Remedial Investigation Report

North Water Street Site
Poughkeepsie, New York
NYSDEC Site # 314070
BCA Index # D3-0004-99-04

December 2010

ARCADIS

Nancy Gensky
Principal-in-Charge

David Bessingpas
Project Manager

David Cornell
Project Geologist

Remedial Investigation Report

North Water Street Site
Poughkeepsie, New York

Prepared for:
Central Hudson Gas & Electric Corporation
Poughkeepsie, New York

Prepared by:
ARCADIS of New York, Inc.
6723 Towpath Road
P.O. Box 66
Syracuse
New York 13214-0066
Tel 315.446.9120
Fax 315.449.0017

Our Ref.:
B0020530.0001.NW302

Date:
December 2010

Tables

Figures

Attachments

1. Introduction

This *Remedial Investigation Report* (RI Report) summarizes the land- and river-based investigation activities that have been completed at the Central Hudson Gas & Electric Corporation (CHGE) North Water Street Site in Poughkeepsie, New York (the site; **Figures 1 and 2**) between 1986 and 2010.

Between 1986 and 2008, several land- and river-based investigations were completed to evaluate the nature and extent of manufactured gas plant (MGP)-related constituents associated with the former MGP operations at the Site. The results of the previous investigations were presented in the following reports:

- *Phase I Investigation, Poughkeepsie (North Water Street) Coal Gasification Plant Site, City of Poughkeepsie, Dutchess County, New York* (Phase I Report; EA Science and Technology, 1987)
- *Phase II Investigation Report, Former Coal Gasification Plant Site, North Water Street Site* (Phase II Report; Blasland & Bouck Engineers, P.C., 1990b)
- *Supplemental Preliminary Site Assessment* (SPSA Report; BBL, 2000c)
- *Data Report – 2003 Land Investigation Activities* (2003 Data Report; BBL, 2004a)
- *Data Report – 2004 Land and River Investigations* (2004 Data Report; BBL, 2005c)
- *Data Report – 2005 River and Land Investigations* (2005 Data Report; BBL, 2006)
- *Data Report – 2008 Supplemental Land and River Investigations* (2008 Data Report; ARCADIS, 2009)

Additional investigation activities were conducted in 2010, in general accordance with the *Work Plan for Supplemental Land/River Investigations* (ARCADIS, 2010), which was submitted to the NYSDEC on January 7, 2010, and approved by the NYSDEC on April 9, 2010[1] (NYSDEC, 2010d).

---

[1] Condition #4 of NYSDEC's April 9, 2010 letter, related to an asbestos assessment, was superseded by Hank Willems' (NYSDEC) July 30, 2010 e-mail to Adam Etringer (CHGE), which indicated that no asbestos-related assessment or sampling was required.

This RI Report summarizes the findings and conclusions from all site investigations conducted to date, including the 2010 investigation, and makes recommendations for future site activities.

1.1 Site History

The site was operated as a carbureted water gas MGP, from 1911 to 1950. CHGE has owned the site since 1926. From 1950 to 1954, as the demand for manufactured gas decreased, the North Water Street MGP was used only for peak gas demands and emergencies. By 1955, some of the gasification facilities and equipment were removed from the property and gas manufacturing was discontinued. The southern portion of the site was formerly operated as an electric station.

During peak operation, waste by-products from the North Water Street, Kingston, and Newburgh gasification operations were reportedly recycled at the North Water Street MGP. By-products were distilled and treated and then recycled back into the MGP, used as fuel for the adjacent electrical power plant, and/or sold. During the recycling process, by-products were reported to have seeped into the Hudson River from unintentional spills near the tar separator. To prevent additional seepage of by-products into the river, a clay dike was installed between the railroad siding and the river in the 1940s.

A detailed summary of the site history is provided in the Phase I Report and Phase II Report. **Figure 2** shows the historic features and facilities associated with the former MGP and electric station operations, as compiled from Sanborn Map and Publishing Company fire insurance maps and CHGE maps.

As indicated above, environmental investigations at the site were initiated in 1986, with a Phase I investigation. Subsequent to completing the Phase I (1986) and Phase II (1990) investigations, CHGE and the NYSDEC signed a Voluntary Cleanup Agreement (VCA: Index Number D3-0004-99-04) in March 2000. Pursuant to the VCA, CHGE conducted a Supplemental Preliminary Site Assessment (SPSA) in 2000. NYSDEC approved the SPSA Report in a letter to CHGE dated March 18, 2002.

On August 29, 2002, the NYSDEC submitted a letter to CHGE indicating that a spill had been reported on the Hudson River near the site. As a result of that letter, and subsequent correspondence and communications between NYSDEC and CHGE, various supplemental investigations were conducted between 2003 and 2010.

In May 2005, CHGE and the NYSDEC signed a Brownfield Site Cleanup Agreement (BCA; Index Number D3-0004-99-04). Investigations conducted at the site after May 2005 have been performed in accordance with the BCA. As defined in the BCA, the site consists of the former MGP operations areas to the north, and the former electric plant area to the south (see Site Boundary on **Figure 2**).

1.2 Report Organization

The remainder of this RI Report is divided into the following sections:

- Section 2 – Remedial Investigation Activities: summarizes the investigation activities conducted to date.
- Section 3 – Remedial Investigation Findings: summarizes the findings of the investigation activities identified in Section 2.
- Section 4 – Qualitative Human Health Exposure Assessment/Conceptual Site Model: summarizes the source areas, release and transport mechanisms, potential exposure points, exposure routes and potential receptors, and identifies complete exposure pathways.
- Section 5 – Fish and Wildlife Resource Impact Analysis (FWRIA): presents the findings of the FWRIA.
- Section 6 – Conclusions and Recommendations: presents the conclusions based on the investigations conducted to date and makes recommendations for future site-related work based on investigation findings/conclusions.
- Section 7 – References: provides a list of documents referred to throughout the report.

This RI Report also includes various tables, figures, and attachments, which are referenced throughout the report text.

2. Remedial Investigation Activities

2.1 Overview

This section presents a summary of the previous investigations and reports completed from 1986 to 2008, and a detailed description of the supplemental investigation activities performed in 2010. The collective results of these investigation activities are presented and discussed in Section 3.

The following table lists the investigations that have been conducted at the site, including a brief summary of the scope of the investigations and reference to applicable work plans and reports.

Investigation	Scope	References
Phase I Investigation (1986)	• Compilation and review of historic site documents, records, files, etc. • Calculation of a preliminary Hazard Ranking System (HRS) score • Site reconnaissance • Soil vapor survey at 24 locations	*Phase I Investigation, Poughkeepsie (North Water Street) Coal Gasification Plant Site, City of Poughkeepsie, Dutchess County, New York* (EA Science and Technology, 1987)
Phase II Investigation (1990)	• Installation of three bedrock and three overburden monitoring wells • Collection and analysis of six subsurface soil, three surface soil, three sediment, three surface water, three bedrock groundwater, and four oil/tar samples • Hydraulic conductivity testing • Calculation of a final HRS score • Preliminary risk assessment	*Work/Quality Assurance Project Plan, Phase II Investigation* (Blasland & Bouck Engineers, P.C., 1989) *Phase II Investigation Report, Former Coal Gasification Plant Site, North Water Street Site* (Blasland & Bouck Engineers, P.C., 1990b)
Supplemental RCRA Testing (1991)	• Advancement of three soil borings • Collection of 12 fill samples for ignitability testing • Collection of one soil sample for TCLP testing	Summarized in the *Supplemental Preliminary Site Assessment*(BBL, 2000c)
Supplemental Preliminary Site Assessment (2000)	• Advancement of eight soil borings • Collection and analysis of seven subsurface soil, two background surface soil, three overburden groundwater, and two bedrock groundwater samples • Evaluation of significant threat • Qualitative human exposure assessment	*Supplemental Preliminary Site Assessment Work Plan, North Water Street* (BBL, 2000b) *Supplemental Preliminary Site Assessment* (BBL, 2000c)

Investigation	Scope	References
Supplemental Land Investigation (2003)	• Advancement of 22 soil borings • Installation of 21 bedrock and 14 overburden NAPL monitoring wells • NAPL monitoring and recovery testing • Groundwater- and river-level monitoring	*Focused Investigation Work Plan, North Water Street Site (BBL, 2003)* *Data Report – 2003 Land Investigation Activities* (BBL, 2004a)
Supplemental Land and River Investigations (2004)	• TarGOST probing at 37 land locations • Advancement of 39 soil borings • Collection of seven subsurface soil samples • Installation of 16 temporary bedrock monitoring wells (one converted to a permanent well) • Installation of two overburden NAPL monitoring wells • Collection and analysis of one groundwater sample • Collection and analysis of two NAPL samples • Specific capacity testing at four overburden wells and three bedrock wells • Monitoring well maintenance • Review of historical site information • Review of NYSDEC remote sensing data/mapping • River reconnaissance • TarGOST probing at 59 river locations • Advancement of 59 sediment borings • Collection of 303 sediment sample for analysis (110 samples) and archiving (193 samples)	*Work Plan – 2004 Land and River Investigations, North Water Street Former MGP Site* (BBL, 2004b) *Data Report – 2004 Land and River Investigations* (BBL, 2005c)
Supplemental River and Land Investigations (2005)	• TarGOST probing at 25 river locations • ROST probing at 24 river locations • Advancement of 101 sediment borings (including 19 background locations) • Collection of 74 sediment samples for laboratory analysis • Collection of 16 sediment samples for geotechnical testing • TarGOST probing at four land locations • Advancement of seven soil borings • Installation of one monitoring well • Collection of seven soil samples for laboratory analysis	*Scope of Work – 2005 River Investigations (Addendum No. 1 to 2004 Work Plan)* (BBL, 2005a) *Scope of Work – 2005 Land Investigations (Addendum No. 2 to 2004 Work Plan)* (BBL, 2005b) *Data Report – 2005 River and Land Investigations* (BBL, 2006)

Investigation	Scope	References
Supplemental Land and River Investigation (2008)	• Enhanced NAPL recovery testing • Advancement of 12 soil borings • Installation of 10 bedrock and one overburden NAPL monitoring wells • Collection of 6 surface soil samples for PCB analysis • Video inspection of 15 abandoned pipes along the bedrock wall and 9 abandoned pipes along the bulkhead • Underwater video inspection of the gas line buffer zone and proposed reactive sediment capping pilot study area • Low-tide bulkhead and shoreline inspections • Advancement of 15 sediment borings • Collection of 41 surface sediment samples for PAH and TOC analysis • Collection of 18 sediment samples for geotechnical parameters • Dart sampling at 28 sediment locations	*Work Plan for Supplemental Land/River Investigations* (ARCADIS, 2008b) *Data Report – 2008 Supplemental Land and River Investigations* (ARCADIS, 2009)
Supplemental Land and River Investigation (2010)	• Collection of 12 surface soil samples • Advancement of 12 soil borings • Dart sampling at 9 sediment locations • Collection of 21 surface sediment samples • Video inspection of 5 abandoned pipes	*Work Plan for Supplemental Land/River Investigations* (ARCADIS, 2010) *(Results of investigation presented herein)*

In addition to the investigations listed above, a semiannual NAPL monitoring program at all site wells has been conducted since June 2004. More frequent NAPL monitoring/removal at NMW-116S and NMW-117S has been ongoing since January 2004 (currently conducted every other month). More frequent NAPL monitoring was also conducted at SB-335 and SB-336 between December 2004 and April 2005, and at 11 wells located within the natural gas regulator station area between July 2008 and June 2009.

Additionally, two wells were installed in January 2005 and a tracer test was conducted on land in March 2005 as part of the proposed in-situ chemical oxidation (ISCO) pilot test project.[2] Also, two soil borings were advanced in February 2008 near the on-shore railroad bridge pier on the southern part of the site to provide geotechnical information for a proposed elevator for the Walkway Over the Hudson.

[2] Based on tracer test results, it was decided not to perform the ISCO pilot test at this site.

The investigations conducted to date have led to an understanding of the nature and extent of site-related impacts on land and in the river. Findings of the investigations performed to date are summarized in Section 3.

2.2 Land-Based Investigations

Between 1986 and 2010, numerous investigations were completed within the upland portion of the Site to characterize the nature and extent of MGP-related impacts. The land-based investigations included the following:

- Surface soil sampling (Section 2.2.1)
- Soil borings (Section 2.2.2)
- TarGOST probing (Section 2.2.3)
- Monitoring well installation (Section 2.2.4)
- Groundwater sampling and analysis (Section 2.2.5)
- NAPL sampling and analysis (Section 2.2.6)
- Water level measurements (Section 2.2.7)
- NAPL monitoring/removal (Section 2.2.8)
- NAPL recovery testing (Section 2.2.9)
- Aquifer testing (Section 2.2.10)
- Soil vapor survey (Section 2.2.11)
- Pipe investigations (Section 2.2.12)
- Other activities (Section 2.2.13)

The section summarizes the scope of land-based investigations conducted to date. Details regarding the investigation procedures are provided in the work plans and reports listed in the table in Section 2.1. Results of the investigation activities described below are summarized in Section 3.

2.2.1 Surface Soil Sampling

Between 1990 and 2010, a total of 30 (7 of which were from soil borings) surface soil[3] samples were collected, within the upland portion of the Site to assess the nature and extent of surface soil impacts at the Site. Surface soil sample locations are shown on **Figure 3.** Visual observations from the surface soil samples are summarized in **Table 1** (note that visual observations of surface soil samples collected from deeper soil borings are summarized in **Table 3** and on soil boring logs in **Attachment C**). Surface soil sample analytical results are summarized in **Table 2** and on **Figure 4A**. Laboratory analytical data sheets are provided in **Attachment A** and Data Usability Summary Reports (DUSRs) are provided in **Attachment B.**

The following provides a summary of the surface soil sampling activities conducted for each investigation event:

- <u>1990 Phase II Investigation:</u> Three surface soil samples (NWS-1 through NWS-3) were collected from the former purifier box area (currently occupied by the propane storage tanks) in March and analyzed for TCL Metals (USEPA Method 200), TCL SVOCs (USEPA Method 8270), TCL VOCs (USEPA Method 8240), PCBs (USEPA Method 8080), ammonia (USEPA Method 350.2), cyanide (Method 9010), and sulfate (USEPA Method 9038).

- <u>2000 Supplemental Preliminary Site Assessment:</u> Four surface soil samples (two from boring NWB-7, NWBG-1 and NWBG-2) were collected in May and June 2000 and analyzed for BTEX (USEPA Method 8260) and PAHs (USEPA 8270).

- <u>2004 Supplemental Land and River Investigation:</u> One surface soil sample was collected from soil boring SB-313 in September 2004 and analyzed for BTEX (USEPA Method 8260B) and TCL PAHs (USEPA Method 8270C).

- <u>2005 Supplemental River and Land Investigation:</u> Four surface soil samples were collected from soil borings SB-400 through SB-402, and SB-404 in October 2005 and analyzed for BTEX (USEPA Method 8260B) and TCL PAHs (USEPA Method 8270C).

---

[3] For the purposes of this RI Report, "surface soil" is defined as any sample encompassing a portion of the 0- to 2-foot depth interval.

- 2008 Supplemental Land and River Investigation: Six surface soil samples (SS-400 through SS-404, and SS-406) were collected in July 2008 from the former electric plant area located in the southern portion of the site and analyzed for PCBs (USEPA Method 8082).

- 2010 Supplemental Land and River Investigation: Twelve surface soil samples (SS-406B, and SS-501 through SS-511) were collected in April 2010 from the former electric plant area and other various locations throughout the site and analyzed for VOCs (USEPA 8260B), SVOCs (USEPA 8270C), inorganics (USEPA 6010B), hexavalent chromium (USEPA 6010B-7199), cyanide (USEPA 9012A), PCBs (USEPA 8082), Pesticides (USEPA 8081A), and Herbicides (USEPA 8151A).

2.2.2 Soil Borings

Between 1990 and 2010, a total of 113 soil borings have been advanced within the upland portion of the Site (of the 113 soil borings, 59 were converted to monitoring wells). Soil boring locations are shown on **Figure 3.** Visual observations from the soil borings are summarized in **Table 3**. The analytical results for subsurface soil samples collected from soil borings are summarized in **Table 4** and on **Figure 4B**. Geotechnical testing results are summarized in **Table 5**. Waste characterization soil sample results are summarized in **Table 6**. Laboratory analytical data sheets are provided in **Attachment A** and DUSRs are provided in **Attachment B.** Soil boring logs are provided in **Attachment C**.

The following provides a summary of the soil boring activities conducted for each investigation event:

- 1990 Phase II Investigation: Six soil borings (MW-1 through MW-6) were advanced and completed as monitoring wells in March 1990. Subsurface soil samples were collected from MW-1 through MW-6 and analyzed for TCL Metals (USEPA Method 200), TCL SVOCs (USEPA Method 8270), TCL VOCs (USEPA Method 8240), PCBs (USEPA Method 8080), ammonia (USEPA Method 350.2), cyanide (Method 9010), and/or sulfate (USEPA Method 9038). In addition, a sample was collected from MW-2 for geotechnical testing: Atterberg limits (ASTM Method D-4318-84) and grain size (ASTM Method D-422-63). Waste characterization samples were collected from MW-4, MW-5 and MW-6 and analyzed for TCLP metals (USEPA Method 1310), ignitability (USEPA Method 1010), corrosivity/pH (USEPA Method 9040, and reactivity (USEPA Method SM 4120, CA 3400-2).

- 1991 Supplemental RCRA Testing: Three soil borings (NWB-MW4, NWB-MW5, and NWB-MW6) were advanced adjacent to monitoring wells MW-4, MW-5 and MW-6 in 1991 to obtain samples for waste characterization analyses. A total of six subsurface soil samples (two from each boring) were collected and analyzed for ignitability (USEPA Method 1010). In addition, a sample from NWB-MW6 was analyzed for TCLP VOCs, SVOCs, herbicides, pesticides and metals. Lab data sheets and DUSRs for these analyses are not available.

- 2000 Supplemental Preliminary Site Assessment: Eight soil borings (NWB-1 through NWB-8) were advanced in May 2000 to further evaluate the nature and extent of the tar/oils observed in the fill overburden near existing wells MW-4 through MW-6 and near former processing or handling facilities in the lower portion of the site. Subsurface soil samples were collected from NWB-1 through NWB-3 and NWB-5 through NWB-7 and analyzed for BTEX (USEPA Method 8260) and PAHs (USEPA 8270). Samples collected from NWB-2 and NWB-3 were also submitted for waste characterization analyses: ignitability (USEPA Method 1010), corrosivity (USEPA Method 7.2.2), reactive cyanide (USEPA Method 7.3.3.2), reactive sulfide (USEPA Method 7.3.3.2), TCLP VOCs (USEPA Method 8240B), TCLP SVOCs (USEPA Method 8270), TCLP metals (USEPA Method 6010/7000) and/or oil identification (USEPA method 8015).

- 2003 Supplemental Land Investigation: Twenty-two soil borings (SB-100 through SB-121), 21 of which were completed as overburden and/or bedrock wells, were advanced in November and December 2003 to evaluate the presence, thickness, and potential recoverability of NAPLs within the overburden and bedrock adjacent the Hudson River (SB-100 through SB-118) and along a portion of the site's northern property boundary (SB-119 through SB-121). No soil samples were collected for laboratory analysis from these soil borings.

- 2004 Supplemental Land and River Investigation: Thirty-nine soil borings (SB-300 through SB-336, DB-01, and DB-03), 18 of which were completed as overburden or bedrock monitoring wells, were advanced between September and November 2004. Subsurface soil samples collected from SB-314 through SB-319 were analyzed for BTEX (USEPA Method 8260B) and TCL PAHs (USEPA Method 8270C).

- 2005 ISCO Pilot Study: Two soil borings (IW-1 and IW-5) were advanced and completed as monitoring wells in January 2005. No soil samples were collected for laboratory analysis from these soil borings.

- 2005 Supplemental River and Land Investigation: Seven soil borings (SB-400 through SB-406) were advanced in October 2005 in the former electric plant portion of the site. Subsurface soil samples were collected from each of the seven soil borings and analyzed for BTEX (USEPA Method 8260B) and TCL PAHs (USEPA Method 8270C).

- 2008 Railroad Bridge Investigation: Two soil borings (B-1 and B-2) were advanced in February 2008 beneath/adjacent to the Poughkeepsie-Highland Railroad Bridge to provide geotechnical data for a proposed elevator for the Walkway Over the Hudson. No soil samples were collected for laboratory analysis from these soil borings.

- 2008 Supplemental Land and River Investigation: Twelve soil borings (SB-500 through SB-511 were advanced and completed as monitoring wells in June 2008 to assess the potential presence of NAPLs in overburden soil and bedrock in the natural gas regulator station area. No soil samples were collected for laboratory analysis from these soil borings.

- 2010 Supplemental Land and River Investigation: Twelve soil borings (SB-601 through SB-612) were advanced in April 2010 to assess the potential presence of NAPLs in overburden soil and weathered bedrock at various areas of the site. No soil samples were collected for laboratory analysis from these soil borings.

2.2.3 TarGOST Probing

TarGOST® (or Tar-specific Green Optical Screening Tool), a technology developed by Dakota Technologies, Inc. (DTI) of Fargo, North Dakota that utilizes laser-induced fluorescence (LIF) techniques to characterize the in-situ distribution of tar-like substances (i.e., NAPLs), was implemented at the site during the 2004 and 2005 investigations. TarGOST technology utilizes a probe that is advanced through the subsurface using a direct-push drilling system. A green laser light is transmitted through a fiber optic cable and exits the probe through a sapphire window near the tip of the probe. As the soil/sediment adjacent to the window is exposed to the laser light, PAHs present in the soil/sediment absorb the laser light and are driven into an electrically excited state, which emits fluorescent light (the higher the concentration of PAHs/NAPLs, the stronger the fluorescence signal). The fluorescent light is then transmitted back up the hole through a fiber optic cable where it is analyzed by a spectrometer. Real-time logs of fluorescence vs. depth are then created to determine the presence/absence of NAPLs as a function of depth.

During the 2004 and 2005 investigations, a total of 41 TarGOST probes were advanced within the upland portion of the Site. TarGOST probe locations are shown on **Figure 3.** The TarGOST results are summarized in **Table 7**. TarGOST logs are provided in **Attachment D**.

The following summarizes the TarGOST probing activities conducted for each investigation event:

- 2004 Supplemental Land and River Investigation: TarGOST probing was conducted at 37 locations (TB-01 through TB-37) in October 2004 to delineate NAPL impacts in the NMW-116S/NMW-117S area, the ISCO pilot test area, and on the former electric plant portion of the site.

- 2005 Supplemental River and Land Investigation: TarGOST probing was conducted at four locations (TB-38 through TB-41) in September 2005 to assess NAPL impacts on the former electric plant portion of the site.

2.2.4 Monitoring Well Installation

A total of 75 monitoring wells (25 overburden, 15 temporary bedrock, and 35 permanent bedrock) have been installed within the upland portion of the site. Monitoring well locations are shown on **Figure 3**. Well construction details are summarized in **Tables 8A and 8B**. Well development information is provided in **Table 9**. Monitoring well logs are provided in **Attachment C**.

The following summarizes the monitoring well installation activities conducted for each investigation event:

- 1990 Phase II Investigation: Three bedrock monitoring wells (MW-1, MW-2, and MW-3) and three overburden monitoring wells (MW-4, MW-5, and MW-6) were installed in April 1990.

- 2003 Supplemental Land Investigations: A total of 37 monitoring wells, 21 bedrock (NMW-100D, NMW-102D through NMW-121D) and 16 overburden (MW-200, MW-201, NMW-102S, NMW-104S through NMW-113S, NMW-115S through NMW-117S), were installed in November and December 2003.

- 2004 Supplemental Land and River Investigation: A total of 18 monitoring wells, two overburden (SB-335 and SB-336) and 16 bedrock (SB-300 through SB-312, SB-320 through SB-322), were installed in September 2004.

- 2005 ISCO Pilot Study: Two overburden monitoring wells (IW-1 and IW-5) were installed in January 2005. These wells were intended to be used for an ISCO pilot study. However, based on tracer test results, it was decided not to perform the ISCO pilot test at this site.

- 2005 Supplemental River and Land Investigation: One overburden monitoring well (SB-400) was installed in October 2005.

- 2008 Supplemental Land and River Investigation: A total of 11 monitoring wells, one overburden (SB-511) and ten bedrock (SB-500 through SB-505, SB-507 through SB-510) were installed in June 2008.

2.2.5 Groundwater Sampling and Analysis

Groundwater sampling activities were conducted in 1990, 2000 and 2004. Groundwater sample locations are shown on **Figure 3.** Groundwater sample analytical results are summarized in **Table 10** and on **Figure 5**. Laboratory analytical data sheets are provided in **Attachment A** and DUSRs are provided in **Attachment B**.

The following summarizes the groundwater sampling and analysis activities conducted for each investigation event:

- 1990 Phase II Investigation: Groundwater samples were collected from three wells (MW-1 through MW-3) in April 1990 and analyzed for TCL inorganics (USEPA Method 200), TCL SVOCs (USEPA Method 8270), TCL VOCs (USEPA Method 8240), ammonia (USEPA Method 350.2), cyanide (Method 335.2), and sulfate (USEPA Method 375.4).

- 2000 Supplemental Preliminary Site Assessment: Groundwater samples were collected from five wells (MW-1, MW-3 through MW-6) in May 2000 and analyzed for BTEX (USEPA 8260) and PAHs (USEPA Method 8270). Note that, except for MW-3, these samples were described as an oil/water mix.

- 2004 Supplemental Land and River Investigation: A groundwater sample was collected from well SB-303 in November 2004 and analyzed for BTEX (USEPA Method 8260B).

2.2.6 NAPL Sampling and Analysis

NAPL sampling activities were conducted in 2004. NAPL sample locations are shown on **Figure 3.** NAPL sample analytical results are summarized in **Table 11**. Laboratory analytical data sheets are provided in **Attachment A** and DUSRs are provided in **Attachment B**.

The following summarizes the NAPL sampling and analysis activities conducted for each investigation event:

- 2004 Supplemental Land and River Investigation: A NAPL sample was collected from well NMW-117S in August 2004 and analyzed for density, viscosity, and interfacial tension. A second NAPL sample was collected from well NMW-117S in November 2004 and analyzed for BTEX (USEPA Method 8260B) and TCL PAHs (USEPA 8270c).

2.2.7 Water Level Measurements

Groundwater level measurements collected periodically from January 2004 to June 2010 are summarized in **Table 12A**.

2.2.8 NAPL Monitoring/Removal

NAPL monitoring/removal data collected periodically from January 2004 to June 2010 are summarized in **Tables 12A through 12E**. A semiannual NAPL monitoring program at all site wells has been conducted since June 2004. More frequent NAPL monitoring/removal at NMW-116S and NMW-117S has been ongoing since January 2004 (currently conducted every other month). More frequent NAPL monitoring was also conducted at SB-335 and SB-336 between December 2004 and April 2005, and at 11 wells located within the natural gas regulator station area between July 2008 and June 2009.

2.2.9 NAPL Recovery Testing

NAPL recovery testing was conducted at wells NMW-116S and NMW-117S in February 2004. The tests consisted of measuring initial NAPL thicknesses, removing NAPL from the wells, and then periodically measuring NAPL thicknesses as NAPL re-entered the wells. This process was repeated twice at NMW-116S and four times at NMW-117S. Tables and graphs summarizing the 2004 NAPL recovery testing data are provided in **Attachment E**.

Additional NAPL recovery tests were conducted between April 30 and May 7, 2008 to evaluate whether enhancing the hydraulic gradient at the wells would significantly improve NAPL recovery rates. This four-day test was conducted after installing pressure transducers in selected wells and the Hudson River and allowing time for equilibration. On Day 1, water levels were monitored in seven existing wells (NMW-109S, NMW-113S, NMW-115S, NMW-116S, NMW-117S, MW-201 and SB-336; **Figure 3**) and in a "piezometer" installed on the bank of the Hudson River to record background water-level fluctuations. On Day 2, groundwater was pumped from NMW-116S at a rate of approximately 1 gallon per minute (gpm) for a period of approximately 8 hours, while water levels were monitored at nearby wells and NAPL thicknesses were monitored at NMW-116S and NMW-117S. On Day 3, groundwater was pumped from NMW-117S at a rate of approximately 1 gpm for a period of approximately 8 hours, while water levels were monitored at nearby wells and NAPL thicknesses were monitored at NMW-116S and NMW-117S. On Day 4, water levels were monitored at nearby wells and NAPL thicknesses were monitored at NMW-116S and NMW-117S. Graphs summarizing the 2008 enhanced NAPL recovery testing data are provided in **Attachment E**.

2.2.10 Aquifer Testing

Hydraulic conductivity testing was performed on bedrock wells MW-1, MW-2 and MW-3 during the 1990 Phase II investigation. Specific capacity testing was performed in August 2004 at monitoring well NMW-106S and in November 2004 at NMW-104S, NMW-105S, NMW-107S, NMW-115S, NMW-106D, NMW-111D and NMW-115D. The results of the aquifer testing are presented in **Table 13**. The 1990 hydraulic conductivity testing data are also presented in **Attachment F**.

2.2.11 Soil Vapor Survey

A soil vapor survey was conducted at 24 locations in November 1986. Soil vapor survey locations are shown on **Figure 3.** Soil vapor analytical results are summarized in **Table 14**.

2.2.12 Pipe Investigations

Video camera inspection of 15 abandoned pipes observed to daylight from the "bedrock wall" that separates the upper and lower portions of the site (RW-PIPE-1 through RW-PIPE-15) was conducted in October 2008. An additional five abandoned pipes observed to daylight in the upper portion of the site (RW-PIPE-15A through RW-PIPE-19) were inspected in October 2010. The locations of the ends of the inspected pipes are shown **Figure 3**. The pipe inspection results are summarized in **Table 15**.

DVDs of the 2010 video footage are provided in **Attachment G**. DVDs of the 2008 video footage were provided in the 2008 Data Report.

2.2.13 Other Activities

2.2.13.1 Dutchess Avenue Sewer Improvements

In December 2003, the City of Poughkeepsie began improvements to the sewer line in Dutchess Avenue, including the installation of a new pump station. As part of the sewer line improvements, a trench (approximately 8 feet wide by 8 feet deep) was excavated in Dutchess Avenue, beginning approximately 230 feet east of the Hudson River and extending up to North Water Street. At the western end of the trench, a new pump station was installed; excavation for the pump station extended approximately 14 feet bgs. CHGE representatives observed the excavation activities associated with the sewer line improvements; no NAPL or other site-related impacts were observed.

2.2.13.2 Former MGP Subsurface Piping Removal

During the historical information review conducted in 2004, a CHGE map identified a "piping bundle" consisting of seven pipes (including a 1.5-inch diameter feed water line, a 3-inch diameter steam line, two 3-inch diameter tar lines, a 1.5-inch diameter condensate line, and two other lines) enclosed in a wooden "box," running between the MGP and electric plant (see **Figure 2**). This piping is consistent with historic documentation that MGP by-products were reused at the MGP and at the electric plant. On November 16, 2004, this piping bundle was located and an approximately 300-foot long section of the piping, extending south from the NMW-110/111 area was removed (**Figure 2**). Piping was not observed further north. The piping south of well NMW-109 did not contain any tar, while some tar was observed in the piping north of NMW-109. However, NAPLs were not observed in the soils surrounding the pipes based on visual observations. Removed piping was sent offsite for disposal by CHGE.

2.2.13.3 ISCO Pilot Test

An ISCO pilot test was proposed to be conducted in the vicinity of monitoring wells NMW-105 and NMW-106, located near the east bank of the Hudson River. During Phase I of the pilot test, two wells (IW-1 and IW-5) were installed in January 2005. In March 2005, a tracer test was conducted. During the tracer test, the tracer migrated outside of the targeted area faster than predicted, suggesting that the fill material adjacent to the river likely is more transmissive than the hydraulic conductivity data indicated. Based on the results of the tracer test, the ISCO pilot test was not conducted at the site.

2.3 River-based Investigations

Between 1990 and 2010, numerous investigations were completed within the Hudson River adjacent to the Site to characterize the nature and extent of MGP-related impacts. The river-based investigations included the following:

- Surface water sampling and analysis (Section 2.3.1)
- Hudson River water level measurements (Section 2.3.2)
- Surface sediment sampling and analysis (Section 2.3.3)
- Sediment borings (Section 2.3.4)
- TarGOST probing (Section 2.3.5)
- ROST probing (Section 2.3.6)
- Dart sampling (Section 2.3.7)
- Pipe investigations (Section 2.3.8)
- Other activities (Section 2.3.9)

The section summarizes the scope of river-based investigations conducted to date. Details regarding the investigation procedures are provided in the work plans and reports listed in the table in Section 2.1. Results of the investigation activities described below are summarized in Section 3.

2.3.1 Surface Water Sampling and Analysis

Three surface water samples (NWSW-1, NWSW-2, and NWSW-3) were obtained from three locations in the Hudson River during the 1990 Phase II Investigation. The samples were analyzed for TCL inorganics (USEPA Method 200), TCL SVOCs (USEPA Method 8270), TCL VOCs (USEPA Method 8240), ammonia (USEPA Method 350.2), cyanide (Method 335.2), and sulfate (USEPA Method 375.4). Surface water sample locations are shown on **Figure 6.** Surface water sample analytical results are summarized in **Table 16** and on **Figure 7**. Laboratory analytical data sheets are provided in **Attachment A** and DUSRs are provided in **Attachment B**.

2.3.2 Hudson River Water Level Measurement

Hudson River water levels have periodically been measured over the years during NAPL monitoring events (see Section 2.2.8) and NAPL recovery testing (see Section 2.2.9). Hudson River water level data obtained during the 2008 enhanced NAPL recovery testing are provided in **Attachment E**.

2.3.3 Surface Sediment Sampling and Analysis

Between 1990 and 2010, a total of 179 surface sediment[4] samples were collected within the Hudson River near the Site for laboratory analysis to assess the nature and extent of surface sediment impacts. Surface sediment sample locations are shown on **Figure 6** (note that surface sediment samples collected from locations upstream of the site are shown on **Figure 8B**). Visual observations from the surface sediment samples are summarized in **Table 17** (note that visual observations of surface sediment samples collected from deeper sediment borings are summarized in **Table 19** and on sediment boring logs in **Attachment H**). Surface sediment sample analytical results are summarized in **Table 18** and on **Figures 8A and 8B**. Laboratory analytical data sheets are provided in **Attachment A** and DUSRs are provided in **Attachment B.**

The following provides a summary of the surface soil sampling activities conducted for each investigation event:

- <u>2004 Supplemental Land and River Investigation:</u> Forty-three surface sediment samples (SED-100C series) were collected from sediment borings advanced in October and November 2004, and analyzed for PAHs (USEPA Method 8270C) and total organic carbon (TOC; Lloyd Kahn Method).

- <u>2005 Supplemental River and Land Investigation:</u> Seventy-four surface sediment samples (SED-200C series), 19 of which were collected from locations upstream of the site, were collected from sediment borings advanced in September and October 2005, and analyzed for PAHs (USEPA Method 8270C) and TOC (Lloyd Kahn Method).

[4] For the purposes of this RI Report, “surface sediment” is defined as any sample encompassing a portion of the 0- to 0.5-foot depth interval.

- <u>2008 Supplemental Land and River Investigation:</u> Thirteen surface sediment samples (SED-400C series) were collected from sediment borings and 28 surface sediment samples (DART-01 through DART-28) were collected by divers in June and July 2008, and analyzed for PAHs (USEPA Method 8270C) and TOC (Lloyd Kahn Method).

- <u>2010 Supplemental Land and River Investigation:</u> Twenty-one surface sediment samples (SED-500C series and DART-101 through DART-109) were collected by divers in April 2010, and analyzed for PAHs (USEPA Method 8270C) and TOC (Lloyd Kahn Method). Two additional surface sediment samples were collected, but not analyzed.

2.3.4 Sediment Borings

Between 1990 and 2008, a total of 184 sediment borings were advanced within the Hudson River adjacent to the site to assess the nature and extent of MGP-related impacts in subsurface sediments. Sediment boring locations are shown on **Figure 6**. Visual observations from the sediment borings are summarized in **Table 19**. The analytical results for subsurface sediment samples collected from sediment borings are summarized in **Table 20** and on **Figure 8C**. Geotechnical testing results are summarized in **Table 21**. Waste characterization sediment sample results are summarized in **Table 22**. NAPL saturation sediment sample results are summarized in **Table 23**. Laboratory analytical data sheets are provided in **Attachment A** and DUSRs are provided in **Attachment B.** Sediment boring logs are provided in **Attachment H**.

The following provides a summary of the sediment boring activities conducted for each investigation event:

- <u>1990 Phase II Investigation:</u> Three sediment borings (NWSED-1 through NWSED-3) were advanced along the river bank in April 1990. A subsurface sediment sample was collected from each boring, and analyzed for TCL Metals (USEPA Method 200), TCL SVOCs (USEPA Method 8270), TCL VOCs (USEPA Method 8240), PCBs (USEPA Method 8080), ammonia (USEPA Method 350.2), cyanide (Method 9010), and sulfate (USEPA Method 9038).

- <u>2004 Supplemental Land and River Investigation:</u> Fifty-nine sediment borings (SED-100C series) were advanced in October and November 2004. Sixty-seven subsurface sediment samples were collected from the 59 sediment borings, and analyzed for PAHs (USEPA Method 8270C) and TOC (Lloyd Kahn Method). Three subsurface sediment samples were collected for geotechnical testing: grain size (sieve and hydrometer; ASTM D422 and D1140), Atterberg limits (ASTM D4318), and/or bulk density (USACE EM-1110-2-1906). Six subsurface sediment samples were also submitted for waste characterization analyses: TCL VOCs (USEPA 8260B), TCL SVOCs (USEPA Method 8270C), PCBs (USEPA Method 8082), total petroleum hydrocarbons (TPH; NYSDOH Method 310-13), inorganics (USEPA Method 6010B/7471A/7841), total cyanide (USEPA Method 9010/9012A, sulfur (USEPA Method 300.0) and TOC (Lloyd Kahn Method).

- 2005 Supplemental Land and River Investigation: One-hundred one sediment borings (SED-200C/300C series) were advanced in September and October 2005. Sixteen subsurface sediment samples from eight locations were submitted for geotechnical testing: grain size (sieve and hydrometer; ASTM D422 and D1140) and Atterberg limits (ASTM D4318). Note that the visual observations for the eight sediment borings advanced for geotechnical sample collection are not available; therefore these borings are not included in **Table 19**.

- 2008 Supplemental Land and River Investigation: Fifteen near-shore sediment borings (SED-401C through SED-415C) were advanced in June and July 2008. Eighteen sediment samples (eight Shelby tube, 10 grab) collected from 10 of the 15 sediment borings were submitted for geotechnical testing. The grab samples were and analyzed for moisture content (ASTM D2216), unit weight (USACE EM1110), and grain size (sieve and hydrometer; ASTM D422). Shelby tube samples, collected from the silt/clay layer, were analyzed for moisture content (ASTM D2216), unit weight (ASTM D2937), grain size (sieve and hydrometer; ASTM D422) and Atterberg limits (ASTM D4318). In addition, 21 samples from six locations were collected using a Vibracore rig within the proposed reactive sediment capping pilot study area in August 2008. These samples were analyzed for moisture content (ASTM D2216), unit weight (ASTM D2937), grain size (sieve and hydrometer; ASTM D422), Atterberg limits (ASTM D4318), and incremental consolidation (ASTM D2435). An additional six samples from two of these six Vibracore locations were collected for NAPL saturation testing. Note that the visual observations for the six Vibracores advanced for geotechnical and NAPL saturation sample collection are not available; therefore these borings are not included in **Table 19**.

2.3.5 TarGOST Probing

During the 2004 and 2005 investigations, a total of 83 TarGOST probes (refer to Section 2.2.3 for a description of TarGOST) were advanced to delineate the vertical and horizontal extent of NAPL-impacted sediments in the Hudson River adjacent to the site. River-based TarGOST probe locations are shown on **Figure 6.** The TarGOST results are summarized in **Table 24**. TarGOST logs are provided in **Attachment I**.

The following summarizes the TarGOST probing activities conducted for each investigation event:

- 2004 Supplemental Land and River Investigation: TarGOST probing was conducted at 58 locations (SED-100 series) in October 2004.

- 2005 Supplemental River and Land Investigation: TarGOST probing was conducted at 25 locations (SED-200 series) in September 2005.

2.3.6 ROST Probing

ROST is a technology developed by DTI that utilizes LIF techniques to characterize the in-situ distribution of PAHs in soil/sediment. ROST is similar to TarGOST (refer to Section 2.2.3), but uses ultraviolet (UV) light instead of green laser light.

During the 2005 Supplemental River and Land Investigation, ROST probing was conducted at 24 locations (SED-200R series) to delineate the horizontal and vertical extents of MGP-related impacts in the Hudson River sediments adjacent to the site. ROST probe locations are shown on **Figure 6.** The ROST results are summarized in **Table 25**. ROST logs are provided in **Attachment J**.

2.3.7 Dart Sampling

Dart sampling is a technology developed by DTI that uses solid- phase extraction (SPE) and laser-induced fluorescence (LIF) principles to delineate PAHs and PAH-containing NAPLs in soils and sediments. A "Dart sampler" consists of a continuous rope or rod made from or coated with SPE media, which attracts and sorbs PAHs. The sampler is inserted into the soil or sediment, allowed to equilibrate, removed, and "analyzed" with an LIF reader for PAH/NAPL concentrations as a function of depth.[5]

In 2008 and 2010, 39 Dart "samples" were collected to assess the presence and extent of NAPL-impacted sediments in utility line "buffer zones" where other investigation techniques (e.g., sediment borings, TarGOST probes) were not allowed. The Dart sampling locations are shown on **Figure 6**. The Dart results are summarized in **Table 26.** Dart logs are provided in **Attachment K.**

---

[5] Additional information regarding the Dart technology can be found on Dakota Technology, Inc.'s website (http://www.dakotatechnologies.com/index.php/Service/Darts.html), and in Attachment 7 of the 2008 Data Report.

The following summarizes the Dart sampling activities conducted for each investigation event:

- 2008 Supplemental Land and River Investigation: Thirty Dart samples were collected from 28 locations (two Darts of different lengths were used at two locations) in July 2008, within the gas line buffer zone area at the north end of the site.

- 2010 Supplemental Land and River Investigation: Nine Dart samples were collected from 9 locations in April 2010, within the electric cable buffer zone area at the south end of the site.

2.3.8 Pipe Investigations

Video camera inspection of nine abandoned pipes observed to daylight from the bulkhead along the Hudson River was attempted in October 2008; only six of the nine pipes were accessible for video inspection. The locations of the ends of the inspected pipes are shown **Figure 3**. The pipe inspection results are summarized in **Table 15**. DVDs of the video footage were provided in the 2008 Data Report.

2.3.9 Other Activities

2.3.9.1 River Reconnaissance and Shoreline Inspections

River reconnaissance activities were conducted during low tide conditions on November 14, 2003 and September 15, 2004. During the 2003 reconnaissance, representatives of BBL, CHGE, and the NYSDEC conducted a reconnaissance of the Hudson River shoreline adjacent to the site to observe shoreline conditions.

During the 2004 reconnaissance, BBL conducted a river reconnaissance of the shoreline along the east side of the Hudson River from the public boat ramp located at Waryas Park to the Poughkeepsie Water Pollution Control Plant (northern limit of reconnaissance.

Additional low-tide bulkhead/shoreline inspections were proposed in the work plan for the 2008 Supplemental Land and River Investigation. However, although low-tide times were chosen for the inspections, river conditions were not conducive (i.e., water levels were not low enough) for observing the bulkhead/shoreline.

2.3.9.2 Remote Sensing Data/Mapping Review

The following remote sensing data/mapping, which were collected/developed as part of the Hudson River Estuary Program Benthic Mapping Project, were obtained from the NYSDEC and reviewed with respect to assessing Hudson River sediment/bottom conditions near the site:

- Multibeam bathymetry
- Side-scan sonar
- Sub-bottom (seismic) profiling
- Core/grab sampling
- Interpretive maps (river bottom morphology, sediment type, and sediment environment)

These data/maps are included in **Attachment L.**

2.3.9.3 Camera Inspections

In July 2008, a weighted diver's camera was used to inspect the sediment surface within the gas line buffer zone. Video images of the sediment surface were obtained along 10 transects within the approximate 200 foot by 400 foot camera inspection area. Depending on the tide, transects were either oriented north to south (during ebbing tides) or south to north (during flooding tides). The boat was anchored, and the anchor ropes were periodically let out to allow the boat and weighted camera to travel down- or up-river (with the tide) along each transect. The weight/camera was raised and lowered using a winch on the boat. The surveyed locations of the camera transects and DVDs of the video footage were provided in the 2008 Data Report. Observations from the camera footage are summarized in **Table 27**.

In June and August 2008, camera inspections of the sediment surface within the proposed reactive sediment capping pilot study area were conducted. Video images of the sediment surface were obtained along nine transects within the approximate 150 foot by 150 foot camera inspection area. The surveyed locations of the camera transects and DVDs of the video footage were provided in the 2008 Data Report. Observations from the camera footage are summarized in **Table 27**.

2.3.9.4 Reactive Sediment Capping Pilot Study

In accordance with the *Reactive Sediment Capping Field Demonstration Work Plan* (ARCADIS, 2008a), installation of a field demonstration reactive sediment cap in the Hudson River adjacent to the site in was completed in May 2009. The pilot study is sponsored by the Electric Power Research Institute (EPRI), and its purpose is to evaluate the effectiveness and implementability of reactive sediment capping for NAPL-impacted sediments.

The installed pilot study sediment cap consists of three different cap configurations, each covering approximately 3,250 square feet:

- Cap Type 1: Triton® Marine Mattresses filled with 6 inches of stone, and organoclay-filled Reactive Core Mat™ (RCM) attached to the bottom
- Cap Type 2: Marine Mattresses filled with 3 inches of stone and 3 inches of sand
- Cap Type 3: Marine Mattresses filled with 3 inches of stone and 3 inches of a sand/bulk organoclay mixture, and organoclay-filled RCM attached to the bottom

Following its installation, four monitoring events have been conducted that include diver and video observations. In addition to monitoring the condition and performance of the cap, these events have provided useful data regarding the sediment conditions at the site.

The pilot study sediment cap is scheduled to be removed from the river in November 2010 for further testing. Results of the pilot study will be considered during the evaluation of sediment remedial alternatives for this site.

2.4 Historical Information Review

In 2004, the following information was reviewed to assess river bathymetry and determine/evaluate potential sources of PAHs/NAPLs to the Hudson River at, upstream of, and downstream of the site:

- Mid-Hudson Bridge construction records
- Governmental database search for environmental records
- City of Poughkeepsie utility maps (i.e., sanitary, storm and combined sewers)
- CHGE historical maps/plans/correspondence

- Aerial photographs
- Sanborn maps

Relevant information obtained from these sources is provided in **Attachment M**.

2.5 Data Usability

Analytical data collected from the various investigations summarized above were reviewed/evaluated to assess the data's quality and usability. DUSRs are provided in **Attachment B**. Data qualifiers resulting from the data usability study are included in the analytical data summary tables and are shown on laboratory analytical data sheets provided in **Attachment A.**

3. Remedial Investigation Findings

3.1 Overview

This section reports the cumulative findings of the site investigations and discusses the nature and condition of the soil, groundwater, soil vapor, sediments, and surface water at and near the North Water Street site. The discussion is divided into the following sections:

- Site location and setting (Section 3.2)
- Geology (Section 3.3)
- Hydrogeology (Section 3.4)
- Soil investigation findings (Section 3.5)
- Groundwater investigation findings (Section 3.6)
- NAPL investigation findings (Section 3.7)
- Soil vapor investigation findings (Section 3.8)
- Pipe investigation findings – land (Section 3.9)
- Surface water investigation findings (Section 3.10)
- Sediment investigation findings (Section 3.11)
- Pipe investigation findings – river (Section 3.12)
- River reconnaissance findings (Section 3.13)
- Remote sensing data/mapping review findings (Section 3.14)
- Camera inspection findings (Section 3.15)
- Historical information review findings (Section 3.16)

3.2 Site Location and Setting

The site is located in the city of Poughkeepsie, Dutchess County, New York. Dutchess Avenue is located immediately north of the site, North Water Street and Amtrak railroad lines are located immediately east of the site, the Hudson River is located immediately west of the site, and the Fall kill Creek is located just south of the site (**Figures 1 and 2**). To the north of the site lies a vacant lumber yard (Dutton Lumber site). This area of Poughkeepsie is zoned I-2, a general industrial district (Raymond, Parish, Pine & Weiner, Inc., 1979).

The town and city of Poughkeepsie are both served by a public water supply from the Hudson River (the water supply intake is located approximately 0.75 miles north of the site). Based on the findings of the Phase I Investigation, the majority of the area within a 3-mile radius of the site uses the City of Poughkeepsie public water supply from the Hudson River and the nearest water supply well is located 1.8 miles north of the site (EA Science and Technology [EA], 1987). According to the Dutchess County Department of Health, there are no wells used for drinking water within one mile of the site (BBL, 2000a).

Adjacent to the site, the Hudson River is designated as Class A waters. According to NYCRR Parts 701 and 858, Class A waters shall be suitable for fish propagation and survival; water supply source for drinking, culinary, or food processing purposes; primary and secondary contact recreation; and fishing. The Hudson River is affected by tidal movements and, during periods of low discharge, the fresh/salt water interface extends to the Poughkeepsie area (Frimpter, 1972).

The site is approximately 2 acres in size and is fenced on the northern, eastern and southern sides. Currently, CHGE operates a propane peaking plant and natural gas regulator station at the site. Features associated with the propane operations include propane storage tanks, a high-pressure compressed air holder, and office/operations buildings. Most of the site is paved or has a gravel cover.

Topographic relief at the site ranges from approximately 5 feet above mean sea level[6] along the river to approximately 65 feet above mean sea level along North Water Street. A north-south trending bedrock cliff is located approximately 100 feet east of the river, dividing the site into the upper (eastern) and lower (western) portions.

---

[6] All elevations reported in this document are based on NGVD 1929.

3.3 Geology

The site-specific geology is discussed in more detail in the following three sections. Geologic cross sections depicting the geology are presented on **Figures 10B through 10K** (cross section locations are shown on **Figure 10A**). Detailed soil and sediment boring logs, complete with geologic descriptions, are presented in **Attachments C and H**, respectively.

3.3.1 Overburden

The observed overburden is primarily of fill materials, consisting of shale fragments mixed with gravel, sand and silt, with lesser amounts of anthropogenic materials (e.g., bricks, concrete, cinders, coal, ash, glass, wood). The fill materials are believed to have been placed along the former shoreline area prior to the construction of the MGP facilities and may have originated from the former electric plant, which operated for approximately 15 years before the MGP was constructed in 1911. Additional fill materials were likely placed during operation of the former MGP, as evidenced by historical aerial photographs and maps showing various shoreline configurations over the years.

Within the overburden fill materials in the lower portion of the site, there are silt and clay lenses between wells NMW-111S and NMW-113S and between wells NMW-119S and NMW-115S, as well as other minor lenses. The silt and clay lens between wells NMW-111S and NMW-113S is located in the general area where a clay dike was installed to mitigate the seepage of MGP NAPLs into the river in the 1940s. A more significant and thicker silt and clay layer is present in the northern section of the lower portion of the site (i.e. north of well NMW-109S) between the fill unit and the shale bedrock. This silt and clay layer thickens from 5 to 25 feet and deepens by approximately 20 feet between wells NMW-110S and NMW-117S, and thickens from 15 to 25 feet and deepens by approximately 15 feet between the locations of wells NMW-120S and NMW-117S. Near the location of well NMW-117S, the silt and clay layer is the deepest compared to adjacent borings to the north, east, and south resulting in a small depression within the surface of the silt and clay layer in this area. Within the overburden fill, wood zones were encountered, and a few of these zones were approximately 10 feet in length. These woods zones likely represent pilings for former docks and other site structures and/or tie backs for the current and former bulkheads along the river. Wood zones were more prevalent in the northern section of the lower portion of the site (i.e., north of the location of well NMW-109S), and between wells NMW-114S and NMW-109S the wood zones penetrate into or through the silt and clay layer.

The overburden thickness in the upper portion of the site is generally 5 feet or less. Within the lower portion of the site, the overburden forms a wedge that is thicker (20 to 60 feet) toward the river and thins to 1 to 5 feet in thickness adjacent to the bedrock cliff that separates the lower and upper portions of the site.

3.3.2 Bedrock

Bedrock at the North Water Street Site consists of dark grey, deformed or low-grade metamorphic shale. During the Phase II Investigation, a one-foot interval of graywacke was encountered at location MW-1, but was not observed at locations MW-2 and MW-3 (refer to Figure 4-2 of the 1990 Phase II Assessment), or at other subsequent locations drilling in the lower portion of the site. The bedrock is highly deformed, exhibiting contorted bedding planes and healed fracture zones. The features observed in the bedrock cores, such as fine-grained minerals with cleavage patterns, suggested that the shale had undergone low-grade metamorphosis, rending the shale to a slate or possibly a phyllite. Evidence of original bedding features were observed in the cores and are often preserved during low-grade metamorphism. Physical characteristics included calcite stringers, calcite banding, peltic inclusions, and vugs. In general, the bedrock exhibited low primary porosity and secondary porosity in the form of fractures and fracture zones.

In general, the inclination of the fractures observed in bedrock cores ranged from 10 to 75 degrees from the horizontal. The fracture surfaces ranged from smooth to irregular and rough. The bedrock can be observed outcropping as cliffs at several locations at the site. Observations of the bedding planes and cleavage in the outcrops at the site also indicate that the bedrock has undergone deformation and low-grade metamorphosis.

A layer of weathered bedrock is present above the competent bedrock in some areas.

A top of bedrock contour map is provided as **Figure 11.**

3.3.3 River Sediment

Near shore sediments are comprised primarily of the same fill materials observed in the overburden soils along the river, underlain by silt and silt/clay. The fill materials pinch out further into the river, and silt and silt/clay become the predominant sediment materials, with periodic sand lenses and organics layers.

3.4 Hydrogeology

3.4.1 Groundwater Occurrence

Groundwater is present in the overburden and bedrock at the site. The bedrock unit is designated as the primary aquifer of concern because the overburden is not saturated throughout the site and the saturated area is not considered to be an aquifer that would yield usable amounts of water. The bedrock is reportedly used for water supply by several commercial and community supply wells. The majority of the area within a 3-mile radius of the site is supplied by public water that is drawn from the Hudson River approximately 0.75 miles north and hydraulically upgradient of the site. The nearest water supply well is located 1.8 miles to the north and hydraulically upgradient of the site (EA, 1987).

Groundwater at the site generally flows to the west, towards the Hudson River. However, as discussed in Section 3.4.3, horizontal hydraulic gradients are small, and alternate from toward to the river to away from the river. The configuration of the monitoring well network, with the majority of the wells located in a row along the Hudson River, and the fact that groundwater levels fluctuate with Hudson River tides significantly reduces the usefulness of groundwater elevation contour maps for this site; accordingly, such maps are not included in this document.

3.4.2 Water Levels

Groundwater level measurements collected periodically from January 2004 to June 2010 are summarized in **Table 12A**. In overburden wells installed in the lower portion of the site, groundwater has been measured at depths ranging from approximately 1 to 13 feet bgs. In bedrock wells installed in the upper portion of the site, groundwater has been measured at depths ranging from approximately 10 to 19 feet bgs. In bedrock wells installed in the lower portion of the site, groundwater has been measured at depths ranging from approximately 0 to 14 feet bgs.

Groundwater levels in monitoring wells located on western portion of the site are influenced by high and low tide in the Hudson River. The groundwater in the overburden is hydraulically connected with the Hudson River. Groundwater in the overburden and bedrock are also hydraulically connected.

Information related to groundwater levels obtained during NAPL recovery testing performed in 2008 is summarized as follows (additional details regarding the associated scope of work are provided in Section 2.2.9, and graphs summarizing the testing data are provided in **Attachment E**):

- Groundwater levels in the test wells (MW-116S and MW-117S) and observation wells (NMW-109S, NMW-113S, NMW-115S, MW-201 and SB-336) are influenced by tidal fluctuations in the adjacent Hudson River.

- The tidal range of 3.5 to 4.5 feet is reflected in all wells observed, with decreasing amplitude and increasing time-delay with distance from the river.

- Water levels at the two test wells (NMW-116S and NMW-117S) oscillate with approximately 87% of the full tidal amplitude and at an approximate 15 to 30 minute delay. Water levels at well SB-336, located farther inshore, oscillate with approximately 40% of the full tidal amplitude and at an approximate 60 minute delay.

3.4.3 Horizontal Hydraulic Gradients

Information related to horizontal hydraulic gradients obtained during NAPL recovery testing performed in 2008 is summarized as follows (additional details regarding the associated scope of work are provided in Section 2.2.9, and graphs summarizing the testing data are provided in **Attachment E**):

- Natural hydraulic gradients are sinusoidal, alternating positive (toward the river) and negative (away from the river), on the tidal frequency but shifted by approximately 6 hours.

- The average hydraulic gradient is slightly toward the river, but stronger from inshore to the test wells (approximately 0.01) than from the test wells to the river (approximately neutral).

- Natural gradients from inshore to the test wells peak at low tide (0.03).

- Hydrographs suggest that pumping creates a slight increase in hydraulic gradients (+ 0.05 to + 0.01). It is inferred that the *apparent* gradient enhancement does not reflect physical reality because the drawdown observed in the test wells was likely due largely to well loss, and that pumping was not able to materially enhance hydraulic gradients beyond the sand packs of the test wells.

3.4.4 Vertical Hydraulic Gradients

Vertical gradients between adjacent overburden and bedrock wells were calculated using water level measurement data collected between 2004 and 2009. The vertical gradient calculations are presented in **Attachment N**. In summary, vertical gradients are relatively weak, and vary from downward to upward at each of the well pairs evaluated. The average calculated vertical gradient was 0.0027 (upward). The vertical gradient data were also evaluated to assess the effect of tides. The average calculated vertical gradient measured during low tide was 0.0049 (upward), while the average calculated vertical gradient measured during high tide was -0.00016 (downward).

3.4.5 Hydraulic Conductivity

Hydraulic conductivity testing was performed on bedrock wells MW-1, MW-2 and MW-3 during the 1990 Phase II investigation. Specific capacity testing was performed in August 2004 at monitoring well NMW-106S and in November 2004 at NMW-104S, NMW-105S, NMW-107S, NMW-115S, NMW-106D, NMW-111D and NMW-115D. The results of the aquifer testing are presented in **Table 13**. The 1990 hydraulic conductivity testing data are also provided in **Attachment F**.

As indicated in **Table 13**, the calculated overburden hydraulic conductivity ranged from 0.04 to 49.6 feet/day, with an average of 13.7 feet/day. The calculated bedrock hydraulic conductivity ranged from 0.22 to 110.5 feet/day, with an average of 25.2 feet/day.

An ISCO pilot test was proposed to be conducted in the vicinity of monitoring wells NMW-105 and NMW-106, located near the east bank of the Hudson River. During Phase I of the pilot test, two wells (IW-1 and IW-5) were installed in January 2005. In March 2005, a tracer test was conducted. During the tracer test, the tracer migrated outside of the targeted area faster than predicted, suggesting that the fill material adjacent to the river likely is more transmissive than the hydraulic conductivity data indicated. Based on the results of the tracer test, the ISCO pilot test was not conducted at the site.

3.5 Soil Investigation Findings

Numerous soil investigations have been conducted between 1990 and 2010, and have included surface soil sampling, soil borings, subsurface soil sampling and TarGOST probing. The results of these investigations are discussed in the following subsections:

- Surface soil (Section 3.5.1)
- Subsurface soil (Section 3.5.2)

3.5.1 Surface Soil

Between 1990 and 2010, a total of 30 (7 of which were from soil borings) surface soil[7] samples were collected to assess the nature and extent of surface soil impacts at the Site. Surface soil sample locations are shown on **Figure 3.** Visual observations from the surface soil samples are summarized in **Table 1** (note that visual observations of surface soil samples collected from deeper soil borings are summarized in **Table 3** and on soil boring logs in **Attachment C**). The analytical results are summarized in **Table 2** and on **Figure 4A**. Laboratory analytical data sheets are provided in **Attachment A** and DUSRs are provided in **Attachment B.**

3.5.1.1 Surface Soil NAPL Impacts

As indicated in **Tables 1 and 3**, no NAPL-impacted soils were observed in any of the surface soil samples.

3.5.1.2 Surface Soil Analytical Results

A total of 30 surface soil samples were collected between 1990 and 2010. The surface soil analytical results are presented in **Table 2,** including a comparison of the data to NYSDEC Soil Cleanup Objectives (SCOs) from 6 NYCRR Part 375, Table 375-6.8(a) for unrestricted use and Table 375-6.8(b) for restricted use (public health, industrial use category). Comparison of the data to SCOs is included for screening purposes only; SCOs do not reflect final cleanup goals for the site. Total BTEX and total PAH results are depicted on **Figure 4A**.

3.5.1.2.1 BTEX

Twenty-two surface soil samples were collected and analyzed for VOCs or BTEX during soil investigations conducted between 1990 and 2010. BTEX constituents were detected in seven of the 22 samples, with detected total BTEX concentrations ranging 0.00061mg/kg (SB-400, 0-2 feet) to 151.1 mg/kg (SB-313, 0.9-1.6 feet). No samples exhibited concentrations of individual BTEX constituents above industrial use SCOs. Benzene, ethylbenzene, toluene and xylenes were detected above the unrestricted use SCOs but below the industrial use SCOs in sample SB-313 (0.9-1.6 feet). No other VOCs were detected at concentrations above unrestricted use SCOs.

---

[7] For the purposes of this RI Report, “surface soil” is defined as any sample encompassing a portion of the 0- to 2-foot depth interval.

3.5.1.2.2 PAHs

Twenty-two surface soil samples were collected and analyzed for SVOCs or PAHs during soil investigations conducted between 1990 and 2010. PAH constituents were detected in 21 of the 22 samples (all except SB-511, 0-0.17 feet), with detected total PAH concentrations ranging 0.55 mg/kg (SB-404, 0-2 feet) to 5,200 mg/kg (SB-313, 0.9-1.6 feet). The following samples exhibited concentrations of individual PAH constituents above industrial use SCOs: NWS-2 (1.2 feet), NWS-3 (1.2 feet), SB-313 (0.6-1.6 feet), SB-400 (0-2 feet), SB-402 (0-2 feet), SB-502 (0-0.17 feet), SB-503 (0-0.17 feet), SB-504 (0-0.17 feet), SB-505 (0-0.17 feet), SB-506 (0-0.17 feet), SB-507 (0-0.17 feet), SB-508 (0-0.17 feet) and SB-510 (0-0.17 feet). The following additional samples exhibited concentrations of individual PAH constituents above unrestricted use SCOs: NWBG-1 and NWBG-2. No other SVOCs were detected at concentrations above unrestricted use SCOs.

3.5.1.2.3 PCBs

Twenty surface soil samples were collected and analyzed for PCBs during soil investigations conducted between 1990 and 2010. PCB constituents were detected in seven of the 20 samples, with total PCB concentrations ranging 0.053 mg/kg (SB-401, 0-1.9 feet) to 2.2 mg/kg (SB-403, 0-2 feet). No samples exhibited concentrations of PCBs above industrial use SCOs. The following samples exhibited concentrations of PCBs above unrestricted use SCOs but below the industrial use SCOs: SS-402 (0-1.9 feet), SS-403 (0-1.3 feet), and SS-502 (0-0.17 feet).

3.5.1.2.4 Inorganics

Fourteen surface soil samples were collected and analyzed for inorganics during soil investigations conducted between 1990 and 2010. One or more metals were detected in all 14 samples. No samples exhibited concentrations of metals above industrial use SCOs. All 14 samples exhibited concentrations of one or more metals above unrestricted use SCOs but below industrial use SCOs. Cyanide was detected in 7 of the 14 samples. One sample (NWS-2, 1.2 feet) exhibited a cyanide concentration above the unrestricted use SCO but below the industrial use SCO.

3.5.1.2.5 Pesticides/Herbicides

Eleven surface soil samples were collected and analyzed for pesticides/herbicides during soil investigations conducted in 2010. One or more pesticides/herbicides were detected in 7 of the 11 samples. Seven of the 11 samples exhibited concentrations of 4,4’ DDE and/or 4,4’-DDT above unrestricted use SCOs but below industrial use SCOs.

3.5.2 Subsurface Soil

Between 1990 and 2010, a total of 113 soil borings and 41 TarGOST probes have been advanced within the upland portion of the Site (**Figure 3)**. Visual observations from the soil borings, including identification of observed NAPL-impacted intervals, are summarized in **Table 3** and on soil boring logs in **Attachment C**. NAPL-impacted intervals identified from the TarGOST probes are summarized in **Table 7** and on TarGOST logs in **Attachment D**. The analytical results for subsurface soil samples collected from soil borings are summarized in **Table 4** and on **Figure 4B**. Geotechnical testing results are summarized in **Table 5**. Waste characterization soil sample results are summarized in **Table 6**. Laboratory analytical data sheets are provided in **Attachment A** and DUSRs are provided in **Attachment B.** Soil boring logs are provided in **Attachment C**.

3.5.2.1 Subsurface Soil/Bedrock NAPL Impacts

The following table summarizes the soil borings, rock corings, and TarGOST probes where NAPL-impacts have been observed/identified. These locations are also depicted in plan view on **Figure 9** and in cross-section view on **Figures 10B and 10D through 10K** (note: only select locations are depicted on the cross sections).

Location	Soil Boring/TarGOST IDs	Locations with Observed/ Identified NAPL
Upper Portion of Site	1990 borings: MW-1 – MW-3 2004 borings: SB-303 – SB-308 (gas holders); SB-309 and SB-310 (oil tank #2); SB-314 and SB-322 (oil tank #5); SB-320 and SB-321 (oil tank #4); SB-313 and SB-323 – SB-334 (SB-313, -323, -324 and -330 along eastern site boundary/North Water Street) 2010 borings: SB-601, SB-602 (purifier house)	1990 borings: MW-1, MW-2 2004 borings: SB-313

Location	Soil Boring/TarGOST IDs	Locations with Observed/ Identified NAPL
Lower Portion of Site	1990 borings: MW-4 – MW-6 (western site boundary along Hudson River) 1991 boring: NWB-MW4 – NMB-MW6 (western site boundary along Hudson River) 2000 borings: NWB-1 (generator house), NWB-2 – NWB-5 (western site boundary along Hudson River), NWB-6 and NWB-7 (relief holder), NWB-8 2003 borings: SB-100 – SB-118 (western site boundary along Hudson River) 2004 borings: DB-01 and DB-03 (western site boundary along Hudson River), SB-300 – SB-302 (relief holder), SB-311 (generator house), SB-312 (oil/tar tanks) 2004 TarGOST: TB-01 – TB-14, TB-22 – TB-27 2005 borings: IW-1, IW-5 2008 borings: SB-506 (oil tank #3) 2010 borings: SB-603 – SB-608 (generator house), SB-609 (oil/tar tanks)	1990 borings: MW-4 – MW-6 1991 boring: vis. observations not avail. (assumed to be NAPL-impacted) 2000 borings: all except NWB-7 2003 borings: all except SB-100, SB-114, SB-118 2004 borings: DB-01, DB-03, SB-302 2004 TarGOST: all except TB-27 2005 borings: IW-1, IW-5 2008 borings: SB-506 2010 borings: SB-603, SB-606, SB-607
Natural Gas Regulator Station Area	2004 borings: SB-335 and SB-336 2004 TarGOST: TB15A – TB-21 2008 borings: SB-500 – SB-505, SB-507 – SB-511	2004 borings: SB-336 2004 TarGOST: TB-15A – TB-21 2008 borings: SB-505, SB-507, SB-511
Former Electric Plant Area	2004 borings: SB-318 and SB-319 2004 TarGOST: TB-28 – TB-37 2005 borings: SB-400 – SB-406 (SB-403 – SB-405 southern site boundary) 2005 TarGOST: TB-38 – TB-41 2008 borings: B-1 and B-2 2010 borings: SB-610 – SB-612	2004 borings: SB-319 2004 TarGOST: TB-31, TB-33 2005 borings: None 2005 TarGOST: TB-41 2008 borings: None 2010 borings: None
Northern Site Boundary along Dutchess Avenue	2003 borings: SB-119 – SB-121 2004 borings: SB-315 – SB-317	2003 borings: None 2004 borings: None

Note: At some of the soil boring locations, overburden and/or bedrock wells were installed; only the borings are listed above, but the well locations are depicted on Figure 9.

In the upper portion of the former MGP, NAPL was observed in three of 32 soil borings (**Figure 9**). Trace NAPL staining was observed at SB-313 in the uppermost 5 feet of weathered bedrock along the eastern boundary of the former MGP; however, NAPLs were not observed in any of the additional 12 boil borings around this location in 2004. During the Phase II Investigation, trace NAPL described as oily stained soil was observed in the overburden and NAPL described as oily staining was observed in bedrock fractures at MW-2, and NAPL described as tar and oil in bedrock fractures was observed at well MW-1. NAPL was not observed within the bedrock at well MW-3. NAPL was not observed in any of the six soil borings beneath the two former gas holder foundations, the six soil borings beneath/adjacent to the foundations of former Oil Tank Nos. 2, 4 and 5, or the two soil borings beneath the former purifier house. As further discussed below in Section 3.7.1, NAPL has not collected in any of the overburden or bedrock wells installed in the upper portion of the site, including MW-1 and MW-2 where NAPL was observed during drilling.

In the lower portion of the former MGP, NAPL was observed in overburden soil at 35 of 48 soil borings and 19 of 20 TarGOST probes, primarily adjacent to the Hudson River from Dutchess Avenue to the railroad bridge (**Figures 9 and 10B**). NAPL was observed in 2 of 5 soil borings beneath the former relief holder foundation, 8 of 12 soil borings/TarGOST probes beneath the former generator house, and in the one soil boring beneath the former Oil Tank No. 3 foundation. NAPL was not observed in either of the two soil borings beneath the former oil/tar tank foundations at the southern end of the former MGP. As further discussed below in Section 3.7.1, NAPL has only collected in four of the overburden and none of bedrock wells installed in the lower portion of the site.

In the natural gas regulator station area, NAPL was observed in the overburden at 4 of 13 soil borings and all seven TarGOST probes, primarily in the western one-third of this area **(Figure 9)**. However, as further discussed below in Section 3.7.1, NAPL has not collected in any of the overburden or bedrock wells installed in this area.

In the former electric plant, NAPL was observed at 1 of 14 soil borings and 3 of 14 TarGOST probes, in the northern section of the former electric station building.

North of the site along Dutchess Avenue, NAPL was not observed in any of the six soil borings. In addition, NAPL was not observed within an 8 feet wide by 8 feet deep trench installed by the City of Poughkeepsie in December 2003 for sewer line improvements within Dutchess Avenue from North Water Street to the river (BBL, 2004a). Along the eastern boundary of the site, NAPL was observed in one of four soil borings. Along the southern boundary of the former electric plant, NAPL was not observed at any of the three borings.

3.5.2.2 Subsurface Soil Analytical Results

A total of 21 subsurface soil samples were collected between 1990 and 2005 for laboratory analysis of VOCs, SVOCs, PCBs and/or inorganics. The subsurface soil analytical results are presented in **Table 4,** including a comparison of the data to NYSDEC SCOs from 6 NYCRR Part 375, Table 375-6.8(a) for unrestricted use and Table 375-6.8(b) for restricted use (public health, industrial use category). Comparison of the data to SCOs is included for screening purposes only; SCOs do not reflect final cleanup goals for the site. Total BTEX and total PAH results are depicted on **Figure 4B**.

3.5.2.2.1 BTEX

Twenty subsurface soil samples were collected and analyzed for VOCs or BTEX during soil investigations conducted between 1990 and 2005. BTEX constituents were detected in 15 of the 20 samples, with total BTEX concentrations ranging 0.001 mg/kg (NWB-5, 2-3.3 feet) to 916 mg/kg (NWB-6, 3.7-4 feet). The highest concentrations of total BTEX were in samples collected from the NAPL-impacted intervals at MW-4, NWB-1 and NWB-6. One sample (NWB-1, 4.5-5.2 feet) exhibited a concentration of an individual BTEX constituent (benzene) above industrial use SCOs. Nine of the 20 samples exhibited concentrations of individual BTEX constituents above unrestricted use SCOs.

3.5.2.2.2 PAHs

Twenty subsurface soil samples were collected and analyzed for SVOCs or PAHs during soil investigations conducted between 1990 and 2005. PAH constituents were detected in 19 of the 20 samples, with total PAH concentrations ranging 0.17 mg/kg (SB-317, 8-9.7 feet) to 16,300 mg/kg (NWB-1, 4.5-5.2 feet). The highest concentrations of total PAHs were in samples collected from the NAPL-impacted intervals at NWB-1, NWB-3 and NWB-6. Twelve of the 20 samples exhibited concentrations of one or more individual PAH constituents above unrestricted use and industrial use SCOs.

3.5.2.2.3 PCBs

Four subsurface soil samples were collected and analyzed for PCBs during soil investigations conducted in 1990. PCBs were not detected in any of the four samples.

3.5.2.2.4 Inorganics

Six subsurface soil samples were collected and analyzed for inorganics during soil investigations conducted in 1990. One or more metals were detected in all six samples. MW-5 (12-14 feet) exhibited a concentration of arsenic above the industrial use SCO; no other samples exhibited concentrations of metals above industrial use SCOs. Five of the six samples exhibited concentrations of one or more metals above unrestricted use SCOs. Cyanide was detected in 3 of 5 samples at concentrations below the unrestricted use SCO.

3.5.2.2.5 Geotechnical

One subsurface soil sample (MW-2, 4-6 feet) was collected for geotechnical testing (grain size and Atterberg limits) in 1990. The results of the analysis are presented in **Table 5**, and summarized as follows:

- Gravel: 21.9 percent
- Sand: 46.5 percent
- Silt & Clay: 31.6 percent
- Liquid limit: 19
- Plastic limit: 16
- Plasticity index: 3

3.5.2.2.6 Waste Characterization

A total of 12 subsurface soil samples and one sample of a solidified black, tarry substance were collected between 1990 and 2000 for laboratory analysis of TCLP VOCs, TCLP SVOCs, TCLP herbicides, TCLP pesticides, TCLP metals, oil analysis and/or RCRA characteristics. The results from the waste characterization analyses are summarized in **Table 6**.

All detected concentrations of TCLP VOCs, TCLP SVOCs, TCLP herbicides, TCLP pesticides and TCLP metals were below RCRA regulatory levels, indicating that the sampled materials do not exhibit the characteristic of toxicity. In addition, the results of the reactivity analyses indicate that the sampled materials do not exhibit the characteristic of reactivity. Regulatory levels for ignitability and corrosivity do not apply to non-liquid materials. In summary, the waste characterization results indicate that the sampled materials are not characteristically hazardous wastes.

The results of the oil analysis performed on sample NWB-2 (7.3-12 feet) indicated the presence of Fuel Oil 2 at a concentration of 6,000 mg/kg.

3.6 Groundwater Investigation Findings

3.6.1 Groundwater Analytical Results

A total of nine groundwater samples were collected in 1990, 2000 and 2004 for laboratory analysis of VOCs, SVOCs and/or inorganics. Sampling was conducted at overburden wells MW-4, MW-5 and MW-6, and bedrock wells MW-1 (sampled twice), MW-2, MW-3 (sampled twice) and SB-303. The groundwater analytical results are presented in **Table 10,** including a comparison of the data to NYSDEC TOGS 1.1.1 Class GA Groundwater Standards and Guidance Values for screening purposes. Total BTEX and total PAH results are depicted on **Figure 5**. Laboratory analytical data sheets are provided in **Attachment A** and DUSRs are provided in **Attachment B**.

3.6.1.1 BTEX

In the three overburden wells sampled for VOCs or BTEX, total BTEX concentrations ranged from non-detect (MW-6, May 2000) to 9,744 ug/L (MW-4, May 2000). Overburden wells MW-4 and MW-5 had at least one BTEX constituent that exceeded the NYSDEC TOGS 1.1.1 Class GA Groundwater Standards and Guidance Values. MW-6 did not have any TOGS 1.1.1 exceedances for BTEX constituents (all BTEX constituents were non-detect, although laboratory reporting limits were higher than all of the associated TOGS 1.1.1 values).

In the six groundwater samples collected from four bedrock wells, total BTEX concentrations ranged from non-detect (MW-3, May 2000) to 138 ug/L (MW-2, April 1990). Bedrock wells MW-1 (both samples), MW-2 and SB-303 had at least one BTEX constituent that exceeded the NYSDEC TOGS 1.1.1 Class GA Groundwater Standards and Guidance Values. MW-3 (both samples) did not have any TOGS 1.1.1 exceedances for BTEX constituents.

3.6.1.2 PAHs

In the three overburden wells sampled for SVOCs or PAHs, total PAH concentrations ranged from non-detect (MW-6, May 2000) to 691 ug/L (MW-4, May 2000). Overburden wells MW-4 and MW-5 had at least one PAH constituent that exceeded the NYSDEC TOGS 1.1.1 Class GA Groundwater Standards and Guidance Values.

MW-6 did not have any TOGS 1.1.1 exceedances for PAH constituents (all PAH constituents were non-detect, although laboratory reporting limits were higher than all of the associated TOGS 1.1.1 values).

In the five groundwater samples collected from three bedrock wells, total PAH concentrations ranged from non-detect (MW-3, April 1990 and May 2000) to 462 ug/L (MW-1, April 1990). Bedrock well MW-1 (both samples) had at least one PAH constituent that exceeded the NYSDEC TOGS 1.1.1 Class GA Groundwater Standards and Guidance Values. MW-2 and MW-3 (both samples) did not have any TOGS 1.1.1 exceedances for PAH constituents.

3.6.1.3 Inorganics

Samples collected from overburden wells were not analyzed for inorganics.

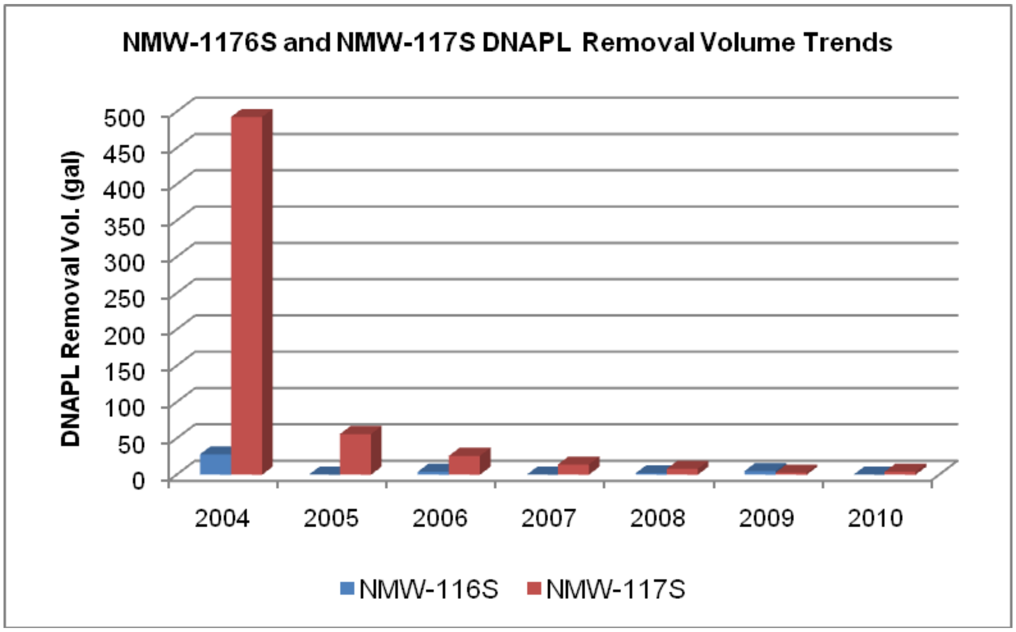
In the three groundwater samples collected from three bedrock wells, the following inorganics were detected above their respective TOGS 1.1.1 values: cadmium (MW-3), cyanide (MW-1 and MW-3), iron (MW-1, MW-2 and MW-3), and manganese (MW-1, MW-2 and MW-3).

3.7 NAPL Investigation Findings

3.7.1 NAPL Monitoring/Removal

NAPL monitoring/removal data collected periodically from January 2004 to June 2010 are summarized in **Tables 12A through 12E**. Measureable DNAPL has been observed in overburden wells NMW-112S (0.10-foot maximum thickness), NMW-116S (4.75-foot maximum thickness) and NMW-117S (11.00-foot maximum thickness). Measureable LNAPL has been observed in one overburden well: NMW-110S (0.20-foot maximum thickness). No measureable DNAPL or LNAPL has been observed in any of the site bedrock wells.

Between January 2004 and August 2010, approximately 39 gallons of DNAPL were removed from NMW-116S and approximately 604 gallons of DNAPL were removed from NMW-117S. The volume of DNAPL recovered at NMW-116S and NMW-117S has declined since 2004, as shown in the following graph:



Besides NMW-110S (approximately 3 gallons of LNAPL/water mixture), NMW-116S and NMW-117S, no DNAPL or LNAPL has been removed from any other overburden well or any bedrock well at the site.

3.7.2 NAPL Recovery Testing Results

NAPL recovery testing was conducted at wells NMW-116S and NMW-117S in February 2004. Tables and graphs summarizing the 2004 NAPL recovery testing data are provided in **Attachment E**.

During the 2004 test, DNAPL at NMW-116S was pumped twice and allowed to recover. Approximately 7 gallons of DNAPL were removed during the first pump down, after which DNAPL levels recovered 1.25 feet in approximately 17.5 hours. Approximately 2 gallons of DNPAL were removed during the second pump down, after which DNAPL levels did not recover in approximately 5 hours.

DNAPL at NMW-117S was pumped down four times and allowed to recover during the 2004 test. Approximately 7 gallons of DNAPL were removed during the first pump down, after which DNAPL levels recovered 2.05 feet in approximately 3 hours. Approximately 3 gallons of DNAPL were removed during the second pump down, after which DNAPL levels recovered 1.35 feet in approximately 22.5 hours. Approximately 2.5 gallons of DNAPL were removed during the third pump down, after which DNAPL levels recovered 0.61 feet in approximately 1.5 hours. Approximately 7 gallons of

DNAPL were removed during the fourth pump down, after which DNAPL levels recovered 1.60 feet in approximately 7 hours.

Additional NAPL recovery tests were conducted in April and May 2008 to evaluate whether enhancing the hydraulic gradient at the wells would significantly improve NAPL recovery rates. Graphs summarizing the 2008 enhanced NAPL recovery testing data are provided in **Attachment E**. The test results are summarized as follows:

- Radius of influence
  - Pumping groundwater at 1 gpm produced approximately 0.5 feet of immediate drawdown within the test wells, but had no measurable effect on water levels in any adjacent wells. It is inferred that the high porosity and permeability of the fill in which the wells are screened limits the influence of low-rate pumping.
  - The pumping influence observed in the test wells was immediate, with no increase in drawdown after 1-2 minutes of pumping. It is inferred that the drawdown observed in the test wells was largely well loss, due to inefficiencies of pumping through a PVC well screen, and that pumping at 1 gpm did not affect groundwater levels significantly beyond the sand packs of the test wells.
- NAPL Recovery
  - NAPL accumulation in the test wells showed no significant improvement during the pumping tests.
  - At the start of each test, accumulated volumes of NAPL in the pumped wells increased for a short duration (0.3 gallons at NMW-116S and 0.4 gallons at NMW-117S), but was not sustained. The apparent increase is attributed to removal of NAPL stored in well sandpack and/or emulsification of existing NAPL in the wells via the turbulence of pumping and frequent NAPL thickness measurements. This inference is supported by the decreases in NAPL volume in the sumps observed after the initial increase.
  - NAPL accumulation was slight and difficult to accurately quantify. Measured volumes of NAPL did not always increase or stay the same, as would be expected of accumulation in a closed-bottom sump.

- NAPL measured in the wells during the tests typically did not settle immediately to the base of the water column, but rather persisted as emulsions (or suspensions) of water/NAPL above the water/NAPL interface. Plotted results (**Attachment E**) reflect a conservative assumption, based on professional judgment, that measured thicknesses of emulsions represent 50% NAPL by volume.

The following conclusions can be drawn from the enhanced NAPL recovery testing data:

- Pumping groundwater at 1 gpm from test wells NMW-116S and NMW-117S caused no apparent improvement in NAPL recovery.
- The hydraulics of the formation are dominated by high energy cyclic swings in gradient and absolute head driven by tides in the Hudson River.
- Pumping groundwater cannot appreciably influence the gradients or flow patterns of the system, such that increased NAPL recovery could be realized.

3.7.3 NAPL Analytical Results

DNAPL analytical data for samples collected from well NMW-117S are summarized in **Table 11**. Total BTEX and total PAH concentrations in the NMW-117S DNAPL sample were 9,300 and 4,200 mg/kg, respectively. Physical properties of the DNAPL, measured at 10 degrees Celsius, were as follows:

- Density: 1.087 grams per milliliter (g/mL)
- Viscosity: 151.1 centipoise (cP)
- Interfacial tension: 22.33 millinewtons per meter (mN/m)

3.8 Soil Vapor Investigation Findings

A soil vapor survey was conducted at 24 locations during the 1986 Phase I Investigation. The results of the soil vapor survey are summarized in **Table 14**. Two of the 24 soil gas samples (VP-7 and VP-12) contained detected levels of benzene (0.01 and 0.02 ppm, respectively). Toluene was not detected in any of the samples.

3.9 Pipe Investigation Findings – Land

Video camera inspection of 15 abandoned pipes observed to daylight from the "bedrock wall" that separates the upper and lower portions of the site was conducted in October 2008. An additional five abandoned pipes observed to daylight in the upper portion of the site were inspected in October 2010. The locations of the ends of the inspected pipes are shown on **Figure 3**. The pipe inspection results are summarized in **Table 15**. DVDs of the 2010 video footage are provided in **Attachment G**. DVDs of the 2008 video footage were provided in the 2008 Data Report.

No NAPL or NAPL staining was observed in 19 of the 20 pipes inspected. An oily substance with a solvent-like odor was observed on the camera upon retrieval from RW-PIPE-16.

3.10 Surface Water Investigation Findings

3.10.1 Surface Water Sample Results

A total of three surface water samples were collected in 1990. The surface water analytical results are presented in **Table 16,** including a comparison of the data to NYSDEC TOGS 1.1.1 Ambient Water Quality Standards and Guidance Values for screening purposes. Total BTEX and total PAH results are depicted on **Figure 7**. Laboratory analytical data sheets are provided in **Attachment A** and DUSRs are provided in **Attachment B**.

3.10.1.1 BTEX

In the three surface water samples analyzed for VOCs, toluene was detected in each sample at a concentration of 1.6 ug/L, which is below the NYSDEC TOGS 1.1.1 value of 5 ug/L. No other VOCs were detected in any of the samples.

3.10.1.2 PAHs

SVOCs were not detected in any of the three surface water samples.

3.10.1.3 Inorganics

In the three surface water samples, the following inorganics were detected above their respective TOGS 1.1.1 values: antimony (NWSW-2 and NWSW-3) and iron (all three samples).

3.10.2 Sheen Observations

During the various river investigations conducted over the years, sheens have periodically been observed on the surface of the Hudson River. Based on visual observations and camera footage, it appears that at certain times surface water sheens are created when NAPL-coated gas bubbles are released from the sediment and are carried up through the water column and break open at the water surface.

3.11 Sediment Investigation Findings

Numerous sediment investigations have been conducted between 1990 and 2010, and have included surface sediment sampling, sediment borings, subsurface soil sampling, and TarGOST/ROST/Dart probing. The results of these investigations are discussed in the following subsections:

- Extent of NAPL-impacted sediments (Section 3.11.1)
- Sediment sample analytical results (Section 3.11.2)

3.11.1 Extent of NAPL-Impacted Sediments

During the 1990, 2004, 2005, 2008, and 2010 river investigations, a total of 83 TarGOST probes, 39 Darts (at 37 locations), 184[8] sediment borings (of which visual observations are available for 167) and 51 additional surface sediment samples (not collected in conjunction with a sediment boring) were advanced/collected in the Hudson River near the site to delineate the extent of impacted sediments. Visual observations from the sediment borings/samples, including identification of observed NAPL-impacted intervals, are summarized in **Tables 17 and 19** and on sediment boring logs in **Attachment H**. NAPL-impacted intervals identified from the TarGOST probes are summarized in **Table 24** and on TarGOST logs in **Attachment I**. NAPL-impacted intervals identified from the Darts are summarized in **Table 26** and on Dart logs in **Attachment K**.

Potential NAPL-impacted sediments were encountered at 27 of the 83 TarGOST probe and 13 of the 37 Dart locations. NAPL-impacted sediments (i.e., sediments described as containing NAPL) were observed at 52 of the 167 sediment borings and 7 of the 51 additional surface sediment samples. Of the remaining 115 sediment borings,

---

[8] Number of sediment boring does not include three borings advanced in 1990, eight borings advanced in 2005 and six Vibracores advanced in 2008 for collection of geotechnical samples.

evidence of impacts (e.g., odors and/or sheens, but no NAPL) was observed at 34 borings and no visual impacts were observed at 81 borings. Of the remaining 44 additional surface sediment samples, evidence of impacts (e.g., odors and/or sheens, but no NAPL) was observed at 4 locations borings and no visual impacts were observed at 40 locations. The TarGOST probe, Dart, sediment boring and surface sediment sample locations are shown on **Figure 12.** To show the areal distribution and depth of NAPL-impacted sediments encountered in the TarGOST probes, Darts, sediment borings and non-boring surface sediment samples, the symbols and IDs on **Figure 12** are color-coded based on the maximum depth at which NAPL-impacted sediments were observed (no NAPL, maximum depth NAPL observed less than 1 foot, maximum depth NAPL observed between 1 and 3 feet, maximum depth NAPL observed between 3 and 7 feet, and maximum depth NAPL observed greater than 7 feet). The vertical and horizontal extents of NAPL-impacted sediments are depicted in cross-section view on **Figures 10C through 10K** (a cross section location map is provided as **Figure 10A**).

As shown on **Figure 12**, NAPL-impacted sediments adjacent to the site extend approximately 250 to 300 feet from the shoreline, and are bounded to the west by the following TarGOST probe/sediment boring locations where NAPL-impacted sediments were not observed (listed in order from north to south)[9]: SED-138/138C, SED-141/141C, SED-142/142C, SED-132/132C, SED-153/153C, SED-133/133C, SED-134/134C, SED-143/143C, SED-162C, SED-136/136C and SED-164C. NAPL was observed in 9 of the 15 near-shore sediment borings advanced west of the former wooden bulkhead (SED-401C, SED-407C through SED-413C and SED-415C, generally between the location of well NWS-116S and approximately 50 feet south of the railroad bridge).

Within the gas line buffer zone, NAPL impacted sediments extend approximately 250 to 300 feet from the shoreline, and are bounded to the west by the following Dart locations where NAPL-impacted sediments were not observed (listed in order from north to south): DART-26, DART-17, DART 13, and DART-2.

North of the site (i.e., north of the gas line buffer zone), NAPL-impacted sediments extend approximately 500 feet north of the northern edge of the gas line buffer zone and from approximately 100 to 200 feet to approximately 250 to 400 feet from the

[9] Trace NAPL blebs were observed in sediment boring SED-163C from 0-0.3'; however, because the total PAH concentration (41.2 mg/kg) in a sample collected from the 0-0.5' interval at this location is not indicative of NAPL-impacted sediments and NAPL-impacted sediments were not observed in any of the borings surrounding this location, SED-163C is not included in the delineated NAPL-impacted sediment area.

shoreline. NAPL-impacted sediments in this area are more sporadic than adjacent to the site, but are generally bounded to the west by (from north to south) SED-502C, SED-261C, SED-255C, SED-285C, SED-273C, SED-274C, SED-234C, SED-159C, SED-208/208C and SED-139; to the north by SED-502C, SED-510C and SED-287C; and to the east by SED-287C, SED-263C, SED-262C, SED-221, SED-204, SED-201, SED-200 and SED-154C. NAPL-impacted sediments were not observed in any of the background borings (SED-236 through SED-254; **Figure 8B**).

Within the electric cable buffer zone, NAPL-impacted sediments were observed at one of nine locations: sediment sample DART-107 (although the corresponding Dart at this location did not indicate the presence of NAPL). South of the site (i.e., south of the electric cable buffer zone), NAPL-impacted sediments were observed at 2 of 14 locations: sediment samples SED-507C and SED-513C.

Of the 99 locations where NAPL-impacted sediments were identified, the maximum depth NAPL-impacted sediments were encountered was less than 1 foot bss at 20 locations (20.2%), between 1 and 3 feet bss at 26 locations (26.3%), between 3 and 7 feet bss at 32 locations (32.3%), and greater than 7 feet bss at 21 locations (21.2%). North of the gas line buffer zone, NAPL-impacted sediments greater than 3 feet bss were only observed at one location (SED-202; NAPL-impacted sediments observed down to 3.4 feet bss).

In the nine 2008 near-shore sediment borings west of the former wooden bulkhead where NAPL was observed, the NAPL-impacted sediments were encountered at depths greater than 7 feet bss at eight locations (the maximum depth of NAPL-impacted sediments at the other boring was between 3 and 7 feet bss), at depths of up to 38.2 feet bss.

At nine of the 52 sediment borings where NAPL-impacted sediments were observed (SED-107C, SED-108C, SED-108CC, SED-112C, SED-114C, SED-121C, SED-121CC, SED-123C, and SED-128C), the NAPL-impacted intervals were described as having “NAPL throughout,” indicating more concentrated NAPL conditions. Except for at SED-121CC, the NAPL observed in these borings was collocated with relatively higher amounts of organic materials (e.g., wood, roots). Less concentrated NAPL conditions were observed at the other 43 sediment boring locations with NAPL impacts.

During low-tide conditions, NAPL has also been observed along the shoreline adjacent to the site, between the existing concrete bulkhead and former wooden bulkheads. During the November 2003 reconnaissance, NAPL was observed within silty sand/gravel/cobble material approximately 10 to 15 feet from the existing concrete bulkhead and behind the former wooden bulkhead location near the locations of wells

NMW-113S and NMW-112S. A second reconnaissance was conducted in September 2004 during a low tide (but not as low as the November 2003 tide). During this reconnaissance, several small areas of sheens were observed on the west side the concrete bulkhead (generally between the locations of wells NMW-102S and NMW-113S). Finally, during video inspection of abandoned pipes in 2008, NAPL impacted sediments were observed below BH-PIPE-3 (near well NMW-104S) on the west side of the concrete bulkhead.

In summary, the extent of NAPL-impacted sediments in the Hudson River adjacent to the site has been delineated. NAPL-impacted sediments generally extend between 200 and 400 feet from the shoreline and were primarily located within the upper 3 to 7 feet of sediment. NAPL-impacted sediments greater than 3 feet bss were primarily located within the area adjacent to the site (i.e., between the CHGE gas line and electric cable river crossings).

3.11.2 Sediment Sample Analytical Results

3.11.2.1 Surface Sediments

Between 1990 and 2010, a total of 179 surface sediment[10] samples were collected within the Hudson River near the Site for laboratory analysis of PAHs and TOC to assess the nature and extent of surface sediment impacts. Surface sediment sample locations are shown on **Figures 6** (note that surface sediment samples collected from locations upstream of the site are shown on **Figure 8B**). Surface sediment sample analytical results are summarized in **Table 18** and on **Figures 8A and 8B**. Laboratory analytical data sheets are provided in **Attachment A** and DUSRs are provided in **Attachment B.**

As indicated in **Table18**, PAHs were detected in 169 of the 179 surface sediment samples. Total PAH concentrations ranged from 0.085 mg/kg (SED-274C) to 12,200 mg/kg (SED-114C). PAH analytical results were compared to the Effects Range-Low (ER-L) value of 4 mg/kg and the Effects Range-Medium (ER-M) value of 45 mg/kg (Long and Morgan, 1990). Note that the ER-L and ER-M values do not reflect final sediment cleanup levels for the site. Comparison of the PAH analytical results to the ER-L and ER-M values is included for screening purposes only. Of the 179 surface sediment samples, 147 samples had total PAH concentrations that exceeded the ER-L value of 4 mg/kg, and 83 samples had total PAH concentrations that exceeded the ER-M value of 45 mg/kg.

---

[10] For the purposes of this RI Report, “surface sediment” is defined as any sample encompassing a portion of the 0- to 0.5-foot depth interval.

Nineteen of the 179 surface sediment samples were collected from locations upstream of the site as part of a background study in 2005 (SED-236C through SED-254C; **Figure 8B**). Total PAHs were detected in 18 of the 19 background samples, at concentrations ranging from 0.12 mg/kg (SED-252C) to 298 mg/kg (SED-238C).

To show the areal distribution of PAH concentrations in surface sediments, the sample symbols and IDs on **Figures 8A and 8B** are color-coded based on their relative total PAH concentration (less than 50 mg/kg, between 50 and 100 mg/kg, between 100 and 500 mg/kg, and greater than 500 mg/kg).

3.11.2.2 Subsurface Sediments

Subsurface sediment samples were collected for chemical analyses, geotechnical testing, waste characterization analyses and NAPL saturation testing. The results of the chemical analyses, waste characterization analyses and NAPL saturation testing are discussed below. The geotechnical testing results are not discussed, but are summarized in **Table 21**, and the associated laboratory data sheets are provided in **Attachment A**.

3.11.2.2.1 Analytical

Between 1990 and 2004, a total of 70 subsurface sediment samples were collected within the Hudson River near the Site for laboratory analysis of VOCs, SVOCs or PAHs, inorganics and/or TOC to assess the nature and extent of subsurface sediment impacts. Subsurface sediment sample locations are shown on **Figure 6**. Subsurface sediment sample analytical results are summarized in **Table 20** and on **Figure 8C**. Laboratory analytical data sheets are provided in **Attachment A** and DUSRs are provided in **Attachment B.**

BTEX and PAH results are discussed below.

3.11.2.2.1.1 BTEX

Nine subsurface sediment samples were collected and analyzed for VOCs during sediment investigations conducted between 1990 and 2004. As indicated in **Table 20**, one or more BTEX constituents were detected in all nine samples, with total BTEX concentrations ranging 0.0091 mg/kg (NWSED-1, 1.5 feet) to 1,310 mg/kg (SED-123C, 2.5-3.4 feet).

3.11.2.2.1.2 PAHs

All 70 subsurface sediment samples collected between 1990 and 2004 were analyzed for SVOCs or PAHs. As indicated in **Table 20**, one or more PAH constituents were detected in all 70 samples, with total PAH concentrations ranging 0.17 mg/kg (SED-121C, 5.2-6.2 feet) to 21,200 mg/kg (SED-114C, 0.5-1 feet).

PAH analytical results were compared to the ER-L value of 4 mg/kg and the ER-M value of 45 mg/kg (Long and Morgan, 1990). Note that the ER-L and ER-M values do not reflect final sediment cleanup levels for the site. Comparison of the PAH analytical results to the ER-L and ER-M values is included for screening purposes only. Of the 70 subsurface sediment samples, 60 samples had total PAH concentrations that exceeded the ER-L value of 4 mg/kg, and 46 samples had total PAH concentrations that exceeded the ER-M value of 45 mg/kg.

3.11.2.2.2 Waste Characterization

Waste characterization samples were collected in 2004 from SED-104C, SED-107C, SED-108C, SED-114C, SED-123C and SED-178C. The results of the waste characterization are provided in **Table 22**.

The following provides a summary of the detected constituents in the six samples analyzed for waste characterization parameters:

- BTEX were detected in all six samples (total BTEX ranged from 20.1 to 1,310 mg/kg) and were the only VOCs detected

- PAHs, 2-methylnaphthalene, and dibenzofuran were detected in all six samples (total PAHs ranged from 431 to 12,300 mg/kg, 2-methylnaphthalene ranged from 110 to 2,800 mg/kg, and dibenzofuran ranged from 3.2 to 93 mg/kg) and were the only SVOCs detected

- PCB Aroclor 1248 (0.15 mg/kg) was detected in sample SED-178-C (3.0-4.0’) and no other PCBs were detected in this sample or the other five samples

- No identifiable TPH constituents were detected in any of the samples; however, unidentifiable TPH constituents (noted as n-Dodecane on the lab data sheets) was detected in all six samples (1,300 to 65,000 mg/kg)

- Arsenic (11.2 to 14.4 mg/kg), barium (55.6 to 144 mg/kg), total chromium (15.4 to 32.5 mg/kg), lead (38.5 to 113 mg/kg), mercury (0.172 to 0.633 mg/kg), nickel (21.4 to 26.9 mg/kg), vanadium (15 to 26 mg/kg), and zinc (89.2 to 191 mg/kg) were detected in all six samples and were the only metals detected

- TOC was detected in all six samples (82,900 to 147,000 mg/kg)

- Total cyanide was not detected in any of the six samples

- Sulfur was detected in all six samples (747 to 4,240 mg/kg)

3.11.2.2.3 NAPL Saturation

Six samples from two locations were collected using a Vibracore rig within the proposed reactive sediment capping pilot study area in August 2008 for NAPL saturation testing. The test results are summarized in **Table 23**. As indicated in **Table 23**, the percentage of the available pore space occupied by NAPL ranged from 3.7 percent to 20.4 percent.

3.12 Pipe Investigation Findings – River

Video inspection of nine abandoned pipes observed to daylight from the bulkhead along the Hudson River was attempted on October 21, 2008; only six of the nine pipes were accessible for video inspection. The locations of the ends of the inspected pipes are shown on **Figure 3**. The video inspection results are summarized in **Table 15.** DVDs of the video footage were provided in the 2008 Data Report.

No NAPL or NAPL staining was observed in any of the six pipes inspected, and no NAPL was observed on the camera upon removal from the pipes. NAPL impacted sediments were observed below BH-PIPE-3, which may or may not be related to historical discharges from this pipe.

3.13 River Reconnaissance Findings

River reconnaissance activities were conducted during low tide conditions on November 14, 2003 and September 15, 2004. During the 2003 reconnaissance, representatives of BBL, CHGE, and the NYSDEC conducted a reconnaissance of the Hudson River shoreline adjacent to the site to observe shoreline conditions. During the reconnaissance, NAPL was observed within silty sand/gravel/cobble material at the edge of water, approximately 10 to 15 feet from the existing bulkhead/retaining wall, adjacent to soil boring locations SB-112 and SB-113. In addition to the NAPL observations, remains of a former wooden bulkhead were also observed during low tide conditions. The wooden bulkhead was located approximately 2 to 15 feet west of the existing bulkhead/retaining wall.

During the 2004 reconnaissance, BBL conducted a river reconnaissance of the shoreline along the east side of the Hudson River from the public boat ramp located at Waryas Park to the Poughkeepsie Water Pollution Control Plant (northern limit of reconnaissance. The following observations were noted during the reconnaissance:

- Rip rap was present along the majority of the riverbank/shoreline
- No stressed vegetation was observed along the riverbank/shoreline
- The bulkhead adjacent to the site was observed to be in disrepair
- One tributary (Fall Kill) was observed
- Several former discharge pipes and existing sewer outfalls/culverts were observed along the shoreline
- No NAPL seeps were observed along the shoreline
- No large sheens were observed on the water surface
- Several small areas of sheens were observed within the rip rap adjacent to the bulkhead along the site (generally between existing well clusters NMW-102 and NMW-113

Additional low-tide bulkhead/shoreline inspections were proposed in the work plan for the 2008 Supplemental Land and River Investigation. However, although low-tide times were chosen for the inspections, river conditions were not conducive (i.e., water levels were not low enough) for observing the bulkhead/shoreline.

3.14 Remote Sensing Data/Mapping Review Findings

Side-scan sonar mapping, sub-bottom profiling track lines and images, grab sample component mapping, sediment type mapping, and sediment environmental mapping generated as part of the Hudson River Estuary Benthic Mapping Project are included in **Attachment L.** A bathymetric contour map and an interpretive map showing sediment waveforms, sediment troughs (lows) and ridges (highs), boulders, bridge piers, utility lines, drag scars, areas of hard sediment/bedrock, and other features were generated using the NYSDEC's multibeam bathymetry and side-scan sonar data. These maps were provided in the 2004 Data Report. Because these maps are considered confidential and not available for public release, they are not included in this report.

3.15 Camera Inspection Findings

In July 2008, a weighted diver's camera was used to inspect the sediment surface within the gas line buffer zone. Video images of the sediment surface were obtained along 10 transects within the approximate 200 foot by 400 foot camera inspection area. Depending on the tide, transects were either oriented north to south (during ebbing tides) or south to north (during flooding tides). The surveyed locations of the camera transects and DVDs of the video footage were provided in the 2008 Data Report. Observations from the camera footage are summarized in **Table 27**. In some cases, the clarity/resolution of the camera footage was limited by turbidity, currents (better clarity was observed during slack tide when currents were not as strong) and the field of vision; however, no obvious areas of NAPL-impacted surface sediments were observed. NAPL and NAPL staining was observed on the camera weight upon retrieval from the river at transects T004 through T006. The following were also observed in various locations: organics (e.g., vegetation, leaves, sticks), anthropogenic debris (e.g., plastic), cobbles, zebra mussels, and shells/shell fragments. The majority of the upper sediments appeared to be very soft in nature.

In June and August 2008, camera inspections of the sediment surface within the proposed reactive sediment capping pilot study area were conducted. Video images of the sediment surface were obtained along nine transects within the approximate 150 foot by 150 foot camera inspection area. The surveyed locations of the camera transects and DVDs of the video footage were provided in the 2008 Data Report. Observations from the camera footage are summarized in **Table 27**. As with the gas line buffer zone area, no obvious areas of NAPL-impacted surface sediments were observed within the reactive sediment capping pilot study area. NAPL and NAPL staining was observed on the camera weight upon retrieval from the river at transect T102. The following were also observed in various locations: organics (e.g., vegetation, leaves, sticks, logs/timber), anthropogenic debris (e.g., plastic, pipes, cable/cord), cobbles, zebra mussels, and shells/shell fragments. As with the gas line buffer zone area, the majority of the upper sediments appeared to be very soft in nature.

3.16 Historical Information Review Findings

The following information was reviewed to assess river bathymetry and determine/evaluate potential sources of NAPLs/PAHs to the Hudson River at, upstream of, and downstream of the site:

- Mid-Hudson Bridge construction records
- Governmental database search for environmental records
- City of Poughkeepsie utility maps (i.e., sanitary, storm, and combined sewers)
- CHGE historical maps/plans/correspondence
- Aerial photographs
- Sanborn maps

Relevant information obtained from these sources is provided in **Attachment M** and is summarized below.

Mid-Hudson Bridge construction plans from 1924 were obtained from the New York State Bridge Authority (NYSBA). The plans include general elevation and plan views of the bridge, as well as data for 15 borings that were advanced in the river along the alignment of the bridge (five borings near the west bridge pier, two borings between the east and west bridge piers, five borings near the east bridge pier, and one boring between the east bridge pier and the shoreline). The boring data indicate that, in the vicinity of the bridge, sediment thicknesses (i.e., thickness of sediment above bedrock) range from 58 to 133 feet. The NYSBA also provided fathometric survey maps from 2002, which depict the river bathymetry (in both plan and cross section views) along the alignment of the bridge.

A governmental database search of available environmental records was ordered from Environmental Data Resources, Inc. (EDR). The EDR database search was conducted in accordance with ASTM E1527-00 (Standard Practice for Environmental Site Assessments), and included a review of federal, state, and local databases for sites located within specified radii of the North Water Street site. The following provides a summary of the EDR database search:

- One Comprehensive Environmental Response, Compensation, and Liability Information System-No Further Remedial Action Planned (CERCLIS-NFRAP) site was identified within an approximately 0.25-mile radius
- Four Resource Conservation and Recovery Information System (RCRIS) sites were identified within an approximately 0.25-mile radius

- Two State Hazardous Waste Site (SHWS) sites were identified within an approximately 1-mile radius

- Five Leaking Storage Tank Incident Report sites were identified within an approximately 0.5-mile radius

- Four Underground Storage Tank (UST) sites were identified within an approximately 0.25-mile radius

- Two Chemical Bulk Storage sites were identified within an approximately 0.25-mile radius

- Two New York Spills List sites were identified within an approximately 0.125-mile radius

The A.C. Dutton Lumber Corporation, the former owner/operator of a wood-treating facility on the Hudson River just north of the North Water Street site, was listed on four of the databases searched.

Maps of existing sanitary, storm, and combined sewer lines were obtained from the City of Poughkeepsie. Based on these maps, there is a combined storm/sanitary sewer that discharges to the Hudson River just north of Dutchess Avenue, a storm sewer that discharges to the Hudson River just north of the Fall Kill, and a storm sewer that discharges to the Hudson River at the south end of Waryas Park at the end of Main Street. The locations of these outfalls were confirmed during the river reconnaissance, as discussed in Section 3.13. The City of Poughkeepsie did not have records/maps of historical sewer lines/discharges.

Several historical maps, plans, photographs, and correspondence were obtained from CHGE's files and reviewed. These included general site plans showing the locations of holders, tanks, piping, and other MGP structures; construction plans and photographs for several holders, tanks, and other MGP structures; and correspondence between CHGE and the U.S. War Department regarding the presence of oil in the Hudson River nearby the North Water Street site. The site plans (along with aerial photographs and Sanborn maps, as discussed below) were used to create a historical features map, which is included as **Figure 2**. The following table summarizes construction information for various MGP holders, tanks, structures based on review of CHGE plans and photographs (see **Figure 2** for approximate locations):

Structure	Construction Information
500M cubic foot gas holder	• Foundation is slab on grade (partially on rock) with footings into rock • Concrete foundation is 12-inches thick where on ground and 6-inches thick where on rock
1000M cubic foot gas holder	• Foundation is slab on grade (partially on rock) with footings to top of rock • Holder had steel bottom and sides
Relief holder	• Foundation is slab on grade (partially on rock) with footings to top of rock • Trenches for inlet/outlet piping filled with concrete
100,000 gallon oil tank	• 37-foot diameter, 9-foot deep concrete pit (5 feet above grade, 4 feet below grade) with footings to top of rock • Bottom of pit was 12-inch thick concrete • 26-foot diameter steel oil tank set in pit
300,000 gallon oil tank (No. 4)	• 50-foot diameter steel dike set partially on grade (rock) and partially on concrete/stone wall • 35.25-foot diameter steel oil tank set inside steel dike
840,000 gallon oil tank (No. 5)	• 67-foot diameter steel dike set partially on grade (rock) and partially on concrete/stone wall • 55-foot diameter steel oil tank set inside steel dike
Drip oil tanks	• Above-ground tanks set on 6-inch thick concrete slab on grade
Tar dehydration equipment	• Above-ground tanks (T-1, T-2, S-1, S-2) set on concrete pads

A historical CHGE map also showed a “piping bundle” consisting of seven pipes (including a 1.5-inch diameter feed water line, a 3-inch diameter steam line, two 3-inch diameter tar lines, a 1.5-inch diameter condensate line, and two other lines) enclosed in a wooden “box”, running between the MGP and electric plant (see **Figure 2** and **Attachment M**). This piping is consistent with historic documentation that MGP by-products were reused at the MGP and at the electric plant. In addition to site reuse, by-products were sold to a variety of industries (Hubbard, 1942). As discussed in Section 2.2.13.2, a portion of this piping was located and removed in November 2004.

Based on a series of letters and memoranda between CHGE and the U.S. War Department from 1933 to 1941, CHGE conducted several actions in the late 1930s and early 1940s to address potential seepage of MGP-related oils to the Hudson River. These actions included:

- Checking all liquid-carrying pipes for leaks
- Collecting liquids in the fill behind the bulkhead for chemical treatment/filtering
- Excavating approximately 1,000 cubic yards of fill (to a depth of approximately 4 feet below mean low tide) from behind the dock in the northern portion of the MGP property, and backfilling the excavation with clay
- Uncovering yard piping around the gas house and installing a "concrete ceiling" over the yard piping so that damaged pipes can be readily detected and repaired
- Installing an underground automatic emptying collection tank for floor draining
- Draining out and cleaning the sedimentation tank of the effluent chemical treating plant
- Installing large rectangular open-top outflow inspection tank in the ground near the dock
- Rearranging of several pipes and structures
- Installing a concrete pad with curb around tanks T-1, T-2, S-1, and S-2

A river inspection report dated February 23, 1938 reported oils and raw sewage being discharged from the City's sewer outlet near the southern end of the CHGE site and oily substances were also observed on the surface of the Fall Kill. Inspection reports from June 1939 reported that oil and sewage were observed coming from the Mill Street sewer outlet and oil from a carrier ship was spilled on Dutton Lumber's dock just north of Dutchess Avenue causing a large, black oily streak on the river.

Aerial photographs from 1960, 1967, 1973, 1980, 1984, and 1995 were also obtained from EDR. The photographs were used to identify historical locations of tanks, holders, and other structures at the former MGP. Sanborn maps from 1887, 1895, 1913, 1950, 1952, 1984, and 1990 were also reviewed to identify the locations of tanks, holders, and other structures at the former MGP, as well as the locations of nearby industries that could have potentially discharged wastes to the Hudson River. Based on a review of the Sanborn maps, former industries located along the east side of the Hudson River north and south of the site included:

- Fallkill Iron Company, later Poughkeepsie Iron Company (on east riverbank, just north of the A.C Dutton Lumber Corporation property, approximately 400 feet north of the former MGP)
- Poughkeepsie Glass Works (on east riverbank, just north of Dutchess Avenue)
- A.C. Dutton Lumber Corporation (on east riverbank, just north of Dutchess Avenue)
- Innis ("manufacturers of dye woods and dye stuffs" – along north and south banks of the Fall Kill)
- Poughkeepsie Dyestuff Corporation, later Burncolor Corporation ("manufacturers of aniline dyes" – south bank of the Fall Kill)
- C.N. Arnold, later Poughkeepsie Chair Company ("manufacturers of chairs and dealer in lumber and building materials" – on east riverbank, just south of the Fall Kill)
- D.C. Foster and Son's Lumber, Coal, and Wood (on east riverbank, approximately 200 feet south of the Fall Kill)
- M. Vassar and Company Brewery and Malt (on east riverbank, approximately 600 feet south of the Fall Kill)
- Hudson River Dry Line Refrigeration and Ice Plant (on east riverbank, approximately 900 feet south of the Fall Kill)
- M.S. Reynolds and Brother, later Swift and Smith Poughkeepsie Coal Company (on east riverbank, approximately 1,000 feet south of the Fall Kill)
- Central Hudson Steamboat Company (on east riverbank, approximately 1,400 feet south of the Fall Kill)
- Poughkeepsie Transportation Company (on east riverbank, just south of the railroad bridge and approximately 1,500 feet south of the Fall Kill)
- Sinclair Refining Bulk Plant (on east riverbank, approximately 1,500 feet south of the Fall Kill)

- F. Gillmann's Kaalrock Beer & Ale Brewery (on east riverbank, approximately 1,800 feet south of the Fall Kill)

- Standard Oil Company of New York, later Mobile Oil Company, Inc. (on east riverbank, approximately 1,800 feet south of the Fall Kill)

The Sanborn maps indicate that many of these industries had coal stored in piles on their property.

4. Qualitative Human Health Exposure Assessment/Conceptual Site Model

This qualitative human health exposure assessment (HHEA) describes the potential for human exposure to site-related constituents in environmental media at the site. This HHEA is conducted consistent with the New York State Department of Health (NYSDOH) guidance as presented in *DER-10 Technical Guidance for Site Investigation and Remediation* (NYSDEC/NYSDOH, 2010e) and uses information regarding current and foreseeable land uses and available site data to evaluate the potential for exposure of human receptors. The HHEA identifies potential source areas, evaluates contaminant fate and transport, and identifies primary constituents of interest, potential receptors, and potentially complete exposure pathways. Because the requirements for a conceptual site model (CSM) are similar to the HHEA requirements, this section also represents the CSM for the site.

4.1 Source Areas

This section describes possible terrestrial and aquatic source areas for MGP-related NAPLs, PAHs and other chemical constituents at the site. This information is then used in the HHEA to help identify primary constituents of interest and potentially complete exposure pathways.

4.1.1 Land

The site consists of the former MGP, separated into an upper and lower portion, and a portion of the former electric plant (**Figure 2**). The upper portion of the former MGP lies on a bedrock bluff that is 40 to 60 feet higher than the lower portion of the former MGP that lies between the bedrock cliff and the Hudson River. NAPLs present at the site may act as sources to the environment depending on the NAPL amount, distribution and composition. NAPLs can migrate as separate-phase liquids, and may also be potential sources of PAHs and other constituents to soil and groundwater. A site plan showing the land-based investigation locations at the site where NAPLs have been observed is provided as **Figure 9**.

In the upper portion of the former MGP, historic gas purifying and gas/oil storage activities resulted in the presence of NAPLs in the overburden and bedrock. NAPL was not observed in any of the surface soil samples collected between 1990 and 2010, but was encountered at depth at three locations: MW-1 (tar and oil in bedrock fractures), MW-2 (oily staining in overburden and bedrock fractures), and SB-313 (trace NAPL staining in the uppermost 5 feet of weathered bedrock). Based on data from the 2004 soil borings/temporary monitoring wells, NAPLs were not observed beneath the foundations of the two former gas holders and three former oil tanks within the overburden and upper 10 to 20 feet of bedrock in the upper portion of the former

MGP. Further, measurable/recoverable amounts of NAPLs have not been observed in any of the overburden or bedrock wells installed in the upper portion of the former MGP.

In the lower portion of the former MGP, historic gas production, processing, and storage activities resulted in the presence of NAPLs throughout much of the overburden, primarily adjacent to the Hudson River from Dutchess Avenue to the railroad bridge (**Figure 9**). Measureable/recoverable NAPLs have been observed in three of the 22 overburden monitoring wells (NMW-116S and NMW-117S primarily, and to a much less degree NMW-110S) installed in this area. Measurable/recoverable NAPLs have not been observed in any of the 21 bedrock monitoring wells throughout the lower portion of the former MGP. In addition, NAPLs were not observed beneath the foundation of the former relief holder within the overburden and upper 17 feet of bedrock in the lower portion of the former MGP (based on data from three 2004 soil borings/temporary monitoring wells), except at one location in the uppermost three feet of weathered bedrock (SB-302). NAPLs have also been observed in the overburden in four of 13 borings and in all seven TarGOST probes, installed in the current natural gas regulator station portion of the site. However, measureable/recoverable NAPLs have not been observed in any of the bedrock or overburden NAPL monitoring wells installed in this area.

Within the former electric plant, NAPLs were observed at in one of 14 borings (SB-319) and in three of 14 TarGOST probes installed within and near the northern section of the former electric station building.

Where present, NAPL is contained within the site and does not appear to have migrated off the site in the overburden or bedrock (with the exception of migration to the Hudson River). North of the site along Dutchess Avenue, no NAPLs were observed at borings and wells SB-315, SB-316, SB-317, NMW-119D, NMW-120D, or NMW-121D. In addition, no NAPLs were observed within an 8 feet wide by 8 feet deep trench installed by the City of Poughkeepsie in December 2003 for sewer line improvements within Dutchess Avenue from North Water Street to the river (BBL, 2004a). Along the eastern boundary of the site, no NAPLs were observed at borings and wells SB-315, SB-330, SB-323, or SB-324, and trace NAPL staining was observed at boring SB-313. Along the southern boundary of the former electric plant, no NAPLs were observed at borings SB-403, SB-404 or SB-405.

4.1.2 River

The Hudson River lies along the western boundary of the site, and NAPLs have been observed in Hudson River sediments in certain locations (**Figure 12**). The NAPLs present in the sediments adjacent to the site may act as sources to the environment depending on the NAPL amount, distribution and composition. NAPLs can migrate as separate-phase liquids, and may also be potential sources of PAHs and other constituents to sediment and surface water. Adjacent to the site, NAPL impacted sediment has been observed to extend approximately 200 to 300 feet from the shoreline. Within the gas line buffer zone, NAPL-impacted sediments also extend approximately 250 to 300 feet from the shoreline. North of the site (i.e., north of the gas line river crossing), NAPL-impacted sediments extend approximately 500 feet north of the northern edge of the gas line buffer zone and from approximately 100 to 200 feet to approximately 250 to 400 feet from the shoreline. Within the electric line buffer zone, NAPL-impacted sediments were observed at 1 of the 9 locations. South of the site (i.e., south of the electric cable river crossing), NAPL-impacted sediments were encountered at 2 of 14 locations south of the southern edge of the electric line buffer zone.

NAPL present in overburden soils from historic gas production, processing, and storage activities was likely a historical source and could potentially be a current source of NAPLs to the river. Another potential historical source of NAPL to the river is from historic direct discharges. Although there is no specific record of direct discharge of MGP coal tar to the river, several abandoned pipes are present along the current bulkhead, which could have served as conduits for discharge of coal tar to the river. However, no NAPL was observed in these pipes during the 2008 camera inspections. NAPL-impacted sediments observed below BH-PIPE-3 (near well NMW-104S) may or may not be related to historical discharges from this pipe.

NAPL currently present in sediments could potentially be a source to non-NAPL-impacted sediments due to erosion/deposition processes within the river. In addition, NAPL could also be carried from deeper NAPL-impacted sediments to overlying non-NAPL-impacted sediments via gas ebullition processes or upward hydraulic gradients. Gas bubbles from the decomposition of organic matter can migrate through sediments until released in the water column. Gas bubbles migrating through NAPL-impacted sediment can become coated with NAPL and therefore also result in NAPL migration. Because the Hudson River is a groundwater discharge area, there may be areas (e.g., at the upland-river interface) where the upward vertical hydraulic gradients are stronger than gravitational forces, which would result in upward NAPL migration.

Based on review of historical documents and other information, in addition to the former MGP, other potential sources that could affect sediment quality in the Hudson River near the site include: historic discharges from a combined storm/sanitary sewer just north of Dutchess Avenue, from a storm sewer just north of the Fall Kill, and from a storm sewer at the south end of Waryas Park at the end of Main Street; and/or historic spills and discharges from numerous industries along the Hudson River north and south of the site (e.g., an aniline dye manufacturer).

4.2 Release and Transport Mechanisms

NAPL migration and the resultant distribution of NAPL at the site is complex and depends on a variety of forces and conditions such as gravity, hydraulic gradients, lithology and lithologic changes, matrices permeability and associated changes, and organic content of native and anthropogenic materials in the subsurface. Historically, NAPL likely migrated downward through the subsurface due to gravity. Where present, NAPL appears to have migrated laterally along the top of silt/clay layers (i.e., capillary barriers), and also moved downward and laterally along former wooden structures (e.g., piles). MGP NAPLs can wick or spread out along organic materials such as wood. Reworking of the land surface during and after operation of the MGP and/or electric plant may have also resulted in the movement of NAPL-impacted soils from one area of the site to another. In addition, the tidally induced hydraulic gradients along the river also influence the resultant distribution of NAPL on land. Where present, NAPL is contained within the site and does not appear to have migrated off the site in the overburden or bedrock with the exception of migration to the Hudson River. Migration pathways for both the land and river environs are further discussed below, and are also depicted on a conceptual cross section on **Figure13.**

4.2.1 Land

In the upper portion of the former MGP, only a thin layer (1 to 8 feet) of overburden consisting of reworked soil and fill material lies above shale and greywacke bedrock. In this portion of the site, NAPL and NAPL staining was observed in localized zones within the bedrock at MW-1 and MW-2, and trace NAPL staining was observed in weathered bedrock at SB-313. NAPLs have not been observed in the overburden in the upper portion of the former MGP except for trace NAPL at MW-2. NAPL presence in the bedrock has resulted in low levels of BTEX and PAH compounds in groundwater at bedrock wells MW-1 and MW-2, but not at MW-3, and low levels of BTEX in groundwater at bedrock well SB-303.

In the lower portion of the former MGP, fill materials consisting of shale fragments mixed with gravel, sand and silt, with lesser amounts of anthropogenic materials (e.g., bricks, concrete, cinders, coal, ash, glass, wood) comprise the primary overburden unit. A cross section depicting the distribution of NAPL and the various geologic units observed in the soil borings/wells in the lower portion of the former MGP (along the river) is provided as **Figure 10B**. The overburden forms a wedge that is thicker (20 to 60 feet) toward the river and thins to 1 to 5 feet in thickness adjacent to the bedrock cliff that separates the lower and upper portions of the site. The fill materials are believed to have been placed along the former shoreline area prior to the construction of the MGP facilities and may have originated from the former electric plant, which operated for approximately 15 years before the MGP was constructed in 1911.

Additional fill materials were likely placed during operation of the former MGP, as evidenced by historical aerial photographs and maps showing various shoreline configurations over the years.

Within the overburden fill materials in the lower portion of the former MGP, there are silt and clay lenses between wells NMW-111S and NMW-113S and between wells NMW-119S and NMW-115S, as well as other minor lenses. The silt and clay lens between wells NMW-111S and NMW-113S is located in the general area where a clay dike was installed to mitigate the seepage of MGP NAPLs into the river in the 1940s. A more significant and thicker silt and clay layer is present in the northern section of the lower portion of the site (i.e. north of well NMW-109S) between the fill unit and the shale bedrock. This silt and clay layer thickens from five to 25 feet and deepens by approximately 20 feet between wells NMW-110S and NMW-117S, and thickens from 15 to 25 feet and deepens by approximately 15 feet between the locations of wells NMW-120S and NMW-117S. Near the location of well NMW-117S, the silt and clay layer is the deepest compared to adjacent borings to the north, east, and south resulting in a small depression within the surface of the silt and clay layer in this area. Within the overburden fill, wood zones were encountered, and a few of these zones were approximately 10 feet in length. These woods zones likely represent pilings for former docks and other site structures and/or tie backs for the current and former bulkheads along the river. Wood zones were more prevalent in the northern section of the lower portion of the site (i.e., north of the location of well NMW-109S), and between wells NMW-114S and NMW-109S the wood zones penetrate into or through the silt and clay layer.

In the lower portion of the former MGP, NAPL is present within the overburden fill unit between SB-101 to the south and well NMW-117S to the north. Between wells NMW-104S and NMW-106S and near NMW-111S, NAPLs are present near or at the top of bedrock. Between wells NMW-109S and NMW-113S and near wells NMW-115S and NMW-117S, distribution of NAPLs within the fill material is generally truncated at the silt and clay layer except at wells NMW-111S and NMW-112S, where NAPLs are observed below the silt and clay layer. These NAPLs may have migrated along wood piles that penetrated the silt and clay layer in this area. Between wells NMW-108S and NMW-113S, NAPL distribution is altered by the possible clay dike observed at well NMW-112S where the NAPL-impacted units appear to have been removed and replaced with silt/clay. More concentrated NAPL areas were observed at the top of the silt and clay layer at wells NMW-109S, NMW-110S, and NMW-113S. North of well NMW-113S, NAPLs appear to have migrated along the top of the silt and clay layer culminating and concentrating in the depression or NAPL pool near the location of well NMW-117S. NAPLs have been recoverable from this well and adjacent well NMW-116S.

The NAPL distribution within the overburden fill materials suggests that spills, leakage, and/or other discharges from the former tar processing, transmission, and storage facilities between the former tar centrifuge house (i.e., near the building in the propane storage area just east of well NMW-113S) and the former generator house (i.e., just north of the railroad bridge near well NMW-100D) entered the overburden and over time migrated downward. At some locations the NAPL reached the top of the shale bedrock or the top of the silt and clay layer. However, the lack of NAPLs throughout the upper portion of the fill unit suggests that some of this fill may have been placed after MGP operations ended or alternatively the areas where NAPL discharges occurred were primarily in the tar processing area (i.e. the area between the former tar centrifuge house and the former northern generator house; roughly the area between wells NMW-113S and NMW-109S) and NAPLs migrated both vertically downward and laterally to the south and north within the fill unit.

NAPLs have only been recovered from wells NMW-116S and NMW-117S. The dissipation of NAPLs over the last almost 60 years since MGP operations were discontinued at the site is believed to be caused by the tidally induced hydraulic gradients with net gradients toward the river that resulted in NAPL movement from the high permeability overburden soils into the river, which has likely led to the NAPL distribution currently observed in the majority of the site.

In the lower portion of the former MGP, NAPL presence in the overburden fill has resulted in the presence of BTEX and PAHs in groundwater at wells MW-4 and MW-5, but not at MW-6. Based on groundwater-level monitoring data, groundwater flow is generally toward the river in both the overburden and bedrock; however, during high tide conditions, localized groundwater flow reversal occurs in the overburden immediately adjacent to the river. Based on the specific capacity test at five overburden wells, horizontal hydraulic conductivity values for the overburden materials ranged from approximately 0.04 to 50 feet per day (ft/day) with an average value of approximately 14 ft/day. Based on the specific capacity tests at three bedrock wells, the horizontal hydraulic conductivity values for the bedrock ranged from approximately 4 to 110 ft/day with an average value of approximately 42 ft/day. The test results indicate that both overburden and bedrock materials at the site have a relatively wide range of hydraulic conductivity values. For overburden, the large range in calculated hydraulic conductivity values is likely due to the heterogeneous nature of the fill materials in which the overburden wells are screened. During the tracer test study conducted as part of the in-situ chemical oxidation pilot test, the tracer migrated outside of the targeted area faster than predicted based on the hydraulic conductivity data, suggesting that the fill material adjacent to the river likely is more transmissive than the specific capacity testing data indicate. For bedrock, the large range in calculated hydraulic conductivity values is likely due to the distribution and density of fractures in the wells' open bedrock intervals.

4.2.2 River

NAPLs are likely present in the river sediments from historic migration and discharges associated with and near the former tar processing area of the former MGP; specifically between the former tar centrifuge house and the former northern generator house. Ongoing migration of NAPL from the upland to the river may also be occurring although based on the hydrogeologic conditions and the NAPL well recovery results this pathway appears to be more historic than current. Specifically, over the last almost 60 years since MGP operations were discontinued at the site, the tidally induced hydraulic gradients with net gradients toward the river have caused NAPL movement from the high permeability overburden soils into the river, which has led to the reduced NAPL levels currently observed in the upland except for the NAPL pool above the depression in the silt and clay unit near wells NMW-116S and NMW-117S. CHGE is currently removing the NAPL from this pool, which further reduces the potential for NAPL migration.

Historically, NAPL likely migrated through the subsurface from land to the river via various migration pathways that were influenced by tidally induced hydraulic gradients, capillary barriers and other site features. Where present, NAPL appears to have migrated laterally toward the river along capillary barriers (i.e. the top of silt/clay layers) and also laterally and vertically along former wooden structures (e.g., piles, tie backs). Placements of NAPL-impacted fill materials in the river during various reworkings of the shoreline/bulkhead and/or direct discharge of MGP coal tars to the river could also have occurred during MGP operations. There is historical documentation of potential NAPL seepage and discharge pathways associated with the former MGP operations. In the 1930s and early 1940s, NAPL seepage was reported near the dock area, near the tar separator area, and near the wooden bulkhead approximately 150 feet from the northwest corner of the property (Note at this time, Dutton Lumber, not CHGE, owned the parcel just south of Dutchess Avenue, which is the current location of the propane peaking plant and the natural gas regulator station). These descriptions generally correspond with the area where the tar processing facilities were located (approximately between the locations of wells NMW-113S and NMW-109S). CHGE investigated the seepage by excavating test pits behind the bulkhead and adjacent to the “open pile and plank covered bulkhead” north of the MGP along the river. No oils were observed in the fill at the northern corner of the MGP property; however, CHGE observed oil impacted fill behind the wooden bulkhead that was potentially attributed to previous spillage and piping failures. To address the potential seepage, CHGE conducted several actions including collecting the liquids in the fill behind the wooden bulkhead for chemical treatment and filtering; replacing the wood filter box associated with the tar separator with a steel filter box; and excavating approximately 1,000 cubic yards of fill (to a depth of approximately 4 feet below mean tide) from behind the dock and backfilling the excavation with clay (previously referred to in this report as the clay dike). In addition to the seepage investigation/mitigation activities, CHGE investigated discharge piping from the MGP operations as potential MGP tar and oil migration pathways to the river. A six-inch discharge pipe from the tar separator and filter, located 125 feet south of the north end of the wooden bulkhead, was identified as a potential pathway. To address this potential pathway, CHGE upgraded the separator system and installed a treatment system.

Recent investigations also evaluated potential NAPL migration pathways from the upland to the river. On November 14, 2003, CHGE, BBL, and NYSDEC conducted a reconnaissance of the shoreline during a period of very low tide. Based on the United States Geological Survey (USGS) records for monitoring station 01372058 located on the Hudson River just south of Poughkeepsie, New York, the minimum river elevation was -3.68 feet msl during the reconnaissance on November 14, 2003 (USGS). A former wooden bulkhead was observed 2 to 15 feet west of the existing concrete bulkhead. Based on historic documentation regarding the NAPL seepage from the 1930s and early 1940s, the wooden bulkhead was present during this time period; the newer concrete bulkhead was installed in the 1950s (based on available information). During the November 2003 reconnaissance, NAPL was observed within silty sand/gravel/cobble material approximately 10 to 15 feet from the existing concrete bulkhead and behind the former wooden bulkhead location near the locations of wells NMW-113S and NMW-112S. These observations correlate with shallow NAPL observations in the borings for wells NMW-113S and NMW-112S and likely represent an area of contiguous historic accumulations near the former tar processing area and behind the former wooden bulkhead. Alternatively, NAPL accumulations in the subsurface closer to the former tar processing area (i.e., closer to wells NMW-113S and NMW-112S) may have migrated toward the wooden bulkhead and river in the past resulting in the NAPL currently observed. It is also possible that the observed NAPL is the result of current seepage from the upland although NAPL has not been recovered from overburden wells NMW-113S and NMW-112S in this area.

A second reconnaissance was conducted in September 2004 during a low tide (but not as low as the November 2003 tide). During this reconnaissance, several small areas of sheens were observed adjacent to the bulkhead (generally between the locations of wells NMW-102S and NMW-113S). In addition, various pipes, outfalls, and/or culverts were observed along the shoreline at the former MGP site. Video inspection of abandoned pipes observed to daylight from the bulkhead along the Hudson River was performed on October 21, 2008. The locations of nine pipes along the bulkhead are shown on **Figure 3.** Video inspections were conducted at six of the nine pipes using a flexible pipe camera with a video recorder; open ends of the other three pipes were not accessible for inspection, as the pipes continued into the river. No NAPL or NAPL staining was observed in any of the six pipes inspected, and no NAPL was observed on the camera upon removal from the pipes. NAPL impacted sediments were observed below BH-PIPE-3 (**Figure 3**), which may or may not be related to historical discharges from this pipe.

Once the NAPL migrated to the river from either upland subsurface migration or direct discharge pathways, the NAPL appears to have accumulated and concentrated at the base of the steeply sloping eastern bank of the Hudson River. The most concentrated NAPL areas were observed within 200 feet from the shoreline and are present at depths of 0.5 to 3 feet and covered by less impacted fill and silt/clay sediments. In some areas, NAPLs that settled at the base of the sediment slope may have been subsequently covered with slag fill or the fill was deposited during shoreline construction projects (e.g. concrete bulkhead) or via erosion from the fill slopes toward the east. NAPL also appears to have migrated as a separate phase within the sediment. Similar to upland migration pathways, NAPLs migrated vertically downward in the sediment as well as horizontally. In some locations, NAPLs appear to have preferentially migrated along high organic sediment intervals. South of the former northern generator house to approximately the railroad bridge, NAPLs originating from within the river (likely from the north) appear to have migrated near the base of the sediment slope forming a continuation of the concentrated NAPL area that is generally narrower and starts approximately 100 feet from the shoreline. This continuation of the concentrated NAPL area is present at depths of 1.0 to 1.7 feet and covered by less impacted fill and silt/clay sediments.

Around the concentrated NAPL areas are less impacted NAPL areas generally represented by trace NAPL blebs in surface sediments. These NAPLs likely represent more recently deposited NAPL that result from erosion and deposition cycles of near surface NAPL-impacted sediments and/or NAPLs released from buried sediment during gas ebullition (NAPL carried upward via gas bubbles) or upward hydraulic gradients (from more concentrated NAPL areas). Conversely non-impacted sediments are also transported within the river by erosion/deposition processes resulting in the presence of non-NAPL-impacted sediments on top of NAPL-impacted sediments in certain areas. This less impacted NAPL area lies immediately adjacent to the more concentrated NAPL areas and extends north of the gas lines and at two locations south of the electric lines. Around the less impacted NAPL areas lie PAH impacted areas.

4.3 Constituents of Potential Concern

Based on the screening of sample data collected between 1990 and 2004 (refer to Section 3), BTEX and PAHs have been identified as the primary COPCs at the site. The following presents a discussion of general environmental fate and transport for these COPCs.

4.3.1 Benzene

The environmental fate and transport of benzene is primarily attributed to its high volatility (ATSDR, 2007a). In soil, benzene partitions to the atmosphere through volatilization, to surface water through runoff and to groundwater through leaching. Bioaccumulation of benzene in the aquatic food chain generally does not occur, and there is no scientific evidence of biomagnification. Aerobic biodegradation is the primary mechanism for degradation of benzene in soils, surface water and groundwater.

4.3.2 Toluene

The majority of toluene released to the environment partitions to air, although rates of volatilization from soils depends on temperature, humidity and soil type (ATSDR, 2000). Transport of toluene from soil to groundwater depends on the degree of adsorption to soil, which is mediated by the presence of organic matter. Toluene will be readily leached from soils with low organic content. Toluene can be metabolized, which limits its biomagnification in the food chain. Degradation of toluene in surface water, soil and sediment occurs primarily by microbial action.

4.3.3 Ethylbenzene

Ethylbenzene has a high vapor pressure and will partition into the atmosphere from surface soils and surface water; subsurface soil infiltration will also occur (ATSDR, 2007b). This chemical has a relatively high mobility in soils because sorption is not significant enough to prevent migration. Ethylbenzene will leach into groundwater, particularly in soils with low organic carbon content. Significant bioaccumulation does not occur in aquatic food chains. In surface water, ethylbenzene can be transformed via photo oxidation and biodegradation. In soils, aerobic soil microbes are responsible for biodegradation.

4.3.4 Xylenes

Xylenes are highly volatile and readily partition into the atmosphere from surface water (ATSDR, 2007c). In soils, xylenes tend to adsorb to organic matter, and will leach into groundwater from subsurface soils with low organic carbon content. Volatilization and photo oxidation are the primary removal mechanisms in surface soil and surface water. Biodegradation is the primary removal mechanism in subsurface soils.

4.3.5 PAHs

The transport and partitioning of PAHs in the environment are dependent on several chemical factors, such as water solubility, vapor pressure, Henry's law constant, octanol-water partition coefficient and organic carbon partition coefficient (ATSDR, 1995). Due to their low solubility and high affinity for organic carbon, PAHs in aquatic systems are generally sorbed to bottom sediments or particulate matter suspended in the water column. Biomagnification of PAHs generally does not occur because many aquatic organisms are able to metabolize (and eliminate) these compounds readily. Biodegradation is the primary mechanism for removal in sediments. In soils, PAHs can volatilize, undergo abiotic degradation, biodegrade, or bioaccumulate in plants. Some PAHs may leach into groundwater from subsurface soils.

4.4 Potential Exposure Points

An exposure point represents an area where humans may be exposed to site-related constituents in environmental media. Potential exposure points for each medium are discussed below.

4.4.1 Surface Soil

CHGE currently operates a natural gas regulator station and propane peaking plant at the site. Features associated with these operations include propane storage tanks, a high pressure compressed gas holder, subsurface and above-ground gas lines, and office/operations buildings. Although PAHs were detected in surface soils, the majority of the soils at the site are covered by impervious materials such as asphalt and buildings, which minimizes the potential for exposures. Total PAH concentrations measured in surface soils were generally within typical urban soil ranges (O'Brien & Gere Engineers, Inc., 2000).

4.4.2 Subsurface Soil/Bedrock

Subsurface soils in some areas of the site are impacted by NAPLs, and relatively elevated concentrations of BTEX and PAHs were observed within the lower portion of the site at depths generally deeper than 5 feet. Exposures of human receptors to the impacted overburden are possible, but unlikely due to the depth of the contamination and the presence of impervious surfaces at the site. Because overburden impacts were not observed outside the site boundaries to the north, east, and south, exposures to offsite receptors (e.g., utility workers involved in water or sewer line repairs) are also not expected.

Exposure to impacted bedrock is unlikely since bedrock is deeper than the overburden, except where bedrock outcrops are present on the upper portion of the site. The bedrock cliff separates the upper portion of the site from the lower portion of the site. Impacted bedrock was observed in the upper portion of the former MGP; however, NAPLs were not observed along the bedrock wall or in the abandoned pipes observed to daylight from the "bedrock wall" that separates the upper and lower portions of the site. Hardened tar staining was observed along the bedrock wall near the tunnel exit. Overall, exposure to the NAPL in the bedrock is not likely.

4.4.3 Groundwater

BTEX and PAHs have been detected in the bedrock and overburden groundwater resulting from the presence of NAPLs. In the upper portion of the site, NAPLs were observed in the overburden and bedrock; and in the lower portion of the site, NAPLs were observed in the overburden where groundwater is shallow (only 4 feet or less bgs).

Site groundwater is not used as a potable source so this medium does not represent an exposure point. Because the overburden and bedrock groundwater discharges to the Hudson River adjacent to the site, the surface water could be impacted by groundwater discharges containing site-related impacts. However, any impacts to surface water are likely attenuated via physical river processes (e.g., dilution).

4.4.4 Soil Vapor/Ambient Air

Soil vapor is unlikely to impact ambient air due to the depth of contamination and the presence of impervious surfaces that cover the majority of the site. Additionally, based on depth of contamination, soil vapor is not expected to migrate to indoor air.

4.4.5 Sediment/Surface Water

NAPL was observed in Hudson River sediments adjacent to the site at depths of 50 to 60 feet below the water surface, and these sediments contained elevated concentrations of BTEX and PAHs. NAPL impacted sediments have also been observed along the shoreline near the bulkhead during low tide, in an area of rip rap between the current concrete bulkhead and the former wooden bulkhead. Surface water sheens have been intermittently observed in the Hudson River adjacent to the site. Sheens appear to be associated with MGP NAPL impacts in sediments and also with other river usage (e.g., discharges from storm sewers or boats on the river). Sheens are not continuous and dissipate in the river system. However, potential human exposures could occur if receptors encounter these sheens.

Potential human exposures could also include the consumption of fish and crustaceans (e.g., blue crabs). However, PAHs typically do not concentrate in the fish parts that are consumed by humans (Brooks, 1997). Similar to fish, PAHs concentrate in crustacean organs that are not normally consumed by humans, except the hepatopancreas is sometimes eaten (Brooks, 1997). Because the Hudson River is a vast river (315 miles long) as opposed to a smaller river or confined water body and aquatic organisms are mobile, the relatively small area of elevated PAHs concentrations in the sediments adjacent to the site is even less likely to result in PAH concentrations in fish and blue crabs. Furthermore, there are fish consumption advisories (one meal per week) and blue crab consumption advisories (six crabs per week) in the Hudson River from Catskill to the New York Harbor for other contaminants.

4.5 Potential Receptors

Current CHGE operations only require workers to be onsite on an intermittent basis. The site perimeter is currently fenced and as such, site access is restricted for the general public. The main receptor groups for the site are workers employed by CHGE and subcontractors. Trespassers represent another potential receptor group for the site itself, and offsite receptors in the adjacent Hudson River may include recreational users such as fishermen and/or boaters.

4.5.1 Surface Soil

Overall, potential human exposures to constituents in surface soils at the site are unlikely for onsite workers because the majority of COPCs in surface soil were below NYSDEC (2006) Industrial SCOs. Additionally, the presence of impervious surfaces precludes direct contact exposures and these receptors would not be expected to be involved in intrusive activities. Further, workers employed by CHGE only frequent the site on an intermittent basis (i.e., the site is unoccupied for the majority of the time). A chain-link fence with locking gates surrounds the northern, eastern, and southern boundaries of the site (the western boundary is bounded by the Hudson River), which greatly minimizes the likelihood of trespassers accessing the site. Overall, potential human exposures to constituents in surface soils at the site are unlikely for trespassers as well as site workers. Potential exposure of site workers to impacted soils could be mitigated by the use of PPE.

4.5.2 Subsurface Soil and Bedrock

Exposure of site workers (e.g., CHGE employees) to subsurface soils and bedrock is unlikely because these receptors are not typically involved in intrusive activities. Likewise, trespassers would not be expected to be involved in intrusive activities at the site. Intrusive site workers such as construction workers could be exposed to surface and subsurface soils during possible future intrusive activities at the site, but potential exposure of these workers could be mitigated by the use of PPE.

4.5.3 Groundwater

Site groundwater is not used as a potable source and therefore, direct exposure of onsite and/or offsite receptors is not expected. Intrusive site workers could be exposed to site groundwater during future intrusive activities at the site. However, potential exposures of these receptors to impacted groundwater could be mitigated by the use of PPE.

4.5.4 Soil Vapor/Ambient Air

Because the majority of the site is covered by impervious surfaces (e.g., asphalt, buildings) and the depth of contamination at the site is relatively deep, soil vapor is not expected to migrate to ambient air. Likewise, based on depth of contamination, soil vapor is not expected to migrate to indoor air (nor are there any full-time indoor workers present in site buildings). Potential future exposure of intrusive site workers that may be exposed to soil vapor and ambient air at depth (e.g., in an excavation trench) could be mitigated by the use of PPE.

4.5.5 Sediment/Surface Water

Offsite and onsite receptors (e.g., trespassers, river recreational users and workers) could be exposed to impacted sediments or surface water when engaging in activities on the Hudson River adjacent to the site. River recreational users adjacent to the site could be exposed to COPCs in shoreline sediments and surface water within the Hudson River. Likewise, workers involved in activities along the Hudson River shoreline (e.g., bulkhead maintenance) could be exposed to shallow sediments and surface water. The 50 to 60 foot water depths in offshore areas and the nature of the near shore areas (i.e., concrete bulkhead, riprap/former wood pilings) make incidental exposure to impacted sediments unlikely. Additionally, potential exposure of workers could be mitigated by the use of standard health and safety practices.

Food chain exposures (e.g., ingestion of biota from the Hudson River) are not considered to be a significant pathway for offsite recreators. Site COPCs are not highly bioaccumulative and current consumption advisories already limit ingestion of fish and blue crab.

4.6 Exposure Routes

Generally, routes of exposure for MGP impacted media at the site include incidental ingestion, dermal contact, and inhalation. For site workers, potential exposures may be mitigated with the use of standard health and safety practices.

4.6.1 Surface Soil

Surface soil does not present a significant exposure pathway for trespassers or workers due to the presence of impervious surfaces. However, receptors may be exposed to COPCs in exposed, impacted surface soils via incidental ingestion, dermal contact, and/or inhalation of dusts and vapors. Potential worker exposures could be mitigated with the use of standard health and safety practices.

4.6.2 Subsurface Soil and Bedrock

Intrusive workers would be the only receptors that could potentially be exposed to subsurface soils and subsurface bedrock. Exposure routes for this receptor group may include incidental ingestion, dermal contact, and/or inhalation of dust and vapors. However, CHGE owns the site and would be able to control any future subsurface activities via institutional controls such as a site management plan.

Hardened tar staining was observed at one location on the exposed bedrock wall at the site. However, given the isolated location of this impact, exposure of trespassers and workers to this NAPL is not likely.

4.6.3 Groundwater

Site groundwater is not used as a potable source so there is no direct contact exposure potential for offsite receptors. Further, future potable use of site groundwater is unlikely given that there is a municipal supply. Specifically, the town and city of Poughkeepsie are both served by a public water supply from the Hudson River approximately 0.75 miles north of the site. According to previous investigations, there are no wells used for drinking water within one mile of the site (EA, 1987; BBL, 2000a).

Intrusive workers may be exposed to shallow groundwater during intrusive activities via incidental ingestion, dermal contact, and/or inhalation of vapors. However, potential exposures could be mitigated by the use of standard health and safety practices.

4.6.4 Soil Vapor/Ambient Air

Based on the presence of impervious surfaces at the site, soil vapor is not expected to impact ambient air. Additionally, site buildings are not currently occupied on a full-time basis so indoor air exposures via the vapor intrusion pathway are not expected to be significant. Further, depth to impacted media at the site is expected to minimize the potential for exposures.

4.6.5 Sediment/Surface Water

Onsite workers, trespassers, and offsite recreational users could be exposed to sediments and surface water along the shoreline of the Hudson River. Specifically, workers could be exposed to sediments and/or surface water via incidental ingestion and dermal contact during maintenance activities (e.g., bulkhead maintenance), although exposures could be mitigated by the use of standard health and safety practices. Offsite recreational users such as fishermen and boaters could be exposed to surface water with MGP-related sheens within the river channel via incidental ingestion and/or dermal contact, but exposure of these receptors to sediments is unlikely given the water depths in this area of the river.

As stated above, potential human exposures through consumption of fish and crustaceans (e.g. blue crabs) by a river user is unlikely because site-related COPCs are not highly bioaccumulative, and additionally, there are already consumption advisories in place for this area.

4.7 Summary and Identification of Complete Exposure Pathways

In summary, potential human receptors that may be exposed to impacted site media (surface soils, subsurface soil/bedrock, groundwater, soil vapor/ambient air, and surface water/sediment) include onsite workers, trespassers, and/or recreational users of the Hudson River. Sediment and surface water in the Hudson River represent potentially complete exposure pathways for workers, trespassers, and offsite receptors (i.e., recreational river users), but soil, groundwater, ambient air, and indoor air are not considered to be significant exposure pathways based on current land use. However, there is potential for some receptor groups to be exposed to site-related COPCs in these media under certain future conditions.

Although some impacted media may present potentially complete exposure pathways, the following factors mitigate the likelihood of such exposures occurring:

- A chain-link fence with locking gates surrounds the northern, eastern, and southern boundaries of the site (the western boundary is bounded by the Hudson River), which minimizes the likelihood of trespassers accessing the site.

- Because the site is owned by CHGE, and impacted media has not migrated offsite (except for to the river), CHGE workers/subcontractors are the primary potential receptors, and potential exposures can be mitigated by the use of standard health and safety practices and institutional controls such as a site management plan.

- A substantial portion of the site is covered by impervious surfaces such as asphalt, concrete, existing and former buildings/foundations, which serve to limit the potential for exposure to impacted surface soils.

- The overburden and bedrock groundwater is not used for drinking water at or within a one mile radius of the site.

- Due to the depth of impacted materials, the lack of occupied buildings on the site, and the generally impervious ground cover, indoor air and ambient air exposures originating from soil vapors are unlikely.

- The 50 to 60 foot water depths in offshore areas and the nature of the near shore areas (i.e., concrete bulkhead, riprap/former wood pilings) make incidental exposure to impacted sediments unlikely.

- Potential exposures by consuming fish and crabs are mitigated due to the fact that site-related constituents accumulate in portions of the organisms that are typically not ingested by humans, and fish and crab consumption advisories are in effect for the Hudson River for other known contaminants.

5. Fish and Wildlife Resource Impact Analysis

This Fish and Wildlife Resource Impact Analysis (FWRIA) identifies the fish and wildlife resources that exist on and in the vicinity of the site, and evaluates the potential for exposure of these resources to site-related constituents in environmental media. This FWRIA was conducted in accordance with the NYSDEC guidance documents entitled *Fish and Wildlife Impact Analysis for Inactive Hazardous Waste Sites* (NYSDEC, 1994) and *DER-10 Technical Guidance for Site Investigation and Remediation* (NYSDEC, 2010e). In accordance with these guidance documents, FWRIAs are conducted in a step-wise manner. Specifically, this FWRIA includes Part 1 (Resource Characterization), which consists of the following five steps:

1) identification of fish and wildlife resources

2) description of resources on site and within a 0.5-mile radius of the site

3) identification of contaminant migration pathways, and fish and wildlife exposure pathways

4) identification of contaminants of ecological concern (i.e., comparison of environmental data to screening benchmarks)

5) conclusions regarding the actual or potential adverse impacts to fish and wildlife resources

If no resources or exposure pathways are present, impact to resources are considered minimal and no additional analyses are required. If further evaluation or definition of potential ecological impact is necessary, then the process continues with a FWRIA Part 2 ecological impact assessment.

Tables and Figures related to the FWRIA are provided in **Attachment O**.

5.1 Ecological Characterization

Topographic maps and aerial photographs were reviewed to identify the general physical and ecological features of the site and surrounding areas. A site visit was conducted by a qualified biologist on June 28, 2010. Information gathered from these resources was used to develop a covertype map for the site and surrounding areas within a 0.5-mile radius of the site. The covertype map (**Figure O1**) classifies these areas into ecological communities based on physical characteristics and vegetation (e.g., industrial/commercial/residential, unconfined river, riparian fringe, and successional shrubland/woodland). As part of the ecological characterization, natural resources (i.e., rivers, wetlands) located within a 2-mile radius of the site were also identified. This information assisted in evaluating wildlife habitat value and human resource value for the site and surrounding areas.

5.1.1 Vegetative Covertypes

Land use in the vicinity of the site is primarily a mixture of residential, commercial, and industrial properties. Ecological communities within a 0.5-mile radius of the site were generally classified according to the NYSDEC (2002a) document entitled *Ecological Communities of New York State, Second Edition*. The four major covertypes identified within a 0.5-mile radius of the site are industrial/commercial/ residential, unconfined Hudson River, riparian fringe, and successional shrubland/woodland. A map depicting the spatial distribution of these covertypes is presented on **Figure O1**. Individual covertypes are described below. **Table O1** presents a list of dominant vegetation observed within each of the vegetated covertypes.

5.1.1.1 Residential/Commercial/Industrial Covertype

The majority of the site and surrounding areas are characterized as a mixture of residential, commercial, and industrial properties (**Figure O1**). The residential/ commercial/industrial covertype generally consists of industrial buildings, commercial businesses, single-family dwellings, apartment buildings, paved and gravel lots, public roads, mowed and landscaped roadsides and lawns with ornamental trees and/or shrubs (NYSDEC, 2002a). The majority of the site itself is covered by impervious surfaces (e.g., pavement, remnants of former structures) and current operations at the site include a propane peaking station and a natural gas regulator station.

5.1.1.2 Unconfined River Covertype

The Hudson River represents the unconfined river covertype, which is located directly west of the site (**Figure O1**). The unconfined river covertype is described as large, quiet, base level sections of streams with a very low gradient (NYSDEC, 2002a). The Hudson River runs through Poughkeepsie in a north-south direction. The section of the Hudson River adjacent to the site is influenced by oceanic tides. River water elevations adjacent to the site can fluctuate by approximately four feet throughout daily tidal cycles. The river banks are primarily composed of rip rap and concrete barriers or walls.

5.1.1.3 Riparian Fringe Covertype

The riparian fringe covertype is located along the banks of the Hudson River. This covertype consists of the narrow transitional zone between the river's edge and the developed upland areas (**Figure O1**). This covertype is characterized by a mixture of woody and herbaceous vegetation. Dominant mature trees and saplings/shrubs include black locust (*Robinia pseudoacacia*), sumac (*Rhus* spp.), and Norway maple (*Acer platanoides*). Dominant herbaceous groundcover includes grasses (*Poa* spp.). River grape (*Vitis riparia*), a vine species, is also present throughout this covertype.

5.1.1.4 Successional Shrubland/Woodland Covertype

The successional shrubland/woodland covertype is located in the south end of the site, near the elevated railroad bridge (**Figure O1**). This covertype is characterized by a mixture of woody and herbaceous vegetation, as well as former man-made structures and paved areas that are being colonized by successional species. A variety of mature trees, shrubs, and herbaceous vegetation are found within this covertype. Dominant trees include red oak (*Quercus rubra*), eastern white pine (*Pinus strobus*), northern catalpa (*Catalpa speciosa*), black locust, sumac, Norway maple, and buckthorn (*Rhamnus cathartica*). Dominant shrubs, vines and herbaceous vegetation include tartarian honeysuckle (*Lonicera tatarica*), multiflora rose (*Rosa multiflora*), black raspberry (*Rubus occidentalis*), grasses, common mullein (*Verbascum* spp.), chicory (*Cichorium* spp.), white sweet clover (*Melilotus alba*), milkweed (*Asclepias syriaca*), white aster (*Aster* spp.), Virginia creeper (*Parthenocissus quinquefolia*), and river grape.

5.1.2 Surface Waters

The main surface water body in the site vicinity is the Hudson River (to the west). During periods of low discharge, the freshwater/saltwater interface extends to the Poughkeepsie area (Frimpter, 1972). The NYSDEC best usage classifications for the stretch of the Hudson River adjacent to the site is Class A. According to New York Regulations Title 6 §701.6, the best usage of Class A waters is as a water source for drinking, culinary, or food processing procedures, primary and secondary contact recreation, and fishing. These waters shall be suitable for fish, shellfish, and wildlife propagation and survival.

5.1.3 Wetlands

According to the NYSDEC Freshwater Wetlands Map for Dutchess County, there are no state wetlands located within a 2-mile radius of the site (**Figure O2**).

The National Wetlands Inventory (NWI) Map for Dutchess County identifies numerous wetlands within a 2-mile radius of the site (**Figure O3**), including palustrine emergent, scrub-shrub and forested wetlands and riverine wetlands, but no wetlands (with the exception of the Hudson River) are located in close proximity to the site. The NWI wetland maps are generated by the U.S. Fish and Wildlife Service (USFWS) using stereoscopic analysis of high-altitude aerial photographs, and the majority of the mapped wetlands are not field verified.

5.1.4 Fish and Wildlife Resources

Due to the surrounding residential/commercial/industrial land use within the City of Poughkeepsie and the limited available natural habitat onsite, wildlife usage of the site is expected to be limited to common species typical of urban environments (e.g., small mammals, passerine birds). **Table O2** presents a list of biota that were observed in the vicinity of the site, as well as typical wildlife species that may utilize the site and/or surrounding areas based on the ecological communities present. The following subsections describe the ecological communities present at the site and/or surrounding areas and the typical fish and wildlife species that may utilize these areas.

5.1.4.1 Residential/Commercial/Industrial Covertype

The majority of the site itself and surrounding areas are classified as a mixture of residential, commercial, and industrial properties. Wildlife species that may use these covertypes generally consist of species that are adapted to urban environments. Typical wildlife species that may use these urban areas include, but are not limited to, avian insectivores (e.g., American robin), avian granivores (e.g., sparrows), mammalian herbivores (e.g., mice), and mammalian omnivores (e.g., raccoon). The residential/commercial/industrial covertype may offer some limited habitat to these species for foraging, nesting, and/or shelter, but regionally this covertype is likely of low value to wildlife.

5.1.4.2 Unconfined River Covertype

The Hudson River borders the site to the west. The Hudson River is a large river, and the section of the river adjacent to the site is influenced by tides. This section of the river is part of the Hudson River Estuary, which is a NYSDEC watershed protection program. Various species of fish are present within the river, including migratory species such as the American shad, striped bass, river herring, and the Atlantic sturgeon (NYSDEC, 2010a). A portion of the shoreline in the vicinity of the site is characterized by rip rap, concrete walls and embankments/structures. This type of shoreline mitigates the use of the river by terrestrial fauna due to lack of natural cover and vegetation. Where present, rip rap, underwater features, bridge supports, and shaded banks may provide marginal habitat to aquatic life.

5.1.4.3 Riparian Fringe Covertype

The riparian fringe covertype is located along a portion of the Hudson River shoreline. This covertype is characterized by a mixture of mature trees, shrubs, and herbaceous vegetation, and occupies the transitional zone between the river's edge and upland areas. The majority of the Hudson River shoreline near the site within this covertype is characterized by the presence of riprap and/or concrete bulkheads. The vegetated portions of this area most likely provides some limited habitat for birds and small mammals. Larger mammals such as whitetail deer or red fox most likely only use this covertype on a very limited extent due to the surrounding residential, commercial, and industrial land use.

5.1.4.4 Successional Shrubland/Woodland Covertype

The successional shrubland/woodland covertype is located in the south end of the site, near the elevated railroad bridge that crosses the Hudson River. This covertype is characterized by a mixture of mature trees, shrubs, and herbaceous vegetation that have colonized areas formerly containing manmade structures. This covertype most likely provides some habitat for birds and small mammals due to the presence of mature trees and groundcover. Larger mammals such as whitetail deer and red fox may use this covertype intermittently, but the relative size of this covertype coupled with the surrounding residential, commercial, and industrial land use likely limits its use by larger fauna.

5.1.5 Threatened/Endangered Species and Significant Habitat

An Information request for threatened/endangered species information was submitted to the NYSDEC Natural Heritage Program (NHP) on June 29, 2010 to inquire about the potential presence of sensitive species or habitats in the vicinity of the site. According to the NYSDEC response dated July 13, 2010, several species were recorded as occurring within the vicinity of the site. Specifically, the peregrine falcon (*Falco peregrinus* – state endangered), shortnose sturgeon (*Acipenser brevirostrum* – state endangered), false hop sedge (*Carex lupuliformis* – rare), and Virginia snakeroot (*Endodeca serpentaria* – state endangered) exist in the vicinity of the site (NYSDEC, 2010c). Peregrine falcons have been recorded as nesting on the mid-Hudson Bridge that runs between Poughkeepsie and Highland (NYSDEC, 2010c). However, the site itself does not provide suitable habitat for the peregrine falcon (e.g., tall buildings for nesting). The shortnose sturgeon may be present in the portion of the Hudson River adjacent to the site. The two vascular plants (false hop sedge and Virginia snakeroot) were recorded as occurring in Ulster County in the Mid-Hudson Woods, near the west shore of the Hudson River and as such, are not expected to be present at the site. Historical records (pre-1979) indicate the potential presence of other threatened/endangered plants in Ulster County (i.e., straw sedge [*Carex straminea*], golden corydalis [*Corydalis aurea*], velvety bush clover [*Lespedeza stuevei*], and heartleaf plantain [*Plantago cordata*]), although these plants would not be expected to be present at the site. Golden club (*Orontium aquaticum*) was historically recorded (ca. 1869) as occurring in Dutchess County in the City of Poughkeepsie; however, this plant species was not observed as occurring at the site.

According to the NYSDEC (2010a), the site is adjacent to a designated Significant Coastal Fish and Wildlife Habitat (i.e., Hudson River), which is part of New York State's Coastal Management Program. The section of the Hudson River adjacent to the site is also part of the Hudson River Estuary Program, which was created in 1987 by the NYSDEC. In coordination with state and federal agencies and public-private partnerships, this watershed protection program focuses on natural resource conservation and protection.

Information on federally listed threatened/endangered species for Dutchess County was obtained on-line through the USFWS website (specifically the USFWS Northeast Field Office). Based on available information for Dutchess County, the bald eagle (*Haliaeetus leucocephalus* – federally delisted, but still protected under the Bald and Golden Eagle Protection Act), Indiana bat (*Myotis sodalis* – federally endangered), Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus* – federal candidate species), shortnose sturgeon (federally endangered), bog turtle (*Clemmys muhlenbergii* – federally threatened), dwarf wedgemussel (*Alasmidonta heterodon* – federally endangered), and New England cottontail (*Sylvilagus transitionalis* – federal candidate species) are known or likely to occur within this county (USFWS, 2010). The USFWS generally recommends an evaluation of site habitat and consultation with the NYSDEC NHP to evaluate the potential presence of threatened/endangered species in the vicinity of the site.

The habitat requirements of the bald eagle are undisturbed areas near large lakes and reservoirs, marshes and swamps, or stretches along rivers where they can find open water with suitable fisheries (NYSDEC, 2009a). The habitat requirements of the Indiana bat are wintering locations such as caves and mines in which they hibernate, and summer locations consisting of surrounding areas for breeding and feeding on flying insects. There are eight hibernacula currently known in New York State in

Albany, Essex, Warren, Jefferson, Onondaga and Ulster Counties (NYSDEC, 2009b). The habitat requirements for the bog turtle are generally slow, shallow, muck-bottomed rivulets of sphagnum bogs, calcareous fens, marshy/sedge-tussock meadows, spring seeps, wet cow pastures, and shrub swamps; suitable habitat generally contains sedges and/or mossy cover (NatureServe, 2010). The New England cottontail generally prefers early successional forests (i.e., thickets) with dense undergrowth (USFWS, 2006). Suitable habitat for these upland species does not exist at the site or within the immediate vicinity of the site. The sturgeon species may be present in the Hudson River. The dwarf wedgemussel is a freshwater mussel and preferred habitat generally includes running waters of all sizes, from small brooks to large rivers with substrates consisting of sand, silt, and gravel (NYSDEC, 2009c). Because this mussel is a freshwater species and the portion of the Hudson River adjacent to the site is tidal, this aquatic species is not expected to occur near the site.

5.1.6 Observations of Stress

Based on observations of field staff during site visits, there is no evidence of stressed vegetation or negative impacts on wildlife within the site or surrounding areas.

5.1.7 Fish and Wildlife Resources Values

As part of the FWRIA, a qualitative assessment was conducted to determine the general ability of the area to support fish and wildlife. The following subsections provide a qualitative evaluation of the value of the identified covertypes to wildlife and the value of these wildlife resources to humans.

5.1.7.1 Value of Habitat to Associated Fauna

The qualitative assessment of habitat value is based on observations, research and professional judgment.

The site itself consists mostly of industrial buildings, propane storage tanks and pipelines, and paved roads and parking lots. Wildlife use of the site is expected to be restricted due to the limited availability of natural habitat, the presence of buildings and pavement, the small size of the site, and the surrounding commercial/industrial/ residential land use. Further, the entire perimeter of the site is fenced, which mitigates use of the site by larger fauna. Generally, urban landscapes do not provide high wildlife value due to the limited amounts of natural habitat for foraging, nesting, and/or cover. Common species such as small mammals and passerine birds that are typically adapted to urban environments may use this mixed residential/commercial/industrial covertype, although wildlife value is expected to be low.

Adjacent to the site, the Hudson River is a tidal river with portions of its shoreline characterized by a mixture of riprap and deteriorating concrete bulkhead walls, and riparian fringe (i.e., transitional, vegetated area between river's edge and uplands). This section of the river likely supports a diverse fishery. The river likely also serves as a potential water source to terrestrial and semi-aquatic fauna. The river is an important ecological resource in the vicinity of the site and is concluded to have moderate value to wildlife.

The riparian fringe covertype exists as a narrow swath along a portion of the Hudson River shoreline. This covertype is characterized by a mixture of mature trees, shrubs/saplings, and herbaceous vegetation. Although limited, the presence of natural vegetation may provide habitat for birds and small mammals. Use of this covertype by larger mammals is most likely restricted due to its small size and surrounding land use. Based on this information, the riparian fringe covertype is concluded to provide low value to local fauna.

The shrubland/woodland covertype exists in a small area in the southern portion of the site, near the elevated railroad bridge that traverses the Hudson River. This covertype is characterized by a mixture of mature trees, shrubs/saplings and herbaceous vegetation and may provide habitat for birds and small mammals. Use of this covertype by larger mammals is most likely very restricted due to the surrounding land use and its small size. Based on this information, this covertype is concluded to provide low habitat to local fauna.

5.1.7.2 Value of Resources to Humans

The site itself is relatively small and is comprised of buildings and other manmade structures, a large paved parking lot and roads. The site itself does not offer any natural resources that would encourage recreational use. However, the adjacent Hudson River may be used as a recreational resource for fishing and/or boating. The location of the river within city limits most likely limits its potential for wildlife observation. Hunting is prohibited in the vicinity of the site (i.e., within the City of Poughkeepsie). Land uses in the areas surrounding the site are likely to remain consistent in the future, and are not likely to be affected by activities or conditions at the site.

5.1.8 Fish and Wildlife Regulatory Criteria

The following New York State laws, rules, regulations and criteria are relevant to this FWRIA:

- Title 6 of the New York Codes, Rules and Regulations (6 NYCRR)
  - Part 608, Use and Protection of Waters
  - Part 664, Freshwater Wetlands Maps and Classifications
  - Part 701, Classifications — Surface Waters and Groundwaters
- Environmental Conservation Law — Chapter 43-B of the Consolidated Laws
  - Article 11, Fish and Wildlife:
    - §11-0503, Polluting Streams Prohibited
    - §11-0535, Endangered and Threatened Species
  - Article 15, Water Resources: Title 5, Protection of Water
  - Article 24, Freshwater Wetlands
- Criteria and Guidelines
  - Draft 6 NYCRR Part 375 Soil Cleanup Objectives for the protection of ecological resources (NYSDEC, 2006)
  - Technical Guidance for Screening Contaminated Sediments (NYSDEC, 1999)
  - Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario (Ontario Ministry of Environment and Energy, 1993)
  - Division of Water Technical and Operational Guidance Series (1.1.1) Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations (NYSDEC, 1998)

5.2 Impact Assessment

The FWRIA includes an impact assessment to determine the impacts, if any, on fish and wildlife resources. This impact assessment includes a pathway analysis, which determines if there are complete or potentially complete ecological exposure pathways to site-related constituents, and a criteria-specific analysis, which compares site data to Standards, Criteria, and Guidelines (SCGs). A criteria-specific analysis is only conducted for those exposure pathways that are considered to be complete.

5.2.1 Pathway Analysis

The objective of the pathway analysis is to evaluate potential pathways by which fish and wildlife receptors may be exposed to site-related constituents in environmental media. A complete exposure pathway consists of the following five elements: 1) contaminant source; 2) contaminant release and transport mechanisms; 3) potential point of exposure; 4) viable route of exposure; and 5) receptor population. If any one of these elements is missing, then the pathway is not considered to be complete and exposure cannot occur, irrespective of chemical concentrations in environmental media. Potential media of interest associated with the site include surface soils, subsurface soils, sediment, surface water, and groundwater. Potential exposure pathways associated with these media are discussed below.

5.2.1.1 Surface Soils

The NYSDEC (2010e) DER-10 guidance indicates surface soils are defined as 0 to 6 inches bgs for an FWRIA. Surface soil samples collected at the site from 2000 to 2010 included various depth intervals ranging from 0 to 2 feet bgs. Therefore, for purposes of this FWRIA, surface soils are assumed to include any depth interval within the top two feet, i.e., from 0 to 2 feet bgs. On-site surface soil samples collected from 2000 to 2010 (**Figure 3**) from areas considered to be an industrial area within an overall urban-type landscape (i.e., asphalt and buildings) with limited habitat. As such, these surface soil samples do not likely represent potential exposure points for ecological receptors as local fauna would not likely inhabit these areas.

5.2.1.2 Subsurface Soils

For purposes of this FWRIA, subsurface soils are defined as soils deeper than 2 feet bgs. Based on the behavior of typical wildlife that would be expected to inhabit an urban landscape, wildlife would not be exposed to subsurface soils during normal activities such as foraging or nesting. Therefore, exposure to subsurface soils is not considered to be a significant ecological exposure pathway.

5.2.1.3 Groundwater

Depth to groundwater at the site is approximately 4 feet bgs. Exposure of wildlife to groundwater would only occur if an animal were to burrow down to the water table, which is unlikely given the depth to groundwater at the site. Therefore, direct contact exposure to groundwater is not considered to be a significant ecological exposure pathway.

5.2.1.4 Sediment

For purposes of this FWRIA, surface sediments (0-0.5 feet bss) are assumed to be accessible to ecological receptors. The 160 surface sediment samples collected from the section of the Hudson River adjacent to the site from 2004 to 2010 (**Figure 6**) are used in this FWRIA. Because the Hudson River likely serves as a significant natural resource to local fish and wildlife, sediment within the river represents a potentially complete exposure pathway.

5.2.1.5 Surface Water

Surface water samples have been collected from the section of the Hudson River adjacent to the site, but these surface water data are historical and do not represent current conditions at the site. Because the Hudson River likely serves as a significant natural resource to local wildlife, surface water within the river represents a potentially complete exposure pathway. However, the evaluation of complete exposure pathways for the Hudson River will focus on sediment since more recent data are available for this medium and site-related constituents such as PAHs are expected to partition to this medium.

5.2.2 Criteria-Specific Analysis

The objective of the criteria-specific analysis is to evaluate potential ecological impacts for those media that represent potentially complete ecological exposure pathways (i.e., Hudson River sediments). Specifically, the criteria-specific analysis compares available sediment data to SCGs to identify COPC.

Sediments that are considered to be available to ecological receptors consist of those found in the top 6 inches. A total of 160 surface sediment samples were collected from the Hudson River, adjacent to the site, from 2004 to 2010. An additional 19 surface sediment samples were collected from locations upstream of the site in 2004 as part of a background study. Surficial sediment samples were analyzed for PAHs and TOC. Sediment data were compared to screening criteria from NYSDEC (1999) Technical Guidance for Screening Contaminated Sediments. Specifically, sediment data were compared to freshwater benthic aquatic life chronic and acute toxicity criteria because more criteria are available for fresh water and fresh water criteria are more conservative. This section of the river is considered part of the Hudson River estuary, and during periods of low discharge the fresh-salt water front extend up to Poughkeepsie the salt front can reach Poughkeepsie (Frimpter, 1992). As such salinity is temporally and spatially variable. Organic screening criteria are based on equilibrium partitioning and therefore, require adjustment based on site-specific TOC. **Table O3** presents the comparison of sediment data to the NYSDEC screening criteria; for comparison purposes, background sediment samples are also included in **Table O3**.

The majority of the surface sediment samples, including background samples, had exceedances of both the chronic and acute criteria for PAHs. The highest PAH concentrations in sediment were found in samples SED-114C and SED-128C collected in 2004. Sample SED-114C was collected near the southern portion of the site, approximately 175 feet from the river shoreline, just north of the elevated railroad bridge that traverses the Hudson River. Sample SED-128C was collected near the northern portion of the site, approximately 200 feet from the river shoreline. Sediment PAH concentrations north and south of the site are generally lower than those concentrations observed adjacent to the site. However, the Hudson River is a highly industrialized river with many point and non-point sources of contamination. Additionally, because the Hudson River is a large system and the aquatic species found within the river (e.g., migratory fish) generally have large home ranges, the exceedance of PAH sediment criteria at several locations near the site is not expected to pose a significant risk to fish and wildlife.

5.3 FWRIA Summary and Conclusions

The FWRIA for the site was conducted in accordance with NYSDEC (1994; 2010e) guidance. The site is a former MGP site that is generally characterized by paved lots and roads, industrial buildings, former building footprints, propane tanks, and former tank foundations. Natural habitats at the site are restricted to a narrow swath of riparian fringe along the shoreline of the Hudson River and a small successional shrubland/woodland area near the elevated railroad bridge that traverses the Hudson River. The Hudson River is located adjacent to and west of the site. Portions of the Hudson River shoreline consist of deteriorating concrete bulkhead structures and riprap. Surrounding land use in the vicinity of the site is predominately a mixture of residential, commercial, and industrial land use. The majority of the site itself and surrounding areas contain little natural habitat and as such, provide limited resources to local wildlife for foraging, nesting, and/or cover. Therefore, these developed areas are concluded to have low wildlife value. The Hudson River likely serves as an important natural resource to local fauna and as such, is concluded to have moderate wildlife value.

Surface soils, subsurface soils, groundwater, sediment, and surface water represent the media of interest at the site. The pathway analysis identified sediment and surface water within the Hudson River as potentially complete ecological exposure pathways. Depth to groundwater at the site precludes direct contact of ecological receptors with this medium. Due to the locations of the majority of surface soils (i.e., within industrialized areas of the site), these sample locations do not represent complete exposure pathways.

Sediment and surface water within the Hudson River represent potentially complete ecological exposure pathways. Recent sediment data (2004 – 2010) were compared to screening criteria to identify COPCs. Because no recent surface water data representing current conditions are available for the site and site-related constituents such as PAHs likely partition to sediment, the criteria-specific analysis for the Hudson River focused on sediments. The majority of the surface sediment samples, including background samples, had exceedances of both the chronic and acute screening criteria. The highest PAH concentrations in sediment were generally found near the site. However, because the Hudson River is a large system and the aquatic species found within the river (e.g., migratory fish) generally have large home ranges, the exceedance of PAH sediment criteria at several locations near the site is not expected to pose a significant risk to fish and wildlife.

6. Conclusions and Recommendations

6.1 Conclusions

As indicated in Sections 2 and 3, numerous land investigations at the site have been conducted between 1986 and 2010. These investigations have led to following key conclusions:

- PAHs were present in 13 of 22 surface soil samples above industrial use SCOs; no other parameters exceeded industrial use SCOs

- NAPL has been observed in soils in various locations throughout the site, as shown on **Figure 9** (plan view) and **Figure 10B** (cross section of borings/wells along the Hudson River shoreline).

- Recoverable NAPL has not been observed in any of the 21 bedrock NAPL monitoring wells along the river during site-wide NAPL monitoring events conducted between January 2004 and August 2010, indicating that migration of NAPL through bedrock is not likely an ongoing source of NAPL to the river sediments.

- Recoverable NAPL has been observed in only two of the 20 overburden monitoring wells along the Hudson River: NMW-116S and NMW-117S. Between January 2004 and August 2010, approximately 39 gallons of NAPL have been recovered from NMW-116S and approximately 604 gallons of NAPL have been recovered from NMW-117S. At NMW-116S and NMW-117S, the monitoring/removal data and enhanced NAPL recovery testing conducted in 2008 indicate that the “pool” of NAPL present in this area has been reduced since 2004, and continued decreasing NAPL volumes are expected to be recovered in the future from these wells.

  In addition, data from the enhanced NAPL recovery testing conducted at NMW-116S and NMW-117S indicate the following:

  - Pumping groundwater at one gpm from test wells NMW-116S and NMW-117S caused no apparent improvement in NAPL recovery

  - The hydraulics of the formation are dominated by high energy cyclic swings in gradient and absolute head driven by tides in the Hudson River

  - Pumping groundwater cannot appreciably influence the gradients or flow patterns of the system, such that increased NAPL recovery could be realized

- Based on the advancement of 17 soil borings and installation/monitoring of 16 temporary wells within and/or adjacent to the various former MGP holder/storage tank foundations, these structures are not current/ongoing sources of NAPL to the subsurface.

- Based on the advancement of 11 soil borings and installation/monitoring of 11 NAPL monitoring wells within the natural gas regulator station area, this area is not a current/ongoing source of NAPL to the subsurface.

- Based on the advancement of soil borings at the northern, eastern, and southern boundaries of the former MGP, it does not appear that MGP-related NAPLs have migrated offsite from the MGP within soil or at the top of bedrock.

- During the tracer test study conducted as part of the ISCO pilot test, the tracer migrated outside of the targeted area faster than predicted based on the hydraulic conductivity data, suggesting that the fill material adjacent to the river likely is more transmissive than the specific capacity testing data indicate.

- It does not appear that any of the abandoned pipes subject to video inspection are active/ongoing conduits for NAPL migration.

- Sediments are present in significant thicknesses above bedrock in the river. Sediment borings/probes were routinely advanced to depths of 10 feet or greater in 2004 and 2005. Between 23 and 49 feet of sediment was observed at the 13 near-shore sediment borings that were advanced to the top of bedrock in 2008. In addition, boring information for the nearby Mid-Hudson Bridge indicates sediment thicknesses of 58 to 133 feet. The uppermost sediments are predominantly silt/clay except for adjacent to the shoreline, where fill materials are present.

- Sheens have periodically been observed on the surface of the Hudson River. Based on visual observations and camera footage, it appears that at certain times surface water sheens are created when NAPL-coated gas bubbles are released from the sediment and are carried up through the water column and break open at the water surface.

- NAPL has been observed in Hudson River sediments adjacent to the site, as shown on **Figure 12** (plan view) and **Figure 10C through 10K** (cross sections).

- Of the 179 surface sediment samples collected, 147 samples had total PAH concentrations that exceeded the ER-L value of 4 mg/kg, and 83 samples had total PAH concentrations that exceeded the ER-M value of 45 mg/kg.

- Based on review of historical documents and other information, in addition to the former MGP, other potential sources that could affect sediment quality in the Hudson River near the site include: historic discharges from a combined storm/sanitary sewer just north of Dutchess Avenue, from a storm sewer just north of the Fall Kill, and from a storm sewer at the south end of Waryas Park at the end of Main Street; and/or historic spills and discharges from numerous industries along the Hudson River north and south of the site (e.g., an aniline dye manufacturer).

- Potential human receptors that may be exposed to impacted site media (surface soils, subsurface soil/bedrock, groundwater, soil vapor/ambient air, and surface water/sediment) include onsite workers, trespassers, and/or recreational users of the Hudson River. Sediment and surface water in the Hudson River represent potentially complete exposure pathways for workers, trespassers, and offsite receptors (i.e., recreational river users), but soil, groundwater, ambient air, and indoor air are not considered to be significant exposure pathways based on current land use.

- Sediment and surface water within the Hudson River represent potentially complete ecological exposure pathways. The majority of the surface sediment samples had exceedances of both the chronic and acute screening criteria. However, because the Hudson River is a large system and the aquatic species found within the river (e.g., migratory fish) generally have large home ranges, the exceedance of PAH sediment criteria at several locations near the site is not expected to pose a significant risk to fish and wildlife.

6.2 Recommendations

Upon completion of the sediment capping pilot study and the NYSDEC approval of this RI Report, CHGE proposes to prepare the Alternatives Analysis Report for the site in accordance with the BCA and DER-10.

Additional sediment sampling may be required following continued discussions between CHGE and the NYSDEC regarding establishment of a sediment clean-up goal for the site.

7. References

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. Toxicological profile for PAHs. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 2000. Toxicological profile for toluene. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 2007a. Toxicological profile for benzene. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 2007b. Toxicological profile for ethylbenzene. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 2007c. Toxicological profile for xylene. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

ARCADIS. 2008a. *Scope of Work – Evaluation of Enhanced DNAPL Recovery*.

ARCADIS, 2008b. *Work Plan for Supplemental Land/River Investigations*.

ARCADIS. 2008c. *Reactive Sediment Capping Field Demonstration Work Plan.*

ARCADIS. 2009. *Data Report – 2008 Supplemental Land and River Investigations.*

ARCADIS. 2010. *Work Plan for Supplemental Land/ River Investigations.*

Blasland and Bouck Engineers, P.C. 1990a. *Work/Quality Assurance Project Plan, Phase II Investigation.*

Blasland and Bouck Engineers, P.C. 1990b. *Phase II Investigation Report, Former Coal Gasification Plant Site, North Water Street Site.*

BBL, 2000a. Personal communication with John Glass, Dutchess County Department of Health, August 1, 2000.

BBL. 2000b. *Supplemental Preliminary Site Assessment Work Plan.*

BBL, 2000c. *Supplemental Preliminary Site Assessment.*

BBL. 2003. *Focused Investigation Work Plan.*

BBL, 2004a. *Data Report – 2003 Land Investigation Activities.*

BBL, 2004b. *Work Plan – 2004 Land and River Investigation.*

BBL. *2005a. Scope of Work – 2005 River Investigations – Addendum No. 1 to 2004 Work Plan.*

BBL. *2005b. Scope of Work – 2005 River Investigations – Addendum No. 2 to 2004 Work Plan.*

BBL, 2005c. *Data Report – 2004 Land and River Investigations*.

BBL, 2006. *Data Report – 2005 River and Land Investigations*.

Brooks, Kenneth, 1997. *Literature Review, Computer Model and Assessment of Potential Environmental Risks Associated with Creosote Treated Wood Products Used in Aquatic Environments for Western Wood Preserves Institute.*

EA Science and Technology, 1987. *Phase I Investigation, Poughkeepsie (North Water Street) Coal Gasification Plant Site, City of Poughkeepsie, Dutchess County, New York.*

Frimpter, M.H., 1972. *Ground-Water Resources of Orange and Ulster Counties, New York*, Geological Survey Water-Supply Paper, 1985, United States Government Printing Office, Washington.

Long, E.R. and L.G. Morgan, 1990. The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program. National Oceanic Atmospheric Administration (NOAA) Technical Memorandum No. 5, OMA 52, NOAA National Ocean Service, Seattle, WA.

NatureServe. 2010. Species profile on bog turtle (*Glyptemys muhlenbergii*). Available at http://www.natureserve.org/explorer/servlet/NatureServe?searchName=Clemmys+muhlenbergii. Updated February 2010.

NYSDEC. 1994. Fish and Wildlife Impact Analysis for Inactive Hazardous Waste Sites. October.

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

NYSDEC. 1999. Technical Guidance for Screening Contaminated Sediments. January.

NYSDEC. 2000. Voluntary Cleanup Agreement (VCA; Index Number D3-0004-99-04). March 2000.

NYSDEC. 2002a. Ecological Communities of New York State, Second Edition. January 2002.

NYSDEC. 2002b. March 18, 2002 letter to CHGE providing approval of Supplemental Preliminary Site Assessment (SPSA).

NYSDEC. 2005. Brownfield Site Cleanup Agreement (BCA; Index Number D3-0004-99-04). May 2005.

NYSDEC. 2006. New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document. September 2006.

NYSDEC, 2008a. January 20, 2008 e-mail from Hank Willems (NYSDEC) to Adam Etringer (CHGE) approving the *Scope of Work – Evaluation of Enhanced DNAPL Recovery*.

NYSDEC, 2008b. April 9, 2008 letter from Hank Willems (NYSDEC) to Adam Etringer (CHGE) providing approval of the *Work Plan – Supplemental Land and River Investigations*.

NYSDEC. 2009a. Bald Eagle Fact Sheet. Available at http://www.dec.ny.gov/animals/9383.html.

NYSDEC. 2009b. Indiana Bat Fact Sheet. Available at http://www.dec.ny.gov/animals/6972.html.

NYSDEC. 2009c. Dwarf Wedgemussel Fact Sheet. Available at http://www.dec.ny.gov/animals/25384.html.

NYSDEC. 2010a. Hudson River Estuary Program 2009-2010. Annual Report to Hudson River Estuary Management Advisory Committee (HREMAC).

NYSDEC. 2010b. Letter to Serese Marotta, ARCADIS, from Tara Salerno, NYSDEC, regarding the potential presence of threatened/endangered species or significant habitat near the North Water Street site. Dated July 13, 2010.

NYSDEC. 2010c. Peregrine Falcon Information for the Mid-Hudson Bridge. Available at http://www.dec.ny.gov/animals/34268.html.

NYSDEC, 2010d. April 9, 2010 ltr from Hank Willems (NYSDEC) to Adam Etringer (CHGE) approving the *Work Plan for Supplemental Land/ River Investigations*; superseded by (July 30, 2010 email from Hank Willems (NYSDEC) to Adam Etringer (CHGE).

NYSDEC. 2010e. DER-10 Technical Guidance for Site Investigation and Remediation.

O'Brien & Gere Engineers, Inc., 2000. *Polycyclic Aromatic Hydrocarbons in Urban Soils – Literature Review.*

Ontario Ministry of the Environment (OME). 1993. Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario. August. Raymond, Parish, Pine & Weiner, Inc., 1979. Zoning Map of the City of Poughkeepsie, New York adopted February 20, 1979.

USFWS. 2006. Species profile for New England cottontail. Available at http://www.fws.gov/northeast/pdf/necotton.fs.pdf. August. USGS, 2006. www.waterdata.usgs.gov/ny/nwis, USGS Station 01372058.

USFWS. 2010. Federally-listed species in New York State (revised October, 14, 2010). Available at http://www.fws.gov/northeast/nyfo/es/ColistCurrent.pdf.