD
10061-02-6	trans-1,3-Dichloropropene	0.055	2	0.000051	2	TBD	TBD
78-93-3	2-Butanone	50	1	0.270	2	TBD	TBD
591-78-6	2-Hexanone	99	2	0.022	2	TBD	TBD
108-10-1	4-Methyl-2-pentanone	170	2	0.033	2	TBD	TBD
67-64-1	Acetone	50	1	0.0087	2	TBD	TBD
71-43-2	Benzene	1	1	0.280	7	TBD	TBD
75-27-4	Bromodichloromethane	50	1	NV, **	--	TBD	TBD
75-25-2	Bromoform	50	1	0.650	2	TBD	TBD
74-83-9	Bromomethane	5	1	NV, **	--	TBD	TBD
75-15-0	Carbon disulfide	0.92	2	0.00085	2	TBD	TBD
56-23-5	Carbon tetrachloride	0.4	1	0.047	2	TBD	TBD
108-90-7	Chlorobenzene	5	1	0.035	7	TBD	TBD
75-00-3	Chloroethane	5	1	NV, **	--	TBD	TBD
67-66-3	Chloroform	7	1	0.022	2	TBD	TBD
74-87-3	Chloromethane	5	1	NV, **	--	TBD	TBD
124-48-1	Dibromochloromethane	50	1	NV, **	--	TBD	TBD
75-71-8	Dichlorodifluoromethane	5	1	NV, **	--	TBD	TBD

CAS No.	Parameter	Surface Water PRDL µg/L	Note	Sediment PRDL mg/Kg	Note	Surface Water* RL µg/L	Sediment* RL mg/Kg
100-41-4	Ethylbenzene	5	1	0.064	7	TBD	TBD
75-09-2	Methylene chloride	5	1	0.370	2	TBD	TBD
100-42-5	Styrene	5	1	0.254	6	TBD	TBD
127-18-4	Tetrachloroethene	0.7	1	0.410	2	TBD	TBD
108-88-3	Toluene	5	1	0.450	7	TBD	TBD
79-01-6	Trichloroethene	5	1	0.220	2	TBD	TBD
75-69-4	Trichlorofluoromethane	5	1	NV, **	--	TBD	TBD
75-01-4	Vinyl chloride	0.3	1	0.202	6	TBD	TBD
1330-20-7	Xylene (total)	5	1	0.920	7	TBD	TBD
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	5	1	NV, **	--	TBD	TBD
79-20-9	Methyl Acetate	610	1	NV, **	--	TBD	TBD
1634-04-4	Methyl-tert-butyl-ether	10	1	NV, **	--	TBD	TBD
110-82-7	Cyclohexane	1000	4	NV, **	--	TBD	TBD
108-87-2	Methylcyclohexane	520	4	NV, **	--	TBD	TBD
98-82-8	Isopropylbenzene	2.6	3	0.120	7	TBD	TBD
120-82-1	1,2,4-Trichlorobenzene	5	1	1.070	7	TBD	TBD
95-50-1	1,2-Dichlorobenzene	3	1	0.120	7	TBD	TBD
541-73-1	1,3-Dichlorobenzene	3	1	0.120	7	TBD	TBD
106-46-7	1,4-Dichlorobenzene	3	1	0.120	7	TBD	TBD
TAL Metals (total recoverable and dissolved for surface water)							
7429-90-5	Aluminum	100	3,5	2600	8	TBD	TBD
7440-36-0	Antimony	3	1	2	7	TBD	TBD
7440-38-2	Arsenic	50	1	0.39	7	TBD	TBD
7440-39-3	Barium	1000	1	0.7	8	TBD	TBD
7440-41-7	Beryllium	3	1	15.4	7	TBD	TBD
7440-43-9	Cadmium	2.1	3	0.6	7	TBD	TBD
7440-70-2	Calcium	NV, **	--	NV, **	--	TBD	TBD
7440-47-3	Chromium	50	1	26	7	TBD	TBD
7440-48-4	Cobalt	5.0	3	10	8	TBD	TBD

CAS No.	Parameter	Surface Water PRDL µg/L	Note	Sediment PRDL mg/Kg	Note	Surface Water* RL µg/L	Sediment* RL mg/Kg
7440-50-8	Copper	9.0	3	16	7	TBD	TBD
7439-89-6	Iron	300	3	20,000	7	TBD	TBD
7439-92-1	Lead	4.5	3	31	7	TBD	TBD
7439-95-4	Magnesium	35000	3	NV, **	--	TBD	TBD
7439-96-5	Manganese	300	3	460	7	TBD	TBD
7439-97-6	Mercury	0.0007	3	0.15	7	TBD	TBD
7440-02-0	Nickel	52.0	3	16	7	TBD	TBD
7440-09-7	Potassium	NV, **	--	NV, **	--	TBD	TBD
7782-49-2	Selenium	4.6	3	0.29	8	TBD	TBD
7440-22-4	Silver	0.1	3,5	1	7	TBD	TBD
7440-23-5	Sodium	20000	3	NV, **	--	TBD	TBD
7440-28-0	Thallium	0.5	1	NV, **	--	TBD	TBD
7440-62-2	Vanadium	14	3	50	8	TBD	TBD
7440-66-6	Zinc	82.6	3	120	7	TBD	TBD
SEM/AVS							
7440-43-9	Cadmium	NA	--	NV, **	--	NA	TBD
7440-50-8	Copper	NA	--	NV, **	--	NA	TBD
7439-92-1	Lead	NA	--	NV, **	--	NA	TBD
7439-97-6	Mercury	NA	--	NV, **	--	NA	TBD
7440-02-0	Nickel	NA	--	NV, **	--	NA	TBD
7440-66-6	Zinc	NA	--	NV, **	--	NA	TBD
NA	Acid Volatile Sulfide	NA	--	NV, **	--	NA	TBD
NA	**Total Organic Carbon**	NV, **	--	NV, **	--	TBD	TBD
NA	**Dissolved Organic Carbon**	NV, **	--	NA	--	TBD	NA
NA	**Total Suspended Solids**	NV, **	--	NA	--	TBD	NA
NA	**Hardness**	NV, **	--	NA	--	TBD	NA
NA	**Grain Size**	NA	--	NA	--	NA	NA

PRDL – Project Required Detection Limit

RL – Reporting Limit
TBD – To be Determined (once contract laboratory selected)
NV – No screening value identified
NA – Not Applicable
* Data are to be reported to the MDL, J-qualified between the MDL and RL, and U-qualified at the RL if not detected.
** The project required detection limit will default to the laboratory's reporting limit in the absence of a readily available screening value.

1 – NYSDEC values for Class A surface waters used as drinking water source (NYSDEC, 1998; NYSDEC, 1999; NYSDEC, 2000).
2 - Sediment: Secondary Chronic Value (Jones, et. al., 1997) Surface water: Secondary Chronic Value (Suter and Tsao, 1996).
3 – NYSDEC aquatic life water quality criteria (NYSDEC, 1998).
4 – No NYSDEC value available. Therefore, USEPA Region 9 Preliminary Remediation Goal for tapwater used. October 2004.
5 - Value presented is for ionic form.
6 - Ecological Screening Level (USEPA, 2003).
7 - NYSDEC sediment criteria (NYSDEC, 1999).
8 – NOAA Screening Quick Reference Tables (SQuiRTs) available at http://response.restoration.noaa.gov/cpr/sediment/squirt/squirt.html

Jones, D.S. G.W. Suter, and R.N. Hull, 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision. Oak Ridge National Laboratory, Oak Ridge, TN. Document ES/ER/TM-95/R4.

NYSDEC, 1998. Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations. Division of Water. Technical and Operational Guidance Series 1.1.1. June 1998.

NYSDEC, 1999. Technical Guidance for Screening Contaminated Sediments. Division of Fish, Wildlife and Marine Resources. January 1999.

NYSDEC, 1999. Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations. Division of Water. Technical and Operational Guidance Series 1.1.1. Errata Sheet. January 1999.

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Suter, G.W. and C.L. Tsao, 1996. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision. Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee. ES/ER/TM-96/R2.

USEPA, 2003. USEPA Region 5 Ecological Screening Levels. Revision August 2003. Available at: http://www.epa.gov/reg5rcra/ca/edql.htm

Table B-1 Sample Container, Preservation, and Holding Time Requirements

Parameter	Container	Preservation	Holding Time [1]
Surface Water			
VOCs	3-40 ml glass vials with Teflon-lined septum caps	HCl to pH<2; no headspace; cool 4°C	14 days
Metals (dissolved)	TBD	Filter immediately and preserve with HNO_3 to pH <2; cool 4°C	6 months (28 days for mercury)
Metals (total recoverable)	TBD	HNO_3 to pH <2; cool 4°C	6 months (28 days for mercury)
Total Suspended Solids	TBD	Cool 4°C	7 days
Dissolved Organic Carbon	TBD	Filter immediately and preserve with H_2SO_4 or HCl to pH <2; cool 4°C	28 days
Total Organic Carbon	TBD	H_2SO_4 or HCl to pH <2; cool 4°C	28 days
Sediment			
VOCs	TBD	Cool 4°C	TBD
% Solids	1-125 ml glass	Cool 4°C	None
Metals	One 8-oz. wide mouth amber jar with Teflon-lined lid	Cool 4°C	6 months (28 days for mercury)
Total Organic Carbon	One 8-oz. wide mouth amber jar with Teflon-lined lid	Cool 4°C	14 days
SEM/AVS	One 8-oz. wide mouth amber jar with Teflon-lined lid	Cool 4°C	14 days
Grain Size	1 liter wide mouth jar	None	None

[1] From time of sample collection

TBD –Will be provided after selection of a laboratory

Table B-2 Analytical Methodologies

Parameter	Methodology
Aqueous	
VOCs	SW-846 5030/8260B
Metals (excl. mercury)	TBD
Mercury, low level	EPA 1631
TSS	TBD
TOC	TBD
DOC	TBD
Hardness	Standard Methods 2340B by calculation
Sediment	
VOCs	SW-846 5035/8260B
% Solids	MCAWW 160.3
Metals	TBD
TOC	Lloyd Kahn
SEM/AVS	EPA 821/R-91-100 Draft
Grain Size	TBD

TBD –Will be provided after selection of a laboratory

Table B-3 Summary of Calibration Frequency and Criteria for Field Instruments

Instrument	Calibration Frequency	Calibration Standards	Acceptance Criteria
pH meter	Initial: Each time instrument is turned on or upon erratic results	Two reference buffers which bracket expected sample values	Within ≤0.1 pH unit of true value
	Check: Every 15 samples and at the end of the day	pH 7 reference buffer	Within ≤0.1 pH unit of true value or instrument will be recalibrated
Specific conductivity meter	Initial: Each time instrument is turned on or upon erratic results	Two reference standards	Within 10% of true value
	Check: Every 15 samples and at the end of the day	Initial reference standard	Within 10% of true value or instrument will be recalibrated
DO meter	Initial: Each time the instrument is turned on or upon erratic results	Moist air	Within 5% of true value (based on altitude and temperature)
	Check: Every 15 samples and at the end of the day	Moist air	Within 5% of true value or instrument will be recalibrated
Temperature meter	Initial: Factory calibrated annually; no field calibration required.	NA	NA
	Check: Prior to use in field	Mercury bulb thermometer	Within 0.5°C of bulb thermometer or instrument will be replaced

QUALITY ASSURANCE PROJECT PLAN
for
HUDSON RIVER OU-2 INVESTIGATION
at
BASF CORPORATION, RENSSELAER, NEW ORK
(Revision 0)

September 2005

Prepared by:
ENSR

Prepared for:
BASF Corporation

13 Sept '05

ENSR Project Manager Date

Sept. 13 2005

ENSR Analytical Task Manager Date

C

APPENDIX C

HEALTH AND SAFETY PLAN

HEALTH AND SAFETY PLAN

Field Investigation
Hudson River Sediment Characterization
Near BASF Facility
Rensselaer, New York

September 2005

Prepared by: Kathleen Harvey Date: September 12, 2005

Approved by: ______________________ Date: September 12, 2005
ENSR Project Manager

Table of Contents

1.0 INTRODUCTION

1.1 HASP Applicability

This site-specific Health and Safety Plan (HASP) has been developed by ENSR Corporation (ENSR). It establishes the health and safety procedures required to minimize potential risk to ENSR and contractor personnel (CR Environmental, Inc.) involved with the characterization of Hudson River sediment adjacent to the BASF facility located in Rensselaer, New York. ENSR is performing this work under contract to BASF.

The provisions of this plan apply to ENSR personnel and CR Environmental personnel who may potentially be exposed to safety and/or health hazards related to activities described in Section 3.0 of this document.

This HASP has been written to comply with the requirements of OSHA's Hazardous Waste Operations and Emergency Response Standard (29 CFR 1910.120). All activities covered by this HASP must be conducted in complete compliance with this HASP and with all applicable federal, state, and local health and safety regulations. It is the sole responsibility of CR Environmental, who is providing the research boat and the captain, to comply with all United States Coast Guard (USCG) regulations that would apply to the vessel being provided, the waters traveled on and the type of work activities being conducted. Personnel covered by this HASP who cannot or will not comply will be excluded from site activities.

This plan will be distributed to each employee involved with the proposed investigative activities at the site, including subcontractor employees. Each employee must sign a copy of the attached health and safety plan sign-off sheet (see Attachment A).

This HASP only pertains to the tasks that are listed in Section 3.0. A task specific HASP or addendum to this HASP will be developed at a later date for any other subsequent investigative/remedial activities at the site.

1.2 Organization/Responsibilities

The implementation of health and safety at this project location will be the shared responsibility of the ENSR Project Manager (PM), the ENSR Regional Health and Safety Manager (RHSM), the ENSR Project Site Safety Officer (SSO) and other ENSR personnel and CR Environmental personnel implementing the proposed sediment characterization study.

1.2.1 ENSR Project Manager

The ENSR PM (John Bleiler) is the individual who has the primary responsibility for ensuring the overall health and safety of this project. As such, the PM is responsible for ensuring that the requirements of this HASP are implemented. Some of the PM's specific responsibilities include:

- Assuring that all personnel, including ENSR subcontractors, to whom this HASP applies have received a copy of it;
- Providing the RHSM with updated information regarding conditions at the site and the scope of site work;
- Providing adequate authority and resources to the on-site SSO to allow for the successful implementation of all necessary safety procedures;
- Supporting the decisions made by the SSO and RHSM;
- Maintaining regular communications with the SSO and, if necessary, the RHSM; and,
- Coordinating the activities of all ENSR subcontractors and ensuring that they are aware of the pertinent health and safety requirements for this project.

1.2.2 ENSR Regional Health and Safety Manager

The ENSR RHSM (Kathleen Harvey) is the individual responsible for the preparation, interpretation and modification of this HASP. Modifications to this HASP which may result in less stringent precautions cannot be undertaken by the PM or the SSO without the approval of the RHSM. Specific duties of the RHSM include:

- Writing, approving and amending the HASP for this project;
- Advising the PM and SSO on matters relating to health and safety on this site;
- Recommending appropriate personal protective equipment (PPE) and respiratory equipment to protect personnel from potential site hazards;
- Conducting accident investigations; and,

- Maintaining regular contact with the PM and SSO to evaluate site conditions and new information which might require modifications to the HASP.

1.2.3 ENSR Site Safety Officer

All ENSR field technicians are responsible for implementing the safety requirements specified in this HASP. However, one field technician will serve as the SSO. The SSO will be appointed by the PM. The SSO will be on-site during all activities covered by this HASP. The SSO is responsible for enforcing the requirements of this HASP once work begins. The SSO has the authority to immediately correct all situations where noncompliance with this HASP is noted and to immediately stop work in cases where an immediate danger is perceived. Some of the SSO's specific responsibilities include:

- Assuring that all personnel to whom this HASP applies have submitted a completed copy of the HASP receipt and acceptance form;
- Assuring that all personnel to whom this HASP applies have attended a pre-entry briefing and any subsequent safety meetings that are conducted during the implementation of the program;
- Maintaining a high level of health and safety consciousness among employees implementing the proposed investigative activities;
- Procuring the air monitoring instrumentation required and performing air monitoring for investigative activities;
- Procuring and distributing the PPE and safety equipment needed for this project for ENSR employees;
- Verifying that all PPE and health and safety equipment used by ENSR is in good working order;
- Verifying that ENSR contractors are prepared with the PPE, respiratory protection and safety equipment required for this program;
- Notifying the PM of all noncompliance situations and stopping work in the event that an immediate danger situation is perceived;
- Monitoring and controlling the safety performance of all personnel within the established restricted areas to ensure that required safety and health procedures are being followed;

- Conducting accident/incident investigations and preparing accident/incident investigation reports;

- Conducting the pre-entry briefing as required by Section 10.0 of the HASP; and,

- Initiating emergency response procedures, in conjunction with the CR Environmental boat captain and crew, and in accordance with Section 11.0 of this HASP.

1.2.4 ENSR Field Personnel

All ENSR field personnel covered by this HASP are responsible for following the health and safety procedures specified in this HASP and for performing their work in a safe and responsible manner. Some of the specific responsibilities of the field personnel are as follows:

- Reading the HASP in its entirety prior to the start of on-site work;

- Submitting a completed HASP Acceptance Form to the ENSR SSO prior to the start of work;

- Attending the required pre-entry briefing prior to beginning on-site work and any subsequent safety meetings that are conducted during the implementation of the program;

- Bringing forth any questions or concerns regarding the content of the HASP to the PM or the SSO prior to the start of work;

- Reporting all accidents, injuries and illnesses, regardless of their severity, to the ENSR SSO;

- Complying with the requirements of this HASP and the requests of the SSO; and,

- Familiarizing themselves with the location and operation of emergency equipment on the boat and coordinating emergency response activities with the boat captain and crew.

1.2.5 Contractors

Additionally, CR Environmental is responsible for:

- Reading the HASP in its entirety prior to the start of on-site work;

- Complying with all applicable USCG regulations and requirements;
- Attending the required pre-entry briefing prior to beginning on-site work and any subsequent safety meetings that are conducted during the implementation of the program;
- Conducting a pre-launch meeting with the ENSR staff and boat crew to review the locations of emergency equipment and to discuss emergency response responsibilities;
- Ensuring, via daily inspections, that their boat and equipment is in good working order;
- Operating their boat and equipment in a safe manner;
- Appointing an on-site safety coordinator to interface with the ENSR SSO;
- Providing ENSR with copies of material safety data sheets (MSDS) for all hazardous materials brought on-site; and,
- Providing all the required PPE, respiratory equipment and safety supplies to their employees.

1.3 Management of Change/ Modification of the HASP

1.3.1 Management of Change

The procedures in this HASP have been developed based on ENSR's review of existing environmental data for the site and the proposed scope of work. Every effort has been made to address the chemical hazards that may be encountered during the implementation of the proposed investigation. Similarly, this document also discusses the physical hazards associated with the proposed activities. However, unanticipated site-specific conditions or situations may occur during the implementation of this project. Also, ENSR and/or the contractors may elect to perform certain tasks in a manner that is different from what was originally intended due to a change in field conditions. As such, this HASP must be considered a *working document* that is subject to change to meet the needs of this dynamic project.

ENSR and/or ENSR's contractors will complete a Job Hazard Analysis (JHA) when new tasks or different investigative techniques not addressed in the HASP are proposed. The use of new techniques will be reviewed and if new hazards are associated with the proposed changes, they will be documented on the JHA. An effective control measure must also be identified for each new hazard. JHAs will be reviewed by the SSO prior to being implemented. Once approved, the JHAs will be reviewed with all field staff during the daily safety meeting. A blank JHA is presented as Attachment B.

1.3.2 HASP Modifications

Should significant information become available regarding potential on-site hazards, it may be necessary to modify this HASP. All proposed modifications to this HASP must be reviewed and approved by the ENSR RHSM before such modifications are implemented. Any significant modifications must be incorporated into the written document as addenda and the HASP must be reissued. The ENSR PM will ensure that all personnel covered by this HASP receive copies of all issued addenda. Sign-off forms will accompany each addendum and must be signed by all personnel covered by the addendum. Sign-off forms will be submitted to the ENSR PM. The HASP addenda should be distributed during the daily safety meeting so that they can be reviewed and discussed. Attendance forms will be collected during the meeting.

2.0 SITE DESCRIPTION AND HISTORY

2.1 Site Location

BASF is the current owner of a former industrial manufacturing site in the City of Rensselaer, Rensselaer County, New York. The site is zoned for heavy industry and includes several unused facilities: a manufacturing plant, water intake and treatment system, wastewater pre-treatment system, lagoons, parking areas, and a closed landfill. In addition, there is an undeveloped parcel at the southern end of the property. The former manufacturing portion of the site (north parcel) has been occupied by industrial manufacturers (principally dyestuffs and pharmaceuticals) for more than a century.

The 88-acre site is situated on the east bank of the Hudson River. The property currently contains approximately 42 acres of developed areas, 23 acres of brushland, 11 acres of poor quality wetlands, 10 acres of unvegetated area, and 2 acres of man-made lagoons. It is bordered by Riverside Avenue and the Hudson River on the west, a truck access road (Irwin Stewart Port Expressway, also known as the Port Access Highway) on the east and south, and by another industrial facility on the north. An 80 MW (nominal) electrical cogeneration plant and a vehicle reclamation facility lie just south and west of site between Riverside Avenue and the Hudson River.

The majority of the site currently lies within the floodplain of the Hudson River and the majority of the site is situated below the 100-year flood elevation (approximately 20.5 feet above mean sea level).

2.2 Sediment Quality

Previous investigations indicate that metals (cadmium, chromium, copper, lead, mercury and zinc) and volatile organic compounds (VOCs) including benzene, chlorobenzene 1,2-dichlorobenzene, 1,3-dichlorobenzene and 1,4-dichlorobenzene are present in sediments adjacent to and downstream of the Site.

Metal concentrations appear to be highest adjacent to the site and downstream of the site, The VOCs of concern are localized along the eastern shore, adjacent to the BASF facility and apparently concentrated around the outfalls (both the historic BASF outfalls and the active municipal outfalls)

3.0 SCOPE OF WORK

3.1 Project Objectives

The objectives of the field investigation include collecting additional data to better characterize the Hudson River adjacent to the BASF facility, to evaluate the potential bioavailability and toxicity of contaminants in sediments, to determine if the ecological community is stressed from BASF related activities, and to obtain additional data for more robust statistical analyses. This information will be used to complete an initial evaluation of fate and transports of contaminants within the river adjacent to the Site and to assess the potential risks to human health or the environment in the Hudson River in the vicinity of the Site.

Characterization of the Hudson River adjacent to the facility will be conducted to determine the level and presence of contaminations attributable to Site sources reaching the Hudson River via historic waste disposal activities (i..e outfalls, spills) or surface water discharge from the Site. The proposed sampling effort focuses on: 1) delineating the extent of selected metals and VOCs within the sediments adjacent to the facility; 2) evaluating Hudson River surface water quality in the vicinity of and downstream of production sewer outfalls; and 3) providing a preliminary analysis of the benthic community in the Hudson River in the vicinity of the Site.

3.2 Study Area

The study area reaches approximately 1500 feet upstream and downstream of the BASF facility. Water depths in the study area range up to 20 to 40 feet in depth. Sampling locations are separated into three distinct areas of interest including adjacent to the Site, upstream from Site, and downstream from Site.

3.3 Sampling Procedures

The field investigations include collecting surface water and sediment samples (surficial and sub-surficial) for analytical chemistry. Sediment samples will be collected at over 90 discrete sampling locations and surface water samples will be collected from a sub-set of seven locations. Surface water samples will be collected from a boat using an alpha bottle or equivalent prior to sediment sample collection. Water quality field measurements will be collected at each sediment station from the surface, mid-depth and near-bottom prior to the collection of sediment. Water quality parameters include temperature, specific conductivity, dissolved oxygen, and pH.

The sediment samples will be collected from a boat using a petit ponar dredge, Ted Young grab sampler (or equivalent), or vibracore depending upon specific sampling-station characteristics. Sediment samples will be placed in a decontaminated stainless steel bowl and visually examined for physical characteristics such as composition, layering, odor and discoloration. The sediment samples collected from the appropriate layer (i.e., either surface or sub-surface) will be composited in the bowl and placed in appropriate sampling containers (if AVS:SEM analysis is planned, the top 4 cm horizon will be collected and placed in the sampling container before homogenization of the sample).

A macroinvertebrate survey is included in the workplan as an optional activity. Macroinvertebrate samples will be rough sorted in a 500-micron sieve bucket and preserved in 95% ethanol to cover the sample.

4.0 CHEMICAL HAZARD ASSESSMENT AND CONTROLS

4.1 Chemical Contaminants of Concern

Previous investigations indicate that metals (cadmium, chromium, copper, lead, mercury and zinc) and VOCs including benzene, chlorobenzene 1,2-dichlorobenzene, 1,3-dichlorobenzene and 1,4-dichlorobenzene are present in sediments adjacent to and downstream of the Site. Although not a constituent of concern for this sampling survey, polychlorinated biphenyls (PCBs) may be present in sediments due to other industrial activities located along the Hudson River.

4.1.1 Metals

4.1.1.1 Cadmium

Cadmium can cause local skin and eye irritation. The early symptoms of overexposure, via inhalation, may include mild irritation of the upper respiratory tract, a sensation of constriction of the throat, a metallic taste and/or a cough. A period of 1-10 hours may precede the onset of rapidly progressing shortness of breath, chest pain and flu-like symptoms. Repeated overexposure to cadmium may result in kidney dysfunction/damage and an increased risk of cancer of the lung and prostate. The OSHA permissible exposure limit (PEL) for cadmium is 5 ug/m3, as an 8-hour time-weighted average (TWA).

4.1.1.2 Chromium

Hexavalent chromium compounds, upon contact with the skin can cause ulceration and possibly an allergic reaction. Inhalation of hexavalent chromium dusts is irritating and corrosive to the mucous membranes of the upper respiratory tract. Chrome ulcers and chrome dermatitis are common occupational health effects from prolonged and repeated exposure to hexavalent chromium compounds. Acute exposures to hexavalent chromium dusts may cause coughing or wheezing, pain on deep inspiration, tearing, inflammation of the conjunctiva, nasal itch and soreness or ulceration of the nasal septum. Certain forms of hexavalent chromium have been found to cause increased respiratory cancer among workers. Trivalent chromium compounds (chromic oxide) are generally considered to be of lower toxicity, although dermatitis may occur as a result of direct handling.

4.1.1.3 Copper

The OSHA PEL for copper dust is 1 mg/m3, as an 8-hr TWA. The inhalation of copper dusts may cause a feeling of illness similar to the common cold with sensations of chills and stuffiness of the head. Small copper particles may enter the eye and cause irritation and/or discoloration. Repeated or prolonged contact with copper dusts may cause skin irritation or greenish discoloration of the skin or hair. Persons with pre-existing Wilson's disease may be more susceptible to the effects of copper exposure. Although not typically considered a route of exposure in an industrial setting, the ingestion of large quantities of copper may cause stomach and intestine ulceration, jaundice and kidney and liver damage.

4.1.1.4 Lead

The OSHA PEL for inorganic lead is 50 $\mu g/m^3$, as an 8-hr TWA. In general, the inhalation of metal dusts is irritating to the upper respiratory tract and nasal mucous membranes. Most metal dusts cause dermatitis and/or eye irritation. The early symptoms of lead poisoning, as a result of overexposure (either through ingestion or inhalation) include fatigue, sleep disturbance, headache, aching bones and muscles, digestive irregularities, abdominal pains, and decreased appetite. Chronic overexposures to lead affect the central nervous system and male and female reproductive systems. Lead has also been identified as a fetotoxin.

4.1.1.5 Mercury

Inorganic mercury, also known as elemental mercury or quicksilver, is used in scientific instrumentation, electrical equipment and amalgams and was used in the tanning and dyeing industries as well as taxidermy, feltmaking and gold and silver extraction.

Inorganic mercury is very volatile. Acute poisoning due to mercury vapors affects the lungs primarily, in the form of interstitial pneumonitis, acute bronchitis and bronchiotitis. Exposure to lower levels of mercury over prolonged periods produce neurological symptom complexes that vary widely with each individual. These may include weakness, loss of appetite, loss of weight, insomnia, metallic taste in the mouth, increased salivation, soreness of the mouth, inflammation of the gums, loosening of the teeth, irritability, loss of memory and tremors of the fingers, eyelids, lips or tongue. More extensive exposures can produce extreme irritability, excitability, anxiety, hallucinations or manic depression and progressive mental derangement. The OSHA PEL for inorganic mercury is 0.1 mg/m3. The ACGIH TLV is 0.025 mg/m3.

The use of methylmercury as a fungicide, timber preservative and disinfectant has been suspended in the United States, and since this was the only commercial use for the chemical, it is no longer manufactured in this country. It is, however, still found in the environment as a result of bacterial methylation of inorganic mercury. Specifically, inorganic mercury wastes, generated from coal-burning power plants, is deposited in a waterbody where anaerobic bacteria in the detritus of the floor convert the inorganic mercury into methyl mercury. Because of this, methylmercury has become concentrated in the natural food webs, poisoning fish and shellfish. As such, the primary route of exposure to methylmercury is via the oral route due to ingestion of contaminated foods.

Methylmercury produces a much more devastating human illness than elemental mercury, affecting primarily the central nervous system, including the brain, with many disturbances including paralysis, constriction of the visual fields or tunnel vision and blindness. Severe poisoning may produce irreversible brain damage resulting in loss of higher functions. Methylmercury is also extremely dangerous to the developing fetus.Children exposed to methylmercury *in utero* are born with severe developmental effects including impaired motor and mental function, hearing loss and blindness. The OSHA PEL for organic mercury is 0.01 mg/m3.

4.1.2 VOCs

4.1.2.1 Benzene

Exposure to the vapors of benzene above the OSHA PEL may produce irritation of the mucous membranes of the upper respiratory tract, nose and mouth. Overexposure may also result in the depression of the central nervous system. Symptoms of such exposure include drowsiness, headache, fatigue and drunken-like behaviors. Prolonged overexposure to benzene vapors has detrimental effects on the blood-forming system ranging from anemia to leukemia. The PEL for benzene is 1 ppm, as an 8 hour TWA. The ACGIH recommends a TLV of 0.5 ppm, as an 8-hr TWA.

4.1.2.2 Chlorobenzene

Chlorobenzene is a colorless liquid with an almond-like odor. It is used in the manufacture of aniline, phenol, and chloronitrobenzene and as an intermediate in the manufacturing of dyestuffs and many pesticides. Exposure may be irritating to the eyes, skin and respiratory tract. Exposure via inhalation may also result in headache, dizziness, drowsiness, cyanosis and loss of consciousness depending on the concentration and duration of exposure. Effects associated with chronic exposures include dyspeptic disorders, lung, liver and kidney damage. The OSHA PEL, as an 8-hr TWA, is 75 ppm. The ACGIH recommends a TLV of 10 ppm, as an 8-hr TWA.

4.1.2.3 Dichlorobenzenes

There are three isomeric forms of dichlorobenzene. 1,2- dichlorobenzene is a colorless to pale yellow liquid with a disagreeable, aromatic odor. 1,4 -dichlorobenzene is a colorless solid with a mothball-like odor. 1,3-dichlorobenzene is a colorless liquid and is considered to be a contaminant of the other two isomers. These compounds are formed almost entirely as by-products during the production of mono-chlorobenzene.

Chlorinated benzenes are irritating to the skin, eyes and mucous membranes of the upper respiratory tract with the 1,2 and 1,4 isomers reportedly being severely irritating. Exposure to the chlorinated benzenes may cause burning pain in the stomach, nausea, vomiting and diarrhea. Chronic exposures may cause liver and kidney damage. The 1,2- and 1,4-isomers of dichlorobenzene have produced experimental teratogenic and reproductive effects and the 1,4 isomer is a suspected carcinogen, causing leukemia and lung cancers. The OSHA PEL for the 1,2 and 1,4 isomers are 75 ppm and 50 ppm, respectively. The recommended TLV for the 1,2 and 1,4 isomers are 25 ppm and 10 ppm, respectively. OSHA has not established a PEL for the 1,3 isomer and the ACGIH has not recommended a TLV.

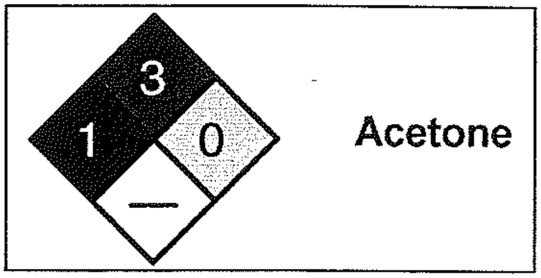
4.1.3 Other Sediment Contaminants

PCBs may be present in the sediment samples collected due to other industrial activities located along the River. Polychlorinated biphenyls are a series of technical mixtures consisting of many isomers and compounds that vary from mobile oily liquids to white crystalline solids to hard non-crystalline resins. PCB oils are typically used in heat transfer applications, hydraulic fluids and lubricants. Technical products vary in composition and in the degree of chlorination. The higher the degree of chlorination, the greater the toxicity. Dermal contact with liquid PCBs may produce skin irritation or a rash. Prolonged or repeated skin contact may cause dermatitis or "chloracne." Studies suggest that chronic exposure to PCBs may be toxic to the liver.

4.1.4 Hazardous Substances Brought On-Site by ENSR

A material safety data sheet (MSDS) must be available for each hazardous substance that ENSR or the contractors bring on the property. This includes solutions/chemicals that will be used to decontaminate sampling equipment, the ethanol used to preserve macroinvertebrate samples and gases needed to calibrate air monitoring equipment.

In addition, all containers of hazardous materials must be labeled in accordance with OSHA's Hazard Communication Standard. Either the original manufacturer's label or an NFPA 704M label specific for the material (as shown at the right) is considered to be an acceptable label.



4.2 Chemical Exposure and Control

4.2.1 Chemical Exposure Potential

Metals are non-volatile in nature, with exposure occurring via the inhalation of dusts and/or fumes. However, the media being sampled will be wet so dusts are not likely to be generated during the proposed characterization study. The highest concentration of VOCs in sediments occurs at the shoreline to the site. Although total VOC concentrations in the sediments previously collected are elevated, due to the wet nature of the material being sampled, exposure to VOC vapors during the sediment sampling activities is not expected. Therefore, the primary route of potential exposure to the contaminants of concern is via direct dermal contact with sediments and surface water during sampling. Direct dermal contact with ethanol may also occur when preserving the macroinvertebrate samples.

4.2.2 Chemical Hazard Control

The chemical hazards associated with the investigative and sampling activities can be controlled in several ways, including:

- ENSR will perform air monitoring (Section 6.1) in the worker's breathing zone to determine exposure to VOC vapors during the collection of sediment samples from the shoreline of the site where total VOC concentrations are reportedly the highest. If exposures exceed the action levels, respiratory protection as discussed in Section 7.2, will be donned.

- To avoid direct dermal contact with contaminated media, protective clothing, as described in Section 7.1, will be required when collecting samples and decontaminating sampling equipment.

- To avoid direct dermal contact with ethanol during sample preservation activities, protective clothing, as described in Section 7.1, will be worn.

- Although highly unlikely, exposure to all of the contaminants of concern may occur via ingestion (hand-to-mouth transfer). The decontamination procedures described in

Section 9.0 address personal hygiene issues that will limit the potential for contaminant ingestion.

5.0 PHYSICAL HAZARDS AND CONTROLS

5.1 Boat Safety and Marine Operations

All sampling will take place from a boat. It is anticipated that CR Environmental will be providing a 32-foot aluminum research vessel with a 1000-lb capacity hydraulic A-frame and 500-lb capacity hydrographic winch to support the vibracore sediment sampling program.

As such, this work presents unique hazards which many workers may not be familiar with therefore special attention has been given to the topic of marine safety in this HASP. No effort has been made to incorporate all applicable United States Coast Guard (USCG) regulations however some selected excerpts from USCG regulations have been included to provide general guidance. CR Environmental is responsible for having knowledge of, and complying with USCG and any other applicable marine regulations.

5.1.1 Boat Inspection

Before the boat is placed in service, it will be inspected and determined to be in safe operating condition before use. A pre-use inspection of the watercraft must also be performed by the operator before each daily use. Watercraft found in an unsafe condition shall be taken out of service and its use prohibited until unsafe conditions have been corrected.

5.1.2 Boat Registration

All watercraft must meet USCG or state watercraft registration and numbering requirements. The US Coast Guard requires that all motorized watercraft be numbered in the state of principal use. A valid certificate showing the numbers issued to the watercraft is required to be on board the watercraft whenever the watercraft is in use. Watercraft registration numbers are required to be painted or permanently attached to each side of the forward half of the watercraft. Watercraft registration must be updated as the governing laws require.

5.1.3 Boat Capacity

Small watercraft shall not be loaded (passengers and gear) beyond the weight capacity printed on the USCG information plate attached to the stern. If there is no capacity label, use the following formula to determine the safe loading capacity:

- # People = (length of boat x width) ÷15

Watercraft shall have sufficient room, freeboard, and stability to safely carry the cargo and number of passengers allowed with consideration given to the weather, and water conditions in which it will be operated. Once on board, distribute the load (people and equipment) evenly and secure all equipment to prevent it from shifting.

5.1.4 Personal Flotation Devices

Employees working over or near water, where the danger of drowning exists, shall wear a USCG-approved personal flotation device (PFD). When selecting the appropriate type and style of PFD, the type of activity being conducted and the required mobility of the user must be considered, because some activities may require a PFD which is less restrictive.

ENSR employees will be required to wear a USCG-approved Type III personal flotation device (PFD). Although not as effective as a Type I in turning an unconscious wearer face-up, a Type III PFD is generally less bulky and restrictive, and is typically the PFD of choice in a marine work environment.

The use of inflatable PFDs is discouraged due to questionable reliability and maintenance requirements.

Prior to and after each use, each PFD shall be inspected for defects which would alter their strength or buoyancy. Defective units shall not be used.

5.1.5 Float Plan

Prior to leaving shore, a plan of the day's activities, including time and place of departure, anticipated return time and list of employees working on the project should be left with the ENSR PM. In the event that the crew does not contact the PM at the pre-designated time, the emergency procedures in the float plan will be activated.

5.1.6 Emergency Equipment

All ENSR personnel working on boat(s) that are owned/operated by others are to be informed of the locations of all safety equipment on the boat, including first-aid kit, fire extinguishers and throw-ring, as applicable to the specific boat being used. Additionally, each crewmember shall be provided instructions in "Abandon ship/boat" and "person overboard" procedures prior to first departure.

5.2 Working in Close Proximity to Vibracore Equipment

Only qualified personnel are permitted to operate the vibracoring system. Support personnel must remain aware of overhead loads and use caution when moving heavy objects on deck. Similarly, only qualified personnel are permitted to operate the tripod tower and handling system. The field-assembled tripod tower must be assembled by those who are experienced with this system and in accordance with the manufacturer's instructions.

5.3 Slips, Trips and Fall Hazards

Due to the nature of the work being performed, it is inevitable that boat decks and walking surfaces will become wet. This presents a potential slip, trip and fall hazard to the sampling team. To the extent possible, accumulate water should be removed from walking surfaces. Additionally, slip-proof matting can be placed in those areas where the most activity is taking place. All employees working on the boat should be wearing appropriate footwear to prevent slips.

Personnel using a watercraft shall properly stow and secure all gear and equipment against unexpected shifts when underway. Decks and open spaces must be kept clear and free from clutter and trash to minimize slip, trip, and fall hazards.

5.4 Noise Exposure

Use of various pieces of equipment to facilitate sampling and monitoring tasks may expose the field team to noise levels that exceed the OSHA PEL of 90 dB for an 8-hour day. Exposure to noise can result in the following:

- Temporary hearing losses where normal hearing returns after a rest period;
- Interference with speech communication and the perception of auditory signals;
- Interference with the performance of complicated tasks; and,
- Permanent hearing loss due to repeated exposure resulting in nerve destruction in the hearing organ.

Since personal noise monitoring will not be conducted during the proposed activities, employees must follow this general rule of thumb: If the noise levels are such that you must shout at someone 5 feet away from you, you need to be wearing hearing protection. Employees can wear either disposable earplugs or earmuffs but all hearing protection must have a minimum noise reduction rating (NRR) of 27 dB.

5.5 Cuts and Lacerations

It may be necessary to cut tubing or other items to facilitate the sampling of sediment and/or surface water or macroinvertebrates. If it is necessary to use knives or blades, follow the safety precautions listed below:

- Keep your free hand out of the way
- Secure the acetate liner so it won't roll or move while you are cutting
- Use only sharp blades; dull blades require more force which results in less knife control
- Pull the knife toward you; pulling motions are easier to manage
- Don't put your knife in your pocket
- Use a hooked knife (i.e. linoleum knife) or a utility knife with a self-retracting blade
- Wear leather or Kevlar™ gloves when using knives or blades.

5.6 Back Safety

Employees will need to load/unload the boat with sampling gear. All of these tasks present a potential back hazard if safe lifting techniques are not used. The boat is equipped with a winch that will be used to retrieve the samples and place them on the boat deck. Using the proper techniques to lift and move heavy pieces of equipment is important to reduce the potential for back injury. The following precautions should be implemented when lifting or moving heavy objects:

- Use mechanical devices to move objects that are too heavy to be moved manually

- If mechanical devices are not available, ask another person to assist you.

- Bend at the knees, not the waist. Let your legs do the lifting.

- Do not twist while lifting

- Bring the load as close to you as possible before lifting

- Be sure the path you are taking while carrying a heavy object is free of obstructions and slip, trip and fall hazards.

If possible, a sampling station should be established on the boat and should include a table so that the cores can be opened and sampled at waist height versus leaning over at the waist to process samples located on the deck of the boat.

5.7 Handling of Fuels

5.7.1 Refueling Equipment

The pneumatic vibracore will require the use of a gas-powered air compressor. Gasoline and it's vapors may ignite if they come in contact with hot components or an electrical spark. Do not refuel when the equipment is running or hot. Turn the engine off and make sure it has cooled down (i.e. 10-minutes) before re-fueling. Smoking is not permitted during refueling operations.

5.7.2 Storage of Fuels

Gasoline must be stored in an approved container or tank. A Type II galvanized steel safety can is recommended for storing gasoline that will be used to refuel equipment. Storage in anything other than an approved container is strictly prohibited.

Gasoline is a flammable liquid and should be stored at room temperature, away from potential heat sources such as the sun and away from ignition sources.

5.8 Sun Exposure

Employees are encouraged to liberally apply sunscreen, with a minimum sun protection factor (SPF) of 15, when working outdoors to avoid sunburn and potential skin cancer, which is associated with excessive sun exposure to unprotected skin. Additionally, employees should wear safety glasses that offer protection from UVA/UVB rays

5.9 Thermal Stress

The proposed field investigation will be taking place in the fall of 2005. Depending on the exact date of the sampling effort, the field team could be working when heat and/or cold stress are a concern, Therefore, the hazards of both are presented in this HASP.

5.9.1 Heat Stress

Types of Heat Stress

Heat related problems include **heat rash, fainting, heat cramps, heat exhaustion and heat stroke.** **Heat rash** can occur when sweat isn't allowed to evaporate, leaving the skin wet most of the time and making it subject to irritation. **Fainting** may occur when blood pools to lower parts of the body and as a result, does not return to the heart to be pumped to the brain. Heat related fainting often occurs during activities that require standing erect and immobile in the heat for long periods of time. **Heat cramps** are painful spasms of the muscles due to excessive salt loss associated with profuse sweating. **Heat exhaustion** results from the loss of large amounts of fluid and excessive loss of salt from profuse sweating. The skin will be clammy and moist and the affected individual may exhibit giddiness, nausea and headache.

Heat stroke occurs when the body's temperature regulatory system has failed. The skin is hot, dry, red and spotted. The affected person may be mentally confused and delirious. Convulsions could occur. EARLY RECOGNITION AND TREATMENT OF HEAT STROKE ARE THE ONLY MEANS OF PREVENTING BRAIN DAMAGE OR DEATH. A person exhibiting signs of heat stroke should be removed from the work area to a shaded area. The person should be soaked with water to promote evaporation. Fan the person's body to increase cooling.

Early Symptoms of Heat-Related Health Problems:

- decline in task performance
- incoordination
- decline in alertness
- unsteady walk
- excessive fatigue
- reduced vigilance
- muscle cramps
- dizziness

Susceptibility to Heat Stress Increases due to:

- lack of physical fitness
- lack of acclimation
- increased age
- dehydration
- obesity
- drug or alcohol use
- sunburn
- infection

People unaccustomed to heat are particularly susceptible to heat fatigue. First timers in PPE need to gradually adjust to the heat.

The Effect of Personal Protective Equipment

Sweating normally cools the body as moisture is removed from the skin by evaporation. However, the wearing of certain personal protective equipment (PPE), particularly chemical protective coveralls (e.g., Tyvek), reduces the body's ability to evaporate sweat and thereby regulate heat buildup. The body's efforts to maintain an acceptable temperature can therefore become significantly impaired by the wearing of PPE.

Measures to Avoid Heat Stress:

The following guidelines should be adhered to when working in hot environments:

- Establish work-rest cycles (short and frequent are more beneficial than long and seldom).
- Identify a shaded, cool rest area.
- Rotate personnel, alternative job functions.
- Water intake should be equal to the sweat produced. Most workers exposed to hot conditions drink less fluid than needed because of an insufficient thirst. DO NOT DEPEND ON THIRST TO SIGNAL WHEN AND HOW MUCH TO DRINK. For an 8-hour workday, 50 ounces of fluids should be drunk.
- Eat lightly salted foods or drink salted drinks such as Gatorade to replace lost salt.
- Save most strenuous tasks for non-peak heat hours such as the early morning or at night.
- Avoid alcohol during prolonged periods of heat. Alcohol will cause additional dehydration.
- Avoid double shifts and/or overtime.

The implementation and enforcement of the above mentioned measures will be the joint responsibility of the project manager, on-site field coordinator, and health and safety officer. Potable water and fruit juices should be made available each day for the field team.

Heat Stress Monitoring Techniques

Site personnel should regularly monitor their heart rate as an indicator of heat strain by the following method: Check radial pulse rates by using fore-and middle fingers and applying light pressure to the pulse in the wrist for one minute at the beginning of each rest cycle. If the pulse rate exceeds 110 beat/minute, shorten the next work cycle by one-third and keep the rest period the same. If, after the next rest period, the pulse rate still exceeds 110 beats/minute, shorten the work cycle by one-third.

5.9.2 Cold Stress

Types of Cold Stress

Cold injury is classified as either localized, as in frostbite, frostnip or chilblain; or generalized, as in hypothermia. The main factors contributing to cold injury are exposure to humidity and high winds, contact with wetness and inadequate clothing.

The likelihood of developing frostbite occurs when the face or extremities are exposed to a cold wind in addition to cold temperatures. The freezing point of the skin is about 30° F. When fluids around the cells of the body tissue freeze, skin turns white. This freezing is due to exposure to extremely low temperatures. As wind velocity increases, heat loss is greater and frostbite will occur more rapidly.

Symptoms of Cold Stress

The first symptom of frostbite is usually an uncomfortable sensation of coldness, followed by numbness. There may be a tingling, stinging or aching feeling in the effected area. The most vulnerable parts of the body are the nose, cheeks, ears, fingers and toes.

Symptoms of hypothermia, a condition of abnormally low body temperature, include uncontrollable shivering and sensations of cold. The heartbeat slows and may become irregular, the pulse weakens and the blood pressure changes. Pain in the extremities and severe shivering can be the first warning of dangerous exposure to cold.

Maximum severe shivering develops when the body temperature has fallen to 95° F. Productive physical and mental work is limited when severe shivering occurs. Shivering is a serious sign of danger. Immediately remove any person who is shivering from the cold.

Methods to Prevent Cold Stress

When the ambient temperature, or a wind chill equivalent, falls to below 40° F (American Conference of Governmental Industrial Hygienists recommendation), site personnel who must remain outdoors should wear insulated coveralls, insulated boot liners, hard hat helmet liners and insulated hand protection. Wool mittens are more efficient insulators than gloves. Keeping the head covered is very important, since 40% of body heat can be lost when the head is exposed. If it is not necessary to wear a hard hat, a wool knit cap provides the best head protection. A facemask may also be worn.

Persons should dress in several layers rather than one single heavy outer garment. The outer piece of clothing should ideally be wind and waterproof. Clothing made of thin cotton fabric or synthetic fabrics such as polypropylene is ideal since it helps to evaporate sweat. Polypropylene is best at wicking away moisture while still retaining its insulating properties. Loosely fitting clothing also aids in sweat evaporation. Denim is not a good protective fabric. It is loosely woven which allows moisture to penetrate. Socks with a high wool content are best. If two pairs of socks are worn, the inner sock should be smaller and made of cotton, polypropylene or similar types of synthetic material that wick away moisture. If clothing becomes wet, it should be taken off immediately and a dry set of clothing put on.

If wind conditions become severe, it may become necessary to shield the work area temporarily. The SSO and the PM will determine if this type of action is necessary. Heated break trailers or a designated area that is heated should be available if work is performed continuously in the cold at temperatures, or equivalent wind chill temperatures, of 20° F.

Dehydration occurs in the cold environment and may increase the susceptibility of the worker to cold injury due to significant change in blood flow to the extremities. Drink plenty of fluids, but limit the intake of caffeine.

5.10 Inclement Weather

Work or task orders shall be preceded by an evaluation of weather reports and conditions by a responsible person to ascertain that safe working conditions exist and safe refuge of personnel is assured. Contractors working in an exposed marine location shall monitor the NOAA marine weather broadcasts and shall use other local commercial weather forecasting services as may be available.

6.0 AIR MONITORING

6.1 Direct Reading Instrumentation

Instrument 1 - RaeSystems Mini-Rae 2000 PID with a 10.6 ev lamp

As a precautionary measure, a RaeSystems Mini-Rae 2000 PID with a 10.6 ev lamp, will be used to monitor the breathing zone of personnel during the proposed near shore sediment samples where VOC concentrations are reportedly the highest. VOC exposure is not expected when collecting sediment samples located away from the shoreline.

If the PID indicates sustained (15 minute) breathing zone vapor concentrations in excess of 1 units or more, respiratory protection, as described in Section 7.2 of this document, will be donned. This action limit is based on the PEL for benzene and its reported response to the selected instrument.

6.2 Personal Air Sampling

Personal air sampling will not be conducted by ENSR during the activities covered by this HASP.

6.3 Calibration and Recordkeeping

Equipment used by ENSR will be calibrated in accordance with ENSR's standard operating procedures. A log of PID readings will be kept in the field notebook. Daily calibration information will also be recorded in the field notebook.

7.0 PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment (PPE) will be worn during these activities to prevent on-site personnel from being injured by the safety hazards posed by the site and/or the activities being performed. In addition, chemical protective clothing will be worn to prevent direct dermal contact with the site's chemical contaminants. The following table describes the PPE and chemical protective clothing to be worn for general site activities and for certain specific tasks.

7.1 Chemical Protective Clothing

PPE Item	Sediment Sampling via Vibracore	Surface Water Sampling	Macroinvertebrate Sampling
Hard Hat	✓		
Rubber Steel-Toed Safety Shoes	✓	✓	✓
Safety Glasses with Sideshields	✓	✓	✓
USCG-approved Type III PFDs	✓	✓	✓
Polycoated Tyvek coveralls	If sediment comes in contact with street clothing		
Outer Nitrile Gloves with inner Latex liners	When touching sediment or equipment contaminated with sediments	✓	✓
Kevlar gloves	When using knives or blades	When using knives or blades	When using knives or blades
Hearing Protection	✓		

7.2 Respiratory Protection

ENSR will perform air monitoring in the worker's breathing zone during the collection of sediment samples near the shoreline of the facility where total VOC concentrations are reported to be the highest. If the PID indicates sustained (15 minutes) breathing zone VOC concentrations of 1 units or more, Level C respiratory protection will be donned.

Level C Specification: Half-mask air-purifying respirator with organic vapor cartridges

All employees who are expected to don respiratory protection must have successfully passed a fit-test within the past year for the brand, model and size respirator they plan to wear on this program.

7.3 Other Safety Equipment

The boat is equipped with a fire extinguisher, first aid kit, 3W transportable cellular phone, VHF radio, a 6-man life raft, ACR Category II EPIRB, 6 survival suits and diver alert network oxygen kit.

8.0 SITE CONTROL/DECONTAMINATION

8.1 River Access

The BASF site is located at 36 Riverside Avenue in Rensselaer. However, the boat will not be launched from the site. It is anticipated that the boat will be launched from a municipal boat launch that is owned, operated and maintained by the City of Rensselaer. The launch is located approximately 2 miles upstream of the site off of Forbes Road.

8.2 Designation of Zones

To prevent both exposure of unprotected personnel and migration of contamination due to tracking by personnel or equipment, hazardous work areas will be clearly identified and decontamination procedures will be required for personnel and equipment leaving those areas.

ENSR designates work areas or zones as suggested in the "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities," NIOSH/OSHA/USCG/EPA, November 1985. They recommend that the areas surrounding each of the work areas to be divided into three zones:

- Exclusion or "Hot" Zone
- Contamination Reduction Zone (CRZ)
- Support Zone

8.2.1 Exclusion Zone

All work is being conducted on the boat so the establishment of an exclusion zone will not be required. However, all personnel working on the boat must wear the prescribed level of protective equipment for the task being performed.

8.2.2 Contamination Reduction Zone

A mini-decontamination zone will be established on the boat. Personnel will remove contaminated gloves and other disposable items in this area and place them in a plastic bag until they can be properly disposed of.

8.1.3 Support Zone

At this site, the support zone will be located at the municipal boat launch where equipment will be mobilized and de-mobilized from the boat and site support vehicles.

8.3 General Site Safety Practices

The following measures are designed to augment the specific health and safety guidelines provided in this plan.

- The "buddy system" will be used at all times by all field personnel. No one is to perform field work alone. Standby team member must be intimately familiar with the procedures for initiating an emergency response.
- Eating, drinking, chewing gum or tobacco, smoking or any practice that increases the probability of hand-to-mouth transfer and ingestion of materials is prohibited in the immediate work area and the decontamination zone.
- Smoking is prohibited in all work areas. Matches and lighters are not allowed in these areas.
- Hands and face must be thoroughly washed upon leaving the work area and before eating, drinking or any other activities.
- Beards or other facial hair that interfere with respirator fit are prohibited.
- The use of alcohol or illicit drugs is prohibited during the conduct of field operations.
- All equipment must be decontaminated or properly discarded before leaving the site in accordance with the project work plan.

9.0 DECONTAMINATION

9.1 Personal Decontamination

Proper decontamination is required of all personnel before leaving the exclusion zone. Decontamination will occur within the contamination reduction zone. Disposable PPE, such as gloves, will be removed in the decontamination reduction zone and placed in garbage bags for disposal as general refuse.

If boots come in contact with sediments that accumulate on the boat deck, they can be rinsed with the river water to remove the sediment and rinsed at the launch area, if tap water is available.

9.2 Hand Washing

Regardless of the type of decontamination system required, as a minimum, a container of potable water and liquid soap should be made available so employees can wash their hands and face before leaving the site for lunch or for the day. Employees should always wash their face and hands with soap and water before eating.

10.0 MEDICAL MONITORING AND TRAINING REQUIREMENTS

10.1 Medical Monitoring

All personnel performing activities covered by this HASP must be active participants in a medical monitoring program that complies with 29 CFR 1910.120(f). Each individual must have completed an annual surveillance examination and/or an initial baseline examination within the last year prior to performing any work on the site covered by this HASP.

10.2 Health and Safety Training

10.2.1 HAZWOPER

All personnel performing activities covered by this HASP must have completed the appropriate training requirements specified in 29 CFR 1910.120 (e). Each individual must have completed an annual 8-hour refresher training course and/or initial 40-hour training course within the last year prior to performing any work on the sites covered by this HASP.

10.2.2 First Aid/CPR

At least one member of the field team must be currently trained in both first aid and CPR.

10.2.3 Pre-Entry Briefing

Prior to the commencement of on-site activities, a pre-entry briefing will be conducted by the SSO to review the specific requirements of this HASP. Attendance of the pre-entry meeting is mandatory for all personnel covered by this HASP and must be documented on the attendance form provided in Attachment C. HASP sign-off sheets should also be collected at the time of the pre-entry briefing. All documentation should be maintained in the project file.

The pre-entry briefing must be completed for each new employee before they begin work at the site. Short safety refresher meetings will be conducted, as needed, throughout the duration of the project.

10.2.4 Pre-Launch Meeting

Prior to launching the boat, the captain and crew will review boat operations, the location of emergency equipment and the operation of emergency communications equipment with the

ENSR sampling team. During this meeting, the captain will assign specific emergency response responsibilities to each person on the boat.

11.0 EMERGENCY RESPONSE

ENSR will develop a plan which addresses response to marine emergencies such as sinking, flooding, severe weather, and man overboard incidents. All members of the field team must be instructed in the specific aspects of the emergency plan for this project. This can be reviewed during the pre-launch safety meeting.

11.1 Daily Float Plan

Prior to leaving shore, a plan of the day's activities, including time and place of departure, anticipated return time and list of employees working on the project should be left with the ENSR PM. If the team does not contact the PM at the pre-determined time, the PM will initiate the emergency response plan.

11.2 Communications

The boat is equipped with a 3W transportable cellular phone and a VHF radio to contact local emergency responders. In the event that an ambulance is needed due to a medical emergency, the caller must identify the launch area as the location for the ambulance to meet the boat. The phone numbers of the police and fire departments, ambulance service, local hospital, and ENSR representatives are provided in the emergency reference sheet. This sheet will be posted in the boat.

11.3 Medical Emergency

At least one member of the field team must be currently trained in first aid and CPR. In the event of a medical emergency, contact local emergency responders and request their assistance at the municipal boat launch area off of Forbes Road. Transport the injured/ill employee to the launch area.

In the event an injury or illness requires more than first aid treatment, the SSO will accompany the injured person to the medical facility and will remain with the person until release or admittance is determined. The escort will relay all appropriate medical information to the on-site project manager and the RHSM.

11.4 Fire

ENSR team members must determine the location of the fire extinguisher on the boat and should be prepared to use it in the event of an emergency that the boat owner/operator can not respond to.

Most boat fires can be put out rapidly if you act immediately. Do not hesitate. If a fire starts, grab the extinguisher, activate it and direct it at the base of the flames. Use short bursts and sweep it from side to side. Do not wait until a fire starts to read the directions on the label. Take the time to make sure that you and those who boat with you regularly know and understand exactly how to use the fire extinguisher.

When extinguishing the fire, make sure it is completely out. If not, it may smolder for a long while and possibly start again. If possible, soak burning materials over the downwind side of the boat.

Follow these steps if fire breaks out while you are underway in order to prevent the fire from spreading to other parts of the boat:

- Slow or stop the boat. Wind from the boat's motion feeds the flames.
- Keep the fire downwind. If the fire is aft, head the bow into the wind. If forward, put the stern into the wind.
- If the motor catches fire, shut off the fuel supply immediately.

If you realize that the fire cannot be put out with the fire extinguisher, put on your life jacket and exit the boat upwind of the burning craft. Use a radio, cellular phone, or visual distress signals to gain assistance.

11.5 Taking on Water/Capsizing

If the boat capsizes or is taking on water, call for emergency assistance and make sure all employees **stay with the boat**. Boats 25 feet or under and built after 1973 must have flotation built in so they should float even if full of water. It's much easier to spot a boat then someone floating alone in the water. Don't try and swim to shore or swim to keep warm. Swimming burns up energy and regardless how warm the water is if you expend all your energy swimming you're likely to succumb to the effects of hypothermia sooner.

11.6 Abandoning Ship

You should only abandon ship when the water is a better place to be then the boat such as in the event of a fire that can not be extinguished or the boat is headed in the direction of another hazard.

11.7 Man Overboard

The first thing you want to do in a man overboard (MOB) situation is to stop the forward progress of the boat. Next, turn the boat towards the side that the person fell over and post a look out so that at least one person is responsible for keeping in visual contact with the MOB. The next thing to do is take anything that floats and throw it overboard. It gives the person in the water something to float on and it creates a visible floating debris slick which will help you or someone else locate the MOB should you loose visual contact with them. If you have the MOB in site, the best thing to do is make a big oval to get back to where the MOB is and pick them up. Do not back up the boat.

Never have anyone go into the water. They will just be another person that needs to be rescued. If someone needs to go over to help a week or injured person, make sure they have floatation and a lifeline secured to them.

11.8 Designation of Responsible Parties

The boat captain is responsible for initiating emergency response. The ENSR SSO will follow the captain's instructions and ensure that the ENSR team is aware of the emergency response actions that need to be taken given the circumstances.

11.9 Employee Accounting Method

The SSO is responsible for identifying all ENSR personnel on-site at all times. On small, short duration jobs this can be done informally as long as accurate accounting is possible. If employees must abandon ship, the ENSR SSO must immediately inform first responders that everyone from the boat crew and ENSR is accounted for.

11.10 Accident Reporting and Investigation

Any incident (other than minor first aid treatment) resulting in injury, illness or property damage requires an accident investigation and report. The investigation should be conducted as soon as emergency conditions are under control. The purpose of the investigation is not to attribute blame but to determine the pertinent facts so that repeat or similar occurrences can be avoided. An ENSR accident investigation form is presented in Attachment D of this HASP. The injured ENSR employee's supervisor and the RHSM should be notified immediately of the injury.

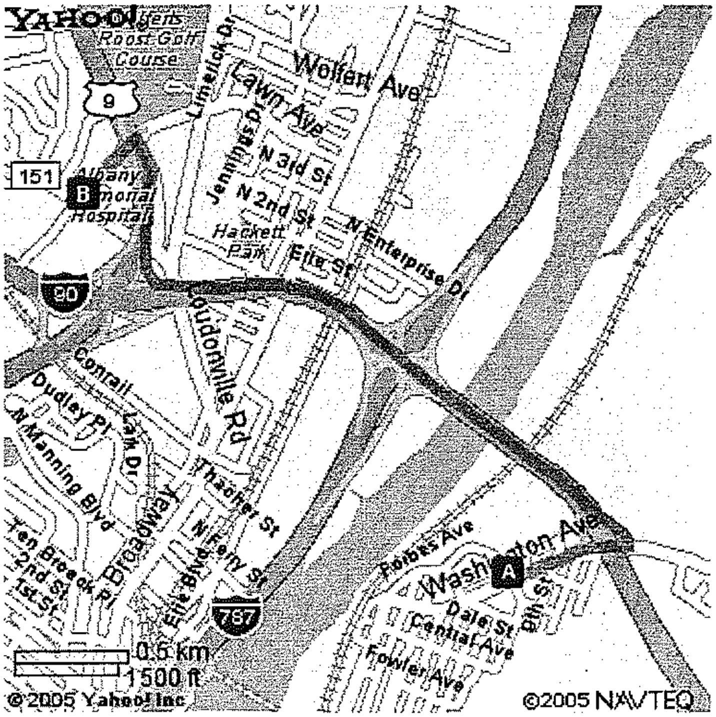
EMERGENCY REFERENCES

Ambulance:	911
Fire:	911
Police:	911
Medical Services:	518-471-3280 Albany Memorial Hospital 600 Northern Blvd Albany, NY
Directions to Hospital:	From the boat launch, follow Forbes Rd for 0.1 mile and turn left on Washington Ave. Go 0.3 miles and turn left onto I-90 West toward Albany/Troy. Go 1.4 miles and take exit # 6/US9 onto a local road. Follow for 0.5 miles and turn left onto Northern Blvd toward US-9S/Hospital/Loudenville. Go 0.2 miles to hospital.
On Site Telephone:	Property is unoccupied and work is occurring off of a boat. Bring portable communications.

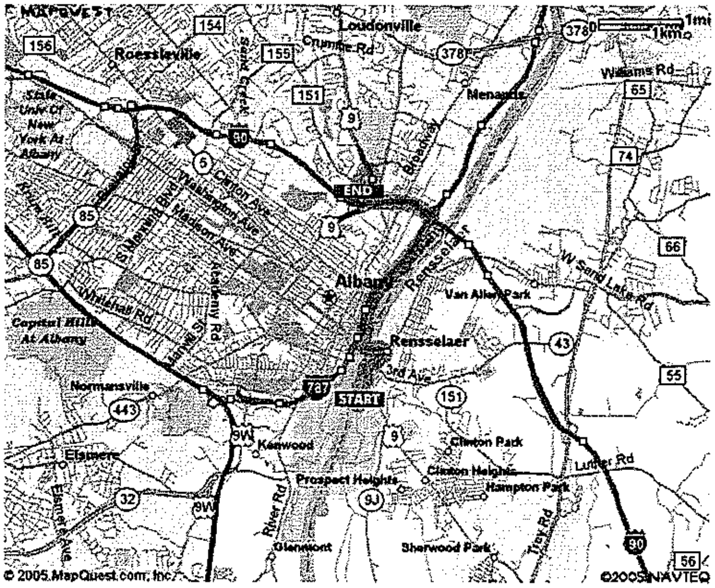
ENSR Project Representatives:

ENSR/Westford, MA	(978) 589-3000
-Kathy Harvey (RHSM)	x 3325
-John Bleiler (PM)	x 3056

Map from the Municipal Boat Launch off of Forbes Rd to Albany Memorial Hospital 600 Northern Blvd - Albany



Map from the BASF Facility at 36 Riverside Avenue to Albany Memorial Hospital 600 Northern Blvd - Albany



Directions to Hospital :

From the BASF facility go north on Riverside Drive. Turn left onto US-9N/US-20W. Merge onto I-787 toward Troy. Merge onto I-90W via Exit 5 toward Buffalo (toll road). Take the US-89N exit toward Loudonville (exit 6). Take the exit toward Northern Boulevard and turn left onto Northern Boulevard. Hospital is 4.4 miles from the BASF facility.

Attachment A

Health and Safety Plan Receipt and Acceptance Form

Health and Safety Plan Receipt and Acceptance Form

Field Investigation
Hudson River Sediment Characterization
Near BASF Facility
Rensselaer, New York

I have received a copy of the Health and Safety Plan prepared for the above-referenced site and activities. I have read and understood its contents and I agree that I will abide by its requirements.

Name:

Signature:

Date:

Representing:

Attachment B

Job Hazard Analysis Form

Job Analysis Form

PRINCIPAL STEPS	**POTENTIAL HAZARDS**	**RECOMMENDED CONTROLS**
SAFETY EQUIPMENT	**INSPECTION REQUIREMENT**	**TRAINING REQUIREMENTS**

Attachment C

Health and Safety Plan Pre-Entry Briefing Attendance Form

Health and Safety Plan Pre-Entry Briefing Attendance Form

Field Investigation
Hudson River Sediment Characterization
Near BASF Facility
Rensselaer, New York

Briefing Conducted By: ______________________________

Date Performed: ____________________

Printed Name	Signature	Representing

Attachment D

Supervisor's Accident Investigation Report Form

H&S SOP NO: 4.2 ENSR ENSR Consulting and Engineering

SUPERVISOR'S ACCIDENT INVESTIGATION REPORT

Injured Employee ______________________ Job Title ______________________

Home Office ______________________ Division/Department ______________________

Date/Time of Accident ____

Location of Accident ____

Witnesses to the Accident ____

Injury Incurred? ________ Nature of Injury ______________________________

____

Engaged in What Task When Injured? ______________________________________

____

Will Lost Time Occur? ________ How Long? ________ Date Lost Time Began ____________

Were Other Persons Involved/Injured? ______________________________________

____

How Did the Accident Occur? ____

____

____

____

____

What Could Be Done to Prevent Recurrence of the Accident? ______________________

____

____

What Actions Have You Taken Thus Far to Prevent Recurrence? ____________________

____

____

Supervisor's Signature ______________________ Title ______________ Date ________

Reviewer's Signature ______________________ Title ______________ Date ________

Note: If the space provided on this form is insufficient, provide additional information on a separate page and attach. The completed accident investigation report must be submitted to the Regional Health and Safety Manager within two days of the occurrence of the accident.