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May 1, 2015

To: Diane Carlton, NYSDEC Region 7 (1PDF)
Holly Sammon, Onondaga County Public Library (1 bound)
Samuel Sage, Atlantic States Legal Foundation (1 bound)
Joseph Heath, Esq (Cover letter only)

Re: Letter of Transmittal –Wastebed B/Harbor Brook RI/FS Repository Addition

The below document has been approved by the New York State Department of Environmental Conservation (NYSDEC) and is enclosed for your document holdings:

- Wastebed B/Harbor Brook Revised Remedial Investigation Report dated March 2015

Sincerely,

John P. McAuliffe by CCC

John P. McAuliffe, P.E.
Program Director, Syracuse

Enc.

cc: Tracy Smith – NYSDEC
Chris Fitch, Brown & Sanford

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Division of Environmental Remediation, Remedial Bureau D
625 Broadway, 12th Floor, Albany, NY 12233-7013
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April 10, 2015

Mr. John P. McAuliffe, P.E.
Honeywell International, Inc.
301 Plainfield Road
Suite 330
Syracuse, NY 13212

Re: Wastebeds B/Harbor Brook Revised Remedial Investigation Report

Dear Mr. McAuliffe:

The New York State Department of Environmental Conservation (NYSDEC) has completed its review of the "Wastebeds B/Harbor Brook Revised Remedial Investigation Report" (RI) dated March 2015 and submitted with your letter dated April 2, 2015 (which included replacement pages for the March 2014 draft RI and CD copies of the complete RI). Based on our review, the RI is approved.

Please submit the draft Feasibility Study within 90 days of this letter. If you have any questions, please contact me at 518-402-9796.

Sincerely,

Tracy A. Smith

Tracy A. Smith
Project Manager

ecc: J. Gregg, NYSDEC
D. Hesler, NYSDEC
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April 2, 2015

Mr. Tracy Smith
Project Manager
New York State Department of Environmental Conservation
Remedial Bureau D
625 Broadway, 12th Floor
Albany, New York 12233

Re: Wastebed B/Harbor Brook Consent Order #D-7-0001-00-02
Revised Remedial Investigation Report

Dear Mr. Smith:

This letter provides replacement pages for insertion into the March 2014 Wastebed B/Harbor Brook Site Revised Remedial Investigation Report prepared by O'Brien & Gere.

- Revised cover page for Volume 1 and Volume 2 binders
- Revised spines for Volume 1 and Volume 2 binders
- Revised inside covers for Volume 1 and Volume 2 binders
- Revised report text (Volume 1)
- Revised Figures 20, 108, 115, and 116 (Volume 1)
- Revised Tables 238, 272, 281, 282, 283, 284, 285, and 286 (Volume 2) including overlapping double-sided pages, as appropriate.

Please contact Tom Conklin of O'Brien & Gere at (315) 956-6408 or me if you have any questions or comments.

Sincerely,

John P. McAuliffe by CCC

John P. McAuliffe
Program Director, Syracuse

Attachments (2 copies, 1 CD)

cc:	Mr. Harry Warner	NYSDEC Region 7 (1 copy, 1 CD)
	Mr. Maureen Schuck	NYSDOH (ltr only)
	Mr. Mark Sergott	NYSDOH (1 copy, 1 CD)
	Mr. Robert Nunes	USEPA (1 copy, 2 CDs)
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Mr. Steven Miller	Parsons (1 CD)
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Mr. Thomas Conklin	O'Brien & Gere (ec ltr only)

REVISED REPORT

VOLUME 1 – TEXT & FIGURES

Remedial Investigation
Wastebed B/Harbor Brook Site
Geddes and Syracuse, New York

Honeywell

March 2014, revised March 2015

O'BRIEN & GERE

Job No. 1163/39597

REVISED REPORT

Remedial Investigation
Wastebed B/Harbor Brook Site
Geddes and Syracuse, New York

Honeywell

Christopher C. Calkins
Program Manager
O'Brien & Gere Engineers, Inc.

March 2014, revised March 2015

O'BRIEN & GERE

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List of Acronyms

ACO	Administrative Consent Order
ARAR	Applicable or Relevant and Appropriate Requirement
bgs	Below Ground Surface
°C	Degrees Celsius
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980, also known as Superfund: Amended in 1986 by the Superfund Amendments and Reauthorization Act
COPC	Constituents of Potential Concern
CPOI	Chemical Parameters of Interest
CRS	Cultural Resources Survey
CSM	Conceptual Site Model
CSO	Combined sewer overflow
DAF	Dilution Attenuation Factor
DNAPL	Dense Nonaqueous Phase Liquid
EM	Electromagnetic
EPAR	Exposure Pathway Analysis Report
ERA	Ecological Risk Assessment
FEMA	Federal Emergency Management Agency
FS	Feasibility Study
GPS	Global Positioning System
HASP	Health and Safety Plan
HSA	Hollow Stem Auger
HHRA	Human Health Risk Assessment
IRIS	Integrated Risk Information System
LEF	Lower East Flume
LLS	Licensed Land Surveyor
MS	Matrix Spike
MSD	Matrix Spike Duplicate
MVA	Mercury Vapor Analyzer
MWH	Montgomery Watson Harza
NCP	National Oil and Hazardous Substances Contingency Plan
NEPA	National Environmental Policy Act
NWI	National Wetlands Inventory
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSFW	New York State Freshwater Wetlands
OCWA	Onondaga County Water Authority
ORP	Oxidation Reduction Potential
OSWER	Office of Solid Waste and Emergency Response
PCB	Polychlorinated Biphenyl
PCDD/PCDFs	Polychlorinated Dibenzo-p-dioxins and Polychlorinated Dibenzofurans
PCDD/Fs	Polychlorinated Dibenzo-p-dioxins and Polychlorinated Dibenzofurans
PID	Photoionization Detector
PSA	Preliminary Site Assessment
PSARCC	Precision, Sensitivity, Accuracy, Representativeness, Comparability,

	and Completeness
QAPP	Quality Assurance Project Plan
QC	Quality Control
RAGS	Risk Assessment Guidance for Superfund
RAOs	Remedial Action Objectives
RF	Risk Factor
RI	Remedial Investigation
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SB	Site Background
SLERA	Screening Level Ecological Risk Assessment
SVOC	Semivolatile Organic Compound
TAL	Target Analyte List
TCL	Target Compound List
TCLP	Toxicity Characteristic Leachate Procedure
TEF	Toxic Equivalency Factor
TEQ	Toxic Equivalencies
TIC	Tentatively Identified Compound
UEF	Upper East Flume
USACOE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USSCS	United States Soil Conservation Service
VOC	Volatile Organic Compound

Executive Summary

Introduction

This document is the revised Remedial Investigation (RI) Report for the Wastebed B/Harbor Brook Site (the Site) in Geddes and Syracuse, New York and was performed pursuant to the Administrative Consent Order (D-7-0001-00-02) between the New York State Department of Environmental Conservation (NYSDEC) and Honeywell International, Inc. (Honeywell) dated April 10, 2000 (NYSDEC, 2000). The RI was performed in accordance with the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (USEPA, 1988) and Part 300.68 of the National Contingency Plan, CERCLA as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986.

This document includes discussion of data collected during the Preliminary Site Assessment, RI, and Supplemental RI between 2000 and 2007. It also contains data collected in 2004 and 2005 during pre-design investigation work for interim remedial measures (IRMs) being implemented under Consent Order #D-7-008-01-09 at the Site and borings advanced during the I-690 bridge replacement (I-690 Limited Investigation), as well as data from previous investigations. Data collected during the design of the IRMs, such as data collected from the Outboard Area in 2008 and 2010, are not presented within this report.

These data were used to develop the understanding of the site including the nature and extent of CPOIs and identification of potential source areas. Subsequent to the completion of the data collection associated with the RI, these data were used to develop designs for the Site IRMs and these IRMs have been implemented to mitigate potential Site impacts. The implementation of these IRMs and other Site efforts has resulted in significant changes to the Site including the Lakeshore Area, AOS#1, the Railroad Area, Penn-Cann Property, Harbor Brook, East Flume, and on-site ditches. The data presented in this report, the data collected as part of the SYW-12 Sources of Contamination Investigation, and the data collected during the design of the various IRMs will be considered during the feasibility study.

Site Description

The Wastebed B/Harbor Brook Site consists of four areas: 1) Harbor Brook, 2) the Lakeshore Area (including Wastebed B, the East Flume (now abandoned), Dredge Spoils Areas (DSA) #1 and #2, wetlands along the lakeshore, and the Route I-690 drainage ditch), 3) the Penn-Can Property, and 4) the Railroad Area. Two additional areas of study (AOS) were added at the request of NYSDEC and include areas east of Harbor Brook, to the north (AOS #1) and south (AOS #2) of I-690. A description of these areas, as well as the AOS east of Harbor Brook, is presented in Section 1.4 below. A Site location is included as **Figure 1**, and Site Plan is included as **Figure 2**. The SYW-12 area was added to the Site during the Supplemental RI. The SYW-12 Site Plan is included as **Figure 3**.

In accordance with the Consent Order, the East Flume and DSAs #1 and #2, originally investigated as part of the Willis Avenue Chlorobenzene Site RI (O'Brien & Gere, 1999), are part of the Wastebed B/Harbor Brook Site. Accordingly, results from the previous investigations of these areas are presented in this document.

Project Objectives
The objectives of the RI were to:

- Collect additional data necessary to evaluate and characterize the nature and extent of Site-related chemical parameters of interest (CPOIs)
- Further evaluate potential CPOI migration pathways
- Evaluation of potential risks to human and ecological receptors via performance of formal risk assessments in accordance with USEPA Risk Assessment Guidance for Superfund (RAGS) and Ecological Risk Assessment Guidance for Superfund (ERAGS) guidance documents
- Identify Preliminary Remedial Action Objectives (RAOs)
- Gather sufficient data to support the FS

Site Conceptual Model
The conceptual site model (CSM) was developed according to the guidelines presented in *Data Quality Objectives for Remedial Response Activities* (USEPA, 1987). The information presented herein is based on the data obtained during the PSA, RI, Supplemental RI, Harbor Brook Sediment IRM (BBL, 2001), Wastebed B/Harbor Brook IRM, I-690 Limited Investigation, and Wastebed B Geotechnical Investigation. The CSM is presented on **Figures 115 and 116**.

Source Areas
Review of data collected during the PSA, RI, Supplemental RI, Harbor Brook Sediment IRM (BBL, 2001), Wastebed B/Harbor Brook IRM, I-690 Limited Investigation, and Wastebed B Geotechnical Investigation and previous studies indicate that the following potential Site-related source areas are present within the Wastebed B/Harbor Brook Site and SYW-12. The areas are:

- The former Barrett Paving Facility
- Historic East Flume discharges
- Historic placement of fill materials (SYW-12, AOS#1, Wetland Area #2, and DSAs)
- Solvay waste associated with Wastebed B
- Co-disposal of other wastes with the historic placement of Solvay waste
- Undigested sewage sludge placed on Wastebed B

Other possible sources of Site-related CPOIs at the Wastebed B/Harbor Brook Site include the Willis Avenue Chlorobenzene Site, the Ballfield Site, and anthropogenic sources (*i.e.*, I-690 drainage, past and present railroad operations, general urban run-off, *etc.*). Wastebed B/Harbor Brook Site-related CPOIs within the East Flume were likely from past operations at the Willis Avenue Facility and ground water infiltrating into the flume. It is believed that anthropogenic sources are also impacting Harbor Brook and historically the East Flume, as well as the adjacent areas.

An apparent source of coal tar residues, including dense non-aqueous phase liquid (DNAPL), was identified in the eastern central portion of the Penn-Can Property. The coal tar residues are associated with the historic operations of the former paving facilities that were located on the central and eastern portions of the Penn-Can Property. These residues are likely present due to releases from the former Barrett Paving facility. Residues from this source area migrated into the subsurface and then down slope through coarse lenses of marl and along the top of low-permeability (confining) geologic units (*i.e.*, silt/clay and till) to the Lakeshore Area, downgradient portions of the Railroad Area, Harbor Brook, portions of AOS # 2, and portions of AOS #1. Ground water has also been impacted in areas

associated with the residues. Soils and surface water have been impacted in areas where shallow and intermediate ground water discharge to surface water bodies (Harbor Brook, I-690 drainage ditch, and other site related ditches).

Dredge spoils from the former UEF were placed in DSA#1 around 1980. These spoils were impacted by CPOIs prior to placement from process and storm water from the former Syracuse Works Main Plant and the former Willis Avenue Plant and potentially from ground water migrating from the Willis Avenue Chlorobenzene Site. Subsequently, constituents from DSA#1 have migrated via ground water and have impacted soils and ground water in the western portion of the Lakeshore Area and surface water and sediment within the former UEF.

Dredge spoils from Onondaga Lake were placed in DSA#2 in 1977 during reconstruction of the East Flume, in particular during installation of the thermal diffuser discharge pipe. Spoils placed in DSA#2 were previously impacted by CPOIs from a variety of sources including historic East Flume discharges associated with the formation of the in-lake waste deposit (ILWD). CPOIs associated with the black stained material in DSA#2 have likely leached from the soil matrix and migrated via ground water and have impacted soils and ground water in the northern central portion of the Lakeshore Area, and surface water and sediment within the former LEF.

AOS #1 and other wetland areas along the lakeshore of the Harbor Brook Site have likely been impacted by historical discharges from the East Flume associated with the formation of the ILWD. AOS#1 and Wetland Area #2 near the mouth of Harbor Brook both appear to have received some fill material in the past; however, the source of this fill is unknown. These two areas have also likely been impacted by Harbor Brook discharges. CPOIs from these areas have migrated via ground water and have impacted soils and ground water in the western and central portion of the Lakeshore Area, and surface water and sediment within Harbor Brook.

There are several possible sources of constituents detected at SYW-12. These include the former Marley property (a former scrapyard on the DestiNY USA mall property), Oil City, materials used to fill the former Onondaga Creek channel/Iron Pier area), materials dredged from the barge terminal area of Onondaga Creek (NYSDOH 1946), materials dredged from Onondaga Lake, MGP wastes, upgradient Solvay waste found during the construction of Carousel Center, and Ley Creek (*e.g.*, during flooding events). In addition, the presence of PXE and PTE in SYW-12 soils suggests a potential influence from Semet material.

Based on historic maps and aerial photos, this area appears to have been filled between 1915 and 1926. Based on the 1946 NYSDOH document, dredge materials were placed along the southern shore of Onondaga Lake which may have included SYW-12. In addition, the current Onondaga Creek channel adjacent to the former MGP site was widened and/or may have been deepened to allow for barge traffic. It is unknown whether any of these materials were disposed of at SYW-12. These dredge materials may have been impacted by the former adjacent MGP plant, Oil City, or other sources.

The mechanics of deposition and/or transport of contaminated materials likely include direct disposal (*e.g.*, dredged material placement) and migration from potential upgradient sources (*e.g.*, former Marley property, Oil City, Ley Creek). The migration pathway(s) of CPOIs from the potential upgradient sources are not clear but may have included historic overland flow through culverts beneath the railroad tracks and the former Onondaga Creek channel since the shallow ground water

does not appear to be impacted to the same extent as the soils at the Site. Therefore, it may be difficult to differentiate between sources of CPOIs at SYW-12. A separate investigation has been undertaken to evaluate the potential sources of impacts to the SYW-12 area. The results of this investigation will be provided under separate cover.

Impacted Media and Potential Transport of CPOIs

Impacted media include soil (surface and subsurface), ground water, sediment, surface water, wetland sediment, and soil vapor. The migration pathways are discussed in Section 6. The following pathways are considered to be viable migration pathways at the Site:

- Shallow and intermediate ground water migration to adjacent water bodies and downward migration into the deep ground water zone
- Deep ground water migration
- DNAPL migration
- Surface water run-off or leaching
- Wind-borne particulate migration
- Vapor migration
- Surface soil to human and ecological receptors
- Surface water and sediment to human and ecological receptors

The majority of shallow and intermediate ground water flows north towards Onondaga Lake. However, some component of the shallow and intermediate groundwater moves eastward from the eastern portion of the Penn-Can Property. This portion of ground water appears to be impacting the down gradient areas (Lakeshore Area, Railroad Area, AOS#1, and Harbor Brook) with contaminants associated with the DNAPL from the Penn-Can Property. It should be noted that shallow and intermediate ground water with these CPOIs will be collected by the Wastebed B/Harbor Brook IRM collection system.

The base of the deep ground water unit is pitched towards Onondaga Lake. Coal tar-like DNAPL was identified in the deep ground water unit (coarse sand and gravel) at five of 13 borings on the Penn-Can Property that were drilled to this terminal depth. This coal tar-like DNAPL on the Penn-Can Property could potentially migrate along the pitched coarse sand and gravel and impact the deep ground water zone along the lakeshore. However, currently there is no evidence that this DNAPL is impacting the deep ground water zone along the lakeshore. Ground water density differences between upgradient deep ground water and native brines under the lake may limit the movement of water within the deep unit. Therefore, northward transport of dissolved CPOIs in the deep ground water under the Penn-Can Property is expected to be limited.

DNAPL from historic sources on the Penn-Can Property appears to have migrated primarily in coarse layers within the marl along flow paths that parallel the direction of ground water. This coal-tar DNAPL has migrated towards Onondaga Lake beneath the Lakeshore Area (Wetland Area #2), western portions of AOS #1, and beneath lower Harbor Brook along the top of the marl layer. DNAPL is also currently migrating into the upper portions of Harbor Brook between AOS #2 and the CSX Railroad Area.

Surface soils may be eroded from the Penn-Can Property via surface water run-off, and CPOIs could potentially be carried to the north towards State Fair Boulevard or to the south towards the CSX railroad. Surface soils may be eroded from the Lakeshore Area via surface water run-off, and CPOIs could potentially be carried to the north towards Onondaga Lake or to the south towards the I-690 drainage ditch. This migration is unlikely due to the dense vegetation generally found within the area. The Dredge Spoil Areas (#1 and #2) and AOS #1 are similar, and transport of constituents via wind is also expected to be limited due to vegetation. CPOIs in surface soils at the Site have the potential for uptake by receptors utilizing the Site. Receptors include both human and ecological receptors.

Surface soils may be eroded via wind, and CPOIs could potentially be carried off each of the areas of the Site. This migration of CPOIs is unlikely due to the dense vegetation generally found on each of the areas. The exceptions to this are portions of the Penn-Can Property and the western portion of the Railroad Area that are sparsely vegetated.

Volatile CPOIs found in soil and ground water may enter the vapor phase. Once in the vapor phase, these compounds can migrate through soil and into the atmosphere. These compounds have the potential to enter the structures on the Penn-Can Property and Lakeshore Area.

Shallow ground water on SYW-12 likely flows toward Onondaga Lake and Ley Creek. Limited CPOIs are found in ground water, because the CPOIs are likely bound to subsurface soils. Due to the random nature of the distribution of stained soils in areas outside the former Iron Pier area, it is difficult to discern a relationship between past practices of fill placement and/or disposal. As discussed above, CPOIs are likely related to several sources including placement of fill material in the former Onondaga Creek channel/Iron Pier area and potential upgradient sources. As stated previously, an additional investigation has been undertaken to further evaluate potential sources of CPOIs at SYW-12 and the results of this investigation will be provided under separate cover.

Surface soils transport is expected to be limited due to heavy vegetation on SYW-12. CPOIs in surface soils at the Site have the potential for uptake by receptors utilizing the Site. Receptors include both human and ecological receptors. Volatile CPOIs found in soil and ground water may enter the vapor phase, however no structure exists on the property.

Risk Assessment Summary

Potential Human and ecological receptors are discussed in the NYSDEC-approved *Wastebed B/Harbor Brook Site Human Health Risk Assessment Revised Report* (O'Brien & Gere, 2009) and the *Wastebed B/Harbor Brook Site Baseline Ecological Risk Assessment Revised Report* (O'Brien & Gere, 2011). A brief risk assessment summary is provided below. It should be noted that completed and on-going IRMs at the site have mitigated or will mitigate many of the potential risks identified in these documents.

Human Health Risk Assessment

The HHRA indicated that cancer risks and non-cancer hazards were within acceptable limits for the Surveillance Worker, Drainage Ditch Worker, and Railroad Worker. Cancer risks and/or non-cancer hazards exceeded the acceptable regulatory thresholds for the adult and child trespassers, utility workers, commercial/industrial workers, adult and child recreators, construction workers, and potential future adult and child residents under the reasonable maximum exposure (RME) scenarios.

The greatest cancer risk posed to current receptors is 2 x 10^{-3} for the adult trespasser and the greatest non-cancer hazard is 30 for the same receptor. The greatest cancer risk and non-cancer hazard posed to a potential future receptor is for the future child resident. The cancer risk of 7 x 10^{-1} is driven primarily by exposure to ground water as a drinking water source and to surface soil. The non-cancer hazard of 8 x 10^{2} is also driven primarily by exposure to ground water as a drinking water source and to surface soil. The use of ground water at the Site for potable applications is considered hypothetical and is extremely unlikely for several reasons: 1) the area is supplied by municipal water from OCWA; 2) the yield of the overburden ground water unit is inadequate for water supply wells; and 3) the high salinity of the deep aquifer (3,000 mg/l chloride) precludes its use as drinking water.

Baseline Ecological Risk Assessment

Multiple methods were utilized within the BERA to evaluate potential exposures and related risks posed to Site ecological receptors. Lines of evidence were developed for the BERA based on toxicological effects, receptor exposures, and field observations at the Site. Average and upper bound detected constituent concentrations in Site surface soil, sediment, surface water, and groundwater were screened against appropriate criteria to evaluate risk to terrestrial plants, soil invertebrates, aquatic organisms, wildlife, benthic invertebrates, and fish. Potential risk to upper trophic level receptors was modeled as an additional line of evidence in this assessment, including the American robin, short-tailed shrew, red fox, red-tailed hawk, belted kingfisher, great blue heron, and mink, based on conservative assumptions in the determination of uptake factors for prey items. These lines of evidence indicate that adverse ecological effects were identified at each of the trophic levels examined.

The site was evaluated as four separate exposure areas that included the main site, aquatic areas (East Flume, Harbor Brook, and site ditches), lakeshore wetlands, and SYW-12. Risks to terrestrial ecological receptors were primarily driven by metals, assorted SVOCs, assorted VOCs, assorted pesticides, and dioxin equivalents. Risks to aquatic receptors were driven primarily by metals, PCBs, assorted SVOCs, assorted VOCs, and dioxin equivalents.

Conclusions

Review of the data collected during the PSA, RI, Supplemental RI, and other investigations suggests that the sources of contamination at the Site are related to historical activities at the Penn-Can Property, Willis Avenue Chlorobenzene Site, historic East Flume discharges, Solvay waste disposal, and the likely co-disposal of coke plant waste products, the placement of fill materials in several areas (AOS#1, DSA#1 and #2, wetland area #2, and SYW-12) at the Site, and potential upgradient sources to SYW-12 as discussed above, and undigested sewage sludge placed on the eastern portion of Wastebed B by Onondaga County and the City of Syracuse during the late 1950s and early 1960s. Based on the investigations conducted, the following conclusions have been developed.

- The Site geology consists of seven distinct layers including fill, Solvay waste, marl, silt and clay, silt and fine-grained sand/basal sand and gravel, till, and bedrock.
- The marl layer pinches out to the south away from the lake.
- The silt and clay confining unit pinches out beneath the Penn-Can Property that provided a pathway for the downward migration of DNAPL.
- The Site has three distinct ground water zones including:
  - a shallow zone that includes the fill layer and underlying Solvay waste (when present);

  - an intermediate zone that consists of a fine-grained marl layer; and
  - a deep zone that encompasses the silt and fine grained sand deposits and the basal sand and gravel deposits.
- Shallow and intermediate ground water generally flow towards and discharges into Onondaga Lake.
- A small component of ground water flows radially outward and discharges to surface water bodies (on-site drainage ditches and Harbor Brook, and historically the East Flume).
- Horizontal hydraulic conductivities in the ground water zones are:
  - shallow zone ranges from 10^{-2} to 10^{-4} cm/sec,
  - intermediate zone ranges from 10^{-3} to 10^{-4} cm/sec, and
  - deep zone ranges from 10^{-2} to 10^{-4} cm/sec.
- CPOIs at the Site include BTEX, chlorinated benzenes, naphthalene and assorted PAHs, phenolic compounds, PCBs, PCDD/PCDFs, and inorganics.
- CPOIs in soil vary between the sub-areas.
  - Chlorinated benzenes and mercury tend to be more prevalent on the western portion of the lakeshore area near the former East Flume.
  - Chlorinated benzenes are more prevalent in soils impacted by historic East Flume discharges.
  - Naphthalene and assorted PAHs tend to be more prevalent on the eastern portion of the lakeshore area, AOS#1, and the Penn-Can Property than other portions of the main site.
  - Assorted PAHs are prevalent in SYW-12 soils, and analytical results indicated that lubricating oil and fuel oil #6 are present as well.
- CPOIs are randomly distributed within the spoils material deposited in areas DSA#1, DSA#2, wetland areas along the lakeshore (WL2 through WL4), AOS#1, and SYW-12.
- CPOIs in shallow and intermediate ground water were similar throughout the Site; dominant CPOIs are BTEX, naphthalene and assorted PAHs, phenolic compounds, and inorganics.
- Chlorinated benzenes were also observed in Lakeshore Area shallow and intermediate ground water wells.
- Deep ground water CPOIs on the Penn-Can Property and Railroad Area include BTEX, naphthalene, assorted PAHs, phenolic compounds, and inorganics.
- Deep ground water at the eastern end of the Lakeshore Area (HB-HB-20D) is not currently impacted by Site related constituents; however, coal tar-like DNAPL is located upgradient in the deep ground water.
- CPOIs in surface water include BTEX, PAHs, and inorganics. Individual VOCs and SVOCs differ between surface water bodies.
- CPOIs in sediment are typically BTEX (particularly benzene), chlorinated benzenes, PAHs, PCDD/PCDFs, PCBs, and inorganics. Acetone is also observed in Penn-Can Property, Railroad Area and AOS #2 sediments and is likely a degradation product of benzene.
- The nature and extent of DNAPL at the Site is well-defined.
  - The source of the coal tar-like DNAPL is related to historic activities on the Penn-Can Property (Barrett Paving).
  - The source of the chlorobenzene DNAPL in HB-SB-01 on the western portion of the Lakeshore Area is related to operations at the former Willis Avenue Chlorobenzene Plant and historic East Flume discharges.
- The coal tar-like DNAPL occurs:
  - in the fill, marl and deep (coarse sand above the till) units on the Penn-Can Property,
  - in the marl unit on the eastern portion of the Lakeshore Area,

  - in the eastern portion of the Railroad Area,
  - beneath Harbor Brook, and
  - in the western portion of AOS #1.
- Stained soils are observed in DSA #1, DSA #2, wetland areas WL2 through WL4, and AOS #1, , which are most likely related to historic East Flume discharges associated with the formation of the ILWD.
- The lubricating oil and Fuel Oil #6 constituents indicate that upgradient sources such as the Marley property and Oil City may have impacted SYW-12.
- Stained soils and "tarry" soils at SYW-12 may be related to materials used to fill the former Onondaga Creek channel (former Iron Pier area) and potential upgradient sources as discussed above. An additional investigation was undertaken to identify the extent and the source of the "tarry material" observed in borings at SYW 12, and the results of this investigation are provided under separate cover (O'Brien & Gere, 2014).
- The presence of PXE and PTE in SYW-12 soils suggest a potential influence from Semet material.
- The nature and extent of the spoils material and stained soils are well defined.
- Current Site conditions indicate that constituents associated with the stained soils have the potential for CPOIs to be leached from these materials.
- Constituent concentrations exceeding media-specific criteria indicate potential impacts to Site receptors.
- Elevated detection limits within all media data that are above guidance values suggest potential impacts to Site receptors.

The nature and extent of CPOIs are well defined, and no further site characterization is warranted.

Preliminary remedial action objectives (RAOs)

Based on the results of the PSA, RI, Supplemental RI, IRMs, geotechnical investigation, I-690 Limited Investigation, and previous studies, the following list of preliminary RAOs has been developed.

- Restore, to the extent practicable, ground water quality to levels that meet state and federal water quality standards, and/or guidance.
- Eliminate, to the extent practicable, unacceptable risks to human receptors associated with direct contact to soils, ground water, surface water and sediment, and inhalation of soil vapors.
- Prevent or minimize, to the extent practicable, adverse ecological impacts to biota from ingestion/direct contact with soil/fill material/Solvay waste/sediment/surface water causing toxicity or impacts from bioaccumulation through the terrestrial food chain. (This was partially addressed as part of the East Flume IRM in accordance with Order on Consent #D-7-0002-01-09, the Wastebed B/Harbor Brook IRM in accordance with Order on Consent #D7-0008-01-09, and the Outboard Area IRM in accordance with Order on Consent # D7-0008-01-09).
- Reduce, to the extent practicable, the level of contaminants in Harbor Brook, on-site ditches, and wetlands surface water and sediment to attain surface water ARARs and sediment remedial goals to be protective of fish, wildlife, and the resources on which they depend.
- Eliminate, to the extent practicable, the migration of constituents of potential concern (COPCs) via ground water, surface water, and sediment to Harbor Brook and Onondaga Lake. (This is currerntly being addressed as part of the Wastebed B/Harbor Brook IRM in accordance with Order on Consent #D-7-0008-01-09).

- Eliminate, to the extent practicable, the migration of soil vapor contaminants to indoor air at concentrations that result in unacceptable health risks.
- Collect, remove, or remediate *in situ*, to the extent practicable, DNAPL within Site soil and sediments.

The preliminary RAOs were not required to be updated based on the findings of the approved Site risk assessments.

Future Activities

Feasibility Study deliverables have been submitted for NYSDEC review. Subsequent to NYSDEC approval of the RI Report, the Feasibility Study (FS) will be advanced. Two separate FS documents, one for SYW-12 and one for the remainder of the Wastebed B/Harbor Brook Site, be submitted in consideration of property ownership and stakeholder complexities associated with SYW-12, which may affect the FS schedule for SYW-12, and to allow the FS for the Wastebed B/Harbor Brook Site to proceed in an unencumbered fashion.

Soils generated as part of the East Flume IRM, Upper Harbor Brook IRM, the East and West Wall installation, and outboard area removals have been placed on Wastebed B. The Wastebed B/Harbor Brook Materials Management, Grading, and Disposal Plan was submitted on March 15, 2013 and subsequently approved by the NYSDEC on March 21, 2013. Additional outboard material will be placed on Wastebed B during the winter of 2014. Once this material has been placed then the existing pile will be shaped per the grading plan and covered with 2 ft of material.This material will be evaluated in the FS process.

1. Introduction

1.1. General

This document is the revised Remedial Investigation (RI) Report for the Wastebed B/Harbor Brook Site (the Site) in Geddes and Syracuse, New York. A Site location plan is included as **Figure 1**. The RI was performed pursuant to the Administrative Consent Order (D-7-0001-00-02) between the New York State Department of Environmental Conservation (NYSDEC) and Honeywell International, Inc. (Honeywell) dated April 10, 2000 (NYSDEC, 2000). In accordance with the requirements of the Consent Order, a Preliminary Site Assessment (PSA) was performed in the summer of 2000 and winter of 2001. A summary of the analytical data collected during the PSA was submitted to the NSYDEC in September 2001 (O'Brien & Gere, 2001). Based on review of the data, and in consideration of other previous study data, the NYSDEC determined that a Remedial Investigation/Feasibility Study (RI/FS) should be implemented at the Site. The determination was communicated to Honeywell in a letter dated November 28, 2001. The RI/FS Work Plan was submitted in September 2002 and approved on November 8, 2002 by the NYSDEC.

The PSA was performed in accordance with the NYSDEC-approved PSA Work Plan (O'Brien & Gere, 2000). Honeywell and NYSDEC agreed that the data to be generated during the PSA would meet many of the data requirements of a RI/FS. The PSA field program was performed between July 2000 and May 2001.

The RI was performed in accordance with the NYSDEC-approved RI/FS Work Plan (O'Brien & Gere, 2002). The scope of the RI was developed during the December 7, 2001 conference call between Honeywell, O'Brien & Gere, TAMS, the United States Environmental Protection Agency (USEPA), and NYSDEC. The minutes of this conference call are documented in a December 17, 2001 letter from Honeywell and a January 3, 2002 letter of reply from NYSDEC. The RI field program was performed between November 2002 and May 2004. The draft RI Report was submitted in August 2004 to the NYSDEC.

An Interim Remedial Measure (IRM) is currently being performed at the Wastebed B/Harbor Brook Site under Consent Order #D-7-008-01-09. Pre-design investigations were performed in accordance with the NYSDEC-approved work plan (O'Brien & Gere and Parsons, 2004a). This work was performed between the fall of 2004 and the spring of 2005.

At the request of the NYSDEC, borings were advanced as part of the I-690 bridge replacement (I-690 Limited Investigation) to evaluate subsurface strata in the area of the bridge. This work was performed under the Wastebed B/Harbor Brook RI/FS Consent Order #D7-0001-00-02. This work was performed in accordance with the December 13, 2005 NYSDEC-approved Letter Work Plan. A geotechnical investigation at Wastebed B was conducted in conjunction with the I-690 Limited Investigation. This work was completed in the fall of 2005.

The NYSDEC requested in a March 19, 2006 letter, May 9, 2006 email, and an August 16, 2006 comment letter that additional field work be completed for the RI. The Supplemental RI was performed in accordance with the September 15, 2006 NYSDEC-approved letter work plan (Honeywell, 2006). The Supplemental RI consisted of further investigation on the Wastebed

B/Harbor Brook Site as well as wetland SYW-12 situated on the southeast corner of Onondaga Lake. The Supplemental RI field program was performed between November 2006 and June 2007.

Revisions were made to the August 2004 report subsequent to completion of the Supplemental RI field program based on this work, and comments in the March 31, 2006 letter from the NYSDEC to Honeywell and Honeywell's response to comment letter dated May 1, 2006. The RI Report was resubmitted in November 2007. The NYSDEC provided comments on the November 2007 revised draft RI Report on November 6, 2008 and have been incorporated into a draft red-line/strikeout RI Report submitted to the NYSDEC on November 17, 2009. The NYSDEC provided comments on the red-line/strikeout draft report on March 29, 2010 and in the July 22, 2010 meeting between Honeywell and the NYSDEC.

Also, the RI/FS was performed in accordance with the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (USEPA, 1988) and Part 300.68 of the National Contingency Plan, CERCLA as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986.

1.2. Site Description

The Wastebed B/Harbor Brook Site consists of four areas: 1) Harbor Brook, 2) the Lakeshore Area (including Wastebed B, the East Flume [now abandoned], Dredge Spoils Areas (DSA) #1 and #2, wetlands along the lakeshore, and the Route I-690 drainage ditch), 3) the Penn-Can Property and 4) the Railroad Area. Two additional areas of study (AOS) were added at the request of NYSDEC and include areas east of Harbor Brook, to the north (AOS #1) and south (AOS #2) of I-690. A description of these areas, as well as the AOS east of Harbor Brook, is presented in Section 1.4, below. A Site Plan is included as **Figure 2**. The SYW-12 area was added to the Site during the Supplemental RI. The SYW-12 Site Plan is included as **Figure 3**.

In accordance with the Consent Order, the East Flume and DSAs #1 and #2, originally investigated as part of the Willis Avenue Chlorobenzene Site RI (O'Brien & Gere, 1999), are part of the Wastebed B/Harbor Brook Site. Accordingly, results from the previous investigations of these areas are presented in this document.

In addition, two interim remedial measures (IRMs) are ongoing which are components of the Wastebed B/Harbor Brook RI/FS: the East Flume IRM and the Wastebed B/Harbor Brook IRM.

1.3. Project Objectives

The objectives of the RI were to:

- Collect additional data necessary to evaluate and characterize the nature and extent of Site-related chemical parameters of interest (CPOIs)
- Further evaluate potential CPOI migration pathways
- Evaluation of potential risks to human and ecological receptors via performance of formal risk assessments in accordance with USEPA Risk Assessment Guidance for Superfund (RAGS) and Ecological Risk Assessment Guidance for Superfund (ERAGS) guidance documents
- Identify Preliminary Remedial Action Objectives (RAOs)
- Gather sufficient data to support the FS

1.4. Site Background

The Wastebed B/Harbor Brook Site consists of four areas: 1) Harbor Brook, 2) the Lakeshore Area, 3) the Penn-Can Property and 4) the Rail Road Area. Additional areas of study (AOS) were added at the request of NYSDEC and include areas east of Harbor Brook, to the north and south of I-690. A description of these areas, as well as the AOS east of Harbor Brook, is presented below. A Site Plan is included as **Figure 2**.

1.4.1. Harbor Brook

The portion of Harbor Brook subject to this RI/FS is classified as a Class C stream by NYSDEC. Harbor Brook originates southeast of Syracuse, NY in the Town of Onondaga and flows through the western side of Syracuse passing Wastebeds D and E, and discharges to the southwest corner of Onondaga Lake adjacent to the eastern end of Wastebed B. Harbor Brook drains a watershed of approximately 13.2 square miles and has an average flow rate of 14.3 cubic feet per second (Blasland & Bouck (B&B), 1989). As part of an on-going interim remedial measure (IRM), the lower portion of Harbor Brook was re-routed through AOS#1 and the upper portion was remediated..

1.4.2. Lakeshore Area

The Lakeshore Area is composed of four sub-areas 1) Wastebed B, 2) the East Flume (now abandoned), 3) Dredge Spoils Areas #1 and #2, and 4) the Route I-690 Drainage Ditch. This area is approximately 3,200 feet wide (east to west) and 800 ft deep (north to south) and is situated along the southern shore of Onondaga Lake, near the southwest corner of the lake. The northern boundary of the Lakeshore Area is Onondaga Lake. The former Upper East Flume (UEF) (described below) defines the western extent of this area and the eastern extent is defined by Harbor Brook near its confluence with Onondaga Lake. The southern extent of the Lakeshore Area is defined by Route I-690. The ecological communities in the Lakeshore Area are representative of *successional old field, successional northern hardwoods, ditch/artificial intermittent stream,* and *freshwater wetland* habitats. Topography of the Lakeshore Area is generally flat with a relatively significant slope to the north in the north-central portion of the area due to the presence of a constructed berm (described below). A topographic map is included as **Figure 4**.

Wastebed B. Historical use of Wastebed B was for the deposition of Solvay waste, a non-hazardous waste consisting primarily of calcium carbonate, calcium silicate and magnesium hydroxide with lesser amounts of carbonates, sulfates, salts and metal oxides. Wastebed B received Solvay waste from approximately 1898 to 1926 (B&B, 1989). Wastebed B was engineered to receive waste by construction of a bulkhead into Onondaga Lake. The bed covers approximately 28 acres, including the relatively flat area between the lake water's edge and the raised, bermed portion of the wastebed (B&B, 1989). Between approximately 1898 and 1908, the filling of Wastebed B was initiated by construction of wooden bulkheads in the lake and placement of Solvay waste out to the bulkhead line. Coke plant waste from the former Main Plant Site may have been disposed of concurrent with the Solvay waste. Additionally, sewage sludge disposal occurred on the southeast portion of the bed in the late 1950's and early 1960's (B&B, 1989). Modification of the shoreline has occurred due to erosional and depositional forces, as well as historical discharges from the East Flume.

Wastebed B is currently subject to an IRM directed towards mitigating discharges of contaminated ground water and DNAPL into Harbor Brook and Onondaga Lake. This IRM consists of a vertical barrier and ground water collection system. The vertical barrier was installed along the Onondaga Lake shoreline perimeter of Wastebed B and upstream along the western bank of Harbor Brook for an

estimated total length of 6,000 ft. The vertical barrier was keyed into the silt and clay layer at approximate depths between 25 ft and 40 ft below ground surface. The actual depth and alignment of vertical barrier, and the depth and configuration of the collection system, were selected during the IRM design. The Final IRM Work Plan was submitted to the NYSDEC in July 2004 (O'Brien & Gere, 2004) and was approved in August 2004.

East Flume. The East Flume was originally an excavated drainage ditch that received process cooling waters from the former Main and Willis Avenue Plants. In addition to cooling waters, the East Flume also carried a combined (Solvay, sanitary, mercury, and organic) waste stream from the Main and Willis Avenue Plants to Onondaga Lake. The East Flume historically received storm water from Solvay Paperboard, General Chemical Corporation, Landis Plastics and the Village of Solvay. It also received process waters from the Trigen Syracuse Energy Corporation. Water depths within the flume typically ranged between 2 ft and 6 ft and channel width varied approximately from a minimum of 20 ft to a maximum of 150 ft. The banks of the flume were vegetated primarily with *Phragmites australis*.

In 1977, the upper portion of the East Flume was re-constructed to serve as a holding pond for the process cooling waters prior to their entry into a thermal diffuser and subsequent discharge to the lake. The upper portion was widened to a maximum width of approximately 150 ft and deepened to a maximum depth of approximately 6 ft. The bottom (substrate) of the UEF was constructed of crushed stone underlain by a geotextile. At the eastern end of the former UEF is the ground water pumping station (former thermal diffuser building) and a high level overflow dam constructed originally to allow cooling water to flow when the former diffuser pumps were turned off. The dam and a berm to the north separated the UEF from the Lower East Flume (LEF) (described below) and Onondaga Lake, respectively. Honeywell was required under the terms of its SPDES discharge permit (No. 0002275) to collect monthly and quarterly samples of surface water from downstream of the dam.

The LEF was a narrower channel that was approximately 25 ft wide with water depths of 3 to 4 ft. The LEF meandered to the south and east and discharged to Onondaga Lake. The LEF was not specifically classified by NYSDEC, and therefore it received the classification of the surface water to which it discharges (Onondaga Lake, Class C). The source of water in the LEF was primarily water from the UEF and, to a lesser degree, ground water. The LEF discharged to Onondaga Lake near the north-central portion of the Lakeshore Area. The LEF was not modified during the 1977 re-construction and maintained the original channelized drainage ditch configuration. The substrate of the LEF was primarily unvegetated sediment. Organic sediments, approximately 2 to 10 ft in depth, were underlain by solidified inorganic sediments.

The East Flume was abandoned as part of three interim remedial measures (IRMs) including the East Flume IRM (Order on Consent #D7-0002-01-09), the Wastebed B/Harbor Brook IRM (Order on Consent #D7-0008-01-09), and the Outboard Area IRM (Order on Consent # D7-0008-01-09). The IRM focused on the elimination (to the extent practicable within the IRM scope) of potential impacts to wildlife resources, transport of contaminants to Onondaga Lake via East Flume sediment, and exposure to trespassers via dermal contact with UEF and LEF sediments. To accomplish these objectives, remedial work was performed on the 42-inch diameter reinforced concrete pipe (RCP) P.A. sewer. Work on this sewer included disconnection of the 72-inch diameter RCP outfall sewer from the 60-inch diameter RCP main sewer, plugging the 72-inch pipe, and extension of the 60-inch RCP into Onondaga Lake. Additional work included transfer of surface water from the UEF and LEF into Onondaga Lake, excavation of sediment from the UEF and LEF outboard of the barrier wall,

cover of UEF sediment inboard of the wall, installation of a low permeability membrane and clean backfill, and restoration activities.

Dredge Spoils Areas. Dredge Spoils Areas (DSAs) #1 and #2 are located in the northwestern portion of the Lakeshore Area. The areas received dredge spoils from the former UEF and from Onondaga Lake, respectively. DSA #1 is situated to the south of the former UEF and is approximately 300 ft by 300 ft at its widest points (**Figure 2**). This area was created in 1979 to hold sediments removed from the UEF that had been deposited within the UEF subsequent to the 1977 construction. A berm was created around the perimeter of the area and sediments were pumped into the bermed area. The average depth of these sediments is 2 ft. Beneath the spoil materials, a layer approximately 1 to 2 ft thick of ash and cinders has been observed (O'Brien & Gere, 1999). DSA #2 is located to the east of the former UEF and south of the former LEF. The area is approximately 350 ft by 350 ft and bermed to the north and east. This area received sediments from the lake, which were removed during installation of the thermal diffuser pipe in 1977. The spoils in this area are approximately 3 to 5 ft thick and are underlain by Solvay waste.

I-690 Drainage Ditch. The I-690 Drainage Ditch appears to have been designed as a storm water drainage feature for the interstate and is maintained by the New York State Department of Transportation (NYSDOT) (O'Brien & Gere, 2001a). The drainage ditch parallels the westbound lane of I-690 at the southern border of the Lakeshore Area. The ditch flows west to east, and discharges to Harbor Brook. Near the midpoint of the ditch, an outfall from the storm drainage system beneath I-690 discharges to the ditch. Portions of the drainage ditch are vegetated with *Phragmites australis*, goldenrod (*Solidago* sp.) and grasses (*Graminae*). The substrate of the drainage ditch primarily consists of weathered Solvay waste. Based on the USGS map for the area, historical aerial photographs of the area, and a Site reconnaissance (2000), it appears that the ditch was constructed on portions of wastebed. At the time of the Site reconnaissance, the NYSDOT had recently removed accumulated sediments from the drainage ditch to allow for less restricted flow of intermittent surface water. This ditch has been subsequently remediated as part of an on-going IRM.

1.4.3. Penn-Can Property

The Penn-Can Property is situated to the south of the Lakeshore Area and south of I-690 (**Figures 2 and 5**). This property has historically been used, and is currently being utilized, for the production and storage of asphalt products. In 1919, the Barrett Division of the Semet Solvay Company of Allied Chemical Corporation began operations. Barrett produced various asphalt emulsions and some coal tar based products used in road construction. The primary constituents of these materials were asphalt, coal tar, caustic soda and muriatic acid. Until 1975, the operation included a barge loading facility, which transferred emulsions to vessels on Onondaga Lake via above ground pipelines. These pipelines were removed, as well as the above ground storage tanks, during the 1978 decommissioning of the Barrett facility. In 1978, approximately 750 to 1,000 cubic yards of asphalt tank bottoms were buried on-site in a pit with dimensions of 40 ft wide, 165 ft long and 7 ft deep. The tank bottoms were covered with 2 ft of low permeability fill, a geotextile, and 2 ft of fill. The pit was subsequently covered with a layer of crushed stone. The locations of historical tanks, and structures, and the approximate location of the pit, are shown on **Figure 5**. In 1983, the property was purchased by Penn-Can Road Materials, Inc. Until recently, the property was being used by Spano Container Corporation for the storage of equipment. The area is approximately 1,600 ft wide (east to west) and 450 ft deep (north to south) and consists of a gravel parking lot, with limited vegetation around the periphery of the area. The buildings on-site were demolished in October 2013, and Honeywell completed its purchase of the Penn-Can Property in November 2013 from Penn-Can Road Materials, Inc (now

Tonodo). A shallow drainage swale runs along the southern and eastern perimeter of the property. The covertype in this area is classified as *urban structure interior*.

1.4.4. Railroad Area

The Railroad Area, owned by CSX, is situated to the south of the Penn-Can Property and is bounded to the north, south and east by rail tracks. The area is approximately 1,400 ft wide (east to west) and 400 ft deep (north to south). The covertype in this area is classified as *successional shrubland* in the southern portion and *urban structure interior* in the northern portion. Historical uses of this area are not known. Based on review of historical aerial photographs, the area appears to have been a vacant lot and has not been used for production purposes in the past. However, Solvay waste was observed in subsurface borings in the northern portion of the Railroad Area. Subsequent to the RI investigation, the area ditches, associated wetlands, and the length of Harbor Brook along the Railroad Area were remediated as part of the Upper Harbor Brook IRM under the Wastebed B/Harbor Brook IRM.

1.4.5. AOS East of Harbor Brook

AOS #1 is a wetland area situated east of Harbor Brook and adjacent to the Lakeshore Area (**Figure 2**). This area was delineated during the Jurisdictional Wetland Survey and Delineation (O'Brien & Gere, 2001b; O'Brien & Gere, 2003) conducted as part of the RI and is part of NYS wetland SYW-19 (NYSDOT, 1973). Based on review of historical aerial photographs, this area is a floodplain created by deposition of Onondaga Lake and Harbor Brook sediments during the 1950's and 1960's. There is also evidence that non-Solvay waste fill was likely placed during this time. Subsequent to the RI investigations, the lower portion of Harbor Brook was re-routed through AOS #1 as part of an on-going IRM, and a vertical sheetpile barrier wall and collection system was installed through AOS #1.

AOS #2 is situated east of Harbor Brook and south of I-690 between Harbor Brook and the western dike of Wastebeds D and E (**Figure 2**). Wastebeds D and E have a combined surface area of approximately 44 acres. Aerial photos indicate that these beds were inactive by 1926 (B&B, 1989). Several buildings were constructed on the eastern end of Wastebed D between 1959 and 1966. Currently, the eastern end of Wastebeds D and E is occupied by multiple car dealerships.

1.4.6. SYW-12

SYW-12 is a wetland area situated along the northeastern shoreline of Onondaga Lake and to the north and south of Ley Creek (**Figure 3**). This area was delineated as part of the Onondaga Lake Wetland/Floodplain Assessment Draft Report (O'Brien & Gere and Parsons, 2004b). The area is bounded by railroad tracks to the east and the Lake to the west. The area is approximately 40.7 acres. The primary vegetation includes a monoculture of common reed and a forested floodplain consisting of cottonwoods.

1.5. Additional Studies

Additional studies at the Site include:

1) Monitoring wells installed during the Hydrogeologic Assessment of the Allied Wastebeds (B&B, 1989)
2) Monitoring well installation and hydropunch samples collected during the Willis Avenue RI (O'Brien & Gere, 2002a)
3) LEF sediment sampling performed by PTI as part of the Onondaga Lake RI (PTI, 1994)

4) Harbor Brook surface water and sediment sampling performed by NYSDEC in November 1996 and October 1997
5) Harbor Brook surface water and sediment sampling by O'Brien & Gere in November 1996
6) East Flume/Dredge Spoils Areas sampling during the Willis Avenue RI (O'Brien & Gere, 1999)
7) Harbor Brook seep sample (O'Brien & Gere, 2002a)
8) Harbor Brook Sediment IRM Investigation (BBL, 2001)
9) Onondaga Lake RI/FS Phase 2A Investigation (Exponent, 2001)
10) Onondaga Lake Wetland / Floodplain Assessment Final Report (O'Brien & Gere and Parsons, 2010)
11) Onondaga Wetlands Subsurface Investigation (C&S Companies, 2001)
12) SYW-12 Wetlands Mitigation Sampling (O'Brien & Gere, 1995)
13) SYW-12 Sources of Contamination Investigation (O'Brien & Gere, 2014)

A Site History Report containing previous study analytical data was submitted to NYSDEC on May 26, 2000 (Honeywell, 2000) and a letter dated January 9, 2004 was submitted by Honeywell to NYSDEC outlining relevant documents that have been submitted to the NYSDEC subsequent to May 26, 2000 (Honeywell, 2004).

Data from the above studies are included within the Site database and discussed within Section 4 of this report.

The data for the Onondaga Lake RI/FS Phase 2 Investigation (Exponent, 2001) are from samples collected along the Onondaga Lake shoreline and are not considered representative of wetland sediment/surface soil samples. These data have been included in the Site database as requested; however, these data were not used in the generation of summary statistics for Section 4 of this report.. The LEF sediment sample results were utilized in the Site risk assessments. These data are included in the Site database as requested and discussed in Section 4 as appropriate. The LEF sediment samples are included within East Flume summary statistics presented in Section 4 of this report. A brief summary of the additional studies is presented below with the exception of the Willis Avenue RI East Flume and Dredge Spoils Area sampling, which are discussed in Sections 2.1.2 and 2.1.11, respectively.

1.5.1. Monitoring Wells Installed During the Hydrogeologic Assessment of the Allied Wastebeds

Wells WB-BL and WB-BU were installed and sampled during the hydrogeologic assessment of the wastebeds (B&B, 1989). The locations of the two wells are presented on **Figure 6**. The integrity of these wells was checked and the wells were re-sampled as part of the Harbor Brook PSA and RI ground water investigations.

1.5.2. Monitoring Well Installation and Hydropunch Samples Collected During the Willis Avenue RI

Six wells were installed in the Lakeshore Area as part of the Willis Avenue RI. Monitoring wells HB-WA-03S, HB-WA-03I and HB-WA-03D were installed in February 1992. These wells are adjacent to the western end of the former UEF. Monitoring wells HB-WA-08S, HB-WA-08I and HB-WA-08D were installed in the center of the Lakeshore Area between December 5 and December 15, 1994. These six wells were subsequently sampled as part of the Willis Avenue RI and Harbor Brook Supplemental RI, and the HB-WA-08 cluster was also sampled as part of the Harbor Brook PSA and RI ground water investigations. The locations of the six wells are presented on **Figure 6**.

Seven hydropunch ground water samples from four locations were collected and analyzed for volatile organic compounds (VOCs) in December 1994 to aid in the selection of a location for well cluster HB-WA-08. The locations of the hydropunch samples are shown on **Figure 6**. The data are presented within **Appendix A**.

1.5.3. Lower East Flume Sediment Sampling Performed by PTI as part of the Onondaga Lake RI

Surface water data were collected from the LEF by PTI (now Exponent) as part of the Onondaga Lake RI. Samples were collected monthly from April to December 1992, during both low flow and high flow conditions. Samples were analyzed for target compound list/target analyte list (TCL/TAL) compounds.

As part of the Onondaga Lake RI, PTI also collected fifteen sediment samples from the 0 to 2 cm (0 to 0.07 ft) interval at five locations within the LEF in 1993. One sample from each location was analyzed for TCL/TAL compounds, grain size, total organic carbon (TOC), chloride and calcium carbonate. Sampling locations are presented on **Figure 6**.

1.5.4. Harbor Brook Surface Water and Sediment Sampling Performed by NYSDEC in November 1996 and October 1997

Surface water and sediment within Harbor Brook were sampled by NYSDEC in November 1996 and October 1997. **Figure 7** presents the approximate sampling locations. NYSDEC collected 20 sediment samples during this effort. The samples were analyzed for VOCs, SVOCs, PCBs and metals. The data are presented within **Appendix B**.

1.5.5. Harbor Brook Sediment Sampling by O'Brien & Gere in November 1996

In November 1996, and concurrent with NYSDEC sampling discussed above, O'Brien & Gere sampled sediment from Harbor Brook at Honeywell's request. Twelve sediment samples were collected from eight locations within Harbor Brook, including one sample upstream of the Site. The samples were collected from the 0 to 12-inch depth interval and from 12 inches to refusal (26.5 inches max.). Samples were analyzed for VOCs, SVOCs, PCBs, pesticides, and inorganics. Two surface water samples were also collected and analyzed for inorganics as part of this sampling effort. Sampling locations are provided on **Figure 7**. The data are presented within **Appendix C**.

1.5.6. Harbor Brook Seep Sample

In April 1999, a seep was discovered along the bank of Harbor Brook downstream of the bridge that traverses the brook north of I-690. Both Honeywell and NYSDEC sampled the seep. Honeywell analyzed the sample for VOCs, SVOCs, PCBs, pesticides, and metals. The seep location is presented on **Figure 7**. Seep data are located in **Appendix D**.

1.5.7. Harbor Brook Sediment IRM Investigation

In July 2001, the Harbor Brook Sediment IRM Investigation Report (BBL, 2001) was issued. The investigation included three tasks: 1) sediment probing, 2) Harbor Brook sediment sampling, and 3) wetlands soil borings. Sediment probing was conducted in March 2000 along 55 transects, 50 to 70 feet apart, extending from the mouth of Harbor Brook to Hiawatha Boulevard. In January and February 2001, sediment samples were collected from 18 cores; the locations are presented on **Figure 7**. Eighty-one sediment samples and two dense non-aqueous phase liquid (DNAPL) samples were collected and submitted for laboratory analyses. From the 81 sediment samples collected, 70 discrete samples were analyzed for VOCs, SVOCs, pesticides, PCBs, metals, total mercury, cyanide, and

TOC, and 42 samples (10 composites, 32 discrete) were analyzed for PCDD/PCDFs (BBL, 2001). Also, two full length cores were analyzed for VOCs, SVOCs, pesticides, and metals using TCLP extraction methods. The two DNAPL samples were collected from locations HB-T-3-2 (6 to 10 ft; HB-T-3-OIL) and HB-T-5-1 (6 to 18 ft; HB-T-5-OIL) and analyzed for VOCs, SVOCs, pesticides, PCBs, metals, total mercury, cyanide, TOC, and PCDD/PCDFs. Data associated with the Harbor Brook IRM are presented in **Appendix E**. Borings logs are provided in **Appendix F**. The location IDs in **Appendix F** do not have an HB- prefix. The HB- prefix was added for database purposes as shown above. However, this change is not reflected in the boring logs.

1.5.8. Onondaga Lake RI/FS Phase 2A results

Wastebed B/Harbor Brook: The Onondaga Lake RI/FS Phase 2A sampling was conducted during August 2000 (Exponent, 2001). As part of this effort, sediment samples were collected from four locations within NYS wetland SYW-19 on the Wastebed B/Harbor Brook Site. Samples were collected at depths of 0 to 0.5 ft and 0.5 to 1 ft using a piston corer. The wetland samples were analyzed for VOCs, SVOCs, pesticides, PCBs (including Aroclor 1268), metals (including cyanide), and PCDD/PCDFs. The locations of the wetland samples (S383, S384, S385, and S386) are presented on **Figure 6**. The data associated with the Onondaga Lake RI/FS Phase 2A sampling are presented in **Appendix G**.

SYW-12: During the summer of 2000 wetland sediment samples were collected at SYW-12. Four locations (S387, S388, S389, and S390) had samples collected from 0 to 0.5 ft and 0.5 to 1.0 ft. These locations are presented on **Figure 8**. Samples were analyzed for VOCs, SVOCs, pesticides, PCBs, and inorganics. The data associated with the Onondaga Lake RI/FS Phase 2A sampling are presented in **Appendix G**.

These Phase 2 samples for both areas were added to the Wastebed B/Harbor Brook Site database as requested. However, these samples were not included in further analyses and discussions within this RI Report. It should be noted that many of these samples appear to have been collected at the shoreline and may not be as representative of Site conditions as the wetland soil samples and surface soil samples collected during the PSA, RI, and Supplemental RI sampling efforts for the Site.

1.5.9. Onondaga Lake Wetland/Floodplain Assessment Draft Report (SYW-12)

As part of the Onondaga Lake Wetland / Floodplain Assessment Draft Report (O'Brien & Gere and Parsons, October 2004) SYW-12 was delineated, a wetland function and value assessment was performed, and an ecological survey was performed in 2004. It should be noted that this report was revised and submitted for review June 12, 2009 for NYSDEC review, and a Final Report was submitted in March 2010 (O'Brien & Gere and Parsons, 2010). Additional portions of the SYW-12 Area located south of Ley Creek were added to the assessment in 2008 in accordance with the July 17, 2008 NYSDEC letter and subsequent conversations between the Site stakeholders (NYSDEC 2008). These areas were also delineated and the wetland function and value assessment and an ecological survey were performed.

The wetlands delineation was conducted in accordance with the United States Army Corps of Engineers (USACOE) *Wetlands Delineation Manual* (USACOE, 1987). This method utilizes a three-parameter approach and calls for the presence of hydrophytic vegetation, hydric soils, and wetland hydrology for an area to be considered a jurisdictional wetland. Therefore, information gathered at SYW-12 included soils/substrate, vegetation, and hydrology.

The portion of SYW-12 (WL 1) delineated and identified by O'Brien & Gere in 2004 consists of approximately 17 acres south of Ley Creek and south and west of the railroad tracks along the northeastern shoreline of Onondaga Lake. Onondaga Lake forms the western border of this wetland. An abrupt rise in topography (*i.e.*, berm and railroad bed) defines the eastern border of the wetland and Ley Creek defines the northern boundary. The delineated wetland boundary somewhat matches the depicted New York State Freshwater Wetlands (NYSFW) mapped boundary for the southern portion of SYW-12 (**Figure 3**). The delineated wetland is a combination of a monoculture stand of common reed and forested floodplain that comprise an overstory of predominantly cottonwoods. Wetland soils were indicated via presence of low matrix chroma and coarse sands with organic streaking of the soil strata. Wetland hydrology was indicated by the presence of saturated soils, drift lines, watermarks, and drainage patterns.

The result of the function and value assessment indicates that the principal functions/values for the delineated portion of SYW-12 are:

- ground water recharge/discharge
- flood flow alteration
- sediment/toxicant retention
- sediment/shoreline stabilization
- wildlife habitat.

The dominant vegetation observed in this wetland was common reed and cottonwood. Other species observed near this wetland include bittersweet nightshade, jewelweed (*Impatiens* sp.), box elder, and pokeweed (*Phytolacca americana*). The primary wildlife species observed were songbirds. Double-crested cormorant (*Phalacrocorax auritus*), mallard, and gulls (*Larus* spp.) were observed transiting the SYW-12 area.

The portions of SYW-12 identified and delineated by O'Brien & Gere in 2008 consist of two small wetlands (WL 2 and WL 3) south of Ley Creek and east of the railroad tracks that border WL 1. WL 2 is a 1.1-acre triangular-shaped area bordered on two sides by railroad tracks and by a dirt road on the third side. The delineated wetland is a monoculture of common reed. Wetland soils were indicated via presence of low chroma colors with organic streaking of the soil strata. Wetland hydrology was indicated by the presence of saturated soils and drainage patterns, with observed standing water in the central portion of the wetland. WL 3 is a 0.26-acre narrow strip of common reed bordered by railroad tracks and a dirt road. Soils were saturated in the upper 12 inches and exhibited low-chroma colors. Soils mapped for both wetland cells were C.F.L. soils.

The function and value assessment was conducted for WL 2 and WL 3 combined as the two cells had similar attributes and were in close proximity of each other, separated only by railroad tracks. The results of the function and value assessment of WL 2 and WL 3 indicate that the principal function/value for these delineated areas is wildlife habitat.

The dominant vegetation observed in these wetlands was common reed. Other species observed near this wetland were eastern cottonwood, bittersweet nightshade, jewelweed, box elder, and American pokeweed. The primary wildlife species observed were songbirds. Double-crested cormorant, mallard, and gulls were observed transiting the SYW-12 area.

The 2008 assessment also included an investigation of two additional areas in the vicinity of the mouth of Ley Creek. These investigations were in response to NYSDEC comments on the initial

version of this report. A qualitative assessment of areas north of Ley Creek concluded that, if delineated, the wetland boundary would be similar to the NYSDEC-wetland boundaries (*i.e.*, an emergent wetland exists between the railroad tracks and Onondaga Lake Parkway starting near the north bank of Ley Creek and extending westward). A survey was conducted of the riparian area along the south bank of Ley Creek. The riparian area was dominated by common reed, but upland species such as bittersweet nightshade, grape, common buckthorn, and poplar were present. Additionally, hydric soils and hydrology were not present at this area. O'Brien & Gere and the NYSDEC agreed that this area did not fully meet wetland criteria and did not require delineation.

1.5.10. Onondaga Wetlands Subsurface Investigation Report (SYW-12)

The Wetland Subsurface Investigation was performed in May 2000 (C&S Companies, 2001). Thirteen subsurface borings were advanced as part of this investigation. Each of the shallow borings was advanced utilizing tripod mounted split spoon sampling apparatus. Borings were advanced to characterize subsurface soils and identify the potential existence of contamination.

Soil samples were collected from the following three intervals:

- Interval 1: existing grade to approximately 6 to 12 inches below ground surface (bgs)
- Interval 2: from 6 or 12 inches below grade to a depth of the proposed finished wetland elevation
- Interval 3: from 6 inches immediately above the proposed wetland finished grade elevation to a depth of 18 to 20 inches below the proposed wetland finished grade elevation.

Soil samples were collected and submitted to Friend Laboratories, Inc. for the following analyses:

- Samples collected from each of the three sampling intervals for Target Analyte List (TAL) metals, pH, and total organic carbon (TOC).
- Samples collected from Interval 3 were analyzed for Target Compound List (TCL) Volatile organic compounds (VOCs), Semivolatile organic compounds (SVOCs), Polychlorinated biphenyls (PCBs), and pesticides.
- One half of the samples collected from Intervals 1 and 2 were analyzed for TCL VOCs, SVOCs, PCBs, and pesticides.

The analytical results are presented in **Appendix H** (Tables 1 through 12).

Three shallow ground water monitoring wells (HB-B-04W, HB-B-08W, and HB-B-10W) were installed in boreholes HB-B-04, HB-B-08, and HB-B-10. Wells were constructed of 2-inch PVC screen and risers. The screen consisted of 0.01-inch slots. The wells were sampled for TCL/TAL parameters and pH.

A black tar-like layer was observed during the completion of borings HB-B-03, HB-B-04W, HB-B-05, HB-B-06, HB-B-08W, HB-B-10W, HB-B-11, and HB-B-13. The black tar-like layer was identified 4- to 12-ft bgs depending on the borings location and exhibited a "heavy oil-like odor". The source of this material is not known. However, the October 15, 1951 aerial photograph of the lake's southeastern corner presents an area that could potentially have been a lagoon on the parcel that was historically known as the Marley Property. This area is upgradient of the SYW-12 area and is a potential source of this black tar-like layer. SYW-12 also likely received dredge material from the barge terminal adjacent to Oil City. (NYSDOH 1946). The SYW-12 area also received material to fill the former Onondaga Creek channel and Iron Pier area. The source of this fill is unknown; however,

this fill may have come from Onondaga Lake or from Onondaga Creek which was widened and potentially deepened to allow barges access to Oil City. The layer varied in thickness from 1 inch to 14 inches depending on location. Samples from the black tar-like layer were analyzed for TCL/TAL parameters, pH, and TOC.

VOCs were detected in six of the soil samples. Constituents included acetone, ethylbenzene, and xylenes. Concentrations ranged from 17 µg/kg to 2,500 µg/kg (**Appendix H**, Table 1). The detected concentrations were compared to the *USEPA Soil Screening Guidance* (USEPA, 1996) and NYCRR Part 375-6 Unrestricted Use Soil Cleanup Objectives (SCOs). Exceedances were observed for ethylbenzene (HB-B-04W [8.5 to 10.5 ft] and HB-B-05 [6 to 8 ft]) and m&p-xylenes (HB-B-05 [6 to 8 ft]).

SVOCs at the Site consisted mainly of polycyclic aromatic hydrocarbons (PAH) compounds and were consistently detected at concentrations greater than the *USEPA Soil Screening Guidance* (USEPA, 1996) and Part 375-6 Unrestricted Use SCOs. The highest concentrations were collected from samples HB-B-05 (6 to 8 ft) and HB-B-10W (1 to 8 ft) (**Appendix H**, Table 2). It should be noted that the sample at HB-B-05 was collected from the black tar-like layer.

No pesticide or PCBs were detected at the Site. However, both pesticides and PCBs had elevated detection limits (**Appendix H**, Tables 3 and 4, respectively). These elevated detection limits were likely due to matrix interferences from the PAHs detected at the Site.

Metals were detected above the *USEPA Soil Screening Guidance* (USEPA, 1996) and Part 375-6 Unrestricted Use SCOs (**Appendix H**, Table 5). The majority of soil samples exceeded these values for the following metals: arsenic, barium, cadmium, calcium, chromium, copper, lead, magnesium, mercury, nickel, potassium, and zinc.

No VOCs, pesticides, or PCBs were detected in Site ground water (**Appendix H**, Table 7, 9 and 10, respectively). The majority of SVOCs identified in Site ground water were PAHs. Concentrations ranged from 1 µg/kg to 62 µg/kg (**Appendix H**, Table 8). The highest detected concentration was naphthalene in well HB-B-04W, which exceeded the TOGS 1.1.1 Class GA Ground Water Quality guidance value.

Metals exceeding TOGS 1.1.1 Class GA Ground Water Quality standards or guidance values by greater than one order of magnitude include cadmium, iron, lead, mercury, and sodium (**Appendix H**, Table 9). Chromium, copper, magnesium, and manganese also exceeded their standards or guidance values.

1.5.11. SYW-12 Wetlands Mitigation Sampling

Four hand augered holes (M1A, M1B, M2A, and M2B) were advanced as part of this investigation (O'Brien & Gere, 1995). Three soil samples from these holes were submitted for RCRA TAL metals analysis for arsenic, cadmium, chromium, lead, and mercury. Concentrations for the selected metals had the following concentration ranges:

- Arsenic: 6.4 to 14 mg/kg
- Cadmium: 11 to 14 mg/kg
- Chromium: 20 to 160 mg/kg
- Lead: 130 to 190 mg/kg

- Mercury: 1 to 2.1 mg/kg

These concentrations were compared against the *USEPA Soil Screening Guidance* (USEPA, 1996) and NYCRR Part 375-6 Unrestricted Use Soil Cleanup Objectives (SCOs). Exceedances were observed for all three arsenic, cadmium, chromium, lead, and mercury concentrations.

1.5.12. SYW-12 Sources of Contamination Investigation

The Sources of Contamination Investigation (SCI) on the SYW-12 property (the Property) was conducted to delineate the former Onondaga Creek channel on the Property and further evaluate sources of constituents in the former channel. The field program included six test trenches, fourteen soil borings, and one round of groundwater samples from newly installed wells HB-MW-28 and HB-MW-29 and existing well HB-MW-26.

Soil, groundwater, and sheen net samples collected during this event were analyzed for TCL/TAL parameters using USEPA SW846 methods 8260B, 8270D, 8082, 6010C, 7471A, 9010C/9014, and Lloyd Kahn for VOCs, semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), metals, mercury, cyanide, and total organic carbon (TOC), respectively (USEPA, 2004). In addition to the TCL/TAL analyses, samples were submitted for fingerprinting analyses using methods 8270M for extended SVOCs and petroleum biomarkers, and method 8015C for total petroleum hydrocarbons and non-halogenated organics.

Field observations and analytical data indicated the presence of a petroleum and/or coal tar-impacted subsurface soils and groundwater. A stained layer was encountered below the reworked fill material that typically had a petroleum and/or coal tar odor. The BTEX compounds and PAHs associated with the stained layer were typically detected at concentrations exceeding their soil or groundwater-based criteria, and the fingerprinting data included detected concentrations of petroleum biomarkers. Full analytical results and field investigation logs are presented in the SCI Revised Report (O'Brien & Gere, 2014).

1.6. Document Organization

This document contains the following sections:

Section 1 – Introduction
Section 2 – Remedial investigation program
Section 3 – Study area physical characteristics
Section 4 – Nature and extent of constituents
Section 5 – Comparison of analytical results to applicable standards and/or guidance values
Section 6 – Constituents fate, persistence, and transport
Section 7 – Wetland delineation
Section 8 – Conceptual Site Model
Section 9 – Conclusions and preliminary remedial action objectives (RAOs)

2. Remedial Investigation Program

This section describes the field methods used to characterize the Wastebed B/Harbor Brook Site and additional AOS. As mentioned in Section 1, the RI consisted of a PSA, RI, and Supplemental RI field programs. The PSA included field activities performed during the summer of 2000 and the winter of 2001. The RI included field activities conducted between November 2002 and May 2004. The Supplemental RI was conducted from October 2006 to June 2007. At the request of the NYSDEC, samples originally collected during the Willis Avenue Chlorobenzene Site Remedial Investigation (Willis Avenue RI) in the Dredge Spoils Areas (DSAs) and the East Flume (EF) are discussed below as part of the Wastebed B/Harbor Brook Site RI.

Also, borings advanced as part of the Wastebed B/Harbor Brook IRM, I-690 Limited Investigation, and Wastebed B Geotechnical Investigation are discussed as part of the RI.

The following field efforts were performed as part of the PSA, RI and Supplemental RI:

- Site reconnaissance
- Utilities clearance
- Surface soil sampling
- Geoprobe borings
- Soil borings
- Wetland borings
- Stream borings
- Test pits
- Temporary well installation via hydropunch
- Ground water screening
- Surface water sampling
- Sediment sampling
- Monitoring well installation
- Well development
- Hydraulic conductivity measurements
- Synoptic ground water elevation measurements
- Ground water density measurements
- Ground water sampling
- Seep reconnaissance and sampling
- Catch basin sampling
- Penn-Can drum survey
- Soil vapor survey
- DNAPL recovery evaluation
- Wetland delineation
- Floodplain survey
- Stage 1A cultural resources survey (CRS)
- Site survey/topographic map

Sample summary matrices are provided for the PSA, RI, and Supplemental RI within **Table 1**.

2.1. Site Characterization Methods

2.1.1. Site Reconnaissance and Utility Clearance

Sampling locations were staked in concurrence with Honeywell and the NYSDEC prior to the initiation of the PSA, RI, Supplemental RI, Wastebed B/Harbor Brook IRM field activities, I-690 Bridge Limited Investigation, and the Wastebed B Geotechnical Investigation. Utilities were marked by the Underground Facilities Protection Organization (UFPO), now Dig Safely New York, locating service. Private utility locations at the Penn-Can Property were identified by the current owners. Once utilities were marked, sample locations were relocated, as necessary, so intrusive work would not impact Site utilities.

2.1.2. Soil Sampling

Soil sampling was performed during the PSA, RI, and Supplemental RI. Soils characterization at the Site consisted of subsurface and surface soil samples from geoprobe borings, soil borings, and test pit excavations. As per Administrative Consent Order No. D-7-0001-00-02, historical samples collected at the Dredge Spoils Areas as part of the Willis Avenue RI are included within this RI Report. Soil borings were also advanced during the Wastebed B/Harbor Brook IRM, the I-690 Bridge Replacement Investigation, and Wastebed B Geotechnical Investigation. A description of these activities is provided below.

Surface Soil Sampling.

Surface soils were collected as part of the PSA, RI, and Supplemental RI. A description of the sampling performed during each phase is presented below.

PSA Surface Soil Sampling

During the completion of the PSA, a total of 54 surface soil samples were collected from a depth of 0 to 2 inches. The surface soils were collected in conjunction with geoprobe boring, soil boring, and wetland boring locations. **Table 2** lists the sample locations, depth interval, and analyses performed for surface soils collected during the PSA. The locations are presented on **Figure 6**. The number of samples collected at each sub-area is listed below:

- 34 surface soil samples collected at the Lakeshore Area (which includes six surface soil samples collected with the wetland soil borings)
- 11 surface soil samples collected at the Penn-Can Property
- Nine surface soil samples collected at the Railroad Area

Samples were collected using dedicated plastic scoops and dedicated aluminum pans. Samples were screened in the field using a photoionization detector (PID) and a mercury vapor analyzer (MVA). The samples were homogenized, transferred to sample containers provided by the laboratory, and placed in a cooler with ice. Representative samples were collected for VOCs prior to homogenization based on PID readings. Samples were then placed in a cooler on ice. Chain of custody records were initiated as the samples were collected and remained with the samples during transport to O'Brien & Gere Laboratories. Chain of custody forms are included in **Appendix I**.

Samples collected by Honeywell were transported to O'Brien and Gere Laboratories for analyses by USEPA SW846 methods (USEPA, 2004). TCL/TAL analyses were performed using Methods 8260, 8270, 8081, 8082, 6010B, 7471, and 9010B for VOCs, SVOCs, pesticides, PCBs (including Aroclor 1268), metals, mercury, and cyanide, respectively.

RI Surface Soil and Wetland Sampling

During the completion of the RI, surface soil samples were collected from depths of 0 to 6 inches and 6 to 12 inches. The surface soils were collected in conjunction with soil boring locations and selected surface soil sampling locations. **Table 3** lists the sample locations, depth interval, and analyses performed for surface soils collected during the RI. The locations are presented on **Figure 6**. The number of samples collected at each sub-area is listed below:

- 27 surface soil samples (14 from 0 to 0.5 ft and 13 from 0.5 to 1 ft) were collected at the Lakeshore Area
- Eight surface soil samples (4 from 0 to 0.5 ft and 4 from 0.5 to 1 ft) were collected at the Penn-Can Property
- Four surface soil samples (2 from 0 to 0.5 ft and 2 from 0.5 to 1 ft) and one tar sample (HB-PSD-TAR) were collected at the Penn-Can Property as part of the Penn-Can Drum Survey section discussed below
- Nine surface soil samples (5 from 0 to 0.5 ft and 4 from 0.5 to 1 ft) were collected at the Railroad Area
- 20 surface soil samples (10 from 0 to 0.5 ft and 10 from 0.5 to 1 ft) were collected at AOS #1
- Two surface soil samples (1 from 0 to 0.5 ft and 1 from 0.5 to 1 ft) were collected at AOS #2

Wetland area substrates were characterized by surface soil sampling within identified wetland areas at the Lakeshore Area during the RI. The following wetland soil samples were collected from eight locations, including:

- Four locations within wetland area WL2 (HB-SS-08, HB-SS-09, HB-SS-10, HB-SS-11)
- Two locations within wetland area WL3 (HB-RISB-01 and HB-RISB-02)
- One location within wetland area WL4 (HB-SS-04)
- One location within wetland area WL5 (HB-SS-01).

Samples were collected using either a manually driven split spoon or a hand auger. Samples were screened in the field using a PID and a MVA. Soils were transferred from the split spoon or hand auger to dedicated aluminum pans using dedicated plastic scoops. The samples were homogenized, transferred to sample containers provided by the laboratory, and placed in a cooler with ice. If there was no evidence of staining and a minimal PID reading (< 0.1 ppm), a representative sample for VOCs analysis was selected prior to homogenization and containerized using Encore™ samplers. If there was staining of the sediment or PID readings were greater than 0.1 ppm, samples for VOCs analysis were collected and placed in standard laboratory containers (*i.e.*, 4-ounce jar).

Chain of custody records were initiated as the samples were collected and remained with the samples during transport to Columbia Analytical Services. Chain of custody forms are included in **Appendix I**. Samples collected by Honeywell were shipped to Columbia Analytical Services for analyses by USEPA SW846 methods. TCL/TAL analyses were performed using Methods 8260 [plus 10 tentatively identified compounds (TICs)], 8270C (plus 20 TICs), 8081A, 8082, 6010B, 7471, and 9010B/9014 for VOCs, SVOCs, pesticides, PCBs (including Aroclor 1268), metals, mercury, and cyanide, respectively. Polychlorinated naphthalenes were evaluated as part of the TICs reported with the 8270C scan. Five wetland soil sample locations, one from each identified wetland area at the Site, were sampled from 0 to 0.5 ft and 0.5 to 1 ft for polychlorinated dioxins and furans (PCDD/PCDFs)

and methyl mercury using USEPA SW846 Method 8290 and modified EPA Method 1630, respectively. The methyl mercury samples were analyzed by Frontier Geosciences.

The split spoons and hand augers that came in contact with soils were decontaminated between each sample using the procedure outlined in the Quality Assurance Project Plan (QAPP) (O'Brien & Gere, 2000a). Equipment blanks were collected by running distilled water through the decontaminated split spoon or hand auger bucket and collecting it in the appropriate laboratory containers.

Penn-Can Drum Survey Sampling

As part of the RI, a Site reconnaissance of the Penn-Can Property was performed on June 5, 2003. A visual inspection of the area was performed. Specifically, the survey was performed in the eastern portion of the Penn-Can Property, where 55-gallon drums were observed during the PSA. Based on the visual inspection and at the request of the NYSDEC, six exploratory holes were dug on October 9, 2003 adjacent to the drum area. Surface soils were collected at two locations from 0 to 6 inches and 6 to 12 inches and submitted to the laboratory for analysis. The sample locations (HB-PSD-01 and HB-PSD-02), depth intervals, and analyses performed for these samples are included on **Table 3.** Also, a tar sample (HB-PSD-TAR) from one of the drums was collected and sent to the laboratory to be analyzed. The analyses for tar sample are also included on **Table 3**. The sample locations are presented on **Figure 6**.

Soils were transferred from the hand auger to dedicated aluminum pans using dedicated plastic scoops. The samples were homogenized, transferred to sample containers provided by the laboratory, and placed in a cooler with ice. VOC samples were collected prior to homogenization based on PID readings. The tar sample was collected with dedicated plastic scoops and placed directly into sample containers.

Chain of custody records were initiated as the samples were collected and remained with the samples during transport to Columbia Analytical Services. Chain of custody forms are included in **Appendix I**. Samples collected by Honeywell were shipped to Columbia Analytical Services for analyses by USEPA SW846 methods. TCL/TAL analyses were performed using Methods 8260 (plus 10 TICs), 8270C (plus 20 TICs), 8081A, 8082, 6010B, 7471, and 9010B/9014 for VOCs, SVOCs, pesticides, PCBs (including Aroclor 1268), metals, mercury, and cyanide, respectively. Polychlorinated naphthalenes were evaluated as part of the TICs reported with the 8270C scan.

The hand augers that came in contact with soils were decontaminated between each sample using the procedure outlined in the QAPP.

Supplemental RI Surface Soil Sampling

During the completion of the Supplemental RI, one surface soil sample was collected from a depth of 0 to 2 ft. The surface soil was collected in conjunction with soil boring location HB-SB-65 based on visual characteristics of the material. **Table 4** lists the sample location, depth interval, and analyses performed for surface soil collected during the Supplemental RI. The location is presented on **Figure 6**.

Soils were transferred from the 2-inch split barrel sampler to a dedicated aluminum pan using a dedicated plastic scoop. The sample was homogenized, transferred to sample containers provided by the laboratory, and placed in a cooler with ice. The VOC sample was collected prior to homogenization. The VOC sample was selected based on PID readings.

The chain of custody record was initiated as the sample was collected and remained with the sample during transport to Life Science Laboratories, Inc. Chain of custody forms are included in **Appendix I**. Samples collected by Honeywell were shipped to Life Science Laboratories, Inc. for analyses by USEPA SW846 methods. TCL/TAL analyses were performed using Methods 8260B (plus 10 TICs), 8270C (plus 20 TICs, 1-phenyl-1-[2,4-dimethylphenyl]-ethane (PXE), and 1-phenyl-1-[4-methylphenyl]-ethane (PTE)], 8081A, 8082, 6010B, 7471A, and 9010B/9014 for VOCs, SVOCs, pesticides, PCBs (including Aroclor 1268), metals, mercury, and cyanide, respectively. Polychlorinated naphthalenes were evaluated as part of the TICs reported with the 8270C scan.

The 2-inch split barrel sampler that came in contact with the soils was decontaminated using the procedure outlined in the QAPP.

Subsurface Soil Sampling

Subsurface soils were sampled at the Site and AOS during the PSA, RI and, Supplemental RI using geoprobe borings, soil borings, and test pit excavations. A description of the sampling performed during each phase is presented below.

PSA Geoprobe Borings

During the completion of the PSA, geoprobe borings were advanced at 34 locations. The geoprobes were advanced adjacent to test pit excavation locations. **Table 5** lists the sample locations, depth interval, and analyses performed for subsurface soils collected during the PSA. The locations are presented on **Figure 6**. The number of samples collected at each sub-area is listed below:

- 20 geoprobe borings were advanced and 21 subsurface samples collected at the Lakeshore Area
- Eight geoprobe borings were advanced and 8 subsurface samples collected at the Penn-Can Property
- Six geoprobe borings were advanced and 6 subsurface samples collected at the Railroad Area

The geoprobe borings at the Lakeshore Area were advanced between July 10 and July 18, 2000. The geoprobes at the Penn-Can Property and Railroad Area were advanced between February 26 and March 27, 2001. The geoprobe borings were advanced 2 feet into native materials (*i.e.*, marl or silt/fine sand) using direct push drilling techniques. The drilling was performed by Parratt-Wolff under the supervision of an O'Brien & Gere geologist. The geologist completed a log for each boring to document encountered subsurface strata and other pertinent observations. Each split spoon was screened using a PID and MVA. Pertinent field observations are included on **Table 6**. The boring logs are included in **Appendix F**. Subsequent to the completion of drilling activities, the borings were grouted with bentonite to the surface.

Based on the results of the screening and visual observation, one subsurface soil sample was collected from each geoprobe boring and submitted for laboratory analyses. Chain of custody records were initiated as the samples were collected and remained with the samples during transport to O'Brien & Gere Laboratories. Chain of custody forms are included in **Appendix I**.

Samples were collected with a split-spoon sampler. Field screening was performed with a PID at the time of collection to determine the appropriate interval from which to collect the sample for VOCs. The VOC sample was containerized in its respective laboratory provided sample container prior to homogenization. The remainder of the sample was then placed in a dedicated aluminum pan and homogenized using a dedicated plastic scoop. The homogenized sample was then containerized in

laboratory provided containers and placed in an iced cooler. The iced cooler lowered the temperature of the samples to the method-required temperature of 2 to 6 °C.

Samples collected by Honeywell were transported to O'Brien and Gere Laboratories for analyses by USEPA SW846 methods. TCL/TAL analyses were performed using Methods 8260, 8270, 8081, 8082, 6010B, 7471, and 9010B for VOCs, SVOCs, pesticides, PCBs (including Aroclor 1268), metals, mercury, and cyanide, respectively.

The drill rig, split spoons, and other tools that came into contact with the soils were decontaminated with high pressure steam prior to and between each boring. In addition, the split spoons were decontaminated between each sample using the procedures outlined in the QAPP. Equipment blanks were collected by running distilled, deionized water through the decontaminated split spoon and collecting it in the appropriate laboratory containers.

PSA Wetland Soil Borings

During the PSA, six borings (HB-HBW-01 through HB-HBW-06) were advanced in wetland areas WL2, WL4, and WL5 situated in the Lakeshore Area. **Table 5** lists the sample locations, depth interval, and analyses performed for subsurface soils collected during the PSA. The boring locations are presented on **Figure 6**. These borings were not part of the initial scope defined in the Harbor Brook Preliminary Site Assessment (O'Brien & Gere, 2000); rather, they were advanced at the request of the NYSDEC.

These borings were advanced using the same methods as the geoprobe borings described above in this report. The wetland soil borings were advanced from August 4 to August 8, 2000 to further evaluate the subsurface conditions at the Site.

Surface and subsurface samples were collected at these locations. Wetland surface soils were collected from 0 to 2 inches using the methods described in the PSA surface soil sampling section. The subsurface samples were collected from a depth greater than 2 inches. Subsurface samples were collected as described in the geoprobe boring section above. Cores were screened with a PID and MVA and were recorded in the boring logs along with other relevant information and observations. Pertinent field observations are included on **Table 6**. The boring logs are included in **Appendix F**. The borings were grouted to the surface with bentonite once drilling had been completed.

Based on the results of the screening and field observations, at least one sample was selected for laboratory analyses from the subsurface soils at each location. Chain of custody records were initiated as the samples were collected and remained with the samples during transport to O'Brien & Gere Laboratories. Chain of custody forms are included in **Appendix I**.

Samples were collected with a split-spoon sampler. Field screening was performed with a PID at the time of collection to determine the appropriate interval from which to collect the sample for VOCs. The VOC sample was containerized in its respective laboratory provided sample container prior to homogenization. The remainder of the sample was then placed in a dedicated aluminum pan and homogenized using a dedicated plastic scoop. The homogenized sample was then containerized in laboratory provided containers and placed in an iced cooler.

Samples collected by Honeywell were transported to O'Brien and Gere Laboratories for analyses by USEPA SW846 methods. TCL/TAL analyses were performed using Methods 8260, 8270, 8081,

8082, 6010B, 7471, and 9010B/9014 for VOCs, SVOCs, pesticides, PCBs (including Aroclor 1268), metals, mercury, and cyanide, respectively.

The drill rig, split spoons, and other tools that came into contact with the soils were decontaminated with high pressure steam prior to and between each boring. In addition, the split spoons were decontaminated between each sample using the procedures outlined in the QAPP. Equipment blanks were collected by running distilled, deionized water through the decontaminated split spoon and collecting it in the appropriate laboratory containers.

Soil Borings

Soil borings were advanced as part of the PSA, RI, Supplemental RI, the Wastebed B/Harbor Brook IRM, I-690 Bridge Limited Investigation, and the Wastebed B Geotechnical Investigation. Soil borings were also advanced within the DSAs as part of the Willis Avenue RI field program. A description of the borings advanced during these programs is discussed below.

PSA Soil Borings. During the completion of the PSA soil borings were advanced at 15 locations at the Site to characterize subsurface soils and facilitate monitoring well installation. **Table 5** lists the sample locations, depth interval, and analyses performed for subsurface soils collected during the PSA. The locations are presented on **Figure 6**. The number of soil borings and the number of samples collected at each sub-area is listed below:

- Eight soil borings were advanced and nine subsurface samples collected at the Lakeshore Area
- Four soil borings were advanced and 6 subsurface samples collected at the Penn-Can Property
- Three soil borings were advanced and 3 subsurface samples collected at the Railroad Area

The PSA soil borings were completed in two phases. During Phase 1, soil borings were advanced at the Lakeshore Area between July 19 and August 2, 2000. Phase 2 soil borings were advanced at the Penn-Can Property and Railroad Area between February 26 and March 27, 2001, subsequent to the execution of access agreements between Honeywell and the owners of the properties. The soil borings were advanced using direct push drilling techniques, and samples were collected continuously throughout the borings in accordance with ASTM Method D1586-84 using a 140-lb hammer and 2-ft split-barrel samplers. The drilling was performed by Parratt-Wolff under the supervision of an O'Brien & Gere geologist, who completed a boring log for each boring to document encountered subsurface strata and other pertinent observations. Each split spoon was screened using a PID and MVA. Pertinent field observations are included on **Table 6**. The boring logs are included in **Appendix F**. Borings not converted to monitoring wells were grouted to the surface with bentonite upon completion of drilling.

It should be noted that no samples were collected at HB-HB-02D. During the advancement of the boring for well installation, a methane pocket was encountered and collapsed the bottom of the boring. As a temporary measure, a standpipe was attached to the protective casing so that the gas could be vented. Also, a temporary fence was installed around the boring/monitoring well with caution tape attached to the fence. The boring was subsequently grouted and abandoned.

Based on the results of the screening and field observation, at least one sample was submitted for laboratory analysis from the subsurface soils at each location. Chain of custody records were initiated as the samples were collected and remained with the samples during transport to O'Brien & Gere Laboratories. Chain of custody forms are included in **Appendix I**.

Samples were collected with a split-spoon sampler. Field screening was performed with a PID at the time of collection to determine the appropriate interval from which to collect the sample for VOCs. The VOC sample was containerized in its respective laboratory provided sample container prior to homogenization. The remainder of the sample was then placed in a dedicated aluminum pan and homogenized using a dedicated plastic scoop. The homogenized sample was then containerized in laboratory provided containers and placed in an iced cooler.

Samples collected by Honeywell were transported to O'Brien and Gere Laboratories for analyses by USEPA SW846 methods. TCL/TAL analyses were performed using Methods 8260, 8270, 8081, 8082, 6010B, 7471, and 9010B for VOCs, SVOCs, pesticides, PCBs (including Aroclor 1268), metals, mercury, and cyanide, respectively.

The drill rig, split spoons, and other tools that came into contact with the soils were decontaminated with high pressure steam prior to and between each boring. In addition, the split spoons were decontaminated between each sample using the procedures outlined in the QAPP. Equipment blanks were collected by running distilled water through the decontaminated split spoon and collecting it in the appropriate laboratory containers.

RI Soil Borings. During the completion of the RI, soil borings were advanced at 23 locations at the Site to characterize subsurface soils and facilitate monitoring well installation. **Table 7** lists the sample locations, depth interval, and analyses performed for subsurface soils collected during the RI. The locations are presented on **Figure 6**. The number of samples collected at each sub-area is listed below:

- Five soil borings were advanced and five subsurface samples collected at the Lakeshore Area
- One soil boring was advanced and one subsurface samples collected at the Penn-Can Property
- Four soil borings were advanced and three subsurface samples collected at the Railroad Area
- Ten soil borings were advanced and 11 subsurface samples collected at the AOS #1
- Three soil borings were advanced and one subsurface sample collected at the AOS #2

The soil borings were advanced between December 13, 2002 and March 10, 2002. Two additional soil borings were advanced within AOS #1 on May 24 and 25, 2004. The additional soil borings were advanced using direct push drilling techniques. Samples were collected continuously throughout the borings in accordance with ASTM Method D1586-84 using a 140-lb hammer and 2-ft split-barrel samplers. The drilling was performed by Parratt-Wolff under the supervision of an O'Brien & Gere geologist, who completed a boring log for each boring to document encountered subsurface strata and other pertinent observations. Each split spoon was screened using a PID and MVA. Pertinent field observations are included on **Table 8**. The boring logs are included in **Appendix F**. Borings not converted to monitoring wells were grouted to the surface with bentonite upon completion of drilling.

Based on the results of the screening and visual observation, at least one sample was collected from the subsurface soils. Chain of custody records were initiated as the samples were collected and remained with the samples during transport to Columbia Analytical Services in Rochester, New York. Chain of custody forms are included in **Appendix I**.

Samples were collected with a split-spoon sampler. Field screening was performed with a PID at the time of collection to determine the appropriate interval from which to collect the sample for VOCs. The VOC sample was containerized in its respective laboratory provided sample container prior to homogenization. The remainder of the sample was then placed in a dedicated aluminum pan and

homogenized using a dedicated plastic scoop. The homogenized sample was then containerized in laboratory provided containers and placed in an iced cooler.

Samples collected by Honeywell were transported to Columbia Analytical for analyses by USEPA SW846 methods. TCL/TAL analyses were performed using methods 8260B plus 10 TICs, 8270C plus 20 TICs, 8081A, 8082, 6010B, 7471A, and 9010B/9014 for VOCs, SVOCs, pesticides, PCBs (including Aroclor 1268), metals, mercury, and cyanide, respectively. Polychlorinated naphthalenes were evaluated as part of the TICs reported with the 8270C scan.

The drill rig, split spoons, and other tools that came into contact with the soils were decontaminated with high pressure steam prior to and between each boring. In addition, the split spoons were decontaminated between each sample using the procedures outlined in the QAPP. Equipment blanks were collected by running distilled water through the decontaminated split spoon and collecting it in the appropriate laboratory containers.

Supplemental RI Soil Borings (Wastebed B/Harbor Brook). During the completion of the Supplemental RI, soil borings were advanced at 28 locations at the Site to characterize subsurface soils and facilitate monitoring well installation. **Table 9** lists the sample locations, depth interval, and analyses performed for subsurface soils collected during the Supplemental RI. The locations are presented on **Figure 6**. It should be noted that the three borings advanced in Harbor Brook as part of the Supplemental RI are discussed in Section 2.1.11 Supplemental RI Sediment Sampling.

The soil borings were advanced between October 2006 and November 2006. The soil borings were advanced using direct push drilling techniques. Samples were collected continuously throughout the borings in accordance with ASTM Method D1586-84 using a 140-lb hammer and 2-ft split-barrel samplers. The drilling was performed by Parratt-Wolff under the supervision of an O'Brien & Gere geologist who completed a boring log for each boring to document encountered subsurface strata and other pertinent observations. Each split spoon was screened using a PID and MVA. Pertinent field observations are included on **Table 10**. The boring logs are included in **Appendix F**. Borings not converted to monitoring wells were grouted to the surface with bentonite upon completion of drilling.

Based on the results of the screening and visual observation, at least one sample was collected from the subsurface soils. Chain of custody records were initiated as the samples were collected and remained with the samples during transport to Life Science Laboratories, Inc. (Life Science) in Syracuse, New York. Chain of custody forms are included in **Appendix I**.

Samples were collected with a split-spoon sampler. Field screening was performed with a PID at the time of collection to determine the appropriate interval from which to collect the sample for VOCs. The VOC sample was containerized in its respective laboratory provided sample container prior to homogenization. The remainder of the sample was then placed in a dedicated aluminum pan and homogenized using a dedicated plastic scoop. The homogenized sample was then containerized in laboratory provided containers and placed in an iced cooler.

Samples collected by Honeywell were transported to Life Science for analyses by USEPA SW846 methods. TCL/TAL analyses were performed using methods 8260B plus 10 TICs, 8270C plus 20 TICs, 8081A, 8082, 6010B, 7471A, and 9010B/9014 for VOCs, SVOCs, pesticides, PCBs (including Aroclor 1268), metals, mercury, and cyanide, respectively. The SVOC analysis also included PXE and PTE. Polychlorinated naphthalenes were evaluated as part of the TICs reported with the 8270C scan.

The drill rig, split spoons, and other tools that came into contact with the soils were decontaminated with high pressure steam prior to and between each boring. In addition, the split spoons were decontaminated between each sample using the procedures outlined in the QAPP. Equipment blanks were collected by running distilled water through the decontaminated split spoon and collecting it in the appropriate laboratory containers.

Supplemental RI Soil Borings (SYW-12). During the completion of the Supplemental RI, soil borings were advanced at 25 locations at the SYW-12 Site to characterize subsurface soils and facilitate monitoring well installation. **Table 9** lists the sample locations, depth interval, and analyses performed for subsurface soils collected during the Supplemental RI. The locations are presented on **Figure 8**.

The soil borings were advanced in December 2006 and January 2007. The soil borings were advanced using direct push drilling techniques. Samples were collected continuously throughout the borings in accordance with ASTM Method D1586-84 using a 140-lb hammer and 2-ft split-barrel samplers. The drilling was performed by Parratt-Wolff under the supervision of an O'Brien & Gere geologist who completed a boring log for each boring to document encountered subsurface strata and other pertinent observations. Each split spoon was screened using a PID and MVA. Pertinent field observations are included on **Table 11**. The boring logs are included in **Appendix F**. Borings not converted to monitoring wells were grouted to the surface with bentonite upon completion of drilling.

Based on the results of the screening and visual observation, at least one sample was collected from the subsurface soils. Chain of custody records were initiated as the samples were collected and remained with the samples during transport to Life Science Laboratories, Inc. in Syracuse, New York. Chain of custody forms are included in **Appendix I**.

Samples were collected with a split-spoon sampler. Field screening was performed with a PID at the time of collection to determine the appropriate interval from which to collect the sample for VOCs. The VOC sample was containerized in its respective laboratory provided sample container prior to homogenization. The remainder of the sample was then placed in a dedicated aluminum pan and homogenized using a dedicated plastic scoop. The homogenized sample was then containerized in laboratory provided containers and placed in an iced cooler.

Samples collected by Honeywell were transported to the laboratory for analyses by USEPA SW846 methods. TCL/TAL analyses were performed using methods 8260B plus 10 TICs, 8270C plus 20 TICs, 8081A, 8082, 6010B, 7471A, and 9010B/9014 for VOCs, SVOCs, pesticides, PCBs (including Aroclor 1268), metals, mercury, and cyanide, respectively. Soil samples were also submitted to the laboratory for total petroleum hydrocarbons and petroleum fingerprint using USEPA method modified 8015. The SVOC analysis also included PXE and PTE. Polychlorinated naphthalenes were evaluated as part of the TICs reported with the 8270C scan.

The drill rig, split spoons, and other tools that came into contact with the soils were decontaminated with high pressure steam prior to and between each boring. In addition, the split spoons were decontaminated between each sample using the procedures outlined in the QAPP. Equipment blanks were collected by running distilled water through the decontaminated split spoon and collecting it in the appropriate laboratory containers.

Willis Avenue RI Dredge Spoils Area Soil Borings. During Phase 3 of the Willis Avenue RI, two soil borings were advanced using direct push drilling techniques (Geoprobe Macrocore) in Dredge Spoils Area #2 (HB-DSA#2-B1 and HB-DSA#2-B2). The borings were advanced to evaluate the hazardous characteristics of the black organic material observed at approximately 5 ft below ground surface (bgs) during excavation of test pits during Phase 2 of the Willis Avenue RI. **Table 12** lists the sample locations, depth interval, and analyses performed for subsurface soils collected during the Willis Avenue RI. Sample locations are presented on **Figure 6**. Boring logs were not developed for these two locations based on their proximity to existing test pits.

Two composite samples for TCLP analyses, which are designated as HB-DSA#2B1 and HB-DSA#2B2, were collected from the western end of test pits HB-DSA#2TP1 and HB-DSA#2TP2, respectively. These samples were extracted using Method 1311 and analyzed using USEPA SW846 methods 8260, 8270, 8081, 6010, and 7470 for VOCs, SVOCs, herbicides, metals, and mercury, respectively. The NYSDEC collected split samples from these locations.

Wastebed B/Harbor Brook IRM Soil Borings. Twenty-seven test borings (HB-SB-01 through HB-SB-05 and HB-SB-07 through HB-SB-28) were installed along or as close as possible to the barrier wall alignment proposed in the Work Plan (O'Brien & Gere and Parsons, 2004), as shown in **Figure 6**. Boring HB-SB-06 was not installed, because it was not accessible with the rig. The objectives of the test borings were to evaluate the stratigraphy along the proposed barrier wall alignment, evaluate the presence and depth of the confining silt and clay layer (Stratum IV), obtain *in situ* strength data along the barrier wall using SPT, and obtain samples for laboratory geotechnical analyses.

Parratt-Wolff performed the drilling under the supervision of an O'Brien & Gere geologist from October 11 to December 15, 2004. A geologist completed a boring log to document encountered subsurface strata and other pertinent observations. Pertinent field observations are included on **Table 13**; the boring logs are included as **Appendix F**. The borings were installed using 6-inch hollow stem augers in accordance with ASTM D 1452. Continuous split spoon samples were collected in glass jars for the entire depth of the boring in accordance with ASTM D 1586 (Standard Method for Penetration Test and Split Barrel Sampling of Soils). Each soil sample was logged and screened using a PID and MVA. Both instruments were calibrated prior to sampling each day.

The borings were advanced at least 10 ft into the silt and clay confining layer (Stratum IV). Six borings (HB-SB-04, HB-SB-10, HB-SB-15, HB-SB-18, HB-SB-21, and HB-SB-24) were advanced beyond the silt and clay and terminated at the bedrock surface (Stratum VIII). The borings advanced beyond the silt and clay confining-layer were installed using double cased drilling methods. The double cased boring was installed to prevent the downward migration of Site constituents. When the silt and clay layer was encountered in each boring, an undisturbed Shelby tube sample was collected in accordance with ASTM D 1587 (Standard Practice for Thin-Walled Tube Sampling of Soils) for subsequent laboratory testing. Additionally, Shelby tube samples were collected when cohesive soils were encountered elsewhere in the borings. Following completion of each boring, the borehole was backfilled and sealed with a bentonite grout mixture.

During advancement of the test borings, split spoon samples and Shelby tubes were collected for geotechnical analyses. Selected split spoon and Shelby tube samples were submitted to PW Laboratories, Inc. for the following analyses:

- Moisture Content (ASTM D2216)
- Sieve Analysis (ASTM D422 & D1140)

- Hydrometer Analysis (ASTM D422)
- Atterberg Limits (ASTM D4318)
- Specific Gravity (ASTM D854)
- Organic Content (ASTM D2974)
- Insoluble Residue in Carbonate Aggregates (ASTM D3042)
- Consolidated Undrained Triaxial Test (with pore water pressure measurements) - 3 point (ASTM D4767)
- Hydraulic Conductivity (ASTM D5084)
- Unconsolidated Undrained Triaxial Test (D2850)

A data summary is provided in Tables D1 through D5 within **Appendix J.**

I-690 Limited Investigation. As part of the I-690 bridge replacement over Harbor Brook, soil borings were advanced at nine locations (HB-SB-42 through HB-SB-50) to the top of the silt and clay unit under and adjacent to the bridge. The locations are presented on **Figure 6**. The borings were advanced using conventional drilling techniques. Samples were collected continuously in accordance ASTM Method D1586-84 using a 140-lb hammer and 2-ft split-barrel samplers for eight borings. Boring HB-SB-43, which is underneath the I-690 bridge, was advanced using a truck-mounted geoprobe due to height restrictions.

Drilling was overseen by a geologist who completed a boring log to document encountered subsurface strata and other pertinent observations. Pertinent field observations are included on **Table 14**. The boring logs are included as **Appendix F**. Samples were not collected and submitted for laboratory analysis. Each split spoon was visually characterized for the presence of dense non-aqueous phase liquid (DNAPL). In addition, each split spoon sample was screened using a PID. Subsequent to the completion of drilling activities the borings were grouted with bentonite to the surface.

Wastebed B Geotechnical Investigation. A geotechnical investigation was conducted at the Site in the fall of 2005. Eight borings were advanced as part of this investigation, with six borings (HB-SB-30, HB-SB-33, HB-SB-35, HB-SB-36, HB-SB-39, and HB-SB-40) advanced into the top of the silt/clay unit and two borings (HB-SB-32 and HB-SB-38) advanced to the top of till. The sample locations are presented on **Figure 6**.

The soil borings were advanced using direct push drilling techniques, and samples were collected continuously throughout the borings in accordance with ASTM Method D1586-84 using a 140-lb hammer and 2-ft split-barrel samplers. The drilling was performed by Parratt-Wolff under the supervision of an O'Brien & Gere geologist. The geologist completed a boring log for each boring to document encountered subsurface strata and other pertinent field observations. Each split spoon was screened using a PID. Pertinent field observations are included on **Table 15**. The boring logs are included in **Appendix F**. The borings were grouted with bentonite to the surface subsequent to the completion of drilling activities.

A total of sixteen Shelby tubes were collected during the investigation. Eight Shelby tubes were collected in the Solvay waste, six were collected in the marl material, and two were collected in the silt and clay layer.

Eleven of the sixteen Shelby tube soil samples collected during the investigation were delivered to P-W Laboratories, Inc. for geotechnical analyses. The following testing was performed on the Shelby tubes:

- six for ASTM D854 (Specific Gravity)
- five for ASTM D5084 (Hydraulic Conductivity)
- six for ASTM D2435 (One Dimensional Consolidation)
- four for ASTM D4767 (Consolidated Undrained Triaxial Shear Test [3 point])

Disturbed split spoon samples were collected during the investigation and submitted to P-W Laboratory, Inc. for analyses. The split spoon samples submitted to the lab were chosen to determine a general makeup of the types of material associated across the Site.

- six for ASTM D2216 (Natural Moisture Content)
- six for ASTM D1140 (Sieve Analysis)
- six for ASTM D422 (Hydrometer Analysis)
- six for ASTM D4318 (Atterberg Limits)

The following table presents the distribution of each laboratory analysis and the associated soil layer.

Table 2.1. *Geotechnical Investigation Laboratory Analysis Summary.*

Laboratory Analyses	Solvay waste	Marl material	Silt and clay
Specific Gravity	2	4	0
Hydraulic Conductivity	2	3	0
One Dimensional Consolidation	3	3	0
Consolidated Undrained Triaxial Shear Test (3 point)	2	Sample disturbance	1
Natural Moisture Content	2	1	3
Sieve Analysis	2	1	3
Hydrometer Analysis	2	1	3
Atterberg Limits	2	1	3

The results from the geotechnical analyses are presented in **Appendix J**.

The drill rig, split spoons, and other tools that came into contact with the soils were decontaminated with high pressure steam prior to field work and between each boring. In addition, the split spoons were decontaminated between each sample outlined in the RI/FS QAPP (O'Brien & Gere, 2002b).

Test Pit Excavations

PSA Test Pits

Test pits were advanced in two phases. The first phase of test pits was performed between July 5, 2000 and July 19, 2000 at the Lakeshore Area. The second phase of test pits was completed from February 26, 2001 to March 8, 2001, subsequent to access agreements being obtained for the Penn-Can Property and the Railroad Area. **Table 16** lists the test pit sample locations, depth intervals, and analyses performed for subsurface soils collected during the PSA.

A total of 48 test pits were advanced during the PSA using a tracked excavator to evaluate the physical and chemical characteristics of shallow subsurface soils (0 to 10 ft) at the Site. Test pits were excavated to be approximately 50 ft in length, 3 ft wide, and 10 ft deep. The excavated materials were

staged adjacent to the pit pending visual inspection by O'Brien & Gere and the NYSDEC, and collection of samples. After inspection and sampling were completed, the test pits were backfilled with the excavated materials. The test pit locations are presented on **Figure 6**. Test pit logs are presented in **Appendix K**. A PID and MVA were used to screen collected samples and monitor the breathing zone during excavation. Pertinent field observations are presented on **Table 17**. The excavator bucket was decontaminated between test pits using a steam cleaner. The waste water derived from decontamination was containerized, tested, and disposed of at an acceptable off-site facility.

The following TCL/TAL samples were collected from the test pits during the PSA:

- Eighteen analytic samples were collected for TCL/TAL analyses from the 32 test pits at the Lakeshore Area
- Eight analytic samples were collected from eight test pits at the Railroad Area
- Eight analytic samples were collected from eight test pits at the Penn-Can Property

Samples were collected by transferring soil from the backhoe bucket to a dedicated aluminum pan and homogenized using a dedicated plastic spatula. Prior to homogenization, a sample for VOCs was collected and containerized. Subsequent to homogenization, soils were collected for the remainder of the analyses. Test pit samples were submitted to O'Brien & Gere Laboratories for TCL/TAL analyses by USEPA SW846 methods 8260, 8270, 8081, 8082, 6010B, 7471, and 9010B for VOCs, SVOCs, pesticides, PCBs (including Aroclor 1268), metals, mercury, and cyanide, respectively.

In addition, five test pit samples and one soil boring sample were collected for Toxicity Characteristic Leachate Procedure (TCLP) analyses, reactivity, and ignitability. TCLP parameter analyses were performed using the methods listed above and extraction Method 1311. Ignitability was analyzed using Method 1010, and reactivity was analyzed using *Test Method to Determine Hydrogen Sulfide Released from Wastes*. Chain of custody forms are included in **Appendix I**.

Supplemental RI Test Pits

Test pits were advanced during the Supplemental RI in November 2006. A total of 17 test pits were advanced using an excavator. The test pit sample locations, depth intervals, and analyses performed for the Supplemental RI are included on **Table 18**. These test pits were advanced to further evaluate the physical and chemical characteristics of shallow subsurface soils (0 to 10 ft) within DSA#1 and DSA#2 at the Site. HB-TP-42 was not completed due to standing water in the area. HB-TP-51 was installed in two sections, one section on each side of the Site access road.

The 17 test pits advanced at and adjacent to DSA #1 and DSA #2 were advanced to further delineate the extent of the "black organic material" previously identified in these areas. The test pits to be advanced at the Penn-Can Property to investigate the presence of the former "open tile waste drain" were replaced with borings due to concerns about excavating near the 24-inch water main on-site. These additional borings are discussed above in section titled *Supplemental RI Soil Borings (Wastebed B/Harbor Brook)*.

Test pits were excavated with varying lengths and depths depending upon their location. The excavated materials were staged adjacent to the pit pending visual inspection by O'Brien & Gere and the NYSDEC and collection of samples. After inspection and sampling were completed, the test pits were backfilled with the excavated materials. The test pit locations are presented on **Figure 6**. Test pit logs are presented in **Appendix K**. A PID and MVA were used to screen collected samples and

monitor the breathing zone during excavation. Pertinent field observations are presented on **Table 19**. The excavator bucket was decontaminated between test pits using a steam cleaner. The waste water derived from decontamination was containerized, tested, and disposed of at an acceptable off-site facility.

Three samples were collected by transferring soil from the backhoe bucket to a dedicated aluminum pan and homogenized using a dedicated plastic spatula. Prior to homogenization, a VOC sample was collected and containerized. Subsequent to homogenization, soils were collected for the remainder of the analyses. Test pit samples were submitted to Life Science Laboratories for TCL/TAL analyses by USEPA SW846 methods 8260B, 8270C, 8081A, 8082, 6010B, 7471A, and 9010B/9014 for VOCs, SVOCs (including PXE and PTE), pesticides, PCBs (including Aroclor 1268), metals, mercury, and cyanide, respectively. Polychlorinated naphthalenes were evaluated as part of the TICs reported with the 8270C scan. Chain of custody forms are included in **Appendix I**.

Willis Avenue Dredge Spoils Area Test Pits
Test pits were excavated in DSA #1 and DSA #2 during Phases 2 and 3 of the Willis Avenue RI. The test pit sample locations, depth intervals, and analyses performed for the Willis Avenue RI are included on **Table 12**. Sample locations were selected in the field in concurrence with Honeywell and the NYSDEC and are presented on **Figure 6**.

Test pits were excavated using a rubber tire, extended reach backhoe. Excavated materials were staged on the ground adjacent to the pit pending visual inspection by O'Brien & Gere and the NYSDEC and collection of samples. After inspection and sampling were completed, the test pits were backfilled with the excavated materials. Test pit logs are presented in **Appendix K**. The location IDs in **Appendix K** have a WA- prefix instead of the HB- shown below. This change was made to reflect that the data for these locations will be used for the Wastebed B/Harbor Brook Site and not Willis Avenue Chlorobenzene Site. The HB- prefix is consistent with the current site database. However, this change is not reflected in the test pit logs.

Dredge Spoils Area #1
The following test pits were excavated and soil samples were collected in the DSA#1 during Phase 2 of the Willis Avenue RI:

- HB-DSA#1 NETP: 100 ft x 3 ft x 6 ft (3 samples; 1 each at 0 to 2 ft, 2 to 5 ft, and 6 ft)
- HB-DSA#1 NWTP: 180 ft x 3 ft x 4 ft (3 samples; 1 each at 0 to 2 ft, 3 to 4 ft, and 5 ft)
- HB-DSA#1 SETP: 125 ft x 3 ft x 6 ft (1 sample at 0 to 2 ft)
- HB-DSA#1 SWTP: 125 ft x 3 ft x 6 ft (no samples collected)
- HB-DSA#1 CENTER TP 40 ft x 3 ft x 6 ft (no samples collected)

Samples collected from 0 to 2 ft were analyzed for VOCs, PCB/pesticides (including hexachlorobenzene), and mercury by USEPA Methods 8260, 8080, and 7471, respectively. The remaining samples were analyzed for TCL/TAL parameters. The NYSDEC collected split samples at these locations and a unique sample at HB-DSA#1 SETP (5 ft). NYSDEC samples were submitted for TCL/TAL parameter analyses.

The following test pits were excavated and soil samples were collected from DSA#1 during Phase 3:

- HB-DSA#1 NETP: 5 ft x 3 ft x 6 ft (1 composite sample at 6 ft)
- HB-DSA#1 SETP: 5 ft x 3 ft x 6 ft (1 composite sample at 5 ft)

These composite samples were collected to evaluate the hazardous characteristics of the black organic material observed during the Phase 2 test pit excavations. Test pits HB-DSA#1 NETP and HB-DSA#1 SETP were advanced at Phase 2 locations HB-DSA#1 NETP and HB-DSA#1 SETP, respectively. Samples were analyzed for TCLP parameters using USEPA extraction Method 1311 and USEPA Methods 8260, 8270, 8082, 6010, and 7470 for VOCs, SVOCs, PCBs, metals, and mercury, respectively. The NYSDEC collected split samples from both locations for TCLP parameter analyses.

Test pit soil samples were collected using a decontaminated trowel and then transferred to a mixing bowl. For locations where the test pit depth was 6 ft or greater, samples were retrieved using the backhoe bucket or collected directly from the staged materials. A representative sample was then placed in a container for VOCs analysis. The remainder of the sample was then homogenized using a trowel. Aliquots of the homogenized sample were then placed in sample containers for SVOCs, PCBs/pesticides (including hexachlorobenzene) and mercury analyses, respectively. Following transfer to laboratory containers, the samples were placed in a cooler containing ice and transported to O'Brien & Gere Laboratories for analyses. NYSDEC samples were sent to Chemtech Consulting Group for VOCs, SVOCs, PCBs/pesticides, and metals analyses. The backhoe was decontaminated between test pits using a steam cleaner.

Dredge Spoils Area #2

During Phase 2 of the Willis Avenue RI, the following test pits were excavated and samples collected in the DSA#2:

- HB-DSA#2 TP1: 150 ft x 3 ft x 6 ft (1 sample at 5 ft)
- HB-DSA#2 TP2: 75 ft x 3 ft x 6 ft (1 sample at 5 ft)
- HB-DSA#2 TP2A: 10 ft x 3 ft x 6 ft (no samples collected)
- HB-DSA#2 TP3: 10 ft x 3 ft x 10 ft (no samples collected)

The same methodology for test pit excavations was used as described above for DSA #1. Test pits were not excavated in DSA#2 during Phase 3. Samples from the DSA #2 were sent to O'Brien & Gere Laboratories analyzed for VOCs, PCB/pesticides (including hexachlorobenzene), and mercury by USEPA methods 8260, 8080, and 7471, respectively. During excavation of HB-DSA#2TP1 and HB-DSA#2TP2, the breathing zone was monitored using a PID because chemical odors were noted. Readings of 3 ppm were observed but not sustained. In general, readings remained steady at just above background (~0.5 ppm). Readings of 10 ppm were obtained about 1 inch above excavated materials. The NYSDEC sample was sent to Chemtech Consulting Group for VOCs, SVOCs, PCBs/pesticides, and metals analyses.

2.1.3. Ground Water Screening

PSA

During the PSA, ground water screening samples (HB-HP-01 through HB-HP-08) were collected along the northern boundary of the Lakeshore Area from eight locations to aid in the selection of soil boring and monitoring well locations. The ground water screening locations are presented on **Figure 6**. The soil borings were advanced using direct push drilling techniques. Samples were collected continuously throughout the borings in accordance with ASTM Method D1586-84 using a 140-lb hammer and 2-ft split-barrel samplers. The drilling was performed by Parratt-Wolff under the supervision of an O'Brien & Gere geologist. The geologist completed a boring log for each boring to document encountered subsurface strata and other pertinent observations. Each split spoon was

screened using a PID and MVA. The field screening results are included on the boring logs that are included in **Appendix F**.

Once first encountered ground water was observed, the boring was stopped at that depth and a temporary well point was installed. The temporary well points were sampled using a peristaltic pump. The samples were submitted to O'Brien & Gere Laboratories for TCL/TAL analyses by USEPA SW846 methods 8260, 8270, 8081, 8082, 6010B, and 7470A for VOCs, SVOCs, pesticides, PCBs (including Aroclor 1268), metals, and mercury, respectively. The sample locations, depth intervals, and analyses performed are included in **Table 20**.

Supplemental RI

During the Supplemental RI, ground water screening samples (HB-GWS-01 through HB-GWS-09) were collected at the SYW-12 area to aid in the selection of monitoring well locations. The ground water screening locations are presented on **Figure 8**. The soil borings were advanced using direct push drilling techniques. Samples were collected continuously throughout the borings in accordance with ASTM Method D1586-84 using a 140-lb hammer and 2-ft split-barrel samplers. The drilling was performed by Parratt-Wolff under the supervision of an O'Brien & Gere geologist. The geologist completed a boring log for each boring to document encountered subsurface strata and other pertinent observations. Each split spoon was screened using a PID and MVA. The field screening results are included on the boring logs that are included in **Appendix F**.

Once first encountered ground water was observed, the boring was stopped at that depth, and a temporary well point was installed. The temporary well points were sampled using a peristaltic pump. The samples were submitted to O'Brien & Gere Laboratories for TCL/TAL analyses by USEPA SW846 methods 8260B, 8270C, 8081A, 8082, 6010B, 7470A, 9010/9014C for VOCs, SVOCs, pesticides, PCBs (including Aroclor 1268), metals, mercury, and cyanide, respectively. Polychlorinated naphthalenes were evaluated as part of the TICs reported with the 8270C scan. Samples were also analyzed for hardness, alkalinity, and major cations and anions (Ca, Mg, Na, Cl, SO_4, CO_3, HCO_3) using methods 310.1/2320B, 2340B, and 6010/E300/2320B, respectively. Specific gravity (density) measurements were collected in the field using a hydrometer. An analytical summary is included as **Table 21** that presents the sample location, sample depth, and analyses performed.

2.1.4. Monitoring Well Installation

Borings were installed using conventional drilling techniques by Parratt-Wolff under the supervision of an O'Brien & Gere geologist. Borings were generally advanced to the top of the silt and clay layer. Soil samples were collected continuously throughout the boring in accordance with ASTM Method D1586-84 using a 140-lb hammer and 2-ft split-barrel sampler. Each sample was logged by the geologist and boring logs were completed to document encountered subsurface material and other pertinent observations including but not limited to soil composition, color, consistency, moisture content, recovery, odor and staining. In addition, each split spoon sample was screened using a PID and a MVA. Boring logs are presented as **Appendix F**. Boring locations are presented on **Figures 6 and 8** and discussed in greater detail below.

Deep ground water monitoring wells screened at the top of till were double cased. The double cased installations were conducted by advancing 6¼-inch inside diameter augers from the ground surface to a minimum depth of 5 ft below the top of the silt and clay layer. During advancement of the 6¼-inch augers, soil samples were collected at continuous 2-ft intervals using 2-inch diameter split-barrel samplers in accordance with ASTM Method D1586-84. At locations where borings were previously

completed, samples were not collected in duplicate intervals. Upon completion of advancement of the 6¼-inch augers, 4-inch diameter steel casing fitted with a plastic end cap was lowered through the auger string. The annular space between the borehole wall and the 4-inch casing was filled with cement/bentonite grout using a tremie pipe as the auger string is removed. A head of grout was maintained within the auger string until all of the augers were removed from the borehole. The grout was allowed to cure for a minimum of 12 hours prior to further borehole advancement.

Subsequent to curing of the grout, fluid-rotary drilling methods were used to deepen the boreholes to the terminal depths. A nominal 3.875-inch diameter roller bit was used to advance the boreholes. Potable water was re-circulated through the drill stem to carry soil cuttings to the ground surface. Cuttings that were carried to the ground surface were initially contained in the re-circulation tub and transferred to 55-gallon drums as needed. During the fluid-rotary drilling, soil samples were collected at continuous 2-ft intervals in accordance with ASTM Method D1586-84.

Subsequent to the terminal depth for the borehole, a 2-inch diameter fiberglass reinforced epoxy (FRE) well consisting of a 10-ft length of 0.010- or 0.020-inch slot screen flush-threaded to riser casing was lowered through the 4-inch casing. The screen size was selected based upon the nature of the subsurface material. The riser casing was extended approximately 2 ft above ground surface. A sandpack suitable for use with the screen slot size was installed within the annular space between the borehole and the well. The sandpack generally extended from the bottom of the well to 2 to 5 ft above the top of the well screen. At least a 3-ft thick bentonite seal was installed in the annular space above the sand pack to prevent water from moving vertically along the borehole. The remaining annular space was filled with a Portland cement/bentonite grout through a tremie pipe to a maximum depth of 5 ft below grade. To protect the well and prevent unauthorized access, a steel guard pipe with a cover and pad lock was installed around each well. A concrete pad was installed around the guard pipe to direct precipitation away from the borehole.

Shallow and intermediate wells, which are screened in the fill and marl units respectively, were installed in a similar manner to the deep wells. The shallower wells were installed directly through the auger string, with no additional casing necessary.

PSA Monitoring Wells

Drilling activities for the installation of the monitoring wells took place in two phases. The first phase occurred between July 19, 2000 and August 3, 2000 at the Lakeshore Area. The second phase occurred between February 26 and March 27, 2001 at the Railroad Area and Penn-Can Property. The monitoring wells installed during the PSA include:

- Lakeshore Area: HB-HB-01S, HB-HB-01D, HB-HB-02S, HB-HB-02I, HB-HB-03S, HB-HB-04S, HB-HB-05S, HB-HB-05I, and HB-HB-06S
- Penn-Can Property: HB-HB-11S, HB-HB-11I, HB-HB-12S, HB-HB-12I, HB-HB-12D, HB-HB-13D, HB-HB-14S, and HB-HB-14D
- Railroad Area: HB-HB-07S, HB-HB-08S, HB-HB-08I, and HB-HB-09S

RI Monitoring Wells

Drilling activities for the soil borings and monitoring wells took place between December 13, 2002 and March 6, 2003. Borings and/or monitoring wells were completed in AOS #1, AOS #2, the Lakeshore Area, the Penn-Can Property, and the Railroad Area to refine the understanding of the subsurface geology, the physical and chemical characteristics of soils and ground water, and the

presence of DNAPL. Three shallow, two intermediate, and six deep ground water monitoring wells were installed during the RI field program. The monitoring wells installed during the RI include:

- Lakeshore Area: HB-HB-04D, HB-HB-05D, and HB-HB-16D
- Penn-Can Property: HB-HB-17D
- Railroad Area: HB-HB-08D
- AOS#1: HB-HB-18S, HB-HB-19S, HB-HB-20S, HB-HB-20I, and HB-HB-20D
- AOS#2: HB-HB-21I

Supplemental RI Monitoring Wells
Drilling activities for the soil borings/monitoring wells took place in December 2006 and January 2007. Six shallow monitoring wells (HB-MW-22 through HB-MW-27) were installed at the SYW-12 area to assist in the understanding of the subsurface geology, and the physical and chemical characteristics of soils and ground water. Monitoring well locations are presented on **Figure 8**.

Wastebed B/Harbor Brook IRM Test Wells and Observation Wells
These wells were installed as part of the Wastebed B/Harbor Brook IRM. The method of installation and a summary of wells installed are provided in the Pump Test Report, which will be submitted under separate cover.

2.1.5. Well Development
Following installation of the wells and prior to collection of ground water samples, each well was developed to remove material that may have settled in and around the well screen. Development consisted of the removal of at least ten well volumes using either a bailer or centrifugal pump. A 50 NTU goal was established. When this goal could not be achieved, the well was purged until no further improvement in turbidity was observed. Development water was contained in 55-gallon drums or 500-gallon polyethylene tanks for subsequent disposal. The water was disposed of at an appropriate off-site facility based on ground water analytical results. Well development logs are included as **Appendix L**. The RI wells were developed by Parratt-Wolff subsequent to well installation and no well development logs are available.

2.1.6. Hydraulic Conductivity Measurements
In-situ hydraulic conductivity tests (K-tests) were performed for each well during the RI to estimate the horizontal hydraulic conductivity of sediments surrounding the well screen. Rising and falling head measurements were obtained following both insertion and removal of a PVC slug into the well.

The data were analyzed using the Bouwer and Rice (1976) method with the software AquiferWin®. Graphs of the K-test curves are included as **Appendix M**. **Table 22** presents the interpreted hydraulic conductivity values. The K-test values represent either rising or falling head measurement data. In general, falling head measurement data were used when the ground water level was below or at the top of the screen interval. Rising head measurement data were used when the ground water level was well above the top of the screen interval. Discussion of these results is included in the Section 3.3.5.

2.1.7. Synoptic Ground Water Elevation Measurements
Synoptic ground water elevations were collected during the PSA, RI, and Supplemental RI. Ground water elevations were collected using a Solinst™ Model 101 water level probe. Measured ground water elevations are presented on **Table 23**.

2.1.8. Ground Water Density Measurements

Ground water density measurements were collected in May and August 2003. The density measurements were collected by measuring both the water pressure, with a pressure transducer, within the monitoring well screen interval and the height of the water column above the pressure transducer. The density is calculated by the following formula: Density (relative to fresh water) = pressure head / water column height. These values are listed in **Table 24** for both sampling periods. The density measurements were also collected at the top and middle of the water column to evaluate the consistency of the water density within the water column in the well.

Ground water density measurements were collected in September 2005, June 2006, September 2006, December 2006, and February 2007 using a hydrometer. The density measurements were used to calculate equivalent fresh water head ground water elevations; the ground water level that would have been measured if the well bore was filled with fresh water. The density corrected elevations ground water elevations are presented on **Table 24**.

2.1.9. Ground Water Sampling

Ground water samples were collected using a low flow purging technique whenever possible. A bailer was used to purge three well volumes from the well and sample the well if the hydrogeologic unit did not produce enough water or the presence of DNAPL did not allow for the collection of low flow samples. Low flow sampling was used if DNAPL had collected within the bottom of a well and there was adequate screened interval above the DNAPL. Low flow purging involved inserting a stainless steel Grundfos® pump (or similar) and dedicated Teflon® tubing within the screened interval of the well and purging at a maximum rate of 0.5 liters/minute. During purging, ground water quality parameters including pH, conductivity, temperature, eH, turbidity and dissolved oxygen were monitored continuously using an in-line YSI® 600XL or a Horiba® U-22 meter. Once the ground water quality parameters stabilized or after removal of three well volumes, samples were collected directly from the Teflon® lined tubing. The pump was decontaminated between wells in accordance with the procedures set forth in the QAPP. Purge water was contained in 55-gallon drums or 500-gallon polyethylene tanks for subsequent disposal. More specific information regarding the ground water sampling is included on the ground water sampling logs presented as **Appendix N**.

PSA Ground Water Sampling

Two rounds of ground water samples were collected during the PSA from newly installed wells in the Lakeshore Area, and one round of ground water samples was collected from new and existing wells at the Penn-Can Property and Railroad Area. Samples were collected from September 26 to September 28, 2000 and May 10 to May 22, 2001. The May 2001 round encompassed all three sub-areas and the sampling was performed during a time of high ground water elevations.

Table 25 lists the monitoring well locations sampled during the PSA and the laboratory analyses performed for these samples. Chain of custody records were initiated as the samples were collected and remained with the samples during transport to O'Brien & Gere Laboratories in Syracuse, New York. Chain of custody forms are included in **Appendix I**.

The samples were submitted to O'Brien & Gere Laboratories for TCL/TAL analyses by USEPA SW846 methods 8260, 8270, 8081, 8082, 6010B, and 7470A for VOCs, SVOCs, pesticides, PCBs (including Aroclor 1268), metals, and mercury, respectively. Additionally, one round of synoptic ground water elevation measurements was collected the week prior to the initiation of the PSA ground water sampling event.

RI Ground Water Sampling
Two rounds of ground water samples were collected from newly installed and existing wells. The first round was collected between May 7, 2003 and May 22, 2003, during a time of high ground water elevations. The second round was collected between August 13, 2003 and August 27, 2003, during a time of low ground water elevation.

Table 26 lists the monitoring well locations sampled during the RI and the laboratory analyses performed for these samples. Chain of custody records were initiated as the samples were collected and remained with the samples during transport to Columbia Analytical Services, Inc. in Rochester, New York. Chain of custody forms are included in **Appendix I**.

Ground water samples were submitted to the laboratory for analysis by USEPA SW846 methods (USEPA, 2004). The first and second rounds of samples were analyzed for TCL/TAL parameters using methods 8260B plus 10 TICs, 8270C plus 20 TICs, 8081A, 8082, 6010B, 7470A, and 9010C/9014 for VOCs, SVOCs, pesticides, PCBs (including Aroclor 1268), metals, mercury and cyanide, respectively. Polychlorinated naphthalenes were evaluated as part of the TICs reported with the 8270C scan. The ground water was also analyzed for major cations and anions (Ca, Mg, Na, K, Cl, SO_4, CO_3, HCO_3).

Additionally, two rounds of synoptic ground water elevation measurements were collected during the sampling events. Synoptic ground water elevation measurements are included on **Table 23**.

Supplemental RI Ground Water Sampling
One round of ground water samples was collected from newly installed and existing wells. The round was collected in March 2007 during a time of high ground water elevations. **Table 27** lists the monitoring wells sampled during the Supplemental RI, and the laboratory analyses performed for these samples.

Chain of custody records were initiated as the samples were collected and remained with the samples during transport to Life Science Laboratories in Syracuse, New York. Chain of custody forms are included in **Appendix I**.

Ground water samples were submitted to the laboratory for analysis by USEPA SW846 methods (USEPA, 2004). The samples were analyzed for TCL/TAL parameters using methods 8260B plus 10 TICs, 8270C plus 20 TICs, 8081A, 8082, 6010B, 7470A, and 9010C/9014 for VOCs, SVOCs, pesticides, PCBs (including Aroclor 1268), metals, mercury and cyanide, respectively. Polychlorinated naphthalenes were evaluated as part of the TICs reported with the 8270C scan. The ground water was also analyzed for hardness, alkalinity, ammonia, total Kejdahl nitrogen (TKN), CBOD, and major cations and anions (Ca, Mg, Na, K, Cl, SO_4, CO_3, HCO_3) using methods 310.1/A2320C, A2320, 350.1, 351.2, 5210B, and 6010B/E300/2320C, respectively. Specific gravity (density) was measured in the field using a hydrometer.

2.1.10. Surface Water Sampling
PSA Surface Water
One round of surface water samples was collected during the PSA. Samples were collected from 11 locations on May 7 and 8, 2001. Sample locations are presented on **Figures 6 and 7**. **Table 28** lists the surface water sampling locations sampled during the PSA, and the laboratory analyses performed for these samples. Samples were collected by immersing a dedicated glass container or dedicated Teflon® bailer within the surface water body. The glass container or Teflon® bailer was then used to

fill the appropriate laboratory containers. The samples were then placed in a cooler on ice. Chain of custody forms were initiated during the sampling and are presented in **Appendix I**. The number of locations sampled at each of the sub-areas of the Site during the PSA is presented below.

- Five samples collected at five locations within Harbor Brook
- Three samples collected at 3threelocations at Penn-Can Property
- One sample collected at two locations at Railroad Area
- Two samples collected at three locations within I-690 drainage ditch on Lakeshore Area

No surface water samples were collected at locations HB-HBSW-4 and HB-HBSW-11 due to the absence of surface water. During sampling, field measurements were collected with a YSI® 600XLM multi-parameter water quality meter. Measurements were collected for temperature, specific conductivity, dissolved oxygen, and pH. Field measurements are provided in **Table 29**.

Surface water samples were sent to O'Brien & Gere Laboratories for analyses using USEPA SW846 Methods 8260, 8270C, 8081, 8082, 6010B, and 7470A for VOCs, SVOCs, pesticides, PCBs, metals, and mercury, respectively.

RI Surface Water

Two rounds of surface water samples were collected during the RI field program. The first round of surface water samples was collected from June 2 through June 4, 2003, and the second round of samples was collected on September 9, 2003. Sample locations are provided on **Figures 6 and 7**. **Table 30** lists the surface water sampling locations sampled during the RI and the laboratory analyses performed for these samples. Samples were collected by immersing a dedicated glass container into the surface water body and using that container to fill the appropriate laboratory container. The samples were placed in a cooler on ice. Chain of custody forms were initiated during sampling and are presented in **Appendix I**. Direct readings were collected with a YSI® 600XLM multi-parameter water quality meter. Measurements were collected for temperature, specific conductivity, dissolved oxygen, and pH. Field measurements are provided in **Table 29**. The number of locations sampled at each of the sub-areas of the Site during each round is presented below.

Round 1

- Five samples collected at five locations within Harbor Brook
- Three samples collected at three locations at Penn-Can Property
- Two samples collected at two locations at Railroad Area
- Three samples collected at three locations within I-690 drainage ditch on Lakeshore Area

Round 2

- Five samples collected at five locations within Harbor Brook
- One sample collected at one location at Railroad Area

During Round 2 surface water sampling, many of the proposed locations were dry and could not be sampled.

Surface water samples were submitted to Columbia Analytical Services for TCL/TAL analysis using USEPA SW846 Methods 8260B, 8270C, 8081A, 8082, 6010B, and 9010B for VOCs, SVOCs, pesticides, PCBs (including Aroclor 1268), metals, and cyanide, respectively. Mercury samples were

collected using method 1669 and analyzed using method 1631. Surface water samples were also analyzed for pH and hardness.

2.1.11. Sediment Sampling

PSA Sediment Sampling

Sediment samples were collected from eight locations from 0 to 0.5 ft during the PSA. The samples were collected between May 7 and 8, 2001 using dedicated Lexan® tubing or dedicated plastic scoops. Sediment sample locations are presented on **Figures 6 and 7**. **Table 31** lists the sediment sampling locations sampled during the PSA, sample depths, and the laboratory analyses performed for these samples. Once the samples were collected, they were placed in a cooler on ice. Chain of custody forms were initiated during the sampling and are presented in **Appendix I**. The number of locations sampled at the various sub-areas of the Site is presented below.

- Three samples collected at three locations at Penn-Can Property
- Two samples collected at two locations at Railroad Area
- Three samples collected at three locations within I-690 drainage ditch on Lakeshore Area

Sediment samples were sent to O'Brien & Gere Laboratories for analyses using USEPA SW846 methods 8260, 8270C, 8081, 8082, 6010B, and 7471 for VOCs, SVOCs, pesticides, PCBs, metals, and mercury, respectively. Samples were also submitted to AXYS Analytical Services for polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/PCDFs) analysis using USEPA method 8290.

CSX Supplemental Sediment Sampling

Subsequent to the PSA sampling and prior to the initiation of the RI sampling, four sediment samples were collected from Harbor Brook at the request of the NYSDEC. Two samples (HB-CSXSED-1 and HB-CSXSED-2) were collected from underneath the CSX rail bridge, and two samples (HB-HBSED-14 and HB-HBSED-15) were collected immediately down stream of the bridge on November 14, 2002. The sample locations are presented on **Figures 6 and 7**. **Table 32** lists the sediment sampling locations sampled during the CSX supplemental sediment sampling, sample depths, and the laboratory analyses performed for these samples. Samples were collected using Lexan® tubing. There was refusal at 0.5 ft or less at each of the four locations. The sediment was transferred from the Lexan® tubing to a dedicated aluminum pan for homogenization using a dedicated plastic scoop. Prior to homogenization, a representative aliquot of sample was collected for VOCs analysis. Subsequent to homogenization, laboratory containers were filled for the remaining analyses. The sample containers were then placed in a cooler on ice. Chain of custody forms were initiated during sampling and the forms accompanied the samples to the laboratory. Chain of custody forms are presented in **Appendix I**.

The samples were submitted to Columbia Analytical Services for TCL/TAL analyses using USEPA SW846 methods 8260B, 8270C, 8081A, 8082, 6010B, 7471A, 9010B/9014, and 8290 for VOCs, SVOCs, pesticides, PCBs, metals, mercury, cyanide, and PCDD/PCDFs, respectively.

RI Sediment Sampling

One round of sediment samples was collected during the RI field program from Harbor Brook and on-site drainage ditches. Sediment samples were collected from June 2 through June 4, 2003 and the locations are provided on **Figures 6 and 7**. **Table 33** lists the sediment sampling locations sampled during the RI, sample depths, and the laboratory analyses performed for these samples. Sediment samples were collected from 0 to 0.5 ft and 0.5 to 1 ft using dedicated plastic scoops and transferred

to a dedicated aluminum pan for homogenization. If the sample collection with the dedicated scoops could not be implemented, alternate collection methods were used including Lexan® tubing or hand auger. Prior to homogenization, a representative sample for VOCs was placed in a laboratory container. Subsequent to homogenization, sediment was transferred to the appropriate laboratory containers for the remainder of the analyses and placed in a cooler containing ice. Chain of custody forms were initiated during sampling and the forms accompanied the samples to the laboratory. Chain of custody forms are provided in **Appendix I**. The number of locations sampled at the various sub-areas of the Site is presented below.

Round 1

- Four samples collected at three locations within Harbor Brook
- Four samples collected at three locations at Penn-Can Property
- Four samples collected at two locations at Railroad Area
- Six samples collected at three locations within I-690 drainage ditch on Lakeshore Area
- Two samples collected at one location within the drainage ditch associated with AOS#2

Sediment samples were submitted to Columbia Analytical Services for TCL/TAL analysis using USEPA SW846 Methods 8260, 8270C, 8081, 8082, 6010B, 7471, and 9010B for VOCs, SVOCs, pesticides, PCBs (including Aroclor 1268), metals, mercury, and cyanide, respectively. Polychlorinated naphthalenes were evaluated as part of the TICs reported with the 8270C scan.

Supplemental RI Sediment Sampling (Harbor Brook Borings)

Three borings (HB-SB-82, HB-SB-83, and HB-SB-90) were advanced within Harbor Brook during the Supplemental RI. The locations are presented on **Figures 6 and 7**. **Table 34** lists the sediment sampling locations sampled during the Supplemental RI, sample depths, and the laboratory analyses performed for these samples. The borings were advanced using conventional drilling techniques. Samples were collected continuously in accordance ASTM Method D1586-84 using a 140-lb hammer and 2-ft split-barrel samplers.

The drilling was performed by Parratt-Wolff under the supervision of an O'Brien & Gere geologist who completed a boring log for each boring to document encountered subsurface strata and other pertinent observations. Each split spoon was screened using a PID and MVA. Pertinent field observations are included on **Table 35**. The boring logs are included in **Appendix F**. Borings not converted to monitoring wells were grouted to the surface with bentonite upon completion of drilling.

Based on the results of the screening and visual observation, at least one sample was collected from the subsurface soils. Chain of custody records were initiated as the samples were collected and remained with the samples during transport to Life Science Laboratories, Inc. in Syracuse, New York. Chain of custody forms are included in **Appendix I**. Samples collected by Honeywell were transported to the laboratory for analyses by USEPA SW846 methods. TCL/TAL analyses were performed using methods 8260B plus 10 TICs, 8270C plus 20 TICs, 8081A, 8082, 6010B, 7471A, and 9010B/9014 for VOCs, SVOCs, pesticides, PCBs (including Aroclor 1268), metals, mercury, and cyanide, respectively. The SVOC analysis also included PXE and PTE. Polychlorinated naphthalenes were evaluated as part of the TICs reported with the 8270C scan.

Willis Avenue RI East Flume Sediment Sampling

Sediment sampling in the East Flume was conducted during Phases 2 and 3 of the Willis Avenue RI. The number of samples collected and analyses performed for each phase of the Willis Avenue RI is summarized below and discussed in the succeeding paragraphs. **Table 36** lists the sediment sampling

locations sampled during the Willis Avenue RI, sample depths, and the laboratory analyses performed for these samples.

Phase 2
Eight core samples were collected from the Upper East Flume (UEF) during Phase 2 to characterize sediments within the flume. The UEF was the area located between the P.A. Sewer/Main Sewer outfall and the spillway adjacent to Onondaga Lake on the northwest portion of the Lakeshore Area. Sample designations and core lengths were: HB-EF1 (0 to 1.5 ft), HB-EF2 (0 to 2.2 ft), HB-EF3 (0 to 3 ft), HB-EF4 (0 to 1.5 ft), HB-EF5A (0 to 2 ft), HB-EF5B (3 to 4 ft), HB-EF6 (0 to 3.25 ft), and HB-EF7 (0 to 2.25 ft). In addition, one sediment core (HB-EF8 [0 to 1 ft]) was collected downgradient of the East Flume spillway. Sample locations were selected in the field in concurrence with Honeywell (formerly AlliedSignal) and the NYSDEC and are presented on **Figure 6**.

- Eight samples from seven locations for VOCs, PCBs/pesticides, and mercury.
- One sample from one location for PCDD/PCDFs and TOC.

Sediment cores were collected using 1.5-inch diameter Lexan® tubing. Representatives from O'Brien & Gere and the NYSDEC collected the samples from a flat bottom row boat. At each location, the Lexan® tube was pushed down into the sediments until the tube came into contact with the crushed stone bottom of the flume. A cap was placed on the exposed end of the tube to create a partial vacuum within the tube and the core was extracted. Once the cores were brought back to land, the tube was cut just above the top of the sediment. The water was then drained, and the core was measured and transferred to a mixing bowl. Sediment cores obtained ranged from 1.5 to 4 ft in length. In accordance with the work plan, the 4-ft core was divided into two separate cores 2 ft in length (HB-EF5A[upper] and HB-EF#5B[lower].

A representative aliquot of sample was placed in a container for VOCs analysis by USEPA method 8260. The remainder of the sample was homogenized, transferred to sample containers and transported to O'Brien & Gere Laboratories for PCBs/pesticides (including hexachlorobenzene) and mercury analyses by USEPA methods 8080 and 7471, respectively. Sample EF#8 was submitted to Triangle Laboratories and AEN for PCDD/PCDFs and TOC analysis using USEPA method DFLM01.1 and the Lloyd Kahn method, respectively.

Phase 3
A total of 19 sediment samples were collected from the East Flume during Phase 3. Seven shallow sediment samples (0 to 0.5 ft) and one deep sediment sample (HB-UEF6 [0.5 to 2.6 ft]) were collected from the UEF.

- Seven samples from seven locations for TCL/TAL parameters, PCDD/PCDFs and TOC.
- 12 samples from 12 locations for PCDD/PCDFs and TOC.

Shallow sediments were analyzed for TCL/TAL parameters, PCDD/PCDFs, and TOC, and deep sediments were analyzed for PCDD/PCDFs and TOC. In addition, the NYSDEC collected two samples from the UEF: HB-UEF6 (0.5 to 1.5 ft) and HB-UEF6 (1.5 to 2.5 ft). NYSDEC samples were analyzed for PCDD/PCDFs and TOC.

Five shallow (0 to 0.5 ft) and six deep (0.5 ft to refusal) sediment samples were collected from the lower East Flume (LEF). Shallow and deep samples were analyzed for PCDD/PCDFs and TOC. In addition, the NYSDEC collected five samples from the LEF: HB-LEF1 (0.5 to 1.5 ft), HB-LEF1 (1.5

to 2.3 ft), HB-LEF2 (0.5 to 1.5 ft), HB-LEF2 (1.5 to 2.3 ft), and HB-LEF3 (0 to 0.5 ft). The NYSDEC samples were analyzed for PCDD/PCDFs and TOC. The NYSDEC sample HB-LEF2 (1.5 to 2.3 ft) was also analyzed for VOCs, SVOCs, and PCBs/pesticides. The NYSDEC also collected a sample at HB-EF8 (0.5 to 1.2 ft) during Phase 3. This sample was analyzed for PCDD/PCDFs and TOC.

TCL/TAL analyses were performed by O'Brien & Gere Laboratories using ASP methods 95-1, 95-2, 95-3, 200.7, 245.1, and 335.2. PCDD/PCDFs analysis was performed using USEPA Method 8290 by Axys Analytic Services. Samples were analyzed for TOC using USEPA Method 9060 by AEN.

2.1.12. SYW-12 Surface Soil/Wetland Soil Sampling

Surface soil samples were collected from 30 locations by boring with a manually driven 2-in split spoon or hand auger. Sample locations were distributed throughout the SYW-12 area to evaluate conditions across the entire area. Samples were collected from the 0 to 6 inch, 6 to 12 inch, and the 12 to 24 inch depth intervals. Samples were not collected from 12 to 24 inches at locations HB-WSD-19 and HB-WSD-22 due to refusal. Surface soil samples locations are presented on **Figure 8**. **Table 37** lists these locations sampled during the Supplemental RI, sample depths, and the laboratory analyses performed for these samples.

Surface soil samples were submitted to Life Science Laboratories in Syracuse, New York for analyses by USEPA SW846 methods (USEPA, 2004). These samples were analyzed for TCL/TAL parameters using methods 8260B plus 10 TICs, 8270C plus 20 TICs, 8081A, 8082, 6010B, 7471A, and 9010C/9014 for VOCs, SVOCs, pesticides, PCBs, metals, mercury, and cyanide respectively. The samples were also analyzed for total petroleum hydrocarbons/petroleum fingerprint, methyl mercury, TOC, and grain size using methods Modified 8015, FGS-070.2, E415.1, and ASTM D422, respectively. Samples collected at ten of the 30 locations were analyzed for PCDD/PCDFs using USEPA SW846 method 8290. The SVOC analysis also included PXE and PTE. Polychlorinated naphthalenes were evaluated as part of the TICs reported with the 8270C scan.

2.1.13. Seeps Reconnaissance and Sampling

A seep reconnaissance was performed as part of the RI. The reconnaissance was performed on four separate occasions and was focused on the shore of Onondaga Lake and the banks of Harbor Brook. Seep locations were staked and the locations were marked using a hand held GPS unit. Identified seeps were sampled. At one seep location, it was not possible to sample the seep water, so sediment in the area of the seep was collected and sent to the laboratory for analyses. Seep locations are presented on **Figure 6**. **Table 38** lists the seep sediment and surface water sampling locations, sample depths, and the laboratory analyses performed for these samples.

Seep water samples were collected on two occasions. Chain of custody records were initiated as the samples were collected and remained with the samples during transport to Columbia Analytical Services. Chain of custody forms are included in **Appendix I**. Samples collected by Honeywell were transported to Columbia Analytical Services for analyses by USEPA SW846 methods. TCL/TAL analyses were performed using Methods 8260B, 8270C, 8081A, 8082, 6010B, and 9010B/9014 for VOCs, SVOCs, pesticides, PCBs (including Aroclor 1268), metals, and cyanide, respectively. The seep samples were also analyzed for major cations and anions (Ca, Mg, Na, K, Cl, SO_4, CO_3, HCO_3). Samples for mercury analysis were collected using Method 1669 and analyzed using method 1631. The sediment sample was analyzed for mercury using method 7471A.

2.1.14. I-690 Storm Drainage Catch Basin Sampling

As part of the RI, three catch basins (HB-DR-69, HB-DR-70, and HB-DR-72) associated with the I-690 storm drain system were sampled to evaluate whether the storm drain system is acting as a conduit for migration of Site-related constituents. The catch basins were sampled on June 5, 2003 and September 11, 2003. The catch basin locations are presented on **Figure 6**. **Table 39** lists the sediment and storm water sampling locations sampled during the RI, sample depths (if applicable), and the laboratory analyses performed for these samples.

Storm sewer sediment and water were collected from each of the catch basins on June 5, 2004, and sediment was collected on September 11, 2003. No storm water was collected on September 11, 2003, because the catch basins were dry. Sediment samples were collected using dedicated plastic scoops. Sediment was placed into a dedicated aluminum pan and homogenized. Prior to homogenization, a representative sample was collected and placed in a laboratory container for VOC analysis. Subsequent to homogenization, sediment was transferred into appropriate laboratory containers for the remainder of the analyses. Surface water samples were collected by immersing the sample container into the water within the respective catch basin. The water was then transferred to the appropriate laboratory containers for analyses. Samples were placed in coolers on ice and the coolers were sealed with custody tape.

Chain of custody records were initiated as the samples were collected and remained with the samples during transport to Columbia Analytical Services. Chain of custody forms are included in **Appendix I**. Samples collected were transported to Columbia Analytical Services for analyses by USEPA SW846 methods. TCL/TAL analyses were performed using Methods 8260B, 8270C, 8081A, 8082, 6010B, 7470A/7471A, and 9010B/9014 for VOCs, SVOCs, pesticides, PCBs (including Aroclor 1268), metals, mercury, and cyanide, respectively. Polychlorinated naphthalenes were evaluated as part of the TICs reported with the 8270C scan. Also, sediment samples were submitted to the lab for PCDD/PCDF analysis using Method 8290.

2.1.15. Soil Vapor Survey

Vapor samples were collected between November 13 and November 15, 2006 to evaluate the potential for vapor intrusion into current and future buildings on the Site. Vapor intrusion may result from ground water, soils, or both. To evaluate these potential pathways:

- Nine soil vapor samples (HB-VI-03 through HB-VI-11) were collected from eleven locations on the Lakeshore Area. No sample was collected at HB-VI-01 or HB-VI-02 because ground water was 1.5 ft below ground surface (bgs).
- Fifteen soil vapor samples were collected from eleven locations on the Penn-Can Property.
- Four sub-slab samples were collected from existing buildings on the Penn-Can Property.

Table 40 presents the locations, sample depths, and analyses performed. The locations are presented on **Figure 6**.

The 24 soil vapor samples were collected through vapor probe holes. The sampling apparatus, consisting of a vapor point and hollow push rods, was driven into the ground using a direct push drill rig. The 1/8-inch tubing was attached to a six-inch stainless steel screen and attached to the drive point after the rods and drive point were advanced. The annular space between the hole and the tubing was first packed using several inches of grade #1A crushed stone or sand allowing a permeable path for soil vapor to enter the drive stem or stainless steel screen. The remainder of the annular space was packed with bentonite grout to preclude ambient air from being drawn into the sampling point and

compromising the sample collection. The bentonite was hydrated for approximately 18 to 24 hours before a sample was collected.

Once the soil vapor probe apparatus had been installed and the bentonite hydrated, the inert sample tubing was purged of one to three volumes of ambient air with a 60-cc syringe to provide samples representative of subsurface conditions. The sample tubing was then connected to a sampling canister at the ground surface, and the sample was collected over a 4-hour period. The purging rate did not exceed 0.2 L/min. Each sampling apparatus, consisting of the vapor sampling point, stone pack, and tubing, was purged of approximately one to three volumes of ambient air with a 60-cc syringe to provide samples that are representative of subsurface conditions. In addition, samples were not collected for at least 30 minutes to allow subsurface conditions to equilibrate after the installation of the sampling point.

Prior to sample collection, probe construction was evaluated using helium as a tracer gas. To administer the helium, a polycarbonate bucket was placed over the location where the probe intersects the ground surface. The sample tubing was then guided through an airtight port in the bucket and secured using a cap or clamp until sampled. The bucket was charged with helium using a second port at the top of the bucket. Once the bucket had been charged, the tubing was connected to a MGD 2002 Helium Leak Detector. If no helium was detected, the tubing was purged as noted above and a soil vapor sample collected in accordance with the *Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York* (NYSDOH, 2006). At the conclusion of sample collection, the gas analyzer was again connected to the sample tubing and a second sample analyzed for helium. No helium was detected at any of the locations so the samples were sent to the laboratory for analysis. If helium had been detected, the soil vapor sample would have been considered invalid if the helium detected equals or exceeds 10%.

Four sub-slab samples (HW-SS-01 [Office], HW-SS-02 [Garage Office], HW-SS-03 [Garage], and HW-SS-04 [Grey Bldg.]) were collected at the Penn-Can Property concurrently with the soil vapor samples described above. Prior to collecting these samples, a pre-sampling survey was conducted to evaluate the physical layout and conditions of the buildings, identify conditions that may affect or interfere with the sampling, and to prepare the buildings for sampling. Results of the survey were documented on a building survey log form. These building survey log forms are provided in **Appendix O**.

For each sub-slab sample, a 3/8-inch hole was drilled to a depth just beneath the bottom of the slab. A 1/8-inch inert tube was then inserted into the hole and the annular space around the tubing was packed with hydrated bentonite to prevent infiltration of ambient air into the sample. The sample lines were purged and connected to a 1-liter stainless steel vacuum extracted canister to collect the samples. The vacuum extracted canisters were equipped with vacuum gauges and valves to control the flow of air during sampling. Prior to sample collection, the vacuum gauge readings were recorded in the field log book. The flow controller was set calibrated to collect the sub-slab samples over a 4-hour duration. At the end of four hours, the vacuum gauge reading was recorded in the field log book.

Samples were collected in accordance with the *Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York* (NYSDOH 2006). After the sample points were purged, air samples were collected in 1.0 L Silonite®-coated stainless steel vacuum canisters. The sampling rate did not exceed 0.2 L/min. Sample flow controllers were calibrated to collect the sample over a 4-hour period.

Chain-of-custody documentation were maintained, and the samples were submitted to NYSDOH-approved laboratory Centek Laboratories for analysis according to USEPA Method TO-15. The full list of TO-15 VOCs were analyzed. Samples were analyzed by methods that were able to achieve a minimum reporting limit of 1 $\mu g/m^3$ or less. Sampling equipment designated for re-use was decontaminated between each installation. The vapor data was validated as per the guidance, and the results of the validation are included within the Supplemental RI Data Validation Report.

2.1.16. DNAPL Recovery Evaluation

Four wells (HB-HB-02I, HB-HB-04S, HB-HB-12I, and HB-HB-13D) screened in zones where DNAPL has been observed were evaluated. Wells HB-HB-02I and HB-HB-04S are located on the Lakeshore Area, and HB-HB-12I and HB-HB-13D are on the Penn-Can Property (**Figure 6**). In order to evaluate the recoverability of DNAPL, these four wells were actively pumped in an attempt to induce DNAPL movement into the wells. The DNAPL recovery evaluation was performed between April 30, 2007 and May 4, 2007. The methods utilized are described below.

Prior to the initiation of pumping water levels and DNAPL levels were measured using a water level probe and an oil/water interface probe. A dual-stage Whale pump (disposable) was installed in each well to be pumped. Each well was purged until dry or until approximately three well volumes were removed. The wells were pumped between 0.9 gpm and 1.6 gpm depending on field conditions. During pumping, water levels and DNAPL levels were monitored periodically. Following pumping the water level in the well was allowed to recover back to the static level. Water level and DNAPL level were monitored throughout. The DNAPL recovery field data forms are provided in **Appendix P**.

The purge/recovery cycle was repeated at each well nine times over a period of approximately 70 to 95 hours, depending on the well. The purpose of repeating the cycles was to stress the aquifer and to evaluate if recoverable DNAPL could be drawn into the wells.

During recovery, the purge water was allowed to separate and observations/measurements of DNAPL presence and volume were performed. DNAPL was sampled and sent for analysis from monitoring well HB-4S for the following analyses: VOCs, SVOCs, viscosity(cP), viscosity(cSt), density(g/mL), and interfacial tension (mN/m) using methods 8260B, 8270C, ASTM D445, ASTM D446, ASTM D1217, and ASTM D971-91, respectively. Purge water was contained in polyethylene tanks located on-site for subsequent disposal at an appropriate off-site facility.

2.1.17. Wetland Delineation

Wastebed B/Harbor Brook. A wetland evaluation was performed for the Site as part of the PSA and RI field efforts. Based on a review of the New York State Freshwater Wetlands (NYSFW) Map (1973) for the area, the State-regulated wetland SYW-19 exists adjacent to the mouth of Harbor Brook. Additionally, wetland habitats identified on the U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) Map (1978) for the area exist near the shore of Onondaga Lake in the area of Harbor Book. The U.S. Soil Conservation Service (USSCS) Soil Survey of Onondaga County (USSCS, 1977) was reviewed and provided information on the mapped soil series for the Site. The USSCS soil survey map (USSCS, 1977), NWI map (USFWS, 1978), and NWSFW map (NYSDEC, 1973) are presented on **Figures 9, 10, and 11**, respectively.

Field activities for the delineation were performed on July 14, 17, and 18, 2000, between September 18 and 21, 2000, and July 15 to 18, 2003 by O'Brien & Gere biologists. A representative of TAMS Consultants, Inc. (TAMS) was present during the September 18 and 21, 2000 field work.

The boundaries associated with wetland areas identified on the aforementioned maps within the Harbor Brook Study Area were field verified in accordance with the criteria presented in the U.S. Army Corps of Engineers (USACOE) 1987 Wetlands Delineation Manual (Manual) to provide a more definitive areal extent of regulated wetlands existing at the Site. In accordance with the Manual, sample plots were established where data concerning the soils, vegetation and hydrology were collected. The wetland boundaries identified in the Lakeshore Area were flagged in the field and surveyed by a New York State licensed surveyor. The wetlands identified in the remainder of the areas were flagged in the field and surveyed using a hand held global positioning system (GPS). The delineated wetlands at the Site are presented on **Figure 12**.

A *Jurisdictional Wetland Survey Report* documenting this effort was submitted to the NYSDEC in February 2001 (O'Brien & Gere, 2001b), and comments on this report were presented in a letter from the NYSDEC dated August 15, 2002. Responses to the NYSDEC comments and the results of additional delineation work at the Site is presented in *Jurisdictional Wetland Delineation Report* (O'Brien & Gere, 2003) submitted to the NYSDEC in December 2003. The NYSDEC reviewed this report and issued a letter on July 17, 2006 accepting the freshwater wetland boundaries as depicted in the report. The results of this jurisdictional wetland survey are presented in Section 7.

SYW-12. A wetland assessment was performed for the SYW-12 area as part of the Onondaga Lake Wetlands/Flood Plain Assessment (O'Brien & Gere and Parsons, 2004). A review of the available reference literature was conducted as part of this assessment that included the following:

- New York State Freshwater Wetlands (NYSFW) Map (1973)
- USFWS National Wetlands Inventory (NWI) Map (1978)
- Onondaga County Wetlands Inventory 1976-1978 (Rhodes and Alexander, 1980)
- USSCS Soil Survey of Onondaga County (USSCS 1977)

The USSCS soil survey map (USSCS, 1977), NWI map (USFWS, 1978), and NWSFW map (NYSDEC, 1973) are presented on **Figures 9, 10, and 11**, respectively.

As part of this assessment, a jurisdictional wetland delineation was conducted at SYW-12 in September 2004. The delineation was conducted in accordance with the Manual. This method utilizes a three-parameter approach and calls for the presence of hydrophytic vegetation, hydric soils, and wetland hydrology for an area to be considered a jurisdictional wetland.

An additional wetland delineation was performed at SYW-12 in 2008 based on July 17, 2008 NYSDEC comments regarding the Onondaga Lake Wetlands/Flood Plain Assessment (O'Brien & Gere and Parsons, 2004). The updated wetland delineation was presented in the Onondaga Lake Wetlands/Flood Plain Assessment Final Report (O'Brien & Gere and Parsons, 2010) submitted to the NYSDEC in March 2010.

A wetland function and value assessment and ecological survey were performed concurrently with the jurisdictional wetland survey. The delineated wetlands at the SYW-12 Site are presented on **Figure 13**. A summary of the work completed as part of this assessment is provided in Section 7.

2.1.18. Floodplain Survey

The Federal Emergency Management Agency (FEMA) floodplain mapping for the area was utilized to evaluate if areas of the Site are within the FEMA defined 100-year and 500-year floodplains. The FEMA defined 100-year and 500-year floodplains (flood zones) are presented on **Figures 14 and 15** for the main Site and SYW-12, respectively.

2.1.19. Phase 1 A Cultural Resources Survey

A Phase 1A Cultural Resources Survey (CRS) was performed for the Honeywell Sites in the area of Onondaga Lake (Pratt & Pratt, 2003). No historic site locations were identified on the Site as part of the Phase 1A CRS. However, only a portion of the Site was covered by "Project Area D" of the Phase 1A CRS, and according to Pratt & Pratt, the area may contain cultural resources.

Based on the Phase 1A CRS (Pratt & Pratt, 2003) and the intrusive nature of the IRMs, a Phase 1A Cultural Resources Assessment (CRA) was performed in October 2004 for Onondaga Lake, Wastebed B, and Wastebed 13 in October 2004 by the Public Archeology Facility (PAF) of Binghamton University. This survey identified Wastebed B as an area of low potential for prehistoric and historic cultural resources (PAF, 2004). The CRA recommended a Phase 1B archaeology survey in the area of the former Geddes Pier for Wastebed B. A Phase 1B archeology survey report was submitted on January 26, 2011 and approved by NYSDEC on February 3, 2011 for the areas of Harbor Brook upstream of I-690.

A Phase 1A Cultural Resource Assessment and Phase 1B Cultural Resource Survey were completed by PAF at SYW-12 and both reports were submitted to the NYSDEC on May 17, 2013. The NYSDEC approved the Phase 1A Report on July, 26, 2013. The NYSDEC provided comments on the SYW-12 Phase 1B report on August 5, 2013. The revised Phase 1B report was submitted on December 20, 2013 and approved by the NYSDEC on Febraury 21, 2014.

2.1.20. Site Survey/Topographic Map

A Site topographic survey was completed in 2000 by Lockwood Mapping. This map is used as the Site base map. A Site survey was completed by Richard M. Rybinski, a New York State licensed land surveyor (LLS) subsequent to completion of the field work for the PSA, RI, and, Supplemental RI. A survey was also completed by Richard M. Rybinski subsequent to the installation of borings, test wells, and observation wells installed as part of the Wastebed B/Harbor Brook IRM field effort. For test pits, hydropunch borings, geoprobe and soil borings, monitoring wells, surface water/sediment sampling locations, storm water catch basins and seeps, the New York State Plane coordinates were surveyed. For geoprobe and soil borings, ground elevation was surveyed. For monitoring wells, the ground surface and top of casing was surveyed to allow for calculation of ground water elevations and development of ground water flow maps. Pertinent Site features were also surveyed to allow for accurate placement of sampling locations on existing Site maps.

2.2. Data Analysis

2.2.1. Laboratory Methods

PSA

The PSA samples were analyzed using the methods and protocols set forth in the approved *Harbor Brook and Ballfield Sites PSA QAPP* (O'Brien & Gere, 2000a) and the revisions detailed in the May 24, 2000 letter from Honeywell to Donald J. Hesler of NYSDEC. Samples for all media were analyzed using USEPA SW-846 methods. The majority of the analyses were performed by O'Brien &

Gere Laboratories of East Syracuse, New York. TCL/TAL parameter analyses were performed using Methods 8260B plus 10 TICs, 8270C plus 20 TICs, 8081A, 8082, 6010B, 7470A/7471 and 9010B/9014 for VOCs, SVOCs, pesticides, PCBs (including Aroclor 1268) and metals, mercury and cyanide respectively. Sediment samples were also be analyzed for PCDD/PCDFs, grain size, and TOC using methods 8290, ASTM D422, and 9060, respectively. The PCDD/PCDF samples were analyzed by AXYS Analytical Services Ltd. of Sidney, British Columbia, Canada.

It should be noted that naphthalene and polychlorinated benzenes (1,2-, 1,3-, and 1,4-dichlorobenzenes; and 1,2,4-trichlorobenzene) were reported in the 8260 and 8270 scans during the PSA. Only naphthalene identified as part of the 8270 scan will be discussed for the purposes of the RI and any future documents for this Site. The 8260 and 8270 results for the four polychlorinated benzenes will be discussed as part of this RI and in future documents. However, the polychlorinated benzenes 8260 scan results will be presented in the data tables provided as part of this RI and any major differences in polychlorinated benzene results between the 8270 and 8260 scans will be discussed as part of the RI. This is consistent with the adjacent Ballfield Site and was requested for the Ballfield Site in a June 7, 2006 telephone conversation between Tracy Smith of the NYSDEC and Thomas Conklin of O'Brien & Gere.

Samples were also collected from test pits for Toxicity Characteristic Leaching Procedure (TCLP) analyses. These samples were selected based on field observation and in concurrence with the NYSDEC. The TCLP samples were extracted and analyzed as per CFR Part 260. TCLP parameter analysis was performed using extraction method 1311 and USEPA SW-846 methods 8260B, 8270C, 8081A, 8151, 6010B, and 7470A/7471 for VOCs, SVOCs, pesticides, herbicides, metals, and mercury, respectively.

RI

The RI samples were analyzed using the methods and protocols set forth in the approved *Harbor Brook and Ballfield Sites RI/FS QAPP* (O'Brien & Gere, 2002b). Samples for all media were analyzed using USEPA SW-846 methods. The majority of the analyses were performed by Columbia Analytical Services of Rochester, New York. TCL/TAL parameter analyses were performed using Methods 8260B plus 10 TICs, 8270C plus 20 TICs, 8081A, 8082, 6010B, 7470A/7471 and 9010B/9014 for VOCs, SVOCs, pesticides, PCBs (including Aroclor 1268) and metals, mercury, and cyanide, respectively. Sediment samples were also analyzed for PCDD/PCDFs, grain size, and TOC using methods 8290, ASTM D422, and 9060, respectively. Ground water, surface water, and seeps were analyzed for mercury using high resolution method 1669. Ground water and seeps were analyzed for major cations/anions using method 6010B/300. Methyl mercury samples were analyzed using modified USEPA Method 1630 by Frontier Geosciences.

Supplemental RI

The Supplemental RI samples were analyzed using the methods and protocols set forth in the approved *Harbor Brook and Ballfield Sites RI/FS QAPP* (O'Brien & Gere, 2002b). Samples for all media were analyzed using USEPA SW-846 methods. The majority of the analyses were performed by Life Science Laboratories, Inc. of Syracuse, New York. TCL/TAL parameter analyses were performed using Methods 8260B plus 10 TICs, 8270C plus 20 TICs, 8081A, 8082, 6010B, 7470A/7471 and 9010B/9014 for VOCs, SVOCs, pesticides, PCBs (including Aroclor 1268) and metals, mercury, and cyanide, respectively. SYW-12 soils were analyzed for petroleum hydrocarbons and petroleum fingerprint using USEPA method Modified 8015. SYW-12 surface soil samples were also analyzed for PCDD/PCDFs, methyl mercury, petroleum hydrocarbons and petroleum fingerprint, grain size, and TOC using methods 8290, FGS-070.2 Modified 8015, ASTM D422, and E415.1,

respectively. The PCDD/PCDFs samples were analyzed by Columbia Analytic Services in Houston, TX. Methyl mercury samples were analyzed by Frontier GeoSciences Inc. in Seattle, WA. Ground water samples were also analyzed for hardness, alkalinity, and major cations and anions (Ca, Mg, Na, K, Cl, SO_4, CO_3, HCO_3) using methods 310.1/2320B, 2340B, and 6010B/E300/2320B, respectively. Specific gravity (density) was measured in the field using a hydrometer. Soil vapor samples were analyzed by Centek Laboratories, LLC in Syracuse, NY using method TO-15.

2.2.2. Data Management

Analytical results were received from the respective laboratories in hard copy and electronic formats. The PSA electronic data were used to establish a database. The electronic RI data collected was added to this database. This database and electronic data received as part of the Supplemental RI were uploaded to the Locus Technologies EIM™ environmental data management system. This data management system was used in developing summary reports for this Report and used as the comprehensive database for all project deliverables.

2.2.3. Data Validation

The data validation report for the PSA was issued to the NYSDEC under separate cover (O'Brien & Gere, 2001c), and the full report is not presented within this report. The RI data validation report was issued in August 2004 to the NYSDEC under a separate cover for review. The Supplemental RI Data Validation Report is included as **Appendix Q**. A summary of the Data Validation Reports is provided below.

PSA

Analytical data from the PSA sampling were validated to assess their completeness and usability. As specified in the project QAPP (O'Brien & Gere, 2000a), the NYSDEC Analytical Services Protocol (ASP) October 1995 revision and appropriate USEPA guidance material were used as the basis of the validation. The assessment was performed in two steps. During the first step, data were compared to relevant validation materials referenced in the project QAPP; during the second step, the quality of the data was evaluated with respect to the data quality objectives established prior to sampling.

The following paragraphs present the adherence of the data to the precision, sensitivity, accuracy, representativeness, comparability, and completeness (PSARCC) parameters.

- Precision is measured through the evaluation of field duplicate samples and MS/MSD samples. For the PSA, none of the data were rejected due to precision excursions.
- Sensitivity is established by reported detection limits which represent measurable concentrations of analytes which can be determined with a designated level of confidence. Sensitivity requirements with respect to reported detection limits were acceptable for the sample data in this project. Dilutions were performed for analyses due to high target analytes present in the samples or matrix interferences. With exception of the dilution analyses utilized by the laboratory, the majority of the reported detection limits met the project requirements.
- Matrix spike samples, internal standard recoveries, surrogate recoveries, LCS recoveries, and initial and continuing calibration criteria indicate the accuracy of the data.

For the Lakeshore Area VOC analyses, 4.9% of the data were rejected due to surrogate recovery excursions, 0.03% of the data were rejected due to MS/MSD recovery excursions, and 1.9% of the data were rejected due to internal standard recovery excursions. For the SVOC analyses, 1.1% of the

data were rejected due to surrogate recovery excursions, 0.2% of the data were rejected due to MS/MSD recovery excursions, and 0.2% of the data were rejected due to LCS recovery excursions.

For the Penn-Can Property and Railroad Area VOC analyses, 0.1% of the data were rejected due to continuing calibration excursions, 0.1% of the data were rejected due to MS/MSD recovery excursions, and 1.6% of the data were rejected due to surrogate recovery excursions. For the SVOC analyses, 0.2% of the data were rejected due to surrogate recovery excursions, 0.1% of the data were rejected due to MS/MSD recovery excursions, 0.4% of the data were rejected due to LCS recovery excursions, and 0.1% of the data were rejected due to internal standard recovery excursions. For the pesticide/PCB analyses, 0.2% of the data were rejected due to surrogate recovery excursions, and 0.2% of the data were rejected due to MS/MSD recovery excursions. For the metals, mercury, cyanide, TOC, BOD, COD, TDS, TSS, TKN, and alkalinity analyses, 0.8% of the data were rejected due to MS recovery excursions.

Comparability is not compromised provided that the analytical methods did not change over time. A major component of comparability is the use of standard reference materials for calibration and QC. These standards are compared to other unknowns to verify their concentrations. Since standard analytical methods and reporting procedures were consistently used by the laboratory, the comparability criteria for the analytical data were met.

For the Lakeshore Area, 100% of the pesticide/PCB, metals, mercury, and cyanide data and approximately 93.2% of the VOC data and 98.3% of the SVOC data were determined to be usable for qualitative and quantitative purposes. For the Penn-Can Property and Railroad Area, 100% of the PCDD/PCDF data, 97.8% of the VOC data, greater than 99% of the SVOC data, greater than 99% of the pesticide/PCB data, and greater than 99% of the metals, mercury, cyanide, TOC, BOD, COD, TDS, TSS, TKN, and alkalinity data were determined usable for qualitative and quantitative purposes following validation.

These high percentages were achieved by maintaining strict adherence to the quality control procedures outline in the project QAPP (O'Brien & Gere, 2000a). Constant communication was maintained with the laboratory while samples were being analyzed in an effort to evaluate the laboratory's performance and difficulties with the analyses that required correction. In most instances, corrective actions were taken by the analytical laboratory immediately after an excursion with QC criteria was identified. Specific examples of these actions are presented in the laboratory case narrative of the PSA Data Validation Report (O'Brien & Gere, 2001c).

RI

Analytical data from the RI sampling were validated to assess their completeness and usability. As specified in the project QAPP (O'Brien & Gere, 2002b), the NYSDEC ASP October 1995 revision, and appropriate USEPA guidance material were used as the basis of the validation. Major deficiencies in the data generation process resulted in data being rejected, indicating that the data are considered unusable for either quantitative or qualitative purposes. Minor deficiencies in the data generation process resulted in sample data being characterized as approximate. Identification of a data point as approximate indicates uncertainty in the reported concentration of the chemical, but not its assigned identity. The use of approximated analytical data for quantitative uses is consistent with the guidance presented in the *USEPA Risk Assessment Guidance for Superfund* (USEPA, 1992).

The following paragraphs present the adherence of the data to the precision, sensitivity, accuracy, representativeness, comparability, and completeness (PSARCC) parameters.

Precision is measured through the evaluation of field duplicate samples, laboratory duplicate, and MS/MSD samples. None of the data for this investigation were rejected due to precision excursions.

Sensitivity is established by reported detection limits which represent measurable concentrations of analytes which can be determined with a designated level of confidence. With the exception of dilutions performed during the analyses, sensitivity requirements were met for the sample data in this project.

Matrix spike samples, internal standard recoveries, recovery standard responses, surrogate recoveries, LCS recoveries, and initial and calibration verification criteria indicate the accuracy of the data.

Rejected data for accuracy excursions include the following:

- 1,1,2,2-tetrachloroethane results in samples HB-RISB-06 (0 to 6 in.), HB-RISB-06 (6 to 12 in.), HB-XSS-01 (0 to 6 in.), and HB-PCSS-01 (6 to 12 in.) due to severely low internal standard recoveries.
- Ten acid fraction SVOC target analytes in samples HB-RISB-02 (18 to 20 ft), HB-SEEP-02 (sediment; 0 to 6 in.), and HB-SEEP-02 (sediment; 6 to 12 in.) due to severely low surrogate recoveries.
- Eleven acid fraction SVOC target analytes in sample HB-HB-11I due to severely low surrogate recoveries.
- Fourteen acid fraction SVOC target analytes in sample HB-HBSED-02 (0 to 6 in.) due to severely low surrogate recoveries.
- The result for pentachlorophenol in sample HB-CSXSED-02 due to severely low MS/MSD recoveries.
- The results for hexachlorocyclopentadiene in samples HB-SS-11 (0 to 6 in.), HB-SS-11 (6 to 12 in.), and HB-SS-08 (0 to 6 in.) were rejected due to severely low LCS recoveries.
- The results for chromium in samples HB-HB-19S, HB-HB-18S, and Equipment Blank 8/27/03 and iron in sample Equipment Blank 8/27/03 were rejected due to severely low detection limit standard recovery.
- The results for selenium in samples HB-RISB-06 (0 to 6 in.), HB-RISB-06 (6 to 12 in.), HB-RISB-06 (22-24'), HB-RISB-04 (0 to 6 in.), HB-RISB-04 (6 to 12 in.), HB-RISB-04 (14 to 16 ft), HB-RISB-03, HB-RISB-12, and HB-SB-11 (34 to 38 ft) due to severely low MS recoveries.
- The results for aluminum in samples HB-HB-02I, HB-HB-21I, HB-HB-09S, HB-HB-07S, Field Duplicate [HB-HB-07S], HB-HB-20D, HB-HB-20I, HB-HB-20S, HB-HB-06S, HB-HB-08I, HB-HB-08D, HB-WB-BL, HB-WB-BU, HB-HB-08S, HB-HB-19S, and HB-HB-18S due to severely low MS recoveries.
- The result for selenium in sample HB-HB-05D due to a severely low post-digestion spike recovery.
- The results for lead in samples HB-CSXSED-01, HB-CSXSED-02, field duplicate [HB-CSXSED-02], HB-HBSED-14, and HB-HBSED-15 due to severely high MS recoveries.

None of the remaining data were rejected due to accuracy excursions.

Holding times, sample preservation, blank analysis, and compound identification and quantification are indicators of the representativeness of the analytical data. Rejected data for representativeness excursions include the following:

- Twenty-nine VOC results, 53 SVOC results, 20 pesticide results, 8 PCB results, 10 metal results and one cyanide result were rejected in sample HB-RISB-05 (0 to 6 in.) due to percent solids of less than 10.

None of the remaining data were rejected due to representativeness excursions.

Comparability is not compromised provided that the analytical methods did not change over time. A major component of comparability is the use of standard reference materials for calibration and QC. These standards are compared to other unknowns to verify their concentrations. Since standard analytical methods and reporting procedures were consistently used by the laboratory, the comparability criteria for the analytical data were met.

Overall, 100% of the inorganic (chloride, sulfate, carbonate alkalinity, bicarbonate alkalinity, TPH, hardness, pH, TOC), methyl mercury, and PCDD/PCDF analyses were determined to be usable for qualitative and quantitative purposes. Greater than 90% of the VOC, SVOC, pesticide, PCB, metals, and cyanide data were usable for qualitative and quantitative purposes.

Therefore, the completeness objective of 90% for this investigation, provided in the O'Brien & Gere QAPP, was met.

RI (addendum)

An addendum to the Data Validation Report for the final two borings (HB-RISB-16 and HB-RISB-17) has been prepared and was submitted to the NYSDEC under separate cover. A summary of the data validation report for the final two borings is provided below.

The additional samples collected at locations HB-RISB-16 and HB-RISB-17 from the Wastebed B/Harbor Brook Site as part of the RI/FS were evaluated based on QA/QC criteria established for the appropriate analytic methods. Data validation qualifiers were applied utilizing the USEPA data validation guidance. Major deficiencies in the data generation process would have resulted in data being rejected, indicating that the data are considered unusable for either quantitative or qualitative purposes. Minor deficiencies in the data generation process resulted in sample data being characterized as approximate. Identification of a data point as approximate indicates uncertainty in the reported concentration of the chemical, but not its assigned identity. The use of approximated analytical data for quantitative uses is consistent with the guidance presented in the *USEPA Risk Assessment Guidance for Superfund* (USEPA, 1992).

The following paragraphs present the adherence of the data to the precision, sensitivity, accuracy, representativeness, comparability, and completeness (PSARCC) parameters.

Precision is measured through the evaluation of field duplicate samples, laboratory duplicates, and MS/MSD samples. None of the data for this investigation were rejected due to precision excursions.

Sensitivity is established by reported detection limits which represent measurable concentrations of analytes which can be determined with a designated level of confidence. With the exception of dilutions performed during the analyses, sensitivity requirements were met for the sample data in this project.

Matrix spike samples, internal standard recoveries, recovery standard responses, surrogate recoveries, LCS recoveries, and initial and calibration verification criteria indicate the accuracy of the data. None of the data for this investigation were rejected due to accuracy excursions.

Holding times, sample preservation, blank analysis, and compound identification and quantification are indicators of the representativeness of the analytical data. None of the data for this investigation were rejected due to representativeness excursions.

Comparability is not compromised provided that the analytical methods did not change over time. A major component of comparability is the use of standard reference materials for calibration and QC. These standards are compared to other unknowns to verify their concentrations. Since standard analytical methods and reporting procedures were consistently used by the laboratory, the comparability criteria for the analytical data were met.

Overall, 100% of the organic and inorganic analyses were determined to be usable for qualitative and quantitative purposes. Therefore, the completeness objective of 90% for this investigation, provided in the O'Brien & Gere QAPP (2002b), was met.

Supplemental RI

Analytical data from the Supplemental RI sampling were validated to assess their completeness and usability. In this validation, the analytical data were compared to the applicable QA/QC criteria provided in the following documents:

- American Society for Testing and Materials (ASTM). 2000. *Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method.* West Conshohocken, PA.
- American Water Works Association (AWWA), American Public Health Association (APHA) and Water Environment Federation (WEF). 1992. *Standard Methods for the Examination of Water and Wastewater*, 18th Edition. Washington, D.C.
- Frontier Geosciences, Inc. 2001a. *Preparation of Sediments for Determination of Methyl Mercury in Sediments by Acidic Potassium Bromate Extraction into Methylene Chloride.* Seattle, Washington
- Frontier Geosciences, Inc. 2001b. *Methyl Mercury Calibration and Analysis.* Seattle, Washington.
- United States Environmental Protection Agency (USEPA). 1983. *Methods for Chemical Analysis of Water and Wastes*, Cincinnati, Ohio.
- United States Environmental Protection Agency (USEPA). 1993. Methods *for the Determination of Inorganic Substances in Environmental Samples*, EPA-600/R-93/100. Washington, D.C
- United States Environmental Protection Agency. 1999a. *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air.* Cincinnati, Ohio.
- United States Environmental Protection Agency (USEPA). 2004. *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, SW-846,* 3rd Edition, Update IIIB. Washington D.C.

Overall, considering the complete data set, greater than 90% of the organic and inorganic data were usable for quantitative and qualtitative purposes. Results for VOCs and pesticides were rejected due to major accuracy excursions.

The samples collected from the Site were evaluated based on QA/QC criteria established by the methods listed above. Data validation qualifiers were applied utilizing the USEPA data validation guidance as listed in **Appendix Q** (Section 1.2). Major deficiencies in the data generation process resulted in data being rejected, indicating that the data are considered unusable for either quantitative or qualitative purposes. Minor deficiencies in the data generation process resulted in sample data being characterized as approximate. Identification of a data point as approximate indicates uncertainty in the reported concentration of the chemical, but not its assigned identity.

The following table summarizes the sample results that were rejected as a result of the data validation process that was performed on the data, based on method criteria, USEPA validation guidance and professional judgment.

Table 2.2. *Summary of Rejected Supplemental RI Sample Results.*

Target Type and Analyte	Sample Identification	Qualifier	Excursion
VOCs (38 non-detected VOC target analytes)	HB-0008-03	R	Major accuracy excursion
VOCs (1,1,2-trichloro-1,2,2-trifluoroethane, carbon disulfide, cyclohexane, methyl acetate, methyl tert-butyl ether)	HB-0031-06	R	Major accuracy excursion
VOCs (1,1,2,2-tetrachloroethane, isopropylbenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, 1,2-dichlorobenzene, 1,2-dibromo-3-chloropropane, 1,2,4-trichlorobenzene.)	HB-1030-03	R	Major accuracy excursion
VOC (Naphthalene)	Trip blank (11/15/06)	R	Major accuracy excursion
Pesticide (Gamma chlordane)	HB-0031-07	R	Major accuracy excursion
Pesticide (Endosulfan sulfate, Endrin)	HB-1019-04	R	Major accuracy excursion
Pesticide (Methoxychlor)	HB-1024-02	R	Major accuracy excursion

Note:
VOCs indicate volatile organic compounds.

A discussion of the overall data quality with regard to the parameters follows:

Data usability with respect to precision is 100% for organic and inorganic data. None of the data were rejected for precision excursions.

Sensitivity is established by reporting detection limits, which represent measurable concentrations of analytes which can be determined with a designated level of confidence, that are less than the project action limits. Dilutions were performed in sample preparation, which elevated detection limits reported for target analytes for this project. Since a current QAPP was not provided for comparison of detection limits to project limits, sensitivity requirements could not be evaluated for this project.

Data usability with respect to accuracy is greater than 90% for organic and inorganic data. Results for VOC and pesticides were rejected due to major accuracy excursions.

Data usability with respect to representativeness is 100% for organic data and inorganic data. None of the data were rejected for representativeness excursions.

Comparability is not compromised provided that the analytical methods did not change over time. A major component of comparability is the use of standard reference materials for calibration and QC. These standards are compared to other unknowns to verify their concentrations. Since standard analytical methods and reporting procedures were consistently used by the laboratory, the comparability criteria for the analytical data were met.

Overall, considering the complete data set, greater than 90% of the organic and inorganic data were usable for qualitative and quantitative purposes. Results for VOCs and pesticides were rejected due to major accuracy excursions.

2.3. Baseline Risk Assessment

2.3.1. Human Health Risk Assessment (HHRA)

The objective of the HHRA is to assess potential risks to human health associated with the Site-related chemical substances under current and reasonably foreseeable future land uses and facilitate the consideration and evaluation of possible future remedial actions. The HHRA focused on chemical substances detected in soil, ground water, surface water, sediment, and soil vapor at the Site. The assessment did not evaluate Site-related chemical substances that may have migrated to Onondaga Lake, since Onondaga Lake was being investigated and evaluated under a separate Consent Order.

The risk assessment was conducted in accordance with the latest applicable USEPA guidance documents.

To date an Exposure Pathway Analysis Report (EPAR) including Tables 1 and 2 of RAGS Part D (USEPA, 2001) was provided to the NYSDEC on February 19, 2004 for review and approval. At the request of the NYSDEC, the Table 4 RAGS Part D (USEPA, 2001) was provided to the NYSDEC for review and approval on March 26, 2004. The NYSDEC provided comments on the EPAR in a letter dated January 21, 2005. Honeywell responded to these comments in a letter dated February 25, 2005. A conference call was held on May 17, 2006 to discuss the February 25, 2005 response to comment letter. A letter was sent to the NYSDEC on July 19, 2007 regarding PAH surrogates at the Site. RAGS Part D Tables 1 through 6 (O'Brien & Gere, 2008a) were submitted to the NYSDEC in February 2008, RAGS D Tables 1 through 10 (O'Brien & Gere, 2008b) were submitted in June 2008, and a draft HHRA (O'Brien & Gere, 2008c) was submitted in September 2008. The NYSDEC provided comments to this report on May 1, 2009 and Honeywell responded to these comments on June 11, 2009 (Honeywell, 2009a). The letter requested a conference call or meeting be held between Honeywell and the NYSDEC to discuss several of the comments prior to finalization of the report. This conference call was held on August 18, 2009. During this call it was agreed that an interim submittal for the soil vapor tables be submitted on September 4, 2009 for NYSDEC review prior to submittal of the revised HHRA Report (O'Brien & Gere, 2009) on October 16, 2009. The risks to receptors are discussed in detail within the revised HHRA Report (O'Brien & Gere, 2009) . The October 2009 HHRA Report was approved by the NYSDEC in a letter dated May 19, 2010.

2.3.2. Ecological Risk Assessment (ERA)

A Problem Formulation Document (PFD) was prepared in accordance with the approved Remedial Investigation/Feasibility Study (RI/FS) Work Plan and submitted under separate cover to the NYSDEC for review and approval on January 8, 2004. The NYSDEC provided comments regarding this document on April 29, 2004. On May 18, 2004, a letter was sent from Honeywell to the NYSDEC requesting an extension for the submittal of the revised PFD. On May 27, 2004 a letter was sent from the NYSDEC to Honeywell granting the extension. A conference call was held on June 21,

2004 regarding the comment letter, and a draft schedule for the BERA was submitted on June 30, 2004. A letter was sent from Honeywell to the NYSDEC on July 7, 2004 providing a revised schedule for the ERA. On August 20, 2004 a letter was sent from Honeywell to the NYSDEC outlining the path forward for the completion of the PFD and BERA. On October 27, 2004, a letter was sent by Honeywell to the NYSDEC providing additional details regarding the approach presented in the August 20, 2004 letter.

Based on the comments and subsequent communications, Honeywell and the NYSDEC agreed to the current BERA approach. A conference call was held on March 21, 2008 and the meeting minutes were submitted to the NYSDEC on April 3, 2008 (Honeywell, 2008). Based on the March 2008 conference call, the Draft BERA Report (O'Brien & Gere, 2008d) was submitted to the NYSDEC for review in October 2008. The NYSDEC provided comments to this report on April 30, 2009 and May 5, 2009, and Honeywell responded to these comments on June 17, 2009 (Honeywell, 2009b). The letter requested a conference call or meeting be held between Honeywell and the NYSDEC to discuss several of the comments prior to finalization of the report. A conference call was held on October 8, 2009 to discuss the June 17, 2009 responses. A revised red-line/strikeout BERA Report was submitted on February 11, 2010. The NYSDEC provided comments on the February 2010 BERA Report in an email dated June 16, 2010. The revised BERA Report was submitted on October 15, 2010. NYSDEC provided additional comments on February 24, 2011. Honeywell revised and resubmitted the BERA Report on August 12, 2011, and NYSDEC approved this document on September 13, 2012. The risks to receptors are discussed in detail within the revised BERA Report (O'Brien & Gere, 2011).

3. Study Area Physical Characteristics

3.1. Climate

Onondaga County has a humid, continental climate. Annual precipitation averages about 39 inches. The mean annual temperature is 48°F, with a mean July temperature of 71°F and a mean January temperature of 23°F. Record temperatures range from 102°F in July to -26°F in January and February. The frost-free season lasts between 150 to 180 days per year. The National Weather Service Station at Hancock International Airport collects weather data for the area (NOAA, 2002).

3.2. Site Topography and Drainage

3.2.1. Wastebed B/Harbor Brook Site Topography and Drainage

A topographic contour map of the Site is included as **Figure 4**. In general, the Site consists of variable terrain with numerous highs and lows ranging from 363 ft above mean sea level (MSL) at the shore of Onondaga Lake to 406 ft above MSL at the highest point on the Penn-Can Property. The site is bisected by numerous transportation features such as I-690, which runs between Penn-Can Property and Wastebed B, and a series of railroad tracks that occupy the Railroad Area on the southwestern quadrant of the Site.

Harbor Brook, which drains into Onondaga Lake, is the primary flowing surface water body on the Site, with the now abandoned East Flume historically flowing in to the lake. Harbor Brook collects surface water runoff from roadways, topographic highs, and drainage ditches,. However, while the East Flume did collect surface water from upgradient off-site drainage ditches, the P.A. Sewer, and the Main Sewer, there was minimal contribution of surface water from the Site.

Drainage patterns and surface water bodies are presented on **Figure 16**. Surface drainage and runoff from Wastebed B flows generally to the north towards Onondaga Lake. Surface drainage from the Penn-Can Property generally flows outward in a radial direction from the central portion of the property to the low-lying areas. Much of the surface drainage and runoff collects in the low areas adjacent to the Site, including several drainage swales, ditches, wetlands, and Harbor Brook and historically included the East Flume.

3.2.2 SYW-12 Site Topography and Drainage

Drainage patterns and surface water bodies are presented on **Figure 17**. Surface drainage and runoff from SYW-12 flows generally to the west towards Onondaga Lake. Ley Creek runs through the northern portion of the property. Heavy vegetation and relatively flat topography likely limit overland flow from SYW-12.

3.3. Site Geology/Hydrogeology

3.3.1. Regional Geology

The Wastebed B/Harbor Brook Site and associated areas are located at the base of the Onondaga Escarpment, which marks the boundary between the Ontario Lowlands and Allegheny Plateau physiographic provinces. Ground elevations range from 363 ft above MSL at the surface of Onondaga Lake to an elevation of over 1,000 ft above MSL near the top of the cuesta forming the escarpment.

The lowlands are characterized by low relief and unconsolidated glaciolacustrine and glaciofluvial sediments deposited in and near the proglacial lake formed during glacial retreat. The unconsolidated deposits vary in thickness from minimal to hundreds of feet. The Silurian age Vernon Shale Formation underlies the unconsolidated deposits near the Site.

The uplands feature higher relief and unconsolidated deposits of predominately glacial drift or valley train deposits. The unconsolidated deposits vary in thickness. Bedrock immediately south of the Site changes stratigraphically from the Silurian Vernon Formation at the base of the cuesta through the Syracuse and Helderberg Formations to the Devonian Onondaga Formation found at the top of the cuesta. Each of these formations has a gentle southward dip of 1 to 2 degrees.

3.3.2. Wastebed B/Harbor Brook Site Geology

Nine geologic cross sections were constructed across the Site at the locations shown on **Figure 18**. Four north to south trending cross sections are presented to show geology variations and DNAPL distribution (discussed in section 6) from the Penn-Can Property to the Lakeshore Area. **Figures 19 (A-A') and 20** (**B-B'**) show cross sections through the Penn-Can Property to Onondaga Lake. **Figures 21 (C-C') and Figure 22** (**D-D'**) show the geologic interpretations and DNAPL distribution along the axis of Harbor Brook. Five east to west cross sections were also generated for Penn-Can Property (**Figures 23 (E-E') and 24 (F-F')**) and Wastebed B (**Figures 25 through Figure 27 (G-G', H-H', and I-I', respectively)**).

In general, Wastebed B/Harbor Brook Site consists of unconsolidated deposits of both natural and anthropogenic origin that range in thickness from less than 20 ft at the Railroad Area to about 130 ft along the lakeshore. The elevations for these deposits are represented on **Figures 28 through 31**. These deposits overlie the Silurian Age Vernon Shale.

Throughout the entire Site a fill layer is present above the natural sediments. The fill unit varies in thickness (<10 ft to 40 ft), composition, and grain size. Depending on location, the coarse grained fraction can include cinders, gravel, and/or crushed limestone; the finer grained fraction typically consists of fly ash, silt, clay, and other fine-grained material. In some cases, the underlying Solvay waste layer and ash are mixed in with the fill.

A discrete layer of Solvay waste underlies the fill layer in most areas. Solvay waste is an anthropogenic material resulting from the production of soda ash and consists primarily of calcium carbonate. The thickness of the Solvay waste layer varies from 0 ft to 35 ft thick, but it is typically 10 ft to 25 ft thick near the lake. **Figure 28** presents the elevation of the bottom of fill and Solvay waste (where present) at the Site.

Below the fill and Solvay waste layers, there is a deposit of freshwater marl. The marl is characterized by a significant amount of shells and calcareous sediment. **Figure 29** presents the thickness of the marl unit, which is thickest near the lake and thins to the south. The marl grades from sand near the top of the unit to silt at its contact with the underlying glaciolacustrine silt and clay. In addition, a transitional zone between the marl and the underlying silt and clay is present in some areas. The marl in these zones, described as "transitional marl" in boring logs, contains less shell material, less coarse, calcareous sediment, and has a higher silt content.

Below the marl, there is a deposit of glaciolacustrine silt and clay ranging in thickness from 19 ft to 80 ft near the lake. The unit thins to the south, away from the lake. **Figure 30** presents the elevation

of the top of silt and clay at the Site. The silt and clay unit grades into the underlying fine sand and silt unit.

Recent data collection activities associated with Harbor Brook IRM indicates a lack of silt and clay on the western portion of Wastebed B between HB-GP-01 and HB-GP-02. The approximate location is represented in **Figure 27** where an apparent thinning of silt and clay occurs between 800 ft and 1200 ft. The context of the extent of the lack of silt and clay and the implications on the Site hydrogeology will be discussed in Harbor Brook IRM deliverables.

The fine sand and silt unit near the lake ranges from non-existent to 25 ft thick. The unit thins to the south and pinches out as the elevation of the till rises. The texture of this unit is variable and there are lenses within this silt and fine sand unit that contain higher percentages of sand or clay. **Figure 31** presents the approximate elevation of the fine sand and silt surface at the Site.

Several deep borings at the Site penetrated a basal sand and gravel unit below the fine sand and silt unit. This basal sand and gravel unit varies in thickness from approximately 1 to 14 ft where present. The basal sand and gravel unit is best characterized as existing in discontinuous pockets at the base of the fine sand and silt unit.

A well-compacted red till unit composed of a clay and silt matrix with some sand and gravel overlies the bedrock surface. When present, the till unit varies in thickness from 1 to 15 ft, as presented in **Figure 32**. The till surface follows the bedrock surface and dips sharply from the south towards Onondaga Lake. **Figure 33** presents the approximate elevation of the top of till/bedrock surface at the Site.

The Site is underlain by the Silurian Age Vernon Shale. Approximately 2 to 5 feet of weathered bedrock (higher conductivity) overlies competent (lower conductivity) bedrock. Fractures exist throughout and frequently have been in-filled with gypsum.

3.3.3. SYW-12 Site Geology

Three geologic cross sections were constructed across the SYW-12 Site at the locations shown on **Figure 34**. The cross-sections are presented on **Figures 35, 36, and 37**. In general, two basic geologic units were encountered in shallow borings during the Supplemental RI. The unconsolidated deposits encountered onsite consist of 2 to 15 ft of reworked fill below a thin layer of recently deposited wetland sediments. The fill unit consists of sand, silt, gravel, shell material and concretions that overly at least 15 to 25 ft of marl. The marl unit becomes gradually more fine grained with depth from a sandy, shell rich marl at the top of the unit to clayey silt marl with a trace of shell material at the bottom of the unit.

3.3.4. Regional Hydrogeology

In general, regional surface water and ground water flows from the Onondaga Escarpment northwards towards the Lake Ontario Basin. The regional hydrogeologic system upgradient of the Site reflects the glacial and fluvial processes that formed the overburden of the Onondaga Valley and the Ninemile Creek Valley where the northward retreating glaciers deposited thick layered, sequences of overburden material of various grain sizes (Kappel and Miller, 2005). The regional ground water flow for the Site vicinity is typical of the other lakeshore sub-sites, where glaciolacustrine deposits have a large influence on ground water movement, which is primarily towards Onondaga Lake and its tributaries. Typically, shallow and intermediate hydrogeologic units are separated from the deep

hydrogeologic unit by a sequence of silt and clay. In areas where the confining silt and clay unit is absent, shallow and intermediate ground water is believed to move into the deep hydrogeologic unit.

Some wells and springs in the Onondaga Lake area produce naturally salty water (Kantrowitz, 1970) from the Syracuse and Salina Formation salt beds. Kantrowitz states that "fresh water moves down and dissolves the rock salt from the middle shale unit and then discharges along a relatively narrow area near the northern edge of the Appalachian Upland." Current research by the United States Geologic Survey (USGS) suggests that other mechanisms helped to form the natural brine documented in wells and springs along Onondaga Lake. This research indicates that a relatively quick dissolution of halite from the Syracuse and Salina formation salt beds during deglaciation created the native brine pool.

Research also indicates that the characteristics of the Onondaga Valley Brine differ from those that typify Appalachian Deep Basin Brine from the deeper Lockport Dolomite Formation. The Onondaga Valley Brines found in Onondaga Valley and in the unconsolidated sediments beneath Onondaga Lake are typically high in strontium, and low in bromide and heavy metals. These differences indicate that there are not multiple sources for the natural brines under Onondaga Lake (Kappel and Miller, 2005). The sole source of the brine is considered to be the salt deposits from the Syracuse Formation, and the Appalachian Deep Basin Brines are not found in the area.

The USGS proposes that this pool has remained relatively unchanged since its formation and initial transportation 16,000 years ago, and notes the native brine daylighting at the surface occurs at the southern end of the brine pool where upwardly moving fresh ground water mixes with the edge of the brine pool (Yager *et al.,* 2007).

3.3.5. Wastebed B/Harbor Brook Site Hydrogeology

Ground Water Setting

There are three basic hydrogeologic units that are monitored in the unconsolidated deposits at the Site, including the shallow fill unit, the intermediate marl unit, and the deep unit primarily consisting of the fine sand and silt with intermittent lenses of sand and gravel typically found immediately above till. Ground water elevation measurements for high and low periods in the shallow and intermediate hydrogeologic units showed ground water flow patterns consistent with what would be expected based on surface topography. These interpretations are discussed later in the ground water flow section.

The shallow fill unit consists mainly of heterogeneous materials of variable hydraulic conductivity. Measured horizontal hydraulic conductivity of the fill ranged from 0.09 to 6.27 ft/day (3.17E-05 to 2.21E-3 cm/sec) **(Table 22)**. Data generated from the adjacent sites show a range of 0.01 to 230 ft/day (3.53E-06 to 8.11E-02 cm/sec) for horizontal hydraulic conductivity and vertical hydraulic conductivity values ranging from 0.006 to 0.06 ft/day (2.12E-06 to 2.12E-05 cm/sec). The coarse grained fraction can include cinders, gravel, and/or crushed limestone; the finer grained fraction typically consists of fly ash, silt, clay, Solvay waste, and other fine-grained material. Ground water was encountered at depths ranging from 2 ft to 11 ft below the ground surface.

The intermediate unit consists of the fine-grained marl immediately underlying the shallow fill unit. The marl varies in hydraulic conductivity depending upon the percentages of silt and sand. Measured horizontal hydraulic conductivity of the marl ranges from 0.05 to 1.33 ft/day (1.76E-05 to 4.69E-04 cm/sec). Data generated from the adjacent sites show a range of 0.003 to 7.52 ft/day (1.06E-06 to

2.65E-03 cm/sec) for horizontal hydraulic conductivity and vertical hydraulic conductivity values ranging from 0.0003 to 0.0022 ft/day (1.06E-07 to 7.76E-07 cm/sec).

Beneath the intermediate marl unit is a silt and clay layer. Because of its low hydraulic conductivity, the silt and clay acts as a confining layer between the deep unit and the intermediate and shallow units. No site specific hydraulic conductivity data were generated from the Wastebed B/Harbor Brook Site itself, but data generated from the adjacent sites show horizontal hydraulic conductivity values ranging from 0.0003 to 0.18 (1.06E-07 to 6.35E-05 cm/sec) ft/day and vertical hydraulic conductivity values ranging from 0.0003 to 0.0022 ft/day (1.06E-07 to 7.76E-07 cm/sec).

The confined deep unit on the Wastebed B Site consists of the fine sand and silt deposits with basal lenses of sand and gravel deposits. These basal deposits correlate stratigraphically with the sand and gravel deposits down along the lakeshore at the Willis Avenue Site, Semet Ponds Site, and Wastebeds 1-8, but unlike at these other sites the sand and gravel deposits are not continuous. The sand and gravel deposits are sporadic lenses of the coarser sand and gravel. Horizontal hydraulic conductivity values measured in the deep monitoring wells ranged from 0.12 to 20.91 ft/day (4.23E-05 to 7.38E-03 cm/sec). Data generated from the adjacent sites show a range of 0.07 to 1,073 ft/day (2.47E-05 to 3.79E-01 cm/sec) for horizontal hydraulic conductivity.

As indicated in earlier sections, ground water chemistry is an indicator of ground water sources and migration patterns in the various hydrogeologic units. Large variations occur in the compositions of dissolved ions in ground water as well as in the magnitude of total dissolved solids (TDS). These variations in composition provide information on the sources of the ground water and the TDS creates density variations in the ground water which influences rates and direction of ground water flow.

Based on the geochemical characteristics of ground water at the Site there are three primary types of ground water with different density characteristics. The first type is a dense, anthropogenic brine that originated from the liquid slurry discharged to the Solvay wastebeds that subsequently infiltrated into the subsurface. This brine has high concentrations of the inorganic ions of calcium and chloride, and has a TDS concentration range between 50,000 and 100,000 mg/L. The second type of ground water found in the overburden is the 16,000 year old native brine. This brine has high concentrations of the inorganic ions of sodium and chloride, and typically has a TDS concentration in range between 80,000 and 160,000 mg/L. The third type of ground water that is found in the overburden at the Harbor Brook site is ground water recharge through native soils. This ground water has low chloride and low TDS respective of the two brines.

Indications of ground water flow, nature, fate and transport can be made given the differences in chemistry, sodium to calcium ratios, chloride, and specific gravity measurements. Ground water elevations are corrected to account for density differences, and the following section describes the process. Ground water flow discussion based on the corrected equivalent heads is discussed subsequent to the density correction discussion. Lastly, ground water nature and geochemistry help to illustrate the transient nature of the Site ground water. This is discussed in ground water nature section.

Ground Water Elevation Measurements

Ground water elevations were measured at the Site during the PSA, RI and SRI. **Table 23** summarizes the ground water elevations measured at the Site from May 2001 through June 2007. In May 2003 and August 2003 density was calculated using TDS. In September 2005, June 2006, September 2006, December 2006, February 2007, and June 2007, density was measured with a

hydrometer concurrently with the collection of ground water elevation measurements. The density information allowed Site water levels to be corrected to reflect equivalent fresh water head (EFH) **(Table 24).** EFH values are calculated to account for variations in the density of the ground water present at the Site.

Equivalent Fresh Water Head Calculations

Ground water head (water level) is conventionally calculated by measuring the depth to water and then subtracting the depth to water from a reference elevation. In using this method, the casing of the well acts as a pressure gauge. The measured water column in the well is equal to the pressure (P) in the aquifer at the base of the well (assumes well has an infinitely small screen) divided by the density of the water (ρ) in the well and the gravitational constant (g).

The height of the water column is a function of the density of the water. Therefore, the ground water head calculated by the conventional method of water level measurements is a function of the density of the water in the well column.

The true head or potential is not a function of the density of the water column in the well. To express head using a common reference, the concept of equivalent fresh water head was introduced. The equivalent fresh water head (EFH) is calculated using the following formula:

*EFH = Specific Gravity * Water level + (1 – Specific Gravity) * Screen depth*

Where: Specific Gravity = Measured relative density by hydrometer (see below), Water level = Measured water level (elevation), and Screen depth = Elevation of screen midpoint.

The density variations encountered in the ground water at the Site are created by several sources of dissolved solids. These sources include Solvay waste, bedrock minerals, and minerals in native overburden.

Ground Water Flow

The ground water elevations measured in September 2006 and June 2007 are presented in **Figures 38 through 43**. September ground water levels represent the seasonal low, and the June ground water levels represent the seasonal high. The specific gravity measurements collected in conjunction with the water levels were used to calculate the EFH values presented on **Figures 38 through 43**. Each figure reports the measured water level in feet above MSL, the measured specific gravity, and the calculated EFH. **Figures 38 though 41** show interpreted ground water EFH contours for the shallow and intermediate zones. **Figures 42 and 43** present collected deep zone well data and calculated EFH. Ground water contour lines were not interpreted for the deep zone given that the slope at the base of the deep unit is distinctly different from the relatively flat slope observed at the base of both the shallow and intermediate units. As a result, interpretation of ground water flow direction would be inappropriate because EFH representations only account for differences in density variations and will not account for the effects of density driven flow in sloped hydrogeologic units.

Anion/cation data was also collected in May and August 2003 and again in March 2007, in order to characterize the nature of the ground water. Anion/cation data are summarized Section 4.

On the Wastebed B/Harbor Brook Site, shallow ground water is encountered at depths ranging from less than 1 ft (AOS #1 wells) to 13 ft (Penn-Can Property) below the ground surface. The shallow ground water contour maps **(Figures 38 and 39)** indicate a general northeast ground water flow

toward Onondaga Lake. There are components of shallow ground water flow from the Railroad Area, the Penn-Can Property and the westernmost portion of the Lakeshore Area that flow toward Harbor Brook and drainage ditches on the site. Generally, the shallow ground water flows radially outward from the eastern portion of the Penn-Can Property with a significant portion of shallow ground water flowing towards and discharging into Harbor Brook. The significance of the shallow ground water discharge to Harbor Brook is discussed in more detail in the Section 8.

The intermediate ground water contour maps **(Figures 40 and 41)** indicate a similar northeast flow direction toward Onondaga Lake. The hydraulic gradient on the eastern portion of the Penn-Can Property suggests that a component of the intermediate ground water flows eastward toward Harbor Brook.

The water level data and the calculated equivalent freshwater heads in the deep ground water zone **(Figures 42 and 43)** are difficult to interpret because of the large variations in groundwater densities within this zone as well as the pronounced slope of this zone towards the lake. The calculated equivalent freshwater heads in all the monitoring wells are similar and there is no spatial trend in the equivalent freshwater heads. This indicates that here is limited deep horizontal ground water flow. The measured densities in the deep unit range from 1.02 gm/cm^3 on the Penn-Can Property to 1.08 gm/cm^3 along the lakeshore. The dense ground water on the lakeshore is native brine as indicated in Piper plots presented and discussed below. The presence of the native halite brine along the lakeshore in the deep zone indicates that ground water flow towards the lake is negligible, had significant flow occurred the native brine would have been displaced lakeward.

Vertical gradients between the fill and the marl (Shallow and Intermediate EFH's) are consistently downward on the upland portions of the Site, notably Penn Can Property and the Ballfield Site, for both high water (June) and low water (September) representations (**Figures 38, 39, 40, and 41**). However, vertical gradients between the fill and the marl in the lower lying areas like the Railroad Area and the Lakeshore Area are spatially variable. Gradients also switch from upward to downward, or vice versa, depending on the season, This temporal variability suggest vertical migration between the fill and the marl is inconsistent.

Ground Water Nature and Quality

Geochemistry from ground water samples was used help define the nature of the ground water on the Wastebed B/Harbor Brook Site. Anion and cation concentrations in ground water at the Site were evaluated using Piper diagrams based on the May 2003, August 2003, and March 2007 ground water sampling events. The Piper diagrams for the shallow, intermediate, and deep ground water zones are included as **Figures 44 through 46, Figures 47 through 49, and Figures 50 through 52**, respectively. Comparisons between RI data and SRI data show little change in inorganic constituents from 2003 and 2007 in most wells, with the exception of HB-17D, HB-05I, and HB-20I. While the changes in water chemistry are only observed in 3 sampling periods spanning 4 years, these changes may be explained by the following two processes.

Water chemistry from monitoring well HB-17D on the Penn Can Property changes from a strong leachate and native brine signature (**Figures 50 and 51**) to a similar signature (**Figure 52**) with dilute inorganic concentrations. Sodium concentrations change from 1980 mg/l and 2520 mg/l in 2003 to 66 mg/l in 2007. Chloride concentrations change from 3560 mg/l and 3550 mg/l in 2003 to 94 mg/l in 2007. Calcium concentrations change from 677 mg/l and 277 mg/l in 2003 to 23 mg/l in 2007. The dilute nature of the water chemistry from the 2007 sample illustrate the influence of fresh water recharge to some wells located on the Penn-Can Property. While the precise nature of transport of the

fresh water recharge is unknown, it may be infiltrating through the overburden in the Railroad Area where overburden deposits are less than 15 feet thick. This ground water may then move through the zones of coarse, reworked till typically found just above the compacted till, to wells such as HB-17D. Slug tests for this well indicate K values of 1.48 ft/day (5.2E-4 cm/sec), which indicate this transport mechanism is possible given the time frame of four years.

This temporal pattern is also observed in other site wells where changes in water chemistry from monitoring well HB-HB-05I (Wastebed B) and HB-HB-20I (AOS #1) illustrate mixing in the intermediate zone along the interface between the native brine and leachate and fresh water recharge. These changes are discussed again at greater length later in this section. While it is unclear exactly how these changes in chemistry at the interface occur temporally across the lakeshore, these changes indicate that the both the vertical and horizontal interface between fresh water recharge, historic leachate and native brine is not static, and may vary though time.

Anion/cation data for Tully Brine (halite brine) and Wastebed leachate (B&B, 1989) are shown on the Piper diagrams to represent two significant ground water types in the area. The halite brine and leachate fall in the general Cl-SO_4 area (Freeze and Cherry, 1979), but the halite brine water contains more sodium (Na-Cl) while wastebed leachate is more calcium enriched (Ca-Cl). While Piper diagrams illustrate the two water types, sodium to calcium ratios also are indicative of the two brine water types where high ratios (high sodium) indicate a native brine type, and vice versa. In general, the Site ground water characteristics fall into three categories, and are typified by their associated ground water zone.

The water quality in the shallow ground water shows significant variability across the Site, in part due to the lower concentrations of anions/cations. Much of the water has quality characteristics between the halite brine and the leachate. While this pattern may suggest a mixing of the two water types, the dilute nature of the shallow ground water indicates that the geochemical signatures are more representative of the material in which the wells are screened. For example, wells situated in and near thick Solvay waste deposits (HB-HB-12S, HB-WA-08S, HB-HB-14S, and HB-WB-BU) appear to have relatively enriched Ca characteristics similar to the leachate signature. Wells located where there are only thin layers of Solvay waste (Railroad Area and along Harbor Brook) do not have the leachate signature.

Monitoring well HB-04S is one exception to these trends. The geochemical signature indicated by the sodium to calcium relationship for this well typifies dilute halite brines, with a higher sodium content compared to calcium that the lower chloride content in this well reflects precipitation mixing with either an on-going discharge of halite brine or remnant brine in the marl.

Chloride concentrations are an indication of the relative impact of the various water types, as chloride is a conservative ion that will not readily precipitate out of solution once dissolved. As discussed earlier, there are two sources for high chloride water. The first is the high calcium leachate originating from the Solvay waste in the waste beds. The second is the high sodium native brine found in the deep overburden deposits.

Overall, chloride concentrations in the shallow wells varied significantly from 8.6 mg/L at HB-HB-08S to 29,200 mg/l at HB-HB-06S. Typically, the highest concentrations are found closer to the lake and are associated with native brine (**Figures 44 through 52**).

The intermediate ground water geochemistry is less variable than in the shallow zone and tends to have characteristics more similar to the halite brine (Na-Cl). There is a component of the leachate (Ca-Na-Cl) in some intermediate wells. While high calcium and carbonate concentrations might be expected in the intermediate zone marl, the concentrations of both calcium and carbonate are well above saturation, so further leaching of these components from the marl is unlikely. The intermediate ground water chemistry likely reflects a combination of remnant halite brine and historic leachate. The two wells located on the Penn-Can Property (HB-HB-11I and HB-HB-12I) show strong Ca-Na-Cl signatures likely from remnant leachate; however, they contain very low anion/cation concentrations.

Intermediate wells in general had higher chloride concentrations than the shallow zone, with the highest concentrations being near the lake. The arithmetic mean of chloride concentrations for 2003 in the intermediate wells is 540.9 meq/l (19,174 mg/l) while for shallow wells the mean is 114.0 meq/l (4042 mg/l). The arithmetic mean of chloride concentrations for 2007 in intermediate wells for the 2007 sampling event is 226.5 meq/l (8,029 mg/l), while for shallow wells the mean is 65.6 meq/l (2,324 mg/l). These data indicate that the shallow ground water reflects a greater influence of dilution by precipitation than the intermediate ground water.

The deep ground water also has geochemical characteristics that are similar to the halite brine, with the exception of the wells on the Penn-Can Property (HB-HB-12D, HB-HB-13D, HB-HB-14D, and HB-HB-17D). These wells have very low TDS and chloride concentrations in comparison with the other deep wells. This suggests a connection to recharge from precipitation and could indicate a migration pathway, as indicated above. However, given the small hydrogeologic gradient in the deep zone toward the lake, the deep ground water may more likely be moving in a more easterly direction towards Harbor Brook. Chloride concentrations are also highest in the deep zone adjacent to the lake.

The geochemical data provide an indication of ground water flow patterns at the Wastebed B/Harbor Brook Site. Since the shallow ground water appears to be primarily influenced by the material the wells are screened in, the primary flow paths are likely horizontal, with some component percolating vertically downward to the intermediate zone.

Overall, the intermediate ground water appears to show geochemical characteristics of a mixing of both leachate from water that infiltrates through the Solvay waste and halite brine from past or present migration from the deep zone. On the eastern portion of the Penn-Can Property, both hydraulic gradients and geochemical signatures presented above suggest that ground water is moving horizontally in the intermediate zone towards Harbor Brook.

Vertical gradients between Shallow and Intermediate presented above indicate that ground water may move downward from the fill to the underlying marl at the upland portions of the Site. However, given the variability and the changes in direction of the vertical gradients on low lying portions of the site, limited vertical migration is likely occurring between the Shallow and Intermediate Units in these areas. This is likely the result of stratification occurring between dense water (historic leachate or remnant native brine) in the Intermediate unit and the less dense ground water (diluted by recharge from precipitation) found in the Shallow unit.

The halite brine signature in the deep ground water near the lakeshore suggests that Halite Brine extends under Wastebed B. This is consistent with the equivalent fresh water heads in the deep zone, which indicates no distinct ground water flow pattern in the deep zone. Based on these data, it is unlikely that deep ground water flows from Wastebed B to the lake. However, as mentioned earlier,

there is a component of deep and intermediate ground water flow that may move from the Penn-Can Property towards Harbor Brook. The ground water in the wells on the Penn-Can Property is typically less dense and is more dilute in comparison.

3.3.6. SYW-12 Site Hydrogeology

The wells installed in association with the Supplemental RI were screened within the reworked fill and upper marl to monitor the water table. Ground water was encountered at depths of 2 to 7 ft bgs. Specific gravity measurements indicate that the shallow ground water has variable density ranging from 1.000 to 1.016 g/cm^3. Therefore, equivalent fresh water head values were calculated for all wells in the shallow unit. High and low ground water elevations from February 2007 and June 2007 and contour interpretations are presented for the shallow unit in **Figure 53 and Figure 54**. Contours of equivalent fresh water head indicate that shallow ground water is moving westward towards and discharging into Onondaga Lake from the central and southern portions of the Site. Ground water on the northern portion of the Site is moving north towards Ley Creek. Hydraulic conductivity values of the shallow unit interpreted from slug tests are summarized in **Table 22**. The hydraulic conductivity values ranged from 0.36 to 27.10 ft/d (1.27E-04 to 9.56E-03 cm/sec) across the SYW-12 Site.

Inorganic geochemistry from monitoring wells on SYW-12 indicate similar geochemical conditions to the shallow zone on the lakeshore on Wastebed B/Harbor Brook site. Chloride levels vary from 730 to 6100 mg/l. A Piper plot of SYW-12 wells indicate that HB-MW-22, HB-MW-23, HB-MW-24, and HB-MW-27 have dilute halite brine signatures, and plot similar to the Tully Brine on the piper diagram **(Figure 55)**. The other wells (HB-MW-25, HB-MW-26, HB-B-04W, HB-B-08W, and HB-B-10W) have low TDS concentrations, and while they plot similar to leachate, this is likely only a coincidence as the ground water likely originates from the infiltrations of local precipitation.

4. Nature and Extent of Constituents

This section of the report presents a discussion of the nature and extent of constituents at the Site based on data collected during the PSA, RI, Supplemental RI, and other investigations including the Harbor Brook Sediment IRM, Wastebed B/Harbor Brook IRM, I-690 Bridge Replacement Investigation, and the Wastebed B Geotechnical Investigation. Due to the complexity of the Site and the additional areas of study (AOS), the nature and extent of constituents for the various media sampled are presented on an area basis for the various media evaluated. A sample summary for all media is presented on **Table 1**.

4.1. Surface Soils Characterization

Soils characterization at the Site consisted of the collection of surface and subsurface soil samples. For the purposes of this RI surface soil is any soil sample collected from 0 to 2 ft bgs.

Volatile organic compounds CPOIs detected in Site surface soils include acetone, benzene, toluene, ethylbenzene, xylene, methylene chloride, and chlorinated benzenes. The concentration of total benzene, toluene, ethylbenzene, and xylenes (BTEX) is presented on **Figure 56**.

Total BTEX consists of the following detected chemical parameters from the 8260 scan:

- benzene
- toluene
- ethylbenzene
- xylenes

SVOC CPOIs detected at the Site include chlorinated benzenes, 4-chloroaniline, naphthalene, and assorted PAHs. Chlorinated benzenes were detected with both the VOC scan and SVOC scan depending on the time of sampling as discussed in Section 2.2.1. Total chlorinated benzene concentrations are presented on **Figure 57**. The total chlorobenzene concentrations were calculated by summing the following detected constituents for a specific sample:

- chlorobenzene
- 1,2-dichlorobenzene
- 1,3-dichlorobenzene
- 1,4-dichlorobenzene
- 1,2,3-trichlorobenzene
- 1,2,4-trichlorobenzene
- hexachlorobenzene

Total PAH concentrations are presented on **Figure 58**. The total PAH concentrations were derived by calculating the sum of the following detected chemical parameters in the USEPA SW-846 Method 8270 scan:

- 2-methylnaphthalene
- acenaphthene
- acenaphthylene
- anthracene
- benzo[a]anthracene
- benzo[a]pyrene
- benzo[b]fluoranthene
- benzo[g,h,i]perylene
- chrysene
- dibenzo[a,h]anthracene
- fluoranthene
- fluorene
- indeno[1,2,3-cd]pyrene
- naphthalene
- phenanthrene
- pyrene

- benzo[k]fluoranthene

The concentration of total PCBs and total PCDD/PCDF TEQs are presented on **Figures 59 and 60**. Total PCB concentrations were calculated by summing the detected constituent concentrations in the USEPA SW-846 Method 8082 scan. Mammal (human) toxic equivalency factors (TEFs) obtained from Van den Berg *et al*. (2006) were used to calculate TEQs for the individual congeners. The individual congener TEQs were summed to calculate the Total TEQ. The concentrations of inorganic CPOIs, including arsenic, chromium, mercury, and nickel are included on **Figures 61, 62, 63, and 64**, respectively. Methyl mercury concentrations are presented on **Figure 65**.

The distribution of constituents in surface soils is discussed below in greater detail by sub-area.

4.1.1. Lakeshore Area Surface Soils

Lakeshore Area surface soil samples were collected during the PSA, RI, and Supplemental RI field programs. A total of 34 surface soil samples were collected from 0 to 0.17 ft at the request of NYSDOH during the PSA. The samples were co-located with geoprobes (21 locations), soil borings (7 locations), and wetland borings (6 locations). A summary of locations and laboratory analyses are included in **Table 2**. Analytical results for the PSA geoprobe boring surface soil data are presented on **Tables 41 through 46** for VOCs, SVOC, pesticides, PCBs, inorganics, and percent solids, respectively. Analytical results for the PSA soil boring surface soil data are presented on **Tables 47 through 52** for VOCs, SVOC, pesticides, PCBs, inorganics, and percent solids, respectively. PSA wetland soil borings surface soil data are presented on **Tables 53 through 58** for VOCs, SVOC, pesticides, PCBs, inorganics, and percent solids, respectively. Sample locations are presented on **Figure 6**. It should be noted that no surface soil samples (0 to 2 ft) were collected from test pits advanced during the PSA as presented on **Tables 1 and 16**.

The RI surface soils were collected at fourteen locations. A summary of locations and laboratory analyses is included in **Table 3**. Three of the surface soil sample locations (HB-HB-16D, HB-RISB-01, and HB-RISB-02) were co-located at boring or monitoring well locations. The remaining eleven surface soil sample locations were collected at locations not associated with borings or monitoring wells. These locations were selected to fill data gaps in areas of interest at the Site. The RI surface soils are presented on **Tables 59 through 67** for VOCs, SVOCs, pesticides, PCBs, inorganics, methyl mercury, PCDD/PCDFs, PCDD/PCDF toxic equivalencies (TEQs), and percent solids, respectively. The RI surface soils associated with soil borings are presented on **Tables 68 through 76** for VOCs, SVOCs, pesticides, PCBs, inorganics, methyl mercury, PCDD/PCDFs, PCDD/PCDF toxic equivalencies (TEQs), and other data, respectively. Sample locations are presented on **Figure 6**.

The Supplemental RI surface soil sample was collected at HB-SB-65 from 0 to 2 ft. A summary of laboratory analyses is included in **Table 4**. The results of this sample are presented on **Tables 77 through 82** for VOCs, SVOCs, pesticides, PCBs, inorganics, and percent moisture. Sample location is presented on **Figure 6**. It should be noted that no surface soil samples (0 to 2 ft) were collected from test pits advanced during the Supplemental RI as presented on **Tables 1 and 18**.

Five surface soil samples, three collected by O'Brien & Gere and two collected by the NYSDEC, were collected in the Dredge Spoils Areas as part of the Willis Avenue RI. These samples were collected at test pit locations. A summary of locations and laboratory analyses are included in **Table 12**. The Willis Avenue RI test pit surface soil results are presented on **Tables 83 through 87** for VOCs, SVOCs, PCBs/pesticides, inorganics, and percent solids, respectively. The NYSDEC results are provided on **Tables 88 through 91** for VOCs, SVOCs, PCBs, and inorganics, respectively.

Summary statistics are provided on **Table 92** for surface soil (0 to 2 ft) chemical parameters detected at the Site. The NYSDEC test pit samples were not included in the summary statistics because the samples are duplicates of the O'Brien and Gere test pit samples. Detected chemical parameters of interest (CPOIs) are listed below in **Table 4.1**. Chemical parameters that were detected in at least twenty percent of the samples or exceeded standards or guidance discussed in Section 5 of this report in at least one of the samples were included as CPOIs and included in **Table 4.1**. Chemical parameters that are considered to be bioaccumulators, such as PCBs and PCDD/PCDFs when detected, were also included in **Table 4.1**.

Table 4.1. *Detected Lakeshore Area Surface Soil CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (μg/kg)						
Benzene	65	15	1.00	101	1,400	11
Acetone	61	8	7.00	127	170	7
Methylene Chloride	65	4	1.70	41.5	160	4
Chlorobenzene	65	23	1.00	220	3,400	3
1,4-Dichlorobenzene	34	13	2.00	1,572	19,000	2
Xylenes, m & p	27	8	4.60	122	420	2
1,2-Dichlorobenzene	34	15	1.00	565	7,600	1
Toluene	65	14	1.00	76.7	680	1
Xylenes, Total	37	9	1.00	254	2,100	1
Ethylbenzene	65	6	3.00	88.8	410	1
1,2,4-Trichlorobenzene	33	5	2.00	2,422	12,000	1
1,3-Dichlorobenzene	33	5	1.00	1,406	7,000	1
Semivolatile Organic Compounds (μg/kg)						
Benzo(b)fluoranthene	62	53	71.0	2,142	9,500	48
Benzo(a)anthracene	61	51	50.0	1,477	6,900	48
Benzo(a)pyrene	62	52	60.0	1,606	6,400	44
1,4-Dichlorobenzene	63	43	9.50	20,820	350,000	36
Chrysene	62	53	65.0	1,681	6,100	29
Dibenzo(a,h)anthracene	61	30	72.0	352	1,400	29
Indeno(1,2,3-cd)pyrene	61	48	47.0	922	4,100	28
Benzo(k)fluoranthene	61	50	46.0	1,037	5,000	22
1,2-Dichlorobenzene	63	33	7.60	15,672	210,000	18
1,2,4-Trichlorobenzene	63	26	2.00	10,561	53,000	18
4-Chloroaniline	61	17	120	610	1,700	17
Hexachlorobenzene	61	13	40.0	1,874	11,000	12
Naphthalene	61	44	77.0	11,876	300,000	9
Phenol	61	9	44.0	899	5,700	3
1,3-Dichlorobenzene	63	9	2.60	1,132	3,700	2
Phenanthrene	62	50	65.0	3976	120,000	1
Dibenzofuran	61	22	51.0	2,546	53,000	1
Fluorene	61	20	50.0	3,230	61,000	1
Acenaphthene	61	19	64.0	1,817	31,000	1
2,4-Dimethylphenol	61	2	76.0	1,988	3,900	1
2,4-Dinitrophenol	61	1	67.0	67.0	67.0	1
2-Methylphenol	61	1	2,000	2,000	2,000	1
Bis(2-chloroethyl)ether	61	1	50.0	50.0	50.0	1
Pentachlorophenol	61	1	130	130	130	1
Fluoranthene	62	56	76.0	3,259	43,000	0
Pyrene	62	56	58.0	3,143	26,000	0
Benzo(g,h,i)perylene	61	47	42.0	1,065	4,700	0

Table 4.1. *Detected Lakeshore Area Surface Soil CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Acenaphthylene	61	41	37.0	1,587	37,000	0
Anthracene	61	40	80.0	1,468	28,000	0
Benzoic acid	31	20	74.0	535	3,000	0
2- Methylnaphthalene	61	32	64.0	4,605	130,000	NA
Carbazole	61	28	65.0	776	15,000	NA
Dioxins/Furans (ng/kg)						
Total TEQ	10	10	0.15	205	759	NA
Pesticides (μg/kg)						
4,4'-DDT	65	1	16.0	16.0	16.0	1
Dieldrin	65	1	200	200	200	1
Hexachlorobenzene	3	2	40.0	435	830	1
PCBs (μg/kg)						
Aroclor-1260	65	46	20.0	1,347	6,000	40
Aroclor-1254	65	9	150	592	2,000	9
Aroclor-1016	65	11	30.0	291	2,000	5
Aroclor-1248	65	1	4,420	4,420	4,420	1
Inorganic Compounds (mg/kg)						
Arsenic	62	62	2.50	8.09	21.4	62
Calcium	62	62	46,900	177,711	352,000	62
Chromium	62	62	6.70	102	391	62
Magnesium	62	62	3,600	12,083	38,300	62
Nickel	62	62	10.1	36.1	72.3	62
Mercury	64	62	0.09	8.19	64.3	61
Barium	62	62	32.5	277	1,240	56
Potassium	62	58	275	1,480	8,170	56
Cadmium	62	51	0.055	27.7	121	49
Lead	62	62	6.10	357	1,800	47
Sodium	62	61	81.9	1,538	4,910	47
Aluminum	62	62	1870	6,834	24,400	45
Copper	62	62	13.4	190	7,44	45
Zinc	62	62	14.8	355	1,520	42
Selenium	62	39	0.35	1.96	3.30	39
Silver	62	37	0.20	26.1	91.9	26
Antimony	62	21	0.29	0.585	0.97	20
Cyanide	62	25	0.68	2.28	5.60	15
Thallium	62	11	0.57	0.949	2.30	11
Manganese	62	62	128	308	722	0
Vanadium	62	60	8.10	20.7	49.1	0
Beryllium	62	35	0.30	0.64	1.40	0
Methyl mercury	13	13	0.86	17.6	96.1	NA
Iron	62	62	2690	12,244	24,400	NA
Cobalt	62	40	3.50	7.06	13.3	NA

Notes:
1 – Exceeds either NYSDEC Part 375.6 Soil Cleanup Objectives or USEPA (1996) Soil Screening Levels.
2 – Mean concentration values have been rounded.
Methyl mercury concentrations are presented in units of μg/kg.
NA = Not applicable as no criteria is available.

For the purposes of the Lakeshore Area nature and extent discussion for the surface soil samples collected during the PSA, RI, and Supplemental RI are discussed together below.

VOC CPOIs within the Lakeshore Area include BTEX compounds and chlorinated benzenes. BTEX constituents tended to be detected in samples collected nearer the lake and in wetland areas and not in upland samples collected away from the lake (**Figure 56**). The highest BTEX concentrations in Lakeshore Area surface soils are associated with wetland area WL2 (HB-SB-65) and wetland area WL3 (HB-RISB-01 and HB-RISB-02). The actual source of the BTEX compounds is unknown. These soils have likely been influenced by the historic East Flume effluent and appear to be similar in nature to the in-lake waste deposit (ILWD).These wetland areas may also have received sediment from Harbor Brook or fill materials including historical dredge materials from the lake. Wastebed B historically received Solvay waste and it is likely that other waste was co-disposed of with the slurry during disposal. Wastebed B also received undigested sewage sludge during the 1950's. The co-disposed waste and the undigested sewage sludge may have influenced Site soils in the lakeshore area.

Chlorinated benzenes were detected in surface soils throughout the Lakeshore Area (**Figure 57**). The original source of the chlorinated benzenes is likely the former Willis Avenue Chlorobenzene Plant. The highest concentrations of chlorinated benzenes in the Lakeshore Area are associated with the DSAs and wetland areas WL2 through WL4. The chlorobenzenes in the DSAs are likely associated with either the historic East Flume effluent or spoils material placed within these areas from the former UEF and Onondaga Lake during the installation of the diffuser building intake pipe. The chlorinated benzenes detected within the wetland areas are likely related to the historic East Flume effluent as well. However, there is the possibility of the historical placement of fill materials within Wetland Area 2 (WL 2). These compounds were also detected in Wastebed B outside of the DSAs. The chlorinated benzenes within Wastebed B are likely related to historic co-disposal with the Solvay waste slurry [PTI 1992 (Sobolewski 1985, pers. Comm.)]; however, there is a lack of information from the chlorinated benzene plant and are no records of this occurring (PTI 1992). It should be noted that chlorinated benzenes detected in both the VOC and SVOC analyses tended to have higher concentrations in the SVOC scan.

Assorted PAHs were detected throughout the Lakeshore Area (**Figure 58**). The highest concentrations are associated with the DSAs and wetland areas WL2 through WL4. The PAHs in these soils are likely associated with the historic East Flume effluent and appear to be similar to the in-lake waste deposit (ILWD). The PAHs detected within the wetland areas may also be related to Harbor Brook sediments deposited in these areas or the potential historical placement of spoils, fill, or dredge materials within these areas. PAHs detected in the upland areas (Wastebed B) of the Lakeshore Area may also be related to historical placement of sludge material by Onondaga County on the wastebed or may be due to the co-disposal of waste with the Solvay waste slurry that formed the wastebed; however there are no records of this occurring. The area is also downgradient of the former Barrett Paving facility, which made asphalt products. The PAHs may be associated with this facility, especially on the eastern portion of the Lakeshore Area (Wetland Area WL2), since Harbor Brook sediment is believed to have been historically impacted by discharges from the Penn-Can drainage ditch associated with the Barrett Paving facility property as discussed in Sections 4.4.4 and 4.4.5.

PCBs were detected throughout the Lakeshore Area. It appears that slightly higher elevations are associated with the wetland areas along the lake than the upland areas on Wastebed B. The soils in the DSAs and the wetland areas have likely been influenced by historic East Flume effluent. Soils in wetland area WL2 have also likely been influenced by Harbor Brook discharges. Total PCB concentrations are provided on **Figure 59**. The soils in the DSAs and the wetland areas have likely been influenced by historic East Flume effluent. Soils in wetland area WL2 have also likely been

influenced by Harbor Brook discharges. PCBs detected in the wetland area WL2 may also be related to fill or dredge material that may have been placed in this area historically. The source of the PCBs detected in Wetland Areas WL3 and WL4 along the lakeshore is unknown. The source of the PCBs detected in the upland areas of the Lakeshore Area (Wastebed B) is unknown. However, the higher concentrations on the eastern portion of Wastebed B are in the area where sludge was historically placed by Onondaga County.

A limited number of samples were analyzed for PCDD/PCDFs in the Lakeshore Area (**Figure 60**). The highest concentrations were detected in wetland area WL3 (HB-SS-04). The PCDD/PCDFs in these soils may related to historic East Flume effluent and the ILWD. The PCDD/PCDFs in the wetland areas may also be related Harbor Brook sediments deposited in these areas or the potential to fill or dredge materials potentially placed in these areas historically.

Inorganics were detected in surface soils throughout the Lakeshore Area. Inorganic surface soil CPOIs include arsenic, chromium, mercury, and nickel. There is no evident pattern of distribution for arsenic, chromium, and nickel (**Figures 61, 62, and 64**). Mercury concentrations are higher in surface soils associated with the Dredge Spoils Areas and the wetland areas (**Figure 63**). The mercury near the DSAs is likely from either the historic East Flume effluent or spoils material placed within these areas from the former UEF and Onondaga Lake during the installation of the diffuser building intake pipe. The mercury detected in the wetland areas may be related to the historic East Flume effluent as well. However, there is the possibility of the historical placement of fill or dredge materials within these areas. The concentrations of calcium and magnesium in surface soils are likely related to the presence of Solvay waste.

4.1.2. Penn-Can Property Surface Soils

Penn-Can Property surface soil samples were collected during the PSA and RI field programs. A total of 11 surface soil samples were collected from 0 to 0.17 ft during the PSA. The samples were co-located with geoprobes and soil borings. A summary of locations and laboratory analyses are included in **Table 2**. Analytical results for the PSA geoprobe boring surface soils are presented on **Tables 41 through 46** for VOCs, SVOC, pesticides, PCBs, inorganics, and percent solids, respectively. Analytical results for the PSA soil borings surface soils are presented on **Tables 47 through 52** for VOCs, SVOC, pesticides, PCBs, inorganics, and percent solids, respectively. It should be noted that no surface soil samples (0 to 2 ft) were collected from test pits advanced during the PSA as presented on **Tables 1 and 16**. Sample locations are presented on **Figure 6**.

The RI surface soils were collected at six locations. A summary of locations and laboratory analyses is included in **Table 3**. Three of the surface soil sample locations (HB-PCSS-01, HB-PCSS-02, and HB-PCSS-03) were sampled to fill in data gaps. Two additional surface soil locations (HB-PSD-01 and HB-PSD-02) and one tar containing drum (HB-PSD-TAR) were sampled as part of the Penn-Can drum survey. HB-PSD-TAR analytic data were not included in this discussion since the material was tar and contained within the drum. The HB-PSD-TAR analytic results are discussed in Section 4.8. One location (HB-HB-17D) was co-located at a soil boring location. The RI surface soils are presented on **Tables 59 through 67** for VOCs, SVOCs, pesticides, PCBs, inorganics, methyl mercury, PCDD/PCDFs, and percent solids. The RI surface soils associated with soil borings are presented on **Tables 68 through 76** for VOCs, SVOCs, pesticides, PCBs, inorganics, methyl mercury, PCDD/PCDFs, PCDD/PCDF TEQs, and percent solids and fuel parameters, respectively. The RI drum survey surface soil samples are presented on **Tables 93 through 98** for VOCs, SVOCs, pesticides, PCBs, inorganics, and percent solids, respectively. Sample locations are presented on **Figure 6**.

Summary statistics are provided on **Table 99** for surface soil (0 to 2 ft) chemical parameters detected at the Site. Detected chemical parameters of interest (CPOIs) are listed below in **Table 4.2**. Chemical parameters that were detected in at least twenty percent of the samples or exceeded standards or guidance discussed in Section 5 of this report in at least one of the samples were included as CPOIs and included in **Table 4.2**. Chemical parameters that are considered to be bioaccumulators, such as PCBs and PCDD/PCDFs when detected, were also included in **Table 4.2**.

Table 4.2. *Detected Penn-Can Property Surface Soil CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (μg/kg)						
Methylene Chloride	23	3	23.0	48.3	90.0	3
Benzene	23	6	0.80	10.3	52.0	2
Acetone	23	1	140	140	140	1
1,2,4-Trimethylbenzene	11	5	0.80	28.1	130	0
Naphthalene	11	5	2.00	453	2,100	0
Toluene	23	5	0.80	5.76	14.0	0
Xylenes, Total	11	5	0.60	2.80	7.00	0
Tetrachloroethene	23	4	0.70	0.83	1.00	0
1,3,5-Trimethylbenzene	11	3	1.00	1.67	2.00	0
Xylenes, m & p	12	3	3.20	10.1	23.0	0
p-Isopropyltoluene	11	3	0.90	4.30	9.00	NA
Semivolatile Organic Compounds (μg/kg)						
Benzo(a)anthracene	23	23	440	20,798	120,000	23
Benzo(a)pyrene	23	23	480	20,314	100,000	23
Benzo(b)fluoranthene	23	23	370	18,617	81,000	23
Chrysene	23	23	490	20,560	110,000	20
Benzo(k)fluoranthene	23	22	330	16,473	94,000	20
Indeno(1,2,3-cd)pyrene	23	22	290	12,638	64,000	20
Dibenzo(a,h)anthracene	23	20	110	4,773	22,000	20
Naphthalene	23	19	490	5,109	23,000	6
Fluoranthene	23	23	630	43,587	310,000	3
Pyrene	23	23	640	33,547	180,000	2
1,4-Dichlorobenzene	23	3	59	253	580	2
Phenanthrene	23	23	290	24,658	210,000	1
Dibenzofuran	23	17	220	3,025	19,000	1
Fluorene	23	16	120	4,926	34,000	1
Phenol	23	1	840	840	840	1
Benzo(g,h,i)perylene	23	22	80	13,406	69,000	0
Anthracene	23	21	180	8,949	61,000	0
Acenaphthylene	23	19	80	7,216	30,000	0
Acenaphthene	23	16	220	3,128	17,000	0
2-Methylnaphthalene	23	17	300	2,991	10,000	NA
Carbazole	23	16	140	3,019	17,000	NA
Pesticides (μg/kg)						
4,4'-DDD	23	3	10.0	73.3	200	3
4,4'-DDE	23	2	10.0	10.0	10.0	2
4,4'-DDT	23	2	40.0	370	700	2
PCBs (μg/kg)						
Aroclor-1254	23	7	20.0	938.6	6000	3
Aroclor-1260	23	5	50.0	100	140	3
Inorganic Compounds (mg/kg)						
Arsenic	23	23	2.50	11.3	34.4	23
Calcium	23	23	5880	129,904	241,000	23

Table 4.2. *Detected Penn-Can Property Surface Soil CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Chromium	23	23	4.30	19.2	93.4	23
Magnesium	23	23	811	17,791	44,400	23
Nickel	23	23	9.50	18.7	51.2	23
Potassium	23	23	378	1,019	1,680	21
Mercury	23	23	0.04	1.35	7.90	18
Aluminum	23	23	1080	5,804	9,220	16
Selenium	23	11	0.34	1.46	3.60	11
Lead	23	23	11.1	72.8	263	10
Zinc	23	23	14.3	107	399	8
Barium	23	23	11.9	67.6	147	7
Antimony	23	11	0.19	1.00	4.90	7
Cadmium	23	7	0.06	0.58	1.40	4
Copper	23	23	5.50	33.9	81.8	3
Sodium	23	23	60.7	343	1630	3
Silver	23	2	0.15	2.73	5.30	1
Thallium	23	1	1.00	1.00	1.00	1
Manganese	23	23	104	285	402	0
Vanadium	23	23	10.4	20.2	44.1	0
Beryllium	23	11	0.20	0.56	1.40	0
Iron	23	23	3300	15,909	30,000	NA
Cobalt	23	19	2.80	6.71	15.6	NA

Notes:
1 – Exceeds either NYSDEC Part 375.6 Soil Cleanup Objectives or USEPA (1996) Soil Screening Levels.
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

For the purposes of the nature and extent discussion the surface soil samples collected during the PSA and RI are discussed together below.

VOC CPOIs detected in Penn-Can Property surface soils include BTEX and methylene chloride. Total BTEX concentrations are presented on **Figure 56**. The Penn-Can Property historically operated as an asphalt materials production and storage facility (Barrett Paving). The BTEX compounds present may be associated with historical use of the property.

SVOC CPOIs detected in surface soils at the Penn-Can Property include naphthalene and assorted PAHs. Total PAH concentrations are presented on **Figure 58**. Elevated total PAH concentrations were observed across Penn-Can Property with the highest at HB-HB-12D, HB-HB-17D, and HB-HB-10. The presence of these compounds in the surface soils is likely related to the historic use of the Site as an asphalt materials production and storage facility. Total chlorobenzenes were only detected along the western perimeter of the Penn-Can Property. The chlorobenzenes are likely related to operations at the former Willis Avenue Plant; however, the method of transport or disposal is unknown.

PCBs were detected in surface soils at the Penn-Can Property. Total PCB concentrations are presented on **Figure 59**. The highest concentration was detected at location HB-HB-10 in the northwest corner of the property.

Inorganics were detected throughout the Penn-Can Property. Inorganic CPOIs include arsenic, chromium, mercury, and nickel. There is no evident pattern of distribution of arsenic, chromium, mercury, and nickel (**Figures 61, 62, 63, and 64**). The mercury detected at the Penn-Can Property is

likely related to operations at the former Willis Avenue Chlorobenzene Site; however, the method of transport or disposal is unknown. The concentrations of calcium and magnesium in surface soils are likely related to the presence of Solvay waste. The source of arsenic, chromium, nickel, and the other inorganics is unknown.

4.1.3. Railroad Area Surface Soils

Railroad Area surface soil samples were collected during the PSA, and RI field programs. A total of nine surface soil samples were collected from 0 to 0.17 ft during the PSA. The samples were co-located with geoprobes and soil borings. A summary of sample locations and laboratory analyses is included in **Table 2**. Analytical results for the PSA geoprobe boring surface soils are presented on **Tables 41 through 46** for VOCs, SVOC, pesticides, PCBs, inorganics, and percent solids, respectively. Analytical results for the PSA soil borings surface soils are presented on **Tables 47 through 52** for VOCs, SVOC, pesticides, PCBs, inorganics, and percent solids, respectively. It should be noted that no surface soil samples (0 to 2 ft) were collected from test pits advanced during the PSA as presented on **Tables 1 and 16**. Sample locations are presented on **Figure 6**.

The RI surface soils were collected at five locations. A summary of sample locations and laboratory analyses is included in **Table 3**. Three of the surface soil sample locations (HB-XSS-01, HB-XSS-02, and HB-XSS-03) sampled to address surface soil data gaps. Two locations (HB-RISB-08 and HB-RISB-09) were co-located at soil boring locations. The RI surface soils are presented on **Tables 59 through 63 and Table 67** for VOCs, SVOCs, pesticides, PCBs, inorganics, and percent solids. The RI surface soils associated with soil borings are presented on **Tables 68 through 76** for VOCs, SVOCs, pesticides, PCBs, inorganics, methyl mercury, PCDD/PCDFs, PCDD/PCDF TEQs, and other data including percent solids and fuel parameters. Sample locations are presented on **Figure 6**.

Summary statistics are provided on **Table 100** for surface soil (0 to 2 ft) chemical parameters detected at the Site. Detected chemical parameters of interest (CPOIs) are listed below in **Table 4.3**. Chemical parameters that were detected in at least twenty percent of the samples or exceeded standards or guidance discussed in Section 5 of this report in at least one of the samples were included as CPOIs and included in **Table 4.3**. Chemical parameters that are considered to be bioaccumulators, such as PCBs and PCDD/PCDFs when detected, were also included in **Table 4.3**.

Table 4.3. *Detected Railroad Area Surface Soil CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (µg/kg)						
Acetone	18	7	4.00	89.0	370	3
Methylene Chloride	18	1	65.0	65.0	65.0	1
p-Isopropyltoluene	9	2	2.00	5.00	8.00	NA
Semivolatile Organic Compounds (µg/kg)						
Benzo(a)anthracene	18	15	57.0	322	1,100	11
Benzo(b)fluoranthene	18	15	81.0	401	1,700	8
Benzo(a)pyrene	18	14	56.0	334	950	5
Dibenzo(a,h)anthracene	18	7	55.0	107	190	5
Chrysene	18	15	82.0	390	1,100	2
Benzo(k)fluoranthene	18	12	66.0	286	810	1
Fluoranthene	18	15	94.0	602	2,000	0
Phenanthrene	18	15	54.0	378	1,500	0
Pyrene	18	15	85.0	496	1,500	0
Benzo(g,h,i)perylene	18	14	37.0	195	480	0
Indeno(1,2,3-cd)pyrene	18	12	55.0	213	470	0

Table 4.3. *Detected Railroad Area Surface Soil CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Naphthalene	18	10	47.0	121	270	0
Anthracene	18	9	49.0	155	450	0
Dibenzofuran	18	8	45.0	69.9	130	0
Acenaphthylene	18	7	61.0	132	200	0
Benzoic Acid	9	2	49.0	165	280	0
2-Methylnaphthalene	18	10	55.0	154	390	NA
Carbazole	18	6	42.0	76.2	100	NA
Pesticides (µg/kg)						
4,4'-DDE	18	4	2.00	6.50	20.0	1
4,4'-DDT	18	1	6.40	6.40	6.40	1
Dieldrin	18	1	4.50	4.50	4.50	1
PCBs (µg/kg)						
Aroclor-1260	18	4	3.00	10.8	20.0	0
Inorganic Compounds (mg/kg)						
Arsenic	18	18	3.30	7.33	19.2	18
Calcium	18	18	6,590	86,444	202,000	18
Chromium	18	18	10.1	17.1	33.2	18
Magnesium	18	18	2,930	36,868	107,000	18
Nickel	18	18	9.80	16.5	24.2	18
Potassium	18	18	764	1,667	3,100	18
Aluminum	18	18	4,530	8,411	13,600	17
Selenium	18	11	0.33	0.97	2.20	11
Mercury	18	14	0.05	0.37	2.00	7
Antimony	18	6	0.18	0.29	0.49	3
Barium	18	18	18.6	98.8	879	2
Lead	18	18	6.80	75.1	849	2
Zinc	18	18	23.1	79.3	607	2
Copper	18	18	16.0	32.2	64.0	1
Manganese	18	18	262	362	522	0
Sodium	18	18	102	192	501	0
Vanadium	18	18	11.4	18.4	30.9	0
Beryllium	18	9	0.35	0.51	0.70	0
Cobalt	18	18	3.40	7.05	10.4	NA
Iron	18	18	10,500	15,878	20,900	NA

Notes:
1 – Exceeds either NYSDEC Part 375.6 Soil Cleanup Objectives or USEPA (1996) Soil Screening Levels.
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

For the purposes of the nature and extent discussion the surface soil samples collected during the PSA and RI are discussed together below.

VOC CPOIs detected in the Railroad Area surface soils include acetone and methylene chloride. The source of the VOCs is unknown. SVOC CPOIs detected in surface soils at the Railroad Area include naphthalene and assorted PAHs (**Figure 58**). The presence of these compounds in the surface soils is likely related to the historic use of the Site. The area is currently surrounded by rail lines on all sides and historically has had rail lines running through it and surrounding it. These organic constituents are likely related to the general urban industrial setting of the area.

PCBs were detected in surface soils at the Railroad Area. Total PCB concentrations are presented on **Figure 59**. The PCBs are likely related to the general urban industrial setting of the area.

Inorganics were detected throughout the Railroad Area. Inorganic CPOIs include arsenic, chromium, mercury, and nickel. There is no evident pattern of distribution of arsenic, chromium, mercury, and nickel (**Figures 61, 62, 63, and 64**). The source of the arsenic, chromium, mercury, nickel, and the other inorganics is unknown. The inorganic constituents are likely related to the general urban industrial setting of the area. The concentrations of calcium and magnesium in surface soils are likely related to the presence of Solvay waste.

4.1.4. AOS#1 Surface Soils

AOS#1 surface soil samples were collected during the RI field program. A total of 20 surface soil samples from ten locations were collected from 0 to 0.5 ft and 0.5 to 1.0 ft during the RI. The samples were co-located soil borings. A summary of locations and laboratory analyses is included in **Table 3**. Analytical results for the RI soil boring surface soils are presented on **Tables 68 through 76** for VOCs, SVOC, pesticides, PCBs, inorganics, methyl mercury, PCDD/PCDFs, PCDD/F TEQs, and other data including fuel parameters and percent solids, respectively. Sample locations are presented on **Figure 6**.

Summary statistics are provided on **Table 101** for surface soil (0 to 2 ft) chemical parameters detected at the Site. Detected chemical parameters of interest (CPOIs) are listed below in **Table 4.4**. Chemical parameters that were detected in at least twenty percent of the samples or exceeded standards or guidance discussed in Section 5 of this report in at least one of the samples were included as CPOIs and included in **Table 4.4**. Chemical parameters that are considered to be bioaccumulators, such as PCBs and PCDD/PCDFs when detected, were also included in **Table 4.4**.

Table 4.4. *Detected AOS #1 Surface Soil CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (μg/kg)						
Acetone	20	9	7.70	86.7	180	5
Benzene	19	5	4.80	8.46	17.0	5
Methylene chloride	20	5	2.10	3.08	5.20	5
Chlorobenzene	20	12	2.40	31.4	100	2
Tetrachloroethene	19	2	4.00	6.25	8.50	2
Ethylbenzene	20	5	2.20	29.3	110	1
Trichloroethene	19	1	7.10	7.10	7.10	1
Xylenes, m & p	20	7	3.30	40.1	220	0
Toluene	20	5	4.60	11.8	28.0	0
2-Butanone	19	4	7.50	29.1	47.0	0
o-Xylene	20	4	1.80	31.1	110	0
Semivolatile Organic Compounds (μg/kg)						
Benzo(a)anthracene	20	20	1,200	12,645	32,000	20
Benzo(a)pyrene	20	20	2,000	12,925	32,000	20
Benzo(b)fluoranthene	20	20	1,900	10,175	27,000	20
Benzo(k)fluoranthene	20	20	1,300	9,585	25,000	20
Chrysene	20	20	1,800	13,630	34,000	20
Indeno(1,2,3-cd)pyrene	20	19	1,400	7,947	20,000	19
Dibenzo(a,h)anthracene	20	15	1,100	2,947	6,200	15
1,4-Dichlorobenzene	20	13	980	9,060	38,000	13
1,2,4-Trichlorobenzene	20	8	1,000	3,450	8,700	8
1,2-Dichlorobenzene	20	8	2,300	6,188	14,000	8
Naphthalene	20	18	300	5,131	21,000	7
Hexachlorobenzene	20	2	930	1,665	2,400	2

Table 4.4. *Detected AOS #1 Surface Soil CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Phenol	20	1	1,900	1,900	1,900	1
Benzo(g,h,i)perylene	20	20	1,600	8,885	24,000	0
Fluoranthene	20	20	2,400	25,630	77,000	0
Phenanthrene	20	20	1,300	18,835	61,000	0
Pyrene	20	20	2,300	21,880	59,000	0
Anthracene	20	18	1,300	6,206	14,000	0
Acenaphthylene	20	17	800	3,600	7,700	0
Fluorene	20	14	330	2,497	6,800	0
Acenaphthene	20	13	350	2,548	5,400	0
Dibenzofuran	20	9	200	1,921	4,300	0
Bis(2-ethylhexyl)phthalate	20	5	720	1,884	3,700	0
2-Methylnaphthalene	20	10	170	1,641	3,400	NA
Carbazole	20	10	620	3,008	5,800	NA
Dioxins/Furans (ng/kg)						
Total TEQ	6	6	1.79	9.33	20.2	NA
Pesticides (μg/kg)						
4,4'-DDD	20	4	43.0	243	730	4
4,4'-DDE	19	3	76.0	92.0	110	3
4,4'-DDT	19	3	40.0	163	390	3
Dieldrin	19	1	110	110	110	1
Heptachlor epoxide	19	1	52.0	52.0	52.0	1
PCBs (μg/kg)						
Aroclor-1260	19	12	240	913	4,000	12
Aroclor-1254	19	5	410	1,170	2,400	5
Aroclor-1248	19	3	200	277	380	3
Inorganic Compounds (mg/kg)						
Calcium	20	20	23,000	94,845	201,000	20
Chromium	20	20	18.4	92.1	191	20
Magnesium	20	20	2,880	11,196	24,200	20
Mercury	20	20	0.72	4.58	11.3	20
Nickel	20	20	9.10	42.4	104	20
Lead	20	20	58.8	505	2,320	19
Potassium	19	19	535	1,447	3,670	19
Arsenic	19	18	2.10	5.57	14.0	18
Barium	20	20	46.2	171	389	17
Copper	20	20	21.8	119	302	16
Zinc	19	19	64.3	271	823	16
Cadmium	20	14	0.97	4.00	9.90	14
Sodium	20	20	154	1,723	12,800	10
Aluminum	20	20	2,820	5,938	14,300	9
Selenium	15	3	1.40	2.47	4.10	3
Silver	19	4	1.70	2.85	4.30	2
Manganese	20	20	60.6	183	330	0
Vanadium	19	17	7.50	21.4	40.9	0
Methyl mercury	12	12	1.12	16.1	37.3	NA
Iron	20	20	5,810	12,255	22,300	NA

Notes:
1 – Exceeds either NYSDEC Part 375.6 Soil Cleanup Objectives or USEPA (1996) Soil Screening Levels.
2 – Mean concentration values have been rounded.
Methyl mercury concentrations are presented in units of μg/kg.
NA = Not applicable as no criteria available.

VOCs within AOS#1 include BTEX compounds, chlorinated benzenes, and methylene chloride. The actual source of the BTEX compounds is unknown. These soils were likely influenced by historic East Flume effluent especially in areas adjacent to Onondaga Lake and is likely contiguous with the ILWD. This area has likely been impacted by sediments transported downstream by Harbor Brook. However, AOS#1 may also have received fill materials including historical dredge materials from the lake.

The chlorinated benzenes were also detected in surface soils in AOS#1 (**Figure 57**). The original source of the chlorinated benzenes is likely the former Willis Avenue Chlorobenzene Plant. The chlorobenzenes in AOS#1 are likely associated with historic East Flume effluent that formed the ILWD, as the soils nearer the lake appear to be similar in nature to the ILWD. This area may have also received fill materials in the past, potentially including dredge materials from Onondaga Lake.

Assorted PAHs were detected throughout AOS#1 (**Figure 58**). The PAHs detected within AOS#1 are likely associated with the historic East Flume effluent that formed the ILWD, as the soils nearer the lake appear similar in nature to the ILWD. Some component of the PAHs in AOS#1 are likely related to the Harbor Brook sediments being deposited in this area. This area may also have received fill materials in the past, potentially including dredge materials from Onondaga Lake. The area is also downgradient of the former Barrett Paving facility which made asphalt products. The PAHs may be associated with historical operations at this facility.

PCBs were detected throughout the AOS#1. Total PCB concentrations are provided on **Figure 59**. The highest concentration was detected at location HB-RISB-07. The PCBs are likely related to upstream Harbor Brook sources and sediments and East Flume sediments historically deposited in this area from the brook; however, the actual source of PCBs is unknown. This area appears to also have received fill materials in the past. However, the source of these fill materials is unknown.

Inorganics were detected throughout AOS#1. Inorganic CPOIs include arsenic, chromium, lead, mercury, and nickel. There is no evident pattern of distribution of arsenic, chromium, mercury, and nickel (**Figures 61, 62, 63, and 64**). The mercury indicates that these soils were likely influenced by historic East Flume effluent and the ILWD. Sediments transported downstream by Harbor Brook are likely source of some of the inorganics in AOS#1. This area may also have received fill materials in the past, potentially including dredge materials from Onondaga Lake.

4.1.5. AOS#2 Surface Soils

AOS#2 surface soil samples were collected during the RI field program. A total of 2 surface soil samples from one location were collected from 0 to 0.5 ft and 0.5 to 1.0 ft during the RI. The samples were co-located soil borings. A summary of locations and laboratory analyses are included in **Table 3**. Analytical results for the RI soil boring surface soils are presented on **Tables 68 through 76** for VOCs, SVOC, pesticides, PCBs, inorganics, methyl mercury, PCDD/PCDFs, PCDD/PCDF TEQs, and percent solids, respectively. Sample locations are presented on **Figure 6**.

Summary statistics are provided on **Table 102** for surface soil (0 to 2 ft) chemical parameters detected at the Site. Detected chemical parameters of interest (CPOIs) are listed below in **Table 4.5**. Chemical parameters that were detected in at least twenty percent of the samples or exceeded standards or guidance discussed in Section 5 of this report in at least one of the samples were included as CPOIs and included in **Table 4.5**. Chemical parameters that are considered to be bioaccumulators, such as PCBs and PCDD/PCDFs when detected, were also included in **Table 4.5**.

Table 4.5. *Detected AOS #2 Surface Soil CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (μg/kg)						
Acetone	2	2	110	150	190	2
Semivolatile Organic Compounds (μg/kg)						
Benzo(a)anthracene	2	2	3,300	4,550	5,800	2
Benzo(a)pyrene	2	2	3,200	4,900	6,600	2
Benzo(b)fluoranthene	2	2	2,300	3,650	5,000	2
Benzo(k)fluoranthene	2	2	2,300	3,500	4,700	2
Chrysene	2	2	3,000	4,250	5,500	2
Indeno(1,2,3-cd)pyrene	2	2	1,700	2,750	3,800	2
Dibenzo(a,h)anthracene	2	1	1,200	1,200	1,200	1
Anthracene	2	2	1,200	1,450	1,700	0
Benzo(g,h,i)perylene	2	2	1,800	2,850	3,900	0
Fluoranthene	2	2	6,400	7,900	9,400	0
Phenanthrene	2	2	3,900	4,900	5,900	0
Pyrene	2	2	5,000	6,250	7,500	0
Acenaphthene	2	1	1,000	1,000	1,000	0
Carbazole	2	1	1,100	1,100	1,100	NA
Inorganic Compounds (mg/kg)						
Arsenic	2	2	2.60	3.00	3.40	2
Barium	2	2	174	212	250	2
Calcium	2	2	192,000	234,500	277,000	2
Chromium	2	2	12.3	15.0	17.7	2
Magnesium	2	2	41,300	50,900	60,500	2
Mercury	2	2	0.15	0.21	0.27	2
Nickel	2	2	13.5	14.9	16.2	2
Potassium	2	2	1,180	1,675	2,170	2
Aluminum	2	2	3,860	3,890	3,920	0
Copper	2	2	16.6	19.5	22.3	0
Lead	2	2	42.9	57.4	71.9	0
Manganese	2	2	239	268	297	0
Sodium	2	2	240	267	294	0
Vanadium	2	2	12.6	16.3	19.9	0
Zinc	2	2	50.4	69.5	88.6	0
Iron	2	2	8,810	9,065	9,320	NA

Notes:
1 – Exceeds either NYSDEC Part 375.6 Soil Cleanup Objectives or USEPA (1996) Soil Screening Levels.
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

Acetone was the only detected VOC in AOS#2 surface soils. SVOC CPOIs include assorted PAHs. Total PAH concentrations are presented on **Figure 58**. This area is adjacent to an active rail line and the area has historically contained railroads. The assorted PAHs may be related to historical use of the area by the railroads. Inorganic CPOIs include arsenic, barium, chromium, mercury and nickel. The concentration of arsenic, chromium, mercury, and nickel are presented on **Figures 61, 62, 63, and 64**, respectively.

4.1.6. SYW-12 Surface Soils/Wetland Soils

A total of 88 surface soil samples were collected from 30 locations in SYW-12 during the Supplemental RI. Samples were not collected from 12 to 24 inches at locations HB-WSD-19 and HB-WSD-22 due to refusal. PCDD/PCDFs samples were collected at 10 of the 30 locations. A summary of Supplemental RI sample locations and laboratory analyses is included in **Table 37**. Analytical

results for the Supplemental RI soil boring surface samples are presented on **Tables 103 through 112** for VOCs, SVOCs, pesticides, PCBs, inorganics, methyl mercury, PCDD/PCDFs, petroleum hyrdocarbons/fingerprint, TOC, and percent solids, and total TEQ, respectively. Sample locations are presented on **Figure 8**.

Summary statistics are provided on **Table 113** for surface soil (0 to 2 ft) chemical parameters detected at SYW-12. Detected chemical parameters of interest (CPOIs) are listed below in **Table 4.6**. Chemical parameters that were detected in at least twenty percent of the samples or exceeded standards or guidance discussed in Section 5 of this report in at least one of the samples were included as CPOIs and included in **Table 4.6**. Chemical parameters that are considered to be bioaccumulators, such as PCBs and PCDD/PCDFs when detected, were also included in **Table 4.6**.

Table 4.6. *Detected SYW-12 Surface Soil/Wetland Sediment CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (µg/kg)						
Benzene	88	3	0.73	1.96	4.30	1
Tetrachloroethene	88	2	0.60	2.35	4.10	1
Methylene chloride	88	1	9.30	9.30	9.30	1
Trichloroethene	88	1	4.30	4.30	4.30	1
1,4-Dichlorobenzene	88	31	0.69	2.18	8.70	0
Xylenes, Total	88	27	0.77	1.87	7.30	0
Toluene	88	25	0.58	1.44	3.80	0
Chlorobenzene	88	23	0.64	2.26	5.80	0
Semivolatile Organic Compounds (µg/kg)						
Benzo(a)anthracene	88	83	53.0	4,327	91,000	81
Benzo(b)fluoranthene	88	83	98.0	5,277	67,000	79
Benzo(a)pyrene	88	83	52.0	3,691	49,000	72
Dibenzo(a,h)anthracene	88	73	50.0	488	5,300	67
Chrysene	88	83	94.0	4,589	89,000	61
Benzo(k)fluoranthene	88	81	63.0	1,831	24,000	50
Indeno(1,2,3-cd)pyrene	88	80	52.0	1,037	13,000	44
Hexachlorobenzene	88	17	48.0	118	240	9
4-Chloroaniline	88	3	59.0	110	200	3
Dibenzofuran	88	57	61.0	796	20,000	2
Fluoranthene	88	85	69.0	7,795	220,000	1
Pyrene	88	84	70.0	8,110	190,000	1
Phenanthrene	88	83	73.0	5,166	200,000	1
Naphthalene	88	71	41.0	878	4,200	1
Fluorene	88	68	51.0	993	37,000	1
Acenaphthene	88	61	48.0	994	31,000	1
4-Methylphenol	88	20	40.0	159	1,300	1
Benzo(g,h,i)perylene	88	80	77.0	1,481	15,000	0
Anthracene	88	79	47.0	2,207	88,000	0
Acenaphthylene	88	76	46.0	1,247	15,000	0
Bis(2-ethylhexyl)phthalate	88	31	41.0	493	2,200	0
2-Methylnaphthalene	88	69	46.0	782	16,000	NA
Carbazole	88	61	47.0	400	6,200	NA
1-Phenyl-1-(2,4-dimethylphenol) ethane	88	59	49.0	1,586	8,000	NA
1-Phenyl-1-(4-methylphenol) ethane	88	54	60.0	1,004	5,300	NA
1,1'-Biphenyl	88	40	47.0	271	4,900	NA

Table 4.6. *Detected SYW-12 Surface Soil/Wetland Sediment CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Petroleum Hydrocarbons (mg/kg)						
Lubricating Oil	88	48	24	492	2,900	NA
#6 Fuel Oil	88	6	230	3,268	10,000	NA
Dioxins/Furans (ng/kg)						
Total TEQ	30	30	0.24	24.3	185	0
Pesticides (μg/kg)						
4,4'-DDT	88	27	2.50	24.5	100	26
Dieldrin	88	10	4.90	12.9	30.0	10
4,4'-DDD	88	11	0.43	27.7	73.0	9
4,4'-DDE	88	5	0.50	4.24	14.0	2
Alpha-BHC	88	2	0.45	0.47	0.49	2
Endrin	87	1	26.0	26.0	26.0	1
alpha-Chlordane	88	25	3.80	24.1	63.0	0
PCBs (μg/kg)						
Aroclor-1254	88	71	22.7	449	2,110	53
Aroclor-1260	88	70	11.8	340	1,360	49
Inorganic Compounds (mg/kg)						
Calcium	88	88	22,000	158,261	370,000	88
Chromium	88	88	4.20	102	410	88
Magnesium	88	88	2,600	8,816	27,000	88
Arsenic	88	85	0.77	5.62	20.0	84
Cadmium	88	81	0.38	12.5	52.0	80
Selenium	88	81	0.27	1.04	2.60	80
Barium	88	88	11.0	150	320	78
Nickel	88	88	2.60	29.4	87.0	78
Mercury	88	88	0.005	1.50	8.60	76
Potassium	88	86	170	872	2,300	74
Zinc	88	88	15.0	246	780	70
Lead	88	88	2.10	139	390	65
Copper	88	88	3.70	101	370	56
Aluminum	88	88	620	4,802	14,000	41
Silver	88	66	0.13	3.44	13.0	33
Antimony	88	34	0.19	0.54	2.10	23
Sodium	88	62	120	397	2,000	7
Beryllium	88	88	0.08	0.34	0.77	0
Manganese	88	88	170	319	630	0
Vanadium	88	88	1.60	13.0	53.0	0
Methyl mercury	88	58	0.35	3.91	13.5	NA
Cobalt	88	88	0.40	5.10	13.0	NA
Iron	88	88	2,200	12,307	31,000	NA

Notes:
1 – Exceeds either NYSDEC Part 375.6 Soil Cleanup Objectives or USEPA (1996) Soil Screening Levels.
2 – Mean concentration values have been rounded.
Methyl mercury concentrations are presented in units of μg/kg.
NA = Not applicable as no criteria available.

The distribution of selected CPOIs exceeding surface soil standards or guidance values or detected throughout SYW-12 Site surface soils are presented on the following figures:

- Selected VOCs CPOIs (benzene and total BTEX) – **Figure 66**.

- Selected Chlorobenzene CPOIs (1,4-dichlorobenzene, chlorobenzene, and hexachlorobenzene) – **Figure 67**.
- SVOC CPOIs (total PAHs and benzo(a)pyrene) – **Figure 68**.
- PCBs (Aroclor 1254 and Aroclor 1260) – **Figure 69**.
- Selected inorganics (cadmium, chromium, copper, mercury, and nickel) – **Figures 70 through 74**.
- Methyl mercury concentrations – **Figure 75.**
- TEQ concentrations are included on **Figure 76**.

Benzene, tetrachloroethene, methylene chloride, and trichloroethene were each detected above the guidance values provided in *USEPA Soil Screening Guidance* (USEPA, 1996) and NYCRR Part 375-6 Unrestricted Use Soil Cleanup Objectives (SCOs). Chlorinated benzenes and BTEX were detected consistently in the surface soils collected at SYW-12; however, the concentrations are not as high as other portions of the Wastebed B/Harbor Brook Site. Carbon disulfide was also detected with some regularity. SYW-12 is located within the floodplain of Onondaga Lake and Ley Creek and downgradient of a historical urban industrial area. The actual source of the VOCs is unknown; however, compounds detected within SYW-12 may be from potential upgradient sources such as the former Marley Property that may have contained a lagoon (October 15, 1951 Aerial Photo) or areas near the Carousel Mall that historically received Solvay waste. Other potential sources include materials used to fill the former Onondaga Creek channel/Iron Pier area and potentially dredge material from Onondaga Lake or the barge terminal area of Onondaga Creek. The source of material used to fill the former Iron Pier is currently not known but based on historic maps and aerial photographs the filling appears to have occurred between 1915 and 1926. Also, the current Onondaga Creek channel adjacent to Metro was widened and/or may have been deepened to allow for barge traffic. It is unknown whether any of these materials were disposed of at SYW-12. These dredge materials may have been impacted by the former MGP plant, Oil City, or other sources. Based on the 1946 NYSDOH document, dredge materials from the barge terminal were placed along the southern shore of Onondaga Lake (which may have included SYW-12 as well as within Onondaga Lake. (NYSDOH 1946)).

Seventeen SVOCs were detected above the guidance values provided in the *USEPA Soil Screening Guidance* (USEPA, 1996) and NYCRR Part 375-6 Unrestricted Use SCOs. These mainly consisted of assorted PAHs. However, hexachlorobenzene was also detected above guidance values. PAHs were detected in every surface soil sample collected at SYW-12. The highest concentration (1,153,800µg/kg) of total PAHs was collected at location HB-WSD-27 adjacent to Ley Creek. The source of the PAHs is unknown. The potential sources described above are likely the same potential sources of the VOCs. PXE and PTE were also detected in these soils suggesting potential influence from Semet material. It is unknown how the PXE and PTE reached the site; however, they may be associated with dredge materials potentially placed on site.

The petroleum hydrocarbon analytical results indicate that both lubricating oil and #6 Fuel Oil are present in Site surface soils. The lubricating oil and Fuel Oil#6 indicate that potential upgradient sources such as the Marley property and/or Oil City may have impacted the site.

Six pesticides were detected exceeding the guidance values provided in the *USEPA Soil Screening Guidance* (USEPA, 1996) and NYCRR Part 375-6 Unrestricted Use Soil SCOs including 4,4'-DDT, alpha-chlordane, and 4,4'-DDD. The source of the pesticides detected on Site is unknown.

PCBs (Aroclor 1254 and Aroclor 1260) were detected in the majority of surface soil samples above the guidance values provided in the *USEPA Soil Screening Guidance* (USEPA, 1996) and NYCRR Part 375-6 Unrestricted Use SCOs. The PCBs may be related to potential upgradient sources such as the former Marley property, unknown fill materials placed historically in this area, barge terminal dredge operations, or historic Ley Creek discharges (*e.g.*, during high flows).

PCDD/PCDFs were detected in each of the surface soil samples. The potential sources of the PCDD/PCDFs detected on this Site include potential upgradient sources such as the Marley propertyand historical fill materials placed in this area, and potential dredge material placed on Site (NYSDOH 1946).

Inorganics exceeding *USEPA Soil Screening Guidance* (USEPA, 1996) and NYCRR Part 375-6 Unrestricted Use SCOs at the Site include cadmium, copper, lead, mercury, zinc, nickel, chromium, silver, and arsenic. There are likely several sources of the inorganics detected on this Site including potential upgradient sources such as the Marley property, Solvay waste located where the current DestiNY mall is, historical fill material placed in this area, and potential dredge material placed on site (NYSDOH 1946). Methyl mercury was detected in 58 of the 88 samples collected. This methyl mercury in soil is likely due to the natural methylation of the mercury in these soils.

4.2. Subsurface Soils Characterization

Subsurface soils are considered soil samples collected from a depth greater than 2 ft. During the PSA, subsurface soil samples were collected from test pits, geoprobe borings, and soil borings. During the RI, subsurface soil samples were collected from soil borings. Subsurface soil samples were collected from test pits and soil borings during the Supplemental RI. It should be noted that samples collected during the Willis Avenue RI within the Dredge Spoils Areas are also discussed within this section as requested by the NYSDEC.

Volatile organic compounds CPOIs detected in Site subsurface soils include benzene, toluene, ethylbenzene, xylene, and chlorinated benzenes. The distribution of total BTEX in subsurface soils is presented on **Figure 77**.

Predominant SVOCs detected in subsurface soils at the Site include chlorinated benzenes, naphthalene, assorted PAHs, dibenzofuran, and assorted phenols. Chlorinated benzenes were detected with both the VOC scan and SVOC scan depending on the time of sampling as discussed in Section 2.2.1. Total chlorinated benzene concentrations in subsurface soils are presented on **Figure 78**. Total PAH concentrations in subsurface soils are presented on **Figure 79**.

Total PCBs concentrations in subsurface soils are presented on **Figure 80**. Mercury concentrations in subsurface soils are included on **Figure 81**.

The nature and extent of constituents in subsurface soils is discussed below in greater detail by sub-area.

4.2.1. Lakeshore Area Subsurface Soils

Lakeshore Area subsurface soil samples were collected during the PSA, RI, and Supplemental RI field programs. A summary of PSA test pit locations and laboratory analyses are included in **Table 16**. Analytical results for the PSA test pit soils are presented on **Tables 114 through 119** for VOCs, SVOC, pesticides, PCBs, inorganics, and percent solids, respectively. Also, two samples were collected from test pits for TCLP parameters. Leachate was extracted using USEPA method 1311 and analyzed for VOCs, SVOCs, pesticides, herbicides, and metals. The TCLP results are presented on **Tables 120 through 124**.

A summary of Willis Avenue RI Dredge Spoils Area Phase 2 test pits and Phase 3 test pit and soil boring locations and laboratory analyses are included in **Table 12**. A summary of Willis Avenue RI Dredge Spoils Area NYSDEC Phase 2 test pits and Phase 3 test pit and soil boring locations and laboratory analyses are also included in **Table 12**. Analytical results for the Willis Avenue test pit soils are presented on **Tables 83 through 87** for VOCs, SVOC, pesticides, PCBs, inorganics, and percent solids, respectively. NYSDEC collected samples concurrently and the NYSDEC data are presented on **Tables 88 through 91**. During Phase 3 of the Willis Avenue RI, two samples were collected from soil borings and two samples from test pits for TCLP parameters in the Dredge Soils Areas. Leachate was extracted using USEPA method 1311 and analyzed for VOCs, SVOCs, pesticides, herbicides, and metals. The TCLP results are presented on **Tables 125 through 128**. The NYSDEC collected split samples during the Willis Avenue Phase 3 for TCLP parameters. The NYSDEC TCLP results are presented on **Tables 129 through 132**.

A summary of PSA subsurface boring sample locations and laboratory analyses is included in **Table 5**. Analytical results for the PSA geoprobe boring subsurface soils are presented on **Tables 41 through 46** for VOCs, SVOC, pesticides, PCBs, inorganics, and percent solids, respectively. Both locations HB-GP-11 (28-30 ft bgs) and HB-GP-11B (28-30 ft bgs) have been included in the summary statistics. Analytical results for the PSA soil borings subsurface soils are presented on **Tables 47 through 52** for VOCs, SVOCs, pesticides, PCBs, inorganics, and percent solids, respectively. Analytical results for the PSA wetland soil borings subsurface soils are presented on **Tables 53 through 58** for VOCs, SVOCs, pesticides, PCBs, inorganics, and percent solids, respectively.

A summary of RI subsurface boring sample locations and laboratory analyses is included in **Table 7**. Analytical results for the RI soil boring subsurface soils are presented on **Tables 68 through 72 and Table 76** for VOCs, SVOCs, pesticides, PCBs, inorganics, and percent solids, respectively.

A summary of Supplemental RI subsurface boring sample locations and laboratory analyses is included in **Table 9**. Analytical results for the Supplemental RI soil boring subsurface samples are presented on **Tables 133 through 138** for VOCs, SVOCs, pesticides, PCBs, inorganics, and percent solids, respectively.

A summary of supplemental RI subsurface test pit locations and laboratory analyses are included in **Table 18**. Analytical results for the Supplemental RI test pit subsurface samples are presented on **Tables 133A through 138A** for VOCs, SVOCs, pesticides, PCBs, inorganics, and percent solids, respectively.

Summary statistics are provided on **Table 139** for subsurface soil (> 2 ft) chemical parameters detected at the Lakeshore Area. The NYSDEC test pit samples were not included in the summary statistics because the samples are duplicates of the O'Brien and Gere test pit samples. Detected

chemical parameters of interest (CPOIs) are listed below in **Table 4.7**. Chemical parameters that were detected in at least twenty percent of the samples or exceeded standards or guidance discussed in Section 5 of this report in at least one of the samples were included as CPOIs and included in **Table 4.7**. Chemical parameters that are considered to be bioaccumulators, such as PCBs and PCDD/PCDFs when detected, were also included in **Table 4.7**.

Table 4.7. *Detected Lakeshore Area Subsurface Soil CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (μg/kg)						
Benzene	76	52	0.006	7,440	190,000	46
Xylenes, Total	68	55	0.70	56,414	860,000	38
Ethylbenzene	71	39	1.00	3,482	35,000	30
1,4-Dichlorobenzene	65	36	1.00	61,064	460,000	26
Toluene	73	49	1.00	23,705	450,000	25
Naphthalene	53	45	7.00	639,414	11,000,000	24
Chlorobenzene	77	37	0.07	10,792	120,000	24
1,2-Dichlorobenzene	65	35	1.00	60,200	920,000	18
Styrene	70	25	0.90	9,635	98,000	18
1,2,4-Trichlorobenzene	59	18	6.00	18,601	120,000	14
1,2,4-Trimethylbenzene	52	46	1.00	27,851	390,000	13
1,3,5-Trimethylbenzene	50	40	1.00	17,433	210,000	8
1,3-Dichlorobenzene	59	16	2.00	6,540	41,000	7
Acetone	73	9	6.20	279	990	7
Methylene chloride	74	4	65.0	84.0	100	4
n-Propylbenzene	50	18	1.00	1,331	11,000	2
sec-Butylbenzene	49	15	1.00	3,140	18,000	2
Tetrachloroethene	73	7	1.00	49.0	330	2
Xylenes, m & p	5	3	17.0	4,972	12,000	2
o-Xylene	5	3	6.40	1,799	4,400	2
Bromoform	70	2	950	2,575	4,200	2
2-Butanone	73	24	4.00	33.0	140	1
Bromomethane	70	1	760	760	760	1
tert-Butylbenzene	48	10	1.00	699	3,900	0
Isopropylbenzene	60	27	1.00	2,450	19,000	NA
p-Isopropyltoluene	51	24	0.90	1,635	16,000	NA
Semivolatile Organic Compounds (μg/kg)						
Benzo(a)anthracene	76	45	81.0	15,196	350,000	45
Benzo(b)fluoranthene	75	43	66.0	11,939	210,000	38
Naphthalene	76	58	67.0	658,444	21,000,000	36
Benzo(a)pyrene	75	41	120	8,737	150,000	29
Chrysene	76	44	73.0	13,433	290,000	27
Phenol	75	37	42.0	2,669	14,000	22
Benzo(k)fluoranthene	75	35	69.0	3,618	38,000	19
1,4-Dichlorobenzene	63	18	1.00	251,794	3,400,000	18
Dibenzo(a,h)anthracene	75	17	81.0	1,350	9,200	17
Indeno(1,2,3-cd)pyrene	75	30	51.0	1,695	13000	16
1,2-Dichlorobenzene	64	17	1.00	201,773	2,700,000	15
2,4-Dimethylphenol	75	16	110	2,944	13,000	13
2-Methylphenol	75	15	100	2,141	7,400	12
Dibenzofuran	76	44	59.0	45,173	1,400,000	11
1,2,4-Trichlorobenzene	63	12	290	52,825	350,000	11
Fluorene	76	37	50.0	64,757	1,800,000	6
Hexachlorobenzene	76	6	19.0	3,187	13,000	6
Acenaphthene	76	38	60.0	31,738	940,000	5

Table 4.7. *Detected Lakeshore Area Subsurface Soil CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
1,3-Dichlorobenzene	64	10	2.00	5,370	25,000	5
Phenanthrene	76	56	78.0	95,138	3,500,000	3
4-Chloroaniline	76	3	440	1,580	3,500	3
Fluoranthene	76	56	62.0	41,209	1,400,000	2
Pyrene	76	54	63.0	29,801	950,000	2
Anthracene	76	46	93.0	28,599	810,000	2
4-Methylphenol	75	2	7500	8,750	10,000	2
Acenaphthylene	76	38	60.0	27,266	850,000	1
2,4-Dichlorophenol	74	1	290	290	290	1
Benzo(g,h,i)perylene	75	28	59.0	2,052	13,000	0
Benzoic acid	45	12	110.0	1,471	7,400	0
2-Methylnaphthalene	76	53	60.0	123,176	3,800,000	NA
Carbazole	75	33	81.0	10,295	220,000	NA
3&4-Methylphenol	75	24	59.0	5,334	72,000	NA
1-Phenyl-1-(2,4-dimethylphenol) ethane	12	10	22,000	291,100	790,000	NA
1-Phenyl-1-(4-methylphenol) ethane	12	10	16,000	142,500	480,000	NA
1,1'-Biphenyl	12	6	1,100	9,033	20,000	NA
Pesticides (μg/kg)						
4,4'-DDD	73	3	19.0	140	300	3
4,4'-DDT	73	3	13.0	19.3	30.0	3
Aldrin	73	3	11.0	67.3	130	3
4,4'-DDE	73	2	5.00	10.0	15.0	2
Dieldrin	73	2	17.0	22.5	28.0	2
Hexachlorobenzene	2	2	19.0	560	1,100	1
Beta-BHC	73	1	31.0	31.0	31.0	1
Delta-BHC	73	1	120	120	120	1
PCBs (μg/kg)						
Aroclor-1260	77	27	7.00	489	4,000	13
Aroclor-1254	77	7	51.0	1,812	6,000	5
Aroclor-1242	77	6	35.0	1,330	3,000	4
Aroclor-1248	77	2	130	507	884	2
Aroclor-1016	77	1	300	300	300	1
Aroclor-1268	70	1	6,590	6,590	6,590	1
Inorganic Compounds (mg/kg)						
Calcium	75	75	40,000	259,804	409,000	75
Chromium	75	75	2.70	29.4	306	75
Magnesium	75	75	3,110	9,111	27,900	75
Sodium	75	75	600	5,068	28,400	72
Selenium	75	61	0.31	1.45	4.70	61
Barium	75	75	9.90	304	1,700	55
Potassium	75	70	146	916	3,060	49
Arsenic	71	64	0.42	8.72	55.4	45
Nickel	75	73	2.40	15.3	98.6	43
Mercury	77	45	0.03	10.7	97.0	43
Aluminum	75	75	1,020	4,747	12,500	34
Copper	75	75	2.00	63.4	629	30
Cadmium	75	34	0.06	8.10	96.1	20
Lead	75	69	0.98	102	1,600	20
Cyanide	75	32	0.97	4.05	22.7	19
Antimony	75	20	0.30	0.66	1.60	19
Thallium	75	13	0.74	1.82	5.70	13

Table 4.7. *Detected Lakeshore Area Subsurface Soil CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Zinc	75	74	7.30	106	2,310	11
Silver	75	20	0.13	11.7	102	3
Manganese	75	75	111	246	608	0
Vanadium	75	73	1.80	11.2	34.2	0
Beryllium	75	66	0.10	0.39	1.00	0
Iron	75	75	2,150	7,836	22,000	NA
Cobalt	75	68	0.27	2.84	9.00	NA

Notes:
1 – Exceeds either NYSDEC Part 375.6 Soil Cleanup Objectives or USEPA (1996) Soil Screening Levels.
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

For the purposes of the Lakeshore Area nature and extent discussion for the subsurface soil samples collected during the PSA, RI, and Supplemental RI are discussed together below.

VOC CPOIs within the Lakeshore Area subsurface soils include BTEX compounds and chlorinated benzenes. BTEX constituents detected in subsurface soils had the highest concentrations from samples collected in the Dredge Spoils Areas and the wetland areas (WL 2 through WL 4) along the shore of Onondaga Lake (**Figure 77**). Other than the samples associated with the dredge spoils area, BTEX concentrations were generally higher in the eastern portion of the Site compared to the western portion of the Site. The sources of the BTEX are the same as discussed in Section 4.1.1 above for the Lakeshore Area surface soils.

Chlorinated benzenes were detected in subsurface soils in the Lakeshore Area (**Figure 78**). The original source of the chlorinated benzenes is likely the former Willis Avenue Chlorobenzene Plant. The highest concentrations of chlorinated benzenes in the Lakeshore Area are associated with the shallow subsurface soils (2 to 10 ft bgs) in DSAs and wetland area WL2. These compounds were also detected in Wastebed B outside of the DSAs and the wetland areas. It should be noted that chlorinated benzenes detected in both the VOC and SVOC analyses tended to have higher concentrations in the SVOC scan. The sources of the chlorinated benzenes are the same as discussed in Section 4.1.1 above for the Lakeshore Area surface soils.

Assorted PAHs were detected throughout the Lakeshore Area (**Figure 79**). The highest concentrations were detected in soils beneath DSA #2 and wetland area WL2. The sources of the PAHs are the same as those presented for surface soils in Section 4.1.1. with shallow subsurface soils in the DSAs likely related to the historical placement of spoils and detected deeper subsurface soils (> 10 ft bgs) on the eastern portion of the Lakeshore Area likely related to historical activities at the Penn-Can Property. DNAPL was detected in subsurface soils within the eastern portion of the Lakeshore Area. PAHs were also detected in subsurface samples collected from Wastebed B outside of the DSAs. It should be noted that PXE and PTE were both detected in Site soils. PXE and PTE are thought to be associated with the Semet process. Since these compounds are present it is likely that Solvay waste was co-mingled with other waste products when disposed of or these compounds were associated with historic East Flume discharges that have impacted the Lakeshore Area.

PCBs were detected in the Lakeshore Area. PCBs were detected with the greatest frequency in subsurface soil samples collected from the DSAs and wetland areas (WL2 through WL4) along the shore of Onondaga Lake. Total PCB concentrations are provided on **Figure 80**. The highest total PCB

concentration was on the island (HB-SB-86) adjacent to the former LEF. PCBs were also detected in several samples collected from Wastebed B. However, the locations with the highest concentrations tended to be in the eastern portion of Wastebed B. The sources of the PCBs are the same as discussed in Section 4.1.1 above for surface soils.

Inorganics were detected throughout subsurface soils in the Lakeshore Area. Inorganic CPOIs include arsenic, barium, chromium, mercury, nickel, and selenium. Mercury concentrations are highest in subsurface soils associated with the Dredge Spoils Areas (**Figure 81**), with its source the same as for surface soils in Section 4.1.1. Location HB-SB-64 within wetland area WL2 had a concentration (39 mg/kg) that was one to two orders of magnitude greater than the other samples collected in this area. Due to this location's proximity to Onondaga Lake and the ILWD, the mercury is likely related to historic East Flume effluent. Inorganics in the eastern portion of Wastebed B may also be related to the historic placement of sewage sludge in this area during the 1950's and early 1960's. The concentrations of calcium and magnesium in subsurface soils are likely related to the presence of Solvay waste. Mercury detected in Wastebed B samples is likely related to the co-disposal of materials with the Solvay waste; however, there are no records indicating this.

Few detected concentrations and no guidance value exceedances were observed for the subsurface soil TCLP analytical results. The organic compounds detected included benzene, chlorinated benzenes, and methylated phenols; the maximum detected value of 5.2 mg/L was for 1,4-dichlorobenzene at HB-DSA#2B2 (4 to 6 ft). Barium was the only inorganic detected.

4.2.2. Penn-Can Property Subsurface Soils

Penn-Can Property subsurface soil samples were collected during the PSA, RI, and Supplemental RI field programs. A summary of PSA test pit locations and laboratory analyses are included in **Table 16**. Analytical results for the PSA test pit soils are presented on **Tables 114 through 119** for VOCs, SVOC, pesticides, PCBs, inorganics, and percent solids, respectively. Also, one sample was collected from the test pits for TCLP parameters. Leachate was extracted using USEPA method 1311 and analyzed for VOCs, SVOCs, pesticides, herbicides, and metals. The TCLP results are presented on **Tables 120 through 124**.

A summary of PSA subsurface boring sample locations and laboratory analyses is included in **Table 5**. Analytical results for the PSA geoprobe boring subsurface soils are presented on **Tables 41 through 46** for VOCs, SVOC, pesticides, PCBs, inorganics, and percent solids, respectively. Analytical results for the PSA soil borings subsurface soils are presented on **Tables 47 through 52** for VOCs, SVOC, pesticides, PCBs, inorganics, and percent solids, respectively. One sample was collected from the soil borings for TCLP parameters. The TCLP results are presented on **Tables 120 through 124**. Analytical results for the PSA wetland soil borings subsurface soils are presented on **Tables 53 through 58** for VOCs, SVOC, pesticides, PCBs, inorganics, and percent solids, respectively.

A summary of RI subsurface boring sample locations and laboratory analyses is included in **Table 7**. Analytical results for the RI soil boring subsurface soils are presented on **Tables 68 through 72 and Table 76** for VOCs, SVOC, pesticides, PCBs, inorganics, and percent solids, respectively.

A summary of Supplemental RI subsurface boring sample locations and laboratory analyses is included in **Table 9**. Analytical results for the Supplemental RI soil boring subsurface samples are presented on **Tables 133 through 138** for VOCs, SVOC, pesticides, PCBs, inorganics, and percent solids, respectively.

Summary statistics are provided on **Table 140** for subsurface soil (> 2 ft) chemical parameters detected at the Penn-Can Property. Detected chemical parameters of interest (CPOIs) are listed below in **Table 4.8**. Chemical parameters that were detected in at least twenty percent of the samples or exceeded standards or guidance discussed in Section 5 of this report in at least one of the samples were included as CPOIs and included in **Table 4.8**. Chemical parameters that are considered to be bioaccumulators, such as PCBs and PCDD/PCDFs when detected, were also included in **Table 4.8**.

Table 4.8. *Detected Penn-Can Property Subsurface Soil CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (μg/kg)						
Xylenes, Total	38	24	3.00	132,166	990,000	21
Ethylbenzene	39	18	1.00	11,576	82,000	16
Benzene	39	14	0.90	21,591	180,000	12
Toluene	39	20	0.70	52,262	300,000	11
Styrene	39	11	77.0	67,208	300,000	10
Naphthalene	24	15	2.00	473,750	3,000,000	9
1,2,4-Trimethylbenzene	24	12	1.00	31,943	180,000	5
Acetone	39	8	22.0	73.0	240	3
Methylene chloride	39	3	2.00	14.7	30.0	3
1,3,5-Trimethylbenzene	22	10	1.00	14,900	75,000	2
o-Xylene	1	1	14,000	14,000	14,000	1
Xylenes, m & p	1	1	39,000	39,000	39,000	1
Semivolatile Organic Compounds (μg/kg)						
Benzo(a)anthracene	39	25	73.0	128,710	2,000,000	24
Naphthalene	39	32	45.0	1,174,911	14,000,000	23
Benzo(b)fluoranthene	39	25	43.0	122,105	1,900,000	20
Benzo(a)pyrene	39	22	70.0	105,915	1,400,000	18
Dibenzofuran	39	28	52.0	160,704	1,800,000	16
Chrysene	39	25	76.0	108,041	1,700,000	16
Fluorene	39	28	46.0	205,107	2,700,000	15
Phenanthrene	39	30	46.0	577,343	9,300,000	14
2,4-Dimethylphenol	39	13	120	19,684	190,000	13
Acenaphthene	39	29	59.0	115,258	1,400,000	12
Benzo(k)fluoranthene	39	19	45.0	57,860	740,000	12
Fluoranthene	39	29	51.0	335,299	5,800,000	9
Pyrene	39	28	140	282,213	4,700,000	9
Indeno(1,2,3-cd)pyrene	39	15	45.0	42,376	410,000	9
Dibenzo(a,h)anthracene	39	9	90.0	21,545	130,000	9
Phenol	39	11	55.0	34,863	360,000	8
2-Methylphenol	39	10	98.0	16,785	160,000	7
Anthracene	37	26	59.0	183,907	3,000,000	6
Acenaphthylene	39	26	44.0	49,239	330,000	3
4-Methylphenol	39	4	42.0	901	1,700	3
Benzo(g,h,i)perylene	38	15	50.0	41,041	380,000	2
2-Methylnaphthalene	39	32	50.0	322,054	3,000,000	NA
Carbazole	39	23	92.0	92,750	1,500,000	NA
3&4-Methylphenol	39	11	51.0	52,076	500,000	NA
1,1'-Biphenyl	14	10	100	67,912	350,000	NA
Pesticides (μg/kg)						
4,4'-DDD	38	5	2.00	6.20	10.0	3
4,4'-DDE	38	3	1.00	5.30	10.0	2
4,4'-DDT	38	2	2.00	6.00	10.0	1
PCBs (μg/kg)						

Table 4.8. *Detected Penn-Can Property Subsurface Soil CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Aroclor-1254	38	3	40.0	147	300	1
Inorganic Compounds (mg/kg)						
Calcium	38	38	17,900	272,513	3,600,000	38
Magnesium	38	38	3,100	22,010	63,000	38
Chromium	38	38	1.70	11.5	26.8	35
Arsenic	38	33	0.76	9.29	103	32
Nickel	38	37	1.90	13.8	38.9	28
Potassium	38	35	53.3	1,196	4,360	28
Selenium	38	25	0.41	1.17	6.20	26
Aluminum	38	38	430	6,517	24,900	22
Sodium	38	38	74.6	971	7,560	13
Barium	38	38	4.80	85.3	962	12
Mercury	38	20	0.006	0.62	5.9	11
Antimony	38	11	0.19	0.43	1.00	7
Zinc	38	35	6.10	62.7	370	6
Cadmium	38	17	0.07	0.97	10.7	6
Cyanide	38	12	0.74	8.46	33.0	6
Lead	38	37	0.67	31.6	348	5
Thallium	38	4	0.65	11	38.5	3
Manganese	38	38	119	445	2,000	3
Copper	38	37	1.20	22.7	112	3
Beryllium	38	37	0.10	0.40	1.00	0
Vanadium	38	37	0.83	14.1	40.0	0
Iron	38	38	1,700	12,182	34,400	NA
Cobalt	38	37	0.29	4.65	10.5	NA

Notes:
1 – Exceeds either NYSDEC Part 375.6 Soil Cleanup Objectives or USEPA (1996) Soil Screening Levels.
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

For the purposes of the nature and extent discussion the surface soil samples collected during the PSA, RI, and Supplemental RI are discussed together below.

VOC CPOIs detected in Penn-Can Property subsurface soils include BTEX, acetone, and styrene. Total BTEX concentrations are presented on **Figure 77**. SVOC CPOIs detected in subsurface soils at the Penn-Can Property include naphthalene, assorted PAHs, and assorted phenols. Total PAH concentrations are presented on **Figure 79**. The sources of these organic constituents are related to historical use of the Site as discussed in Section 4.1.2.

Inorganics were detected throughout the Penn-Can Property subsurface soils. Inorganic CPOIs include aluminum, arsenic, calcium, chromium, magnesium, mercury, nickel, and selenium. The source of inorganic CPOIs may be related to the Solvay waste and other fill present in the subsurface at the Penn-Can Property. The highest detected mercury concentration (5.9 mg/kg) was detected at HB-TP-33 within the fill layer. Subsurface soil mercury concentrations are presented on **Figure 81**.

4.2.3. Railroad Area Subsurface Soils

Railroad Area subsurface soil samples were collected during the PSA, RI, and Supplemental RI field programs. A summary of PSA test pit locations and laboratory analyses are included in **Table 16**. Analytical results for the PSA test pit soils are presented on **Tables 114 through 119** for VOCs, SVOC, pesticides, PCBs, inorganics, and percent solids, respectively. Also, two samples were

collected from test pits for TCLP parameters. Leachate was extracted using USEPA method 1311 and analyzed for VOCs, SVOCs, pesticides, herbicides, and metals. The TCLP results are presented on **Tables 120 through 124**.

A summary of PSA subsurface boring sample locations and laboratory analyses is included in **Table 5**. Analytical results for the PSA geoprobe boring subsurface soils are presented on **Tables 41 through 46** for VOCs, SVOC, pesticides, PCBs, inorganics, and percent solids, respectively. Analytical results for the PSA soil borings subsurface soils are presented on **Tables 47 through 52** for VOCs, SVOC, pesticides, PCBs, inorganics, and percent solids, respectively. Analytical results for the PSA wetland soil borings subsurface soils are presented on **Tables 53 through 58** for VOCs, SVOC, pesticides, PCBs, inorganics, and percent solids, respectively.

A summary of RI subsurface boring sample locations and laboratory analyses is included in **Table 7**. Analytical results for the RI soil boring subsurface soils are presented on **Tables 68 through 72 and Table 76** for VOCs, SVOC, pesticides, PCBs, inorganics, and percent solids, respectively.

A summary of Supplemental RI subsurface boring sample locations and laboratory analyses is included in **Table 9**. Analytical results for the Supplemental RI soil boring subsurface samples are presented on **Tables 133 through 138** for VOCs, SVOC, pesticides, PCBs, inorganics, and percent solids, respectively.

Summary statistics are provided on **Table 141** for subsurface soil (> 2 ft) chemical parameters detected at the Railroad Area. Detected chemical parameters of interest (CPOIs) are listed below in **Table 4.9**. Chemical parameters that were detected in at least twenty percent of the samples or exceeded standards or guidance discussed in Section 5 of this report in at least one of the samples were included as CPOIs and included in **Table 4.9**. Chemical parameters that are considered to be bioaccumulators, such as PCBs and PCDD/PCDFs when detected, were also included in **Table 4.9**.

Table 4.9. *Detected Railroad Area Subsurface Soil CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (μg/kg)						
Benzene	19	10	1.00	249	1,100	7
Ethylbenzene	19	6	5.00	1,882	9,000	4
Toluene	19	9	1.00	700	3,900	2
Xylenes, Total	16	8	0.60	4,055	30,000	2
Acetone	19	6	11.0	50.8	110	2
Methylene chloride	19	2	82.0	85.5	89.0	2
o-Xylene	3	2	290	1,695	3,100	2
Tetrachloroethene	19	2	3.20	6.60	10.0	2
Xylenes, m & p	3	2	320	4,360	8400	2
Naphthalene	15	8	3.00	16,325	130,000	1
1,2,4-Trimethylbenzene	15	4	3.00	1,033	4,100	1
Styrene	19	1	470	470	470	1
2-Butanone	19	6	7.00	18.7	41.0	0
1,3,5-Trimethylbenzene	15	3	1.00	501	1,500	0
Carbon Disulfide	4	3	15.0	55.3	130	0
Semivolatile Organic Compounds (μg/kg)						
Benzo(a)anthracene	19	9	160	2,084	8,200	9
Benzo(b)fluoranthene	19	7	250	1,339	5,200	7
Naphthalene	19	11	71.0	44,164	330,000	4
Chrysene	19	9	190	1,846	5,700	4

Table 4.9. *Detected Railroad Area Subsurface Soil CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Benzo(a)pyrene	19	7	170	1,097	3,700	4
Benzo(k)fluoranthene	19	7	80.0	687	1,800	2
Dibenzofuran	19	7	190	7,924	32,000	2
Dibenzo(a,h)anthracene	19	3	70.0	210	410	2
Acenaphthene	19	7	55.0	6,263	26,000	1
Fluorene	19	6	88.0	10,521	36,000	1
Indeno(1,2,3-cd)pyrene	19	6	110	433	1,500	1
Phenol	19	5	45.0	170	510	1
2,4-Dimethylphenol	19	2	240	1,020	1,800	1
Fluoranthene	19	9	260	7,172	29,000	0
Phenanthrene	19	9	92.0	16,130	77,000	0
Pyrene	19	9	260	5,610	24,000	0
Acenaphthylene	19	8	50.0	4,071	20,000	0
Anthracene	19	7	98.0	4,753	17,000	0
Benzo(g,h,i)perylene	19	6	120	442	1,500	0
2-Methylnaphthalene	19	9	66.0	16,887	100,000	NA
Carbazole	19	7	81.0	2,139	5,800	NA
Pesticides (μg/kg)						
4,4'-DDD	19	3	5.00	11.7	20.0	3
Inorganic Compounds (mg/kg)						
Calcium	19	19	14,500	144,247	276,000	19
Chromium	19	19	2.40	11.7	27.5	19
Magnesium	19	19	4,290	19,203	56,900	19
Potassium	19	19	350	1,512	4,110	18
Arsenic	19	16	0.80	5.54	22.7	15
Selenium	19	13	0.34	1.43	8.30	13
Aluminum	19	19	1,190	7,597	26,500	12
Nickel	19	17	2.90	13.0	39.0	12
Sodium	19	19	53.2	1,012	3,000	10
Mercury	19	10	0.007	0.15	0.59	6
Barium	19	19	33.5	68.1	107	5
Antimony	19	5	0.24	0.66	1.90	4
Lead	19	19	2.00	28.5	376	1
Zinc	19	19	8.20	54.6	398	1
Copper	19	18	3.10	19.3	64.1	1
Cadmium	19	2	0.14	0.72	1.30	1
Thallium	19	1	1.20	1.20	1.20	1
Manganese	19	19	158	262	397	0
Vanadium	19	17	2.60	15.0	43.5	0
Beryllium	19	16	0.11	0.46	0.85	0
Iron	19	19	2,680	12,443	29,200	NA
Cobalt	19	17	1.20	4.89	13.0	NA

Notes:
1 – Exceeds either NYSDEC Part 375.6 Soil Cleanup Objectives or USEPA (1996) Soil Screening Levels.
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

For the purposes of the nature and extent discussion the surface soil samples collected during the PSA, RI, and Supplemental RI are discussed together below.

VOC CPOIs detected in Railroad Area subsurface soils include BTEX, acetone, and methylene chloride. Total BTEX concentrations are presented on **Figure 77**. SVOC CPOIs detected in

subsurface soils at the Railroad Area include naphthalene, assorted PAHs, and assorted phenols. Total PAH concentrations are presented on **Figure 79**. The presence of these compounds in the subsurface soils is likely related to the historic use of the area by the railroads, as discussed in Section 4.1.3 above.

Inorganics were detected throughout the Railroad Area subsurface soils. Inorganic CPOIs include aluminum, arsenic, chromium, mercury, nickel, and selenium. The source of inorganic CPOIs may be related to the Solvay waste and other fill present in the subsurface at the Railroad Area. The highest detected mercury concentration (0.59 mg/kg) was detected at HB-TP-24 within the fill layer. Subsurface soil mercury concentrations are presented on **Figure 81**. The concentrations of calcium and magnesium in subsurface soils are likely related to the presence of Solvay waste.

4.2.4. AOS#1 Subsurface Soils

AOS#1 subsurface soil samples were collected during the RI and Supplemental RI field programs. A summary of RI subsurface boring sample locations and laboratory analyses is included in **Table 7**. Analytical results for the RI soil boring subsurface soils are presented on **Tables 68 through 73 and Table 76** for VOCs, SVOC, pesticides, PCBs, inorganics, methyl mercury, and percent solids, respectively.

A summary of Supplemental RI subsurface boring sample locations and laboratory analyses is included in **Table 9**. Analytical results for the Supplemental RI soil boring subsurface samples are presented on **Tables 133 through 138** for VOCs, SVOC, pesticides, PCBs, inorganics, and percent solids, respectively.

Summary statistics are provided on **Table 142** for subsurface soil (> 2 ft) chemical parameters detected at AOS#1. Detected chemical parameters of interest (CPOIs) are listed below in **Table 4.10**. Chemical parameters that were detected in at least twenty percent of the samples or exceeded standards or guidance discussed in Section 5 of this report in at least one of the samples were included as CPOIs and included in **Table 4.10**. Chemical parameters that are considered to be bioaccumulators, such as PCBs and PCDD/PCDFs when detected, were also included in **Table 4.10**.

Table 4.10. *Detected AOS #1 Subsurface Soil CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (µg/kg)						
Benzene	17	7	1.30	460	1,600	6
Acetone	17	12	14.0	79.6	250	4
Ethylbenzene	17	7	1.00	1,090	5,700	4
o-Xylene	11	6	1.70	676	3,000	3
Xylenes, m & p	11	4	18.0	2,130	5,800	3
Toluene	17	8	2.10	1,144	5,300	2
Chlorobenzene	17	4	2.30	324	1,100	2
Xylenes, Total	6	4	3.60	7,320	29,000	2
Styrene	17	1	1,700	1,700	1,700	1
Vinyl chloride	17	1	2.80	2.80	2.80	1
Carbon disulfide	17	15	1.10	12.2	63.0	0
2-Butanone	17	10	4.20	29.3	100	0
Isopropylbenzene	6	2	18.0	1,709	3,400	NA
Semivolatile Organic Compounds (µg/kg)						
Benzo(a)anthracene	17	11	85.0	12,588	63,000	11
Chrysene	17	11	79.0	13,217	74,000	7

Table 4.10. *Detected AOS #1 Subsurface Soil CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Benzo(a)pyrene	17	9	130	12,287	56,000	7
Benzo(b)fluoranthene	17	9	91.0	8,030	35,000	7
Benzo(k)fluoranthene	17	8	91.0	9,529	37,000	6
Dibenzo(a,h)anthracene	17	6	100	3,060	9,500	6
Indeno(1,2,3-cd)pyrene	17	8	62.0	6,277	24,000	5
Dibenzofuran	17	9	80.0	9,111	51,000	3
Phenanthrene	17	11	75.0	39,560	120,000	2
Naphthalene	17	4	480	145,795	570,000	2
1,4-Dichlorobenzene	11	2	2,600	4,750	6,900	2
Fluoranthene	17	12	60.0	25,133	110,000	1
Anthracene	17	10	71.0	60,293	510,000	1
Fluorene	17	9	64.0	13,902	59,000	1
Acenaphthene	17	8	290	9,788	33,000	1
4-Methylphenol	6	1	390	390	390	1
Pyrene	17	11	120	22,921	93,000	0
Acenaphthylene	17	8	57.0	7,031	31,000	0
Benzo(g,h,i)perylene	17	8	72.0	7,205	27,000	0
Bis(2-ethylhexyl)phthalate	17	5	64.0	594	1,500	0
2-Methylnaphthalene	17	9	160	23,113	140,000	NA
Carbazole	17	8	59.0	3,059	10,000	NA
1-Phenyl-1-(2,4-dimethylphenyl) ethane	6	3	48.0	866	2,300	NA
3&4-Methylphenol	11	3	73.0	348	680	NA
1-Phenyl-1-(4-methylphenyl) ethane	6	2	130	500	870	NA
PCBs (µg/kg)						
Aroclor-1260	17	3	260	500	750	3
Aroclor-1248	17	1	760	760	760	1
Inorganic Compounds (mg/kg)						
Calcium	17	17	33,000	194,965	340,000	17
Chromium	17	17	2.80	15.3	59.7	17
Magnesium	17	17	3,690	10,446	26,000	17
Sodium	17	17	300	9,769	23,000	16
Potassium	17	16	280	941	2,300	14
Barium	17	17	14.0	104	353	11
Nickel	17	11	3.40	15.1	31.0	10
Arsenic	17	9	1.90	4.62	7.80	9
Mercury	17	11	0.02	1.32	6.20	8
Aluminum	17	17	910	4,502	13,000	6
Lead	17	16	1.90	44.9	159	4
Copper	17	16	2.60	27.2	103	3
Zinc	17	16	10.5	49.7	143	3
Cadmium	17	6	0.07	0.86	3.70	3
Selenium	17	2	0.38	0.63	0.87	2
Cyanide	17	2	1.80	1.95	2.09	1
Manganese	17	17	111	294	560	0
Vanadium	17	10	2.30	12.2	19.0	0
Beryllium	17	6	0.09	0.33	0.47	0
Methyl mercury	1	1	1.25	1.25	1.25	0
Iron	17	17	3000	9,435	25,000	NA
Cobalt	17	6	0.55	5.39	9.70	NA

Table 4.10. *Detected AOS #1 Subsurface Soil CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]

Notes:
1 – Exceeds either NYSDEC Part 375.6 Soil Cleanup Objectives or USEPA (1996) Soil Screening Levels.
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

For the purposes of the nature and extent discussion the surface soil samples collected during the RI and Supplemental RI are discussed together below.

VOC CPOIs detected in AOS#1 subsurface soils include BTEX, acetone, and methylene chloride. Total BTEX concentrations are presented on **Figure 77**. The range in concentrations of the BTEX compounds detected in AOS#1 was quite variable (1 μg/kg to 29,000 μg/kg). The variability in concentrations is likely due to the nature of the material found in this Area and the multiple sources discussed for AOS #1 surface soils in Section 4.1.4 influencing this area.

Chlorinated benzenes were detected in AOS#1 subsurface soils. Total chlorobenzene concentrations are presented on **Figure 78**. The chlorinated benzenes were detected in sample locations adjacent to the lake and are likely related to historic East Flume effluent discharges discussed in Section 4.1.4. This area of AOS#1 adjacent to Onondaga Lake is likely contiguous with the ILWD.

SVOC CPOIs detected in subsurface soils at the AOS#1 include naphthalene and assorted PAHs. Total PAH concentrations are presented on **Figure 79**. The presence of these compounds in the subsurface soils is likely related to historic East Flume effluent discharges associated with the formation of the ILWD especially in areas adjacent to Onondaga Lake and this area is likely contiguous with the ILWD. The AOS#1 area has also likely been influenced by Harbor Brook discharges over time. It is believed that this area also received fill materials in the past possibly including dredge materials from Onondaga Lake but there is no record of this. This area is also down gradient from the Penn-Can Property (formerly Barrett Paving) which produced and stored asphalt products. Naphthalene and PAHs may be related to historical operations at this facility. It should be noted that PXE and PTE were both detected in AOS#1 subsurface soils. PXE and PTE are thought to be associated with the Semet process. Since these compounds are present it is likely that Solvay waste was co-mingled with other waste products when disposed of or these compounds were associated with historic East Flume discharges that have impacted this area.

PCBs were detected at three locations within AOS#1. Total PCB concentrations are presented on **Figure 80**. The sources of the PCBs are the same as the surface soils and discussed in Section 4.1.4 above.

Inorganics were detected throughout AOS#1 subsurface soils. Inorganic CPOIs include aluminum, arsenic, barium, chromium, mercury, and nickel. The source of inorganic CPOIs may be related to the Solvay waste and other fill present in the subsurface at AOS#1. The highest detected mercury concentration (6.2 mg/kg) was detected at HB-RISB-04 within the fill layer. Subsurface soil mercury concentrations are presented on **Figure 81**. The mercury in AOS#1 is likely related to historic East Flume effluent discharges associated with the formation of the ILWD especially in areas adjacent to Onondaga Lake. The concentrations of calcium and magnesium in subsurface soils are likely related to the presence of Solvay waste.

4.2.5. AOS#2 Subsurface Soils

AOS#2 subsurface soil samples were collected during the RI and Supplemental RI field programs. A summary of RI subsurface boring sample locations and laboratory analyses is included in **Table 7**. Analytical results for the RI soil boring subsurface soils are presented on **Tables 68 through 73 and Table 76** for VOCs, SVOC, pesticides, PCBs, inorganics, methyl mercury, and percent solids, respectively.

A summary of Supplemental RI subsurface boring sample locations and laboratory analyses is included in **Table 9**. Analytical results for the Supplemental RI soil boring subsurface samples are presented on **Tables 133 through 138** for VOCs, SVOC, pesticides, PCBs, inorganics, and percent solids, respectively.

Summary statistics are provided on **Table 143** for subsurface soil (> 2 ft) chemical parameters detected at AOS#2. Detected chemical parameters of interest (CPOIs) are listed below in **Table 4.11**. Chemical parameters that were detected in at least twenty percent of the samples or exceeded standards or guidance discussed in Section 5 of this report in at least one of the samples were included as CPOIs and included in **Table 4.11**. Chemical parameters that are considered to be bioaccumulators, such as PCBs and PCDD/PCDFs when detected, were also included in **Table 4.11**.

Table 4.11. *Detected AOS #2 Subsurface Soil CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (µg/kg)						
Benzene	3	3	2.70	4.83	6.70	3
Methylene chloride	3	2	1.20	1.35	1.50	2
Acetone	3	3	11.0	50.7	91.0	1
Tetrachloroethene	3	1	3.50	3.50	3.50	1
Carbon disulfide	3	3	4.90	11.3	20.0	0
Toluene	3	3	1.60	3.23	5.10	0
2-Butanone	3	2	6.60	7.40	8.20	0
Xylenes, Total	2	2	2.90	3.00	3.10	0
o-Xylene	1	1	1.50	1.50	1.50	0
Semivolatile Organic Compounds (µg/kg)						
Benzo(a)anthracene	3	1	83.0	83.0	83.0	1
Bis(2-ethylhexyl)phthalate	3	3	64.0	84.0	100	0
Acenaphthene	3	1	99.0	99.0	99.0	0
Anthracene	3	1	92.0	92.0	92.0	0
Benzo(a)pyrene	3	1	100	100	100	0
Benzo(b)fluoranthene	3	1	59.0	59.0	59.0	0
Benzo(k)fluoranthene	3	1	120	120	120	0
Chrysene	3	1	72.0	72.0	72.0	0
Dibenzofuran	3	1	100	100	100	0
Fluoranthene	3	1	210	210	210	0
Fluorene	3	1	130	130	130	0
Phenanthrene	3	1	390	390	390	0
Pyrene	3	1	170	170	170	0
1,1'-Biphenyl	2	1	74.0	74.0	74.0	NA
2-Methylnaphthalene	3	1	69.0	69.0	69.0	NA
PCBs (µg/kg)						
4,4'-DDE	3	1	0.39	0.39	0.39	0
Inorganic Compounds (mg/kg)						
Arsenic	3	3	1.80	1.93	2.10	3
Calcium	3	3	159,000	206,333	260,000	3

Table 4.11. *Detected AOS #2 Subsurface Soil CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Chromium	3	3	5.90	8.27	9.90	3
Magnesium	3	3	7,000	13,067	19,200	3
Nickel	3	3	8.40	9.73	11.5	3
Potassium	3	3	500	843	1,190	3
Thallium	3	2	1.10	2.65	4.20	2
Aluminum	3	3	2,600	4,180	5,840	1
Barium	3	3	48.1	68.0	87.0	1
Sodium	3	3	520	1,477	3,330	1
Selenium	3	1	0.35	0.35	0.35	1
Copper	3	3	8.30	11.9	15.0	0
Lead	3	3	5.60	9.77	18.0	0
Manganese	3	3	250	317	362	0
Vanadium	3	3	5.10	8.57	13.2	0
Zinc	3	3	16.0	23.9	29.0	0
Beryllium	3	2	0.19	0.22	0.25	0
Cadmium	3	2	0.27	0.30	0.33	0
Mercury	3	2	0.02	0.05	0.07	0
Iron	3	3	8,100	9,500	10,600	NA
Cobalt	3	2	3.80	5.40	7.00	NA

Notes:
1 – Exceeds either NYSDEC Part 375.6 Soil Cleanup Objectives or USEPA (1996) Soil Screening Levels.
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

For the purposes of the nature and extent discussion the surface soil samples collected during the RI and Supplemental RI are discussed together below.

VOC CPOIs detected in AOS#2 subsurface soils include benzene, acetone, and methylene chloride. Total BTEX concentrations are presented on **Figure 77**. SVOC CPOIs detected in subsurface soils at the AOS#2 include assorted PAHs and bis(2-ethylhexyl)phthalate. Total PAH concentrations are presented on **Figure 79**. These detected organic compounds are likely related to general urban/industrial surroundings of the area. No PCBs were detected within AOS#2.

Inorganics were detected in AOS#2 subsurface soils. Inorganic CPOIs include arsenic, barium, chromium, nickel, and thallium. The source of inorganic CPOIs may be related to the fill present in the subsurface soils at AOS#2. The concentrations of calcium and magnesium in subsurface soils are likely related to the proximity of these locations to Wastebed D.

4.2.6. SYW-12 Subsurface Soils

SYW-12 subsurface soil samples were collected during the Supplemental RI field program. A summary of Supplemental RI subsurface boring sample locations and laboratory analyses is included in **Table 9**. Analytical results for the Supplemental RI soil boring subsurface samples are presented on **Tables 144 through 149** for VOCs, SVOC, pesticides, PCBs, inorganics, and percent moisture and petroleum hydrocarbons, respectively. Sample locations are presented on **Figure 8**.

Summary statistics are provided on **Table 150** for subsurface soil (> 2 ft) chemical parameters detected at SYW-12. Detected chemical parameters of interest (CPOIs) are listed below in **Table 4.12**. Chemical parameters that were detected in at least twenty percent of the samples or exceeded standards or guidance discussed in Section 5 of this report in at least one of the samples were

included as CPOIs and included in **Table 4.12**. Chemical parameters that are considered to be bioaccumulators, such as PCBs and PCDD/PCDFs when detected, were also included in **Table 4.12**.

Table 4.12. *Detected SYW-12 Subsurface Soil CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (µg/kg)						
Ethylbenzene	25	9	3.00	1,535	6,000	6
2-Butanone	25	18	3.10	32.5	220	1
Acetone	25	3	27.0	269	730	1
1,4-Dichlorobenzene	25	2	56.0	133	210	1
Chlorobenzene	25	2	24.0	50.5	77.0	1
Methylene chloride	25	1	80.0	80.0	80.0	1
Carbon disulfide	25	19	0.81	8.86	26.0	0
Toluene	25	8	0.79	88.0	290	0
Xylenes, Total	25	7	0.96	18.5	52.0	0
Isopropylbenzene	25	9	0.80	560	2,000	NA
Semivolatile Organic Compounds (µg/kg)						
Benzo(a)anthracene	25	15	370	9,916	53,000	15
Benzo(b)fluoranthene	25	15	430	11,355	45,000	15
Benzo(a)pyrene	25	15	380	10,697	46,000	14
Chrysene	25	15	390	10,849	59,000	13
Indeno(1,2,3-cd)pyrene	25	15	160	2,493	6,200	13
Dibenzo(a,h)anthracene	25	13	140	1,241	3,500	13
Benzo(k)fluoranthene	25	15	160	3,083	9,500	12
Naphthalene	25	14	230	31,315	380,000	5
4-Methylphenol	25	9	84.0	736	1,800	5
Acenaphthene	25	14	53.0	20,309	210,000	2
Phenanthrene	25	15	250	30,807	280,000	1
Pyrene	25	15	640	22,969	140,000	1
Fluorene	25	14	48.0	10,161	86,000	1
Acenaphthylene	25	15	92.0	5,176	26,000	0
Anthracene	25	15	130	10,411	79,000	0
Benzo(g,h,i)perylene	25	15	160	3,856	16,000	0
Fluoranthene	25	15	690	14,946	91,000	0
Dibenzofuran	25	8	91.0	521	1,600	0
Bis(2-ethylhexyl)phthalate	25	6	140	632	1,500	0
2-Methylnaphthalene	25	14	150	32,011	400,000	NA
1-Phenyl-1-(2,4-dimethylphenyl) ethane	25	12	76.0	7,784	44,000	NA
1,1'Biphenyl	25	11	97.0	6,337	58,000	NA
1-Phenyl-1-(4-methylphenyl) ethane	25	8	65.0	4,413	22,000	NA
Carbazole	25	8	75.0	1,108	5,700	NA
Petroleum Hydrocarbons (mg/kg)						
Lubricating Oil	25	9	28	3,792	13,000	NA
#6 Fuel Oil	25	4	3,500	17,975	60,000	NA
Pesticides (µg/kg)						
4,4'-DDT	25	3	4.90	18.6	31.0	3
4,4'-DDD	25	1	4.40	4.40	4.40	1
Dieldrin	25	1	2.00	2.00	2.00	1
PCBs (µg/kg)						
Aroclor-1254	25	6	7.88	546	1,530	3
Aroclor-1260	25	7	12.2	159	853	2
Aroclor-1248	25	1	1,110	1,110	1,110	1
Inorganic Compounds (mg/kg)						

Table 4.12. *Detected SYW-12 Subsurface Soil CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Calcium	25	25	51,000	168,520	400,000	25
Chromium	25	25	3.00	47.1	470	25
Magnesium	25	25	3,800	10,212	18,000	25
Potassium	25	25	370	860	1,800	23
Arsenic	25	23	1.00	4.74	12.0	22
Nickel	25	25	3.60	25.0	110	19
Sodium	25	25	250	2,768	15,000	19
Selenium	25	19	0.32	0.82	1.60	19
Barium	25	25	33.0	125	330	18
Cadmium	25	16	0.05	9.66	100	14
Mercury	25	25	0.007	0.83	6.00	13
Antimony	25	14	0.28	0.57	0.94	13
Lead	25	25	1.50	101	410	12
Copper	25	25	2.80	75.4	450	11
Zinc	25	25	10.0	183	1,200	11
Aluminum	25	25	730	4,557	9,900	10
Silver	25	13	0.23	3.30	13.0	8
Cyanide	25	5	0.96	1.79	3.00	2
Thallium	25	2	1.10	1.10	1.10	2
Beryllium	25	25	0.11	0.30	0.64	0
Manganese	25	25	170	277	410	0
Vanadium	25	25	1.80	9.34	23.0	0
Cobalt	25	25	0.62	4.17	9.80	NA
Iron	25	25	3,200	11,376	23,000	NA

Notes:
1 – Exceeds either NYSDEC Part 375.6 Soil Cleanup Objectives or USEPA (1996) Soil Screening Levels.
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

VOC CPOIs detected in SYW-12 Site subsurface soils include ethylbenzene, acetone, 2-butanone, and chlorinated benzenes. Distributions of selected VOC CPOIs (Total BTEX) are presented on **Figure 82**.

SVOC CPOIs include naphthalene, 4-methylphenol, and assorted PAHs. The distributions of selected SVOC CPOIs are presented on **Figure 83** and include benzo(a)pyrene and total PAHs.

Other chemical parameter distribution figures for SYW-12 subsurface soils include:

- Total PCBs concentrations – **Figure 84**
- Selected inorganics (arsenic, chromium, mercury, and nickel) – **Figures 85, 86, 87, and 88**, respectively

There was no clear pattern of distribution of VOC chemical parameters within subsurface soil at the SYW-12 Site. Concentration results were highly variable between locations. No apparent source area was identified at the Site for VOC constituents. The sources of constituents in the subsurface soils are believed to be the same as the surface soil sources described in Section 4.1.6.

PAHs were also distributed throughout shallower subsurface soils (2 to 14 ft bgs) at the SYW-12 Site. PAHs were not detected in the deeper subsurface samples. The potential sources described above in Section 4.1.6. for surface soils are likely the same sources of these PAHs. PXE and PTE were also

detected in these soils suggesting potential influence from Semet material. It is unknown how PXE and PTE reached the site; however, they may be associated with dredge materials potentially placed on site (NYSDOH, 1946).

The petroleum hydrocarbon analytical results indicate that both lubricating oil and Fuel Oil#6 constituents are present in Site soils. These may be related to potential upgradient sources such as the Marley property and/or Oil City.

PCBs were only detected in subsurface soils between 2 and 10 ft bgs. PCBs were not detected in deeper subsurface soils.

Inorganics were detected throughout the SYW-12 Site in subsurface soils. The highest concentrations of chromium, mercury, and nickel were detected at location HB-GWS-05 near the mouth of Ley Creek. The reason for the high concentrations of these inorganics at this location is unknown.
The sources of organic and inorganic constituents in the subsurface soils are believed to be the same as the surface soil sources described in Section 4.1.6.

4.3. Ground Water Characterization

Ground water samples were collected as part of the PSA, RI, Supplemental RI, and Willis Avenue RI. Ground water samples were collected at ground water screening (hydropunch) locations and at monitoring wells. One round of ground water samples was collected during the PSA, two rounds of ground water samples were collected during RI field program, and one round of ground water samples was collected during Supplemental RI. The sampling included wells installed as part of these field efforts and wells previously installed at the Site. The existing wells at the lakeshore include HB-WA-03S, HB-WA-03I, HB-WA-03D, HB-WA-08S, HB-WA-08I, HB-WA-08D, HB-WB-BL, and HB-WB-BU. The existing wells at SYW-12 included HB-B-04W, HB-B-08W, and HB-B-10W.

Volatile organic compounds CPOIs detected in Site ground water include acetone, BTEX, and chlorinated benzenes. The distribution BTEX is presented on **Figures 89, 90, and 91** for shallow, intermediate, and deep ground water respectively.

Predominant SVOCs detected at the Site in ground water include chlorinated benzenes, naphthalene, assorted PAHs, and assorted phenols. Naphthalene concentrations in shallow, intermediate, and deep ground water are presented on **Figures 92, 93, and 94**, respectively. Total PAH concentrations in shallow, intermediate, and deep ground water are presented on **Figures 95, 96, and 97**, respectively. Naphthalene concentrations from the 8270 scan are used for the naphthalene and total PAH concentration figures.

The concentration of total phenols in shallow, intermediate, and deep ground water are presented on **Figures 98, 99, and 100**, respectively. The total phenol concentrations were derived by calculating the sum of the following detected chemical parameters in the USEPA SW-846 Method 8270 scan:

- 2,4,5-trichlorophenol
- 2,4,6-trichlorophenol
- 2,4-dichlorophenol
- 2,4-dimethylphenol
- 2,4-dinitrophenol
- 3+4-methylphenol or 4-methylphenol
- 2-nitrophenol
- 4,6-dinitro-2-methylphenol
- 4-chloro-3-methylphenol
- 4-nitrophenol

- 2-chlorophenol
- 2-methylphenol
- pentachlorophenol
- phenol

Inorganic CPOIs include mercury, iron, and sodium. The mercury concentrations in shallow, intermediate, and deep ground water are presented on **Figures 101, 102, and 103**, respectively.

For the purposes of the nature and extent discussion the ground water data has been separated by sub-area and zone, and every round of data were evaluated and discussed together.

4.3.1. Lakeshore Area Ground Water

Lakeshore Area ground water samples were collected during the PSA, RI, and Supplemental RI field programs. Sample locations are presented on **Figure 6**. Ground water screening samples were collected in July 2000 from six locations (HB-HP-01 through HB-HP-06). These samples were analyzed for VOCs, SVOCs, pesticides, PCBs, and inorganics. The PSA ground water screening data are presented on **Tables 151 through 155**. Nine wells were installed at the Lakeshore Area as part of the PSA. These nine wells were sampled in September 2000 for biological oxygen demand (BOD), chemical oxygen demand (COD), nitrogen, alkalinity, total dissolved solids (TDS), and total organic carbon (TOC) as part of the PSA. These data are provided in **Table 156**. A second round of samples was collected in May 2001 from the nine wells installed as part of the PSA and five previously installed wells. Samples collected in May 2001 as part of the PSA were analyzed for VOCs, SVOCs, pesticides, PCBs, inorganics, and the parameters listed above. The PSA ground water data are provided on **Tables 157 through 162**.

Three deep wells were installed in the Lakeshore Area as part of the RI. These three wells, the nine wells installed as part PSA, and the five wells previously installed were sampled as part of the RI field program in May 2003. A second round of RI ground water sampling was conducted in August 2003. Samples collected as part of the RI were analyzed for VOCs, SVOCs, pesticides, PCBs, and inorganics including major cations and anions. The RI ground water data are provided on **Tables 163 through 168**.

One round of ground water samples was collected during the Supplemental RI in the Lakeshore Area. Samples collected as part of the Supplemental RI were analyzed for VOCs, SVOCs, pesticides, PCBs, inorganics including major cations and anions, alkalinity, hardness, ammonia, TKN, and CBOD. The Supplemental RI ground water data are provided on **Tables 169 through 174**.

The Willis Avenue RI data was collected in 1992, 1994, and 1995 and analyzed for VOCs, SVOCs, and inorganics. The Willis Avenue RI data are included in **Appendix A**.

Lakeshore Area Shallow Ground Water

Summaries of shallow ground water sample locations and analyses performed during the PSA, RI, and Supplemental RI at the Lakeshore Area are provided in **Tables 25, 26, and 27**, respectively. Summary statistics are provided on **Table 175** for shallow ground water chemical parameters detected at the Lakeshore Area. Chemical parameters that were detected in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included as CPOIs and included in **Table 4.13**.

Table 4.13. *Detected Lakeshore Area Shallow Ground Water CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (µg/L)						
Benzene	36	31	0.30	950	3,900	29
Toluene	35	27	0.39	1,836	5,740	22
Ethylbenzene	37	23	0.70	128	350	18
Styrene	35	16	0.30	461	850	14
Chlorobenzene	35	14	8.70	543	3,080	14
Xylenes, m & p	16	13	6.40	1,063	2,300	13
Acetone	35	18	3.06	105	460	12
Xylenes, Total	19	15	0.29	1,130	3,500	12
o-Xylene	16	13	3.30	417	890	12
1,4-Dichlorobenzene	16	8	0.11	1,469	8,700	6
1,2-Dichlorobenzene	8	8	0.19	1,773	7,560	5
Naphthalene	7	3	870	10,957	23,000	3
Isopropylbenzene	17	5	0.10	21.9	68.0	2
Vinyl chloride	36	4	0.70	2.43	4.10	2
1,2,4-Trichlorobenzene	17	2	68.0	268	468	2
1,3-Dichlorobenzene	17	2	3.60	6.80	10	2
Methylene chloride	36	2	5.50	15.3	25.0	2
2-Butanone	35	10	2.00	11.2	23.0	0
1,2,4-Trimethylbenzene	8	7	2.00	266	780	NA
1,3,5-Trimethylbenzene	8	7	0.60	110	260	NA
p- Isopropyltoluene	8	2	0.80	10.4	20.0	NA
sec-Butylbenzene	8	2	1.00	60.5	120	NA
Semivolatile Organic Compounds (µg/L)						
Phenol	35	30	2.80	1,918	18,000	30
Naphthalene	35	29	1.50	5,232	35,000	27
2-Methylphenol	35	16	3.80	2,098	8,000	16
Acenaphthene	35	17	1.40	190	2,200	14
2,4-Dimethylphenol	35	16	3.00	2,174	7,500	12
1,4-Dichlorobenzene	27	10	6.90	1,331	4,500	10
1,2-Dichlorobenzene	27	9	9.80	1,815	4,200	9
Fluorene	36	18	1.70	316	4,200	7
2,4-Dichlorophenol	35	7	7.40	33.8	75.0	7
4-Methylphenol	12	7	1.80	2,383	12,000	7
Phenanthrene	36	17	1.20	621	8,300	6
Fluoranthene	36	9	1.50	438	3,200	5
Pyrene	36	9	1.10	268	1,900	5
Anthracene	36	6	2.80	398	2,000	4
1,2,4-Trichlorobenzene	28	4	46.0	143	260	4
Benzo(a)anthracene	36	4	20.0	209	690	4
Chrysene	36	4	16.0	177	590	4
1,3-Dichlorobenzene	27	3	8.40	28.0	62.0	3
Benzo(b)fluoranthene	36	3	10.0	90.0	240	3
Bis(2-ethylhexyl)phthalate	35	4	1.00	21.7	65.0	2
2,4,5-Trichlorophenol	35	2	2.00	4.50	7.00	2
2-Nitrophenol	35	2	2.60	2.80	3.00	2
4-Nitrophenol	35	2	3.00	5.50	8.00	2
2-Chlorophenol	35	1	2.00	2.00	2.00	1
Benzo(k)fluoranthene	35	1	340	340	340	1
Indeno(1,2,3-cd)pyrene	35	1	110	110	110	1
2-Methylnaphthalene	35	28	1.00	685	9,800	NA
Carbazole	35	22	2.00	156	840	NA
Dibenzofuran	35	20	1.50	254	3,400	NA

Table 4.13. *Detected Lakeshore Area Shallow Ground Water CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Acenaphthylene	36	18	1.20	255	2,700	NA
3&4-Methylphenol	26	14	2.00	3,267	16,000	NA
1,1'-Biphenyl	9	7	1.20	29.0	83.0	NA
Benzoic acid	9	5	3.00	492	2,300	NA
1-Phenyl-1-(2,4-dimethylphenyl) ethane	9	3	8.40	13.0	16.0	NA
1-Phenyl-1-(4-methylphenyl) ethane	9	2	17.0	20.0	23.0	NA
Pesticides (µg/L)						
4,4'-DDD	33	1	2.20	2.20	2.20	1
4,4'-DDT	33	1	20.0	20.0	20.0	1
Alpha-BHC	33	1	0.17	0.17	0.17	1
Inorganic Compounds (mg/L)						
Sodium	36	36	62.0	1,869	10,560	36
Iron	37	34	0.03	4.31	29.0	24
Chloride	25	25	130	4,611	29,200	21
Mercury	36	23	0.0001	0.002	0.009	16
Magnesium	36	31	0.06	90.8	513	10
Sulfate	25	18	4.57	427	1,870	8
Manganese	36	28	0.002	0.29	1.90	5
Barium	36	35	0.002	1.47	20.3	4
Lead	36	19	0.001	0.02	0.10	4
Chromium	36	22	0.002	0.02	0.05	1
Cadmium	36	4	0.0007	0.004	0.01	1
Copper	36	18	0.003	0.04	0.15	0
Cyanide	35	16	0.01	0.05	0.12	0
Zinc	36	15	0.01	0.05	0.16	0
Arsenic	36	8	0.004	0.008	0.01	0
Calcium	36	36	120	1,196	7,970	NA
Potassium	37	34	1.99	47.4	182	NA
Aluminum	34	30	0.05	1.60	12.7	NA
Nickel	36	18	0.001	0.01	0.04	NA
Vanadium	36	15	0.0007	0.008	0.03	NA
Ammonia	5	4	1.10	8.40	18.0	NA

Notes:
1 – Exceeds NYSDEC Class GA ground water standards and guidance values.
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

VOC CPOIs in shallow ground water include BTEX, styrene, acetone, and chlorinated benzenes. The highest concentrations of VOCs in shallow ground water are typically found in the eastern portion of the Lakeshore Area and along the western portion of the Lakeshore Area around the former East Flume in the Dredge Spoil Areas. The highest concentrations of BTEX in Lakeshore Area shallow ground water were detected in wells located downgradient of the Penn-Can Property. Total BTEX concentrations in shallow ground water are presented on **Figure 89**.

Naphthalene, PAHs, and Phenols have a distribution similar to Total BTEX. The highest concentrations of these SVOCs were detected downgradient of the Penn-Can Property (HB-WB-BU and HB-HB-02S). Shallow ground water concentrations of naphthalene, total PAHs, and total Phenols are presented on **Figures 92, 95, and 98**, respectively. In addition, chlorobenzene was detected in shallow ground water in HB-WA-03S, HB-HB-03S, and HB-HB-01S along the former

East Flume and HB-HB-06S in WL2. PXE and PTE were detected in shallow ground water in the vicinity of the former East Flume (HB-HB-01S and HB-HB-03S). PXE and PTE are thought to be associated with the Semet process. Since these compounds are present it is likely that these compounds were associated with historic East Flume discharges that have historically impacted this area.

The areas where organic CPOIs have been detected in shallow ground water are associated with one of the following:

- Sediments impacted by historic East Flume effluent associated with the formation of the ILWD.
- Sediments dredged from the East Flume (now abandoned) and Onondaga Lake (*e.g.*, ILWD) during installation of the diffuser building intake pipe.
- DNAPL associated with the marl.

Mercury was detected in eight of the shallow wells within the Lakeshore Area. High mercury concentrations were detected in wells HB-HB-01S and HB-HB-03S. These wells are adjacent to the former East Flume and likely associated with the historic East Flume effluent discharges associated with the formation of the ILWD. The East Flume historically received a combined waste stream from the former Main Plant and Willis Avenue Plant. The Willis Avenue Plant used mercury in it its operation. The mercury in these wells is likely related to historic practices at the Willis Avenue Site and former East Flume. High mercury concentrations were also detected in 2001 at HB-HB-02S (in wetland WL2) and HB-HB-04S (near Harbor Brook). The elevated mercury concentrations at HB-HB-02S may be associated with historic East Flume effluent discharges. The mercury at both locations may also be related to sediment transported by Harbor Brook. Mercury concentrations in shallow ground water are presented on **Figure 101**.

Inorganic compounds associated with Solvay waste or native brines like calcium, magnesium, chloride, and sodium are also found in exceedence of ground water standards, however the distribution varies across the Site.

Lakeshore Area Intermediate Ground Water

Summaries of intermediate ground water sample locations and analyses performed during the PSA, RI, and Supplemental RI at the Lakeshore Area are provided in **Tables 25, 26, and 27**, respectively. Summary statistics are provided on **Table 176** for intermediate ground water chemical parameters detected at the Lakeshore Area. Chemical parameters that were detected in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included as CPOIs and included in **Table 4.14**.

Table 4.14. *Detected Lakeshore Area Intermediate Ground Water CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (µg/L)						
Benzene	15	10	0.80	368	1,000	8
Toluene	16	10	0.17	23.6	130	5
Xylenes, Total	10	6	2.27	13.8	40	5
Chlorobenzene	16	3	25.1	392	620	3
Acetone	15	6	2.33	122	560	2
2-Butanone	15	5	3.14	45.2	100	2
1,2-Dichlorobenzene	7	2	10.2	12	14	2
1,4-Dichlorobenzene	7	2	6.50	8.80	11.1	2

Table 4.14. *Detected Lakeshore Area Intermediate Ground Water CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Naphthalene	2	2	91.0	211	330	2
Carbon disulfide	13	4	1.30	53.8	200	1
Chloroform	16	1	23.0	23.0	23.0	1
Vinyl chloride	16	1	3.00	3.00	3.00	1
Xylenes, m&p	6	1	14.0	14.0	14.0	1
1,2,4-Trimethylbenzene	3	3	0.60	4.53	11.0	NA
1,3,5-Trimethylbenzene	3	2	0.90	2.45	4.00	NA
Semivolatile Organic Compounds (µg/L)						
Phenol	15	15	1.40	380	2,100	15
Naphthalene	15	12	1.10	61.2	150	10
2-Methylphenol	15	8	1.20	158	450	8
2,4-Dimethylphenol	15	7	2.00	542	1,200	5
Bis(2-ethylhexyl)phthalate	15	4	1.00	7.28	16.0	2
1,2-Dichlorobenzene	12	2	920	1,310	1,700	2
1,4-Dichlorobenzene	12	2	770	845	920	2
4-Methylphenol	4	2	2.00	39.0	76.0	2
1,2,4-Trichlorobenzene	11	1	26.0	26.0	26.0	1
1,3-Dichlorobenzene	12	1	17.0	17.0	17.0	1
2,4-Dichlorophenol	15	1	7.00	7.00	7.00	1
Benzo(a)anthracene	15	1	1.10	1.10	1.10	1
Acenaphthene	15	9	1.00	2.87	10.0	0
Fluorene	15	9	1.00	4.31	16.0	0
Phenanthrene	15	6	0.70	4.02	11.0	0
2-Methylnaphthalene	15	11	1.10	10.2	42.0	NA
3&4-Methylphenol	11	11	2.90	101	360	NA
Dibenzofuran	15	9	1.00	4.22	16.0	
Acenaphthylene	15	7	1.30	3.43	10.0	NA
Carbazole	14	4	1.20	3.45	9.00	NA
Benzyl alcohol	10	3	3.00	66.3	100	NA
Benzoic acid	4	2	69.0	72.5	76.0	NA
Inorganic Compounds (mg/L)						
Sodium	16	16	180	17,790	42,500	16
Iron	16	16	0.05	3.23	10.0	14
Chloride	10	10	280	31,160	64,000	10
Manganese	16	14	0.007	0.44	0.84	8
Sulfate	10	8	259	1,341	2,910	8
Magnesium	16	16	1.16	154	460	7
Cyanide	16	7	0.01	0.19	0.53	3
Lead	16	7	0.004	0.01	0.03	2
Chromium	16	6	0.03	0.08	0.27	2
Mercury	16	5	0.00005	0.01	0.03	2
Copper	16	6	0.004	0.08	0.23	1
Arsenic	16	2	0.01	0.02	0.03	1
Thallium	16	1	0.09	0.09	0.09	1
Barium	16	16	0.04	0.19	0.66	0
Zinc	16	6	0.007	0.10	0.50	0
Calcium	16	16	521	2,197	3,760	NA
Potassium	16	16	10.0	116	272	NA
Aluminum	16	10	0.12	2.45	5.94	NA
Nickel	16	7	0.001	0.10	0.22	NA
Vanadium	16	6	0.002	0.006	0.01	NA
Ammonia	3	3	0.59	12.9	22.0	NA

Table 4.14. *Detected Lakeshore Area Intermediate Ground Water CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]

Notes:
1 – Exceeds NYSDEC Class GA ground water standards and guidance values.
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

Total BTEX concentrations detected in intermediate ground water are presented on **Figure 90**. The highest BTEX concentrations detected in the intermediate ground water at the Lakeshore Area were at location HB-WA-08I. This location is down gradient of the Penn-Can Property and the concentrations are likely related to contaminated ground water migrating downgradient from the Penn-Can Property.

The highest chlorinated benzene concentrations in the intermediate ground water are detected in the western portion of the Lakeshore Area (HB-WA-03I). This well is adjacent to the former East Flume that received a combined waste stream from the former Willis Avenue Plant and former Main Plant. The chlorinated benzenes detected in this well are likely associated with the historic East Flume discharges associated with the former Willis Avenue Plant that manufactured chlorinated benzenes.

Naphthalene, PAHs, and phenols were detected at their highest concentrations in intermediate well HB-WA-08I. This well is down gradient of the Penn-Can Property. Naphthalene, total PAH, and total phenol concentrations in intermediate ground water are presented on **Figures 93, 96, and 99**, respectively.

The concentrations and distribution of other parameters are variable over the entire site, and frequently change between sampling events in the middle and eastern portion of the Lakeshore Area. Inorganic constituent concentrations are also variable across the Site. This may be due to the mixing of leachate and native brines and was discussed in Section 3. The highest mercury concentrations in intermediate ground water at were detected in well HB-HB-05I (**Figure 102**). These concentrations are higher than those observed for shallow wells (discussed above); however, HB-HB-05I is not located near any of the shallow monitoring wells with high mercury concentrations. The mercury concentrations at this location may be related to historic East Flume effluent discharges associated with the formation of the ILWD and the vertical migration from this material along the lakeshore to intermediate ground water. Mercury detected in the intermediate wells may also be from vertical migration from shallow ground water (as discussed in Section 4.3.7).

Lakeshore Area Deep Ground Water

Summaries of deep ground water sample locations and analyses performed during the PSA, RI, and Supplemental RI at the Lakeshore Area are provided in **Tables 25, 26, and 27**, respectively. Summary statistics are provided on **Table 177** for deep ground water chemical parameters detected at the Lakeshore Area. Chemical parameters that were detected in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included as CPOIs and included in **Table 4.15**.

Table 4.15. *Detected Lakeshore Area Deep Ground Water CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (μg/L)						
Chloroethane	25	4	5.6	17.4	29.0	4
Benzene	25	4	0.38	1.75	3.00	1
Toluene	25	6	0.20	0.89	1.80	0
Acetone	24	5	1.11	4.35	10.7	0
Xylenes, Total	13	4	0.10	0.18	0.33	0
Chlorobenzene	25	2	0.20	3.60	7.00	0
1,4-Dichlorobenzene	10	2	0.26	0.28	0.30	0
Semivolatile Organic Compounds (μg/L)						
Naphthalene	24	3	1.10	29.0	55.0	2
Phenol	24	2	1.20	1.20	1.20	2
Bis(2-ehtylhexyl)phthalate	24	6	1.00	3.53	6.40	1
1,2-Dichlorbenzene	18	1	4.00	4.00	4.00	1
1,3-Dichlorbenzene	18	1	6.00	6.00	6.00	1
1,4-Dichlorbenzene	18	1	6.00	6.00	6.00	1
2-Methylphenol	24	1	1.60	1.60	1.60	1
Inorganic Compounds (mg/L)						
Iron	24	24	0.57	40.7	446	24
Magnesium	24	24	72.6	296	925	24
Sodium	24	24	4,200	20,522	44,730	24
Manganese	24	24	0.08	2.76	16.1	21
Chloride	19	19	2,000	37,596	73,300	19
Sulfate	19	18	700	2,153	3,930	18
Chromium	24	13	0.01	0.09	0.33	7
Lead	24	9	0.01	0.07	0.29	4
Arsenic	24	8	0.01	0.03	0.10	3
Copper	24	8	0.02	0.17	0.50	3
Barium	24	24	0.03	0.18	1.17	1
Cadmium	24	1	0.02	0.02	0.02	1
Zinc	24	7	0.03	0.21	0.78	0
Cyanide	24	5	0.01	0.02	0.03	0
Calcium	24	24	360	2,674	6,200	NA
Potassium	24	24	36.1	172	293	NA
Aluminum	24	17	0.27	32.1	291	NA
Ammonia	4	4	6.8	11.1	15	NA

Notes:
1 – Exceeds NYSDEC Class GA ground water standards and guidance values.
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

In general, deep ground water under the Lakeshore Area does not typically exceed ground water standards for concentrations of VOCs, naphthalene, PAHs, phenols or Mercury. Total BTEX was detected at the highest concentrations at HB-HB-16D (**Figure 91**). Ground water from HB-HB-16D does exceed ground water standards for concentrations of some constituents including naphthalene and phenol. Naphthalene, total PAH, and total phenol concentrations are presented on **Figures 94, 97, and 100**, respectively.

In general, inorganic compounds that exceed ground water standards in deep wells are related to the native brine found on the Site. These inorganics are typically sodium, iron, chloride, and magnesium. Mercury was only detected in deep ground water on the Lakeshore Area at one well (HB-HB-01D). Mercury concentrations at the Site are presented on **Figure 103**.

4.3.2. Penn-Can Property Ground Water

Penn-Can Property ground water samples were collected during the PSA, RI, and Supplemental RI field programs. Sample locations are presented on **Figure 6**. One round of samples was collected in May 2001 from the nine wells installed as part of the PSA at the Penn-Can Property. Samples collected as part of the PSA were analyzed for VOCs, SVOCs, pesticides, PCBs, inorganics, and the parameters listed above. The PSA ground water data are provided on **Tables 157 through 162**.

One deep well was installed in the Penn-Can Property as part of the RI. This well and eight of the nine wells installed as part PSA were sampled as part of the RI field program in May 2003 and August 2003. HB-HB-11S was not sampled during either event because it was dry. Samples collected as part of the RI were analyzed for VOCs, SVOCs, pesticides, PCBs, inorganics including major cations and anions. The RI ground water data are provided on **Tables 163 through 168**.

One round of ground water samples was collected during the Supplemental RI in the Penn-Can Property. Monitoring wells HB-HB-14S and HB-HB-14D were not sampled because the wells had been destroyed. Samples collected as part of the Supplemental RI were analyzed for VOCs, SVOCs, pesticides, PCBs, inorganics including major cations and anions, alkalinity, hardness, ammonia, TKN, and CBOD. The Supplemental RI ground water data are provided on **Tables 169 through 174**.

Penn-Can Property Shallow Ground Water

Summaries of shallow ground water sample locations and analyses performed during the PSA, RI, and Supplemental RI at the Penn-Can Property are provided in **Tables 25, 26, and 27**, respectively. Summary statistics are provided on **Table 178** for shallow ground water chemical parameters detected at the Penn-Can Property. Chemical parameters that were detected in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included as CPOIs and included in **Table 4.16**.

Table 4.16. *Detected Penn-Can Property Shallow Ground Water CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (µg/L)						
1,1,1-Trichloroethane	9	4	6.00	16.8	32.0	4
Benzene	9	3	1.70	14.4	32.5	3
Toluene	9	4	2.70	6.73	16.9	1
Chloroform	9	2	5.56	16.3	27.0	1
Xylenes, m & p	4	2	4.40	6.20	8.00	1
Xylenes, Total	5	2	2.00	3.53	5.06	1
Ethylbenzene	9	4	0.50	1.14	1.56	0
Tetrachloroethene	9	4	0.14	0.66	1.70	0
o-Xylene	4	2	1.80	2.75	3.70	0
Naphthalene	3	1	1.00	1.00	1.00	0
1,2,4-Trimethylbenzene	3	1	0.30	0.30	0.30	NA
1,3,5-Trimethylbenzene	3	1	0.20	0.20	0.20	NA
Semivolatile Organic Compounds (µg/L)						
Bis(2-ethylhexyl)phthalate	9	7	1.20	27.7	71.0	5
Chrysene	9	3	1.00	21.3	62.0	3
Naphthalene	9	3	9.50	21.3	33.0	2
Benzo(a)anthracene	9	2	1.00	35.0	69.0	2
Fluoranthene	9	5	1.20	25.2	120	1
Pyrene	9	5	1.10	21.1	99.0	1
Phenanthrene	9	3	1.00	40.7	120	1
4-Methylphenol	2	1	1.90	1.90	1.90	1

Table 4.16. *Detected Penn-Can Property Shallow Ground Water CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Acenaphthene	9	1	29.0	29.0	29.0	1
Benzo(b)fluoranthene	9	1	78.0	78.0	78.0	1
Benzo(k)fluoranthene	9	1	27.0	27.0	27.0	1
Indeno(1,2,3-cd)pyrene	9	1	27.0	27.0	27.0	1
Phenol	9	1	34.0	34.0	34.0	1
2,4-Dimethylphenol	9	2	1.00	3.65	6.30	0
2-Methylnaphthalene	9	2	3.10	6.55	10.0	NA
PCBs (µg/L)						
Aroclor-1254	8	1	0.3	0.3	0.3	1
Inorganic Compounds (mg/L)						
Sodium	8	8	16.0	40.3	83.0	6
Iron	8	7	0.06	3.18	9.84	5
Manganese	8	6	0.02	0.15	0.36	2
Chromium	8	5	0.004	0.02	0.05	1
Lead	8	4	0.007	0.01	0.03	1
Antimony	8	1	0.005	0.005	0.005	1
Mercury	8	1	0.0009	0.0009	0.0009	1
Barium	8	8	0.04	0.09	0.19	0
Magnesium	8	7	2.15	12.9	23.3	0
Chloride	6	6	45.0	105	200	0
Sulfate	6	5	66.1	139	192	0
Zinc	8	5	0.02	0.05	0.07	0
Arsenic	8	3	0.004	0.009	0.02	0
Copper	8	3	0.002	0.009	0.02	0
Cyanide	8	2	0.02	0.03	0.04	0
Silver	8	2	0.001	0.01	0.02	0
Calcium	8	8	73.0	224	760	NA
Potassium	8	8	1.88	6.88	13.0	NA
Aluminum	8	7	0.05	2.71	8.46	NA
Nickel	8	3	0.006	0.01	0.03	NA
Vanadium	8	2	0.001	0.008	0.02	NA

Notes:
1 – Exceeds NYSDEC Class GA ground water standards and guidance values.
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

The highest total BTEX shallow ground water concentrations at the Penn-Can Property were detected in monitoring well HB-HB-12S. Total BTEX concentrations in shallow ground water are presented on **Figure 89**.

Naphthalene, PAHs and Phenols were detected in the shallow ground water on the Penn-Can Property. Concentrations of naphthalene, total PAHs, and total phenols are presented on **Figures 92, 95, and 98**, respectively. PAHs were detected in previous sampling rounds at monitoring wells HB-HB-11S and HB-HB-14S; however, no PAHs were detected in HB-11S during the latest round of sampling, and HB-HB-14S was not sampled because the well was destroyed. The SVOCs detected in the Penn-Can Property shallow ground water are likely related to former operations associated with the Barrett Paving facility on this property.

Mercury concentrations were found in exceedence of ground water standards at only HB-HB-11S on the Penn-Can Property. Mercury concentrations in shallow ground water are presented on **Figure 101**. The source of the mercury at the Penn-Can site is unknown.

Penn-Can Property Intermediate Ground Water

Summaries of intermediate ground water sample locations and analyses performed during the PSA, RI, and Supplemental RI at the Penn-Can Property are provided in **Tables 25, 26, and 27**, respectively. Summary statistics are provided on **Table 179** for intermediate ground water chemical parameters detected at the Penn-Can Property. Chemical parameters that were detected in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included as CPOIs and included in **Table 4.17**.

Table 4.17. *Detected Penn-Can Property Intermediate Ground Water CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (µg/L)						
Benzene	8	6	14.0	354	1,100	6
Toluene	8	8	1.00	672	2,400	5
Ethylbenzene	8	5	2.40	320	540	4
Xylenes, Total	4	4	2.00	1,370	4,800	3
Styrene	8	3	380	788	1,500	3
Xylenes, m & p	4	4	1.10	1,476	3,100	2
Naphthalene	2	2	130	9,065	18,000	2
o-Xylene	4	2	1,300	1,350	1,400	2
Acetone	8	3	5.20	38.7	100	1
Chloroform	8	3	0.70	1.30	2.00	0
1,2,4-Trimethylbenzene	2	2	1.00	451	900	NA
1,3,5-Trimethylbenzene	2	1	320	320	320	NA
Semivolatile Organic Compounds (µg/L)						
Naphthalene	7	7	15.0	4,138	13,000	7
Phenol	7	7	2.00	90.0	250	7
2-Methylphenol	6	5	31.0	137	230	5
2,4-Dimethylphenol	6	5	22.0	159	440	4
Fluorene	8	7	1.40	47.2	120	3
Phenanthrene	8	7	2.20	40.0	99.0	3
Acenaphthene	8	6	1.50	60.5	130	3
Bis(2-ethylhexyl)phthalate	8	3	5.60	17.5	30.0	3
Chrysene	8	3	1.00	2.00	3.40	3
4-Methylphenol	2	2	43.0	1,132	2,220	2
4-Nitrophenol	8	2	1.40	9.70	18.0	2
Benzo(a)anthracene	8	2	1.60	2.55	3.50	2
Benzo(b)fluoranthene	8	2	1.30	2.00	2.70	2
Benzo(k)fluoranthene	8	2	1.20	1.90	2.60	2
Anthracene	8	6	1.20	24.5	97.0	1
Indeno(1,2,3-cd)pyrene	8	1	1.60	1.60	1.60	1
Nitrobenzene	8	1	2.60	2.60	2.60	1
Fluoranthene	8	5	1.20	3.92	6.90	0
Pyrene	8	4	1.20	2.88	5.40	0
2-Methylnaphthalene	7	7	2.70	370	1,100	NA
Dibenzofuran	8	7	1.60	57.5	150	NA
Carbazole	7	6	1.50	105	280	NA
Acenaphthylene	8	5	7.00	94.9	180	NA
3&4-Methylphenol	5	4	1.80	133	310	NA
Benzo(a)pyrene	8	2	1.50	1.50	1.50	NA
Benzyl alcohol	6	2	2.60	4.30	6.00	NA
1,1'-Biphenyl	2	1	33.0	33.0	33.0	NA
Inorganic Compounds (mg/L)						
Sodium	8	8	29.6	49.2	140	8

Table 4.17. *Detected Penn-Can Property Intermediate Ground Water CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Iron	8	8	0.18	1.27	2.75	6
Lead	8	6	0.002	0.01	0.04	1
Chromium	8	4	0.004	0.02	0.07	1
Barium	8	8	0.05	0.08	0.14	0
Magnesium	8	8	0.42	2.79	6.16	0
Manganese	8	8	0.006	0.04	0.10	0
Chloride	6	6	41.8	90.7	200	0
Sulfate	6	6	76.6	107	150	0
Zinc	8	4	0.01	0.03	0.04	0
Copper	8	3	0.002	0.003	0.004	0
Mercury	8	2	0.0002	0.0003	0.0003	0
Silver	8	2	0.002	0.003	0.004	0
Aluminum	8	8	0.12	0.86	2.10	NA
Calcium	8	8	376	572	720	NA
Potassium	8	8	5.90	11.6	22.0	NA
Nickel	8	4	0.001	0.01	0.04	NA
Vanadium	8	3	0.001	0.001	0.002	NA

Notes:
1 – Exceeds NYSDEC Class GA ground water standards and guidance values.
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

Both of the intermediate wells (HB-HB-11I and HB-HB-12I) on the Penn-Can Property contained concentrations of BTEX (**Figure 90**), naphthalene (**Figure 93**), PAHs (**Figure 96**), and phenols (**Figure 99**) in exceedence of ground water quality standards. The highest concentrations of BTEX, Naphthalene, and PAHs were detected in ground water at HB-HB-12I. The highest concentrations of phenols were detected at HB-HB-11I for the March 2007 round of ground water sampling. The reason for the increase in total phenol concentrations at this location is unknown. The SVOCs detected in the Penn-Can Property intermediate ground water are likely related to former operations associated with the Barrett Paving facility on this property.

Mercury was detected historically at HB-HB-11I, but the concentrations did not exceed the Class GA standard (**Figure 102**). No mercury concentrations were detected during the most recent round of sampling. Mercury was also detected in well HB-HB-11S suggesting that the mercury present in the intermediate zone at this location may be from the downward migration of waters from the shallow zone.

Penn-Can Property Deep Ground Water

Summaries of deep ground water sample locations and analyses performed during the PSA, RI, and Supplemental RI at the Penn-Can Property are provided in **Tables 25, 26, and 27**, respectively. Summary statistics are provided on **Table 180** for deep ground water chemical parameters detected at the Penn-Can Property. Chemical parameters that were detected in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included as CPOIs and included in **Table 4.18**.

Table 4.18. *Detected Penn-Can Property Deep Ground Water CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]

Table 4.18. *Detected Penn-Can Property Deep Ground Water CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (µg/L)						
Benzene	14	14	32.0	13,821	126,000	14
Toluene	14	14	2.30	3,062	6,500	13
Ethylbenzene	14	13	17.6	459	1,000	13
Styrene	14	10	34.0	1,991	17,000	10
o-Xylene	8	8	27.0	579	1,000	8
Xylenes, m & p	8	8	10.0	1,353	2,800	8
Xylenes, Total	6	6	11.4	1,537	4,500	6
Naphthalene	3	3	1,700	7,533	18,000	3
Acetone	14	2	9.40	255	500	1
Chloroform	14	2	2.00	121	240	1
Isopropylbenzene	6	2	1.00	2.50	4.00	0
1,2,4-Trimethylbenzene	3	3	67.0	339	840	NA
1,3,5-Trimethylbenzene	3	2	28.0	139	250	NA
n-Propylbenzene	3	1	2.00	2.00	2.00	NA
p-Isopropyltoluene	3	1	1.00	1.00	1.00	NA
Semivolatile Organic Compounds (µg/L)						
Naphthalene	12	12	1.30	5,590	14,000	11
2,4-Dimethylphenol	13	10	1.40	17,189	38,000	9
2-Methylphenol	12	9	87.0	7,132	15,000	9
Phenol	12	9	1.50	1,751	6,500	9
Acenaphthene	12	10	4.90	180	640	8
Benzo(a)anthracene	13	6	2.40	168	700	6
Chrysene	13	6	2.00	138	530	6
Fluorene	12	8	3.30	310	1,100	5
Phenanthrene	12	8	6.80	536	2,100	5
Anthracene	12	8	1.20	183	590	4
Fluoranthene	12	7	2.10	201	680	4
Pyrene	12	7	16.0	142	510	4
Benzo(k)fluoranthene	13	3	11.0	65.0	140	3
Bis(2-ethylhexyl)phthalate	13	4	2.40	21.6	55.0	2
4-Methylphenol	3	2	23,000	26,500	30,000	2
Benzo(b)fluoranthene	13	2	44.0	202	360	2
Indeno(1,2,3-cd)pyrene	13	2	17.0	53.0	89.0	2
4-Nitrophenol	13	1	1.40	1.40	1.40	1
2-Methylnaphthalene	12	10	14.0	867	3,100	NA
Acenaphthylene	12	9	5.40	302	1,000	NA
Carbazole	13	9	2.40	222	930	NA
Dibenzofuran	12	8	15.0	309	1,000	NA
3&4-Methylphenol	9	7	500	15,010	24,000	NA
Benzo(a)pyrene	13	3	11.0	110	270	NA
1,1'-Biphenyl	3	1	17.0	17.0	17.0	NA
Pesticides (µg/L)						
4,4'-DDT	14	1	0.22	0.22	0.22	1
alpha-BHC	14	1	0.19	0.19	0.19	1
delta-BHC	14	1	0.10	0.10	0.10	1
Inorganic Compounds (mg/L)						
Iron	14	14	0.50	56.6	361	14
Sodium	14	14	47.1	2,947	7,140	14
Magnesium	14	14	2.20	125	621	11
Chloride	10	10	94.0	4,050	7,910	9
Chromium	14	10	0.005	0.20	0.86	8
Manganese	14	14	0.02	1.56	10.5	7

Table 4.18. *Detected Penn-Can Property Deep Ground Water CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Lead	14	9	0.003	0.05	0.14	4
Sulfate	11	6	61.5	368	631	4
Barium	14	14	0.01	0.55	1.19	2
Copper	14	9	0.006	0.12	0.36	2
Arsenic	14	5	0.002	0.04	0.09	2
Beryllium	14	2	0.001	0.004	0.007	1
Zinc	14	10	0.02	0.23	0.92	0
Cyanide	14	3	0.01	0.04	0.07	0
Calcium	14	14	23	378	1870	NA
Potassium	14	14	3.00	34.6	89.0	NA
Aluminum	14	12	0.47	42.3	155	NA
Nickel	14	9	0.002	0.11	0.39	NA
Vanadium	14	8	0.001	0.12	0.41	NA
Cobalt	14	3	0.02	0.08	0.12	NA

Notes:
1 – Exceeds NYSDEC Class GA ground water standards and guidance values.
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

The highest CPOI concentrations in the deep ground water in the Penn-Can Property are generally found on the eastern portion of the property in HB-HB-13D and HB-HB-12D. The highest concentrations of total BTEX (**Figure 91**) were detected in HB-HB-12D. Total BTEX concentrations have increased from the PSA sampling to the Supplemental RI on HB-HB-12D and decreased in HB-HB-13D.

Historically, HB-HB-13D had the highest concentration of naphthalene; however, in the latest sampling round of sampling HB-HB-12D had the highest concentration (**Figure 94**). The highest concentration of total PAHs was detected in well HB-HB-13D during the PSA sampling (**Figure 97**). Naphthalene and total PAH concentrations have declined one to two orders of magnitude in HB-HB-13D from the PSA to the Supplemental RI. It should be noted that DNAPL was found in the well initially and DNAPL has not been seen in the more recent samples at this location. The decrease in DNAPL may be from DNAPL moving downslope from this location, DNAPL moving into bedrock, or DNAPL was mobilized from the surrounding subsurface soils during the initial drilling and has subsequently stabilized. The decrease of DNAPL in the well has likely resulted in the decline of concentrations at this location. The transport of DNAPL is discussed in greater detail in Section 6.3.

Phenols were detected at their highest concentrations in wells HB-HB-12D and HB-HB-13D (**Figure 100**). Total phenol concentrations at HB-HB-12D have been steady from the PSA to the Supplemental RI while total phenol concentrations at HB-HB-13D are increasing. The increasing total phenol concentrations may be related to the decline to total BTEX concentrations that may indicate a breakdown of BTEX to phenols. Pilot tests indicate biodegradation is occurring via microbial fermentation; however, this environment may not be conducive for natural attenuation (Parsons, 2003). This is discussed in greater detail within Section 6 of this report.

Mercury was detected in HB-HB-13D during the PSA and RI. However, no mercury was detected in the deep ground water at the Penn-Can Property during the March 2007 Supplemental RI sampling event. Mercury is not included in **Table 4.18** because it was not detected in at least 20% of the samples and it did not exceed NYSDEC class GA standards.

4.3.3. Railroad Area Ground Water

Railroad Area ground water samples were collected during the PSA, RI, and Supplemental RI field programs. Sample locations are presented on **Figure 6**. One round of samples was collected in May 2001 from the three wells installed as part of the PSA at the Railroad Area. Samples collected as part of the PSA were analyzed for VOCs, SVOCs, pesticides, PCBs, inorganics, and the parameters listed above. The PSA ground water data are provided on **Tables 157 through 162**.

One deep well was installed in the Railroad Area as part of the RI. This well and eight of the nine wells installed as part of the PSA were sampled as part of the RI field program in May 2003 and August 2003. HB-HB-11S was not sampled during either event because it was dry. Samples collected as part of the RI were analyzed for VOCs, SVOCs, pesticides, PCBs, and inorganics including major cations and anions. The RI ground water data are provided on **Tables 163 through 168**.

One round of ground water samples was collected during the Supplemental RI in the Railroad Area. Samples collected as part of the Supplemental RI were analyzed for VOCs, SVOCs, pesticides, PCBs, inorganics including major cations and anions, alkalinity, hardness, ammonia, TKN, and CBOD. The Supplemental RI ground water data are provided on **Tables 169 through 174**.

Railroad Area Shallow Ground Water

Summaries of shallow ground water sample locations and analyses performed during the PSA, RI, and Supplemental RI at the Railroad Area are provided in **Tables 25, 26, and 27**, respectively. Summary statistics are provided on **Table 181** for shallow ground water chemical parameters detected at the Railroad Area. Chemical parameters that were detected in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included as CPOIs and included in **Table 4.19**.

Table 4.19. *Detected Railroad Area Shallow Ground Water CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (μg/L)						
Acetone	12	3	3.00	28.3	79.0	1
Benzene	12	1	2.15	2.15	2.15	1
Hexachlorobutadiene	3	1	1.00	1.00	1.00	1
Naphthalene	3	2	1.00	2.00	3.00	0
Toluene	12	2	0.20	0.46	0.72	0
Xylenes, Total	6	2	0.20	0.72	1.23	0
1,2,3-Trichlorobenzene	3	1	1.00	1.00	1.00	NA
1,2,4-Trimethylbenzene	3	1	0.10	0.10	0.10	NA
Semivolatile Organic Compounds (μg/L)						
Bis(2-ethylhexyl)phthalate	12	9	1.20	30.4	110	6
Naphthalene	12	4	1.00	7.30	15.0	2
Inorganic Compounds (mg/L)						
Sodium	12	12	13.2	598	2,280	9
Iron	12	11	0.03	2.78	15.0	8
Magnesium	12	12	14.2	69.9	167	7
Chloride	9	9	8.60	1,088	3,770	2
Manganese	12	8	0.12	0.87	2.70	5
Sulfate	9	9	41.0	190	464	2
Chromium	12	7	0.005	0.03	0.05	1
Barium	12	10	0.02	0.10	0.28	0
Zinc	12	6	0.01	0.04	0.05	0
Lead	12	5	0.002	0.006	0.02	0

Table 4.19. *Detected Railroad Area Shallow Ground Water CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Copper	12	4	0.003	0.02	0.04	0
Calcium	12	12	59.8	146	285	NA
Potassium	12	10	1.20	9.76	21.7	NA
Aluminum	9	9	0.05	2.28	15.1	NA
Nickel	12	4	0.004	0.02	0.04	NA
Vanadium	12	4	0.0007	0.003	0.01	NA

Notes:
1 – Exceeds NYSDEC Class GA ground water standards and guidance values.
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

Three shallow wells are located on the Railroad Area:

- HB-HB-07S
- HB-HB-08S
- HB-HB-09S

In shallow ground water at the Railroad area BTEX compounds have only been detected in HB-HB-08S. The total BTEX concentrations are lower in comparison to upgradient wells on the Penn-Can Property (**Figure 89**). Naphthalene has been detected in each of the three shallow wells. The highest naphthalene concentration (15 µg/L) was detected in HB-HB-08S (**Figure 92**). Total PAH concentrations are presented on **Figure 95**. Phenols have been detected in wells HB-HB-08S and HB-HB-09S (**Figure 98**) and typically have lower concentrations than the up gradient wells on the Penn-Can Property. Mercury was not detected in shallow ground water in the Railroad Area (**Figure 101**).

Railroad Area Intermediate Ground Water

Summaries of intermediate ground water sample location and analyses performed during the PSA, RI, and Supplemental RI at the Railroad Area are provided in **Tables 25, 26, and 27**, respectively. Summary statistics are provided on **Table 182** for intermediate ground water chemical parameters detected at the Railroad Area. Chemical parameters that were detected in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included as CPOIs and included in **Table 4.20**.

Table 4.20. *Detected Railroad Area Intermediate Ground Water CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (µg/L)						
Benzene	4	4	290	451	585	4
Ethylbenzene	4	4	160	188	210	4
Styrene	4	4	300	338	400	4
Toluene	4	4	295	476	590	4
o-Xylene	2	2	440	485	530	2
Xylenes, m & p	2	2	1,000	1,100	1,200	2
Xylenes, Total	2	2	760	1,130	1,500	2
Isopropylbenzene	2	1	17.0	17.0	17.0	1
1,2,4-Trimethylbenzene	1	1	640	640	640	NA
1,3,5-Trimethylbenzene	1	1	240	240	240	NA
n-Propylbenzene	1	1	12.0	12.0	12.0	NA

Table 4.20. *Detected Railroad Area Intermediate Ground Water CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Semivolatile Organic Compounds (μg/L)						
2,4-Dimethylphenol	4	4	340	558	850	4
2-Methylphenol	4	4	39.0	52.5	59.0	4
Acenaphthene	4	4	13.0	68.3	120	3
Fluorene	4	4	11.0	61.3	110	3
Naphthalene	3	3	2,900	8,233	12,000	3
Phenol	3	3	52.0	59.7	74.0	3
Phenanthrene	4	4	15.0	43.8	60.0	2
Bis(2-ethylhexyl)phthalate	4	2	15.0	15.5	16.0	2
1,2-Dichloroebenzene	3	1	5.00	5.00	5.00	1
4-Methylphenol	1	1	59.0	59.0	59.0	1
Anthracene	4	3	3.80	8.93	13.0	0
Fluoranthene	4	2	4.00	4.95	5.90	0
Pyrene	4	2	3.00	3.60	4.20	0
1,4-Dichloroebenzene	3	1	2.00	2.00	2.00	0
Dibenzofuran	4	4	11.0	78.3	140	NA
2-Methylnaphthalene	3	3	120	423	610	NA
3&4-Methylphenol	3	3	58.0	62.0	66.0	NA
Acenaphthylene	3	3	19.0	76.3	110	NA
Carbazole	3	3	30.0	100	140	NA
1,1'-Biphenyl	1	1	7.80	7.80	7.80	NA
Inorganic Compounds (mg/L)						
Sodium	4	4	82.1	131	190	4
Iron	4	4	0.21	0.48	0.87	3
Thallium	4	1	0.006	0.006	0.006	1
Magnesium	4	4	1.48	1.96	2.40	0
Chloride	3	3	129	167	190	0
Sulfate	3	3	74.1	83.5	89.0	0
Cyanide	4	3	0.01	0.03	0.05	0
Manganese	4	3	0.01	0.01	0.02	0
Barium	4	2	0.03	0.04	0.06	0
Copper	4	2	0.002	0.002	0.002	0
Chromium	4	1	0.004	0.004	0.004	0
Lead	4	1	0.001	0.001	0.001	0
Silver	4	1	0.002	0.002	0.002	0
Zinc	4	1	0.003	0.003	0.003	0
Calcium	4	4	37.6	48.4	61.8	NA
Potassium	4	4	5.68	6.34	7.10	NA
Aluminum	3	3	0.34	0.47	0.54	NA
Nickel	4	2	0.002	0.003	0.005	NA
Vanadium	4	2	0.002	0.004	0.006	NA
Ammonia	1	1	3.70	3.70	3.70	NA

Notes:
1 – Exceeds NYSDEC Class GA ground water standards and guidance values.
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

The one intermediate well (HB-HB-08I) in the Railroad Area contained BTEX concentrations that were comparable to the upgradient Penn-Can Property intermediate well HB-HB-12I. Total BTEX concentrations in intermediate ground water are presented on **Figure 90**. Naphthalene, total PAH, and total phenol concentrations were also similar to the upgradient Penn-Can Property. Naphthalene, total PAH and total phenol concentrations in intermediate ground water are presented on **Figures 93, 96**

and 99, respectively. Concentrations for each of these CPOIs has dropped by roughly one order of magnitude from historic data to the 2007 sampling event with the exception of phenol which has increased from historic to present sampling events. Phenol is a known breakdown product of benzene. The increase in phenol may be related to the break down of the other CPOIs in the intermediate aquifer. However, pilot tests indicate that this environment is not conducive for biodegradation (Parsons, 2003). The decline in CPOIs could be from contaminant migration from this area or more likely from sampling uncertainty and the inherent variation between sampling rounds. The CPOIs found in well HB-HB-08I are likely related to previous activities at the Penn-Can Property.

Railroad Area Deep Ground Water

Summaries of deep ground water sample location and analyses performed during the PSA, RI, and Supplemental RI at the Railroad Area are provided in **Tables 25, 26, and 27**, respectively. Summary statistics are provided on **Table 183** for deep ground water chemical parameters detected at the Railroad Area. Chemical parameters that were detected in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included as CPOIs and included in **Table 4.21**.

Table 4.21. *Detected Railroad Area Deep Ground Water CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (µg/L)						
Ethylbenzene	3	3	28.0	39. 7	48.0	3
Benzene	3	3	0.34	16.8	28.0	2
o-Xylene	2	2	4.30	4.35	4.40	0
Xylenes, m & p	2	2	1.10	1.10	1.10	0
Isopropylbenzene	1	1	0.88	0.88	0.88	0
Toluene	3	1	0.30	0.30	0.30	0
Xylenes, Total	1	1	1.96	1.96	1.96	0
Semivolatile Organic Compounds (µg/L)						
Bis(2-ethylhexyl)phthalate	3	2	1.30	1.55	1.80	0
Naphthalene	3	2	2.10	2.85	3.60	0
Inorganic Compounds (mg/L)						
Chloride	3	3	19,000	19,733	20,600	3
Sulfate	3	3	2,170	2,383	2,600	3
Iron	3	3	3.80	10.0	19.9	3
Magnesium	3	3	170	185	204	3
Manganese	3	3	0.65	0.81	1.09	3
Sodium	3	3	10,880	12,333	13,120	3
Barium	3	3	0.03	0.07	0.12	0
Chromium	3	2	0.007	0.02	0.03	0
Lead	3	1	0.02	0.02	0.02	0
Zinc	3	1	0.04	0.04	0.04	0
Calcium	3	3	1,690	1,750	1,860	NA
Potassium	3	3	74.8	106	144	NA
Aluminum	2	2	1.60	9.80	18.0	NA
Ammonia	1	1	7.40	7.40	7.40	NA

Notes:
1 – Exceeds NYSDEC Class GA ground water standards and guidance values.
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

Ground water from HB-HB-08D had concentrations of BTEX in deep ground water in exceedence of ground water standards. The major component is ethylbenzene. The total BTEX concentrations were

several orders of magnitude lower than the deep wells (HB-HB-12D and HB-HB-13D) on the eastern portion of the Penn-Can Property (**Figure 91**). Naphthalene and PAHs were also detected in HB-HB-08D. These compounds were also several orders of magnitude lower than the deep wells on the eastern portion of the Penn-Can Property (**Figures 94 and 97**). Phenols were not detected in the deep ground water at the Railroad Area (**Figure 100**).

4.3.4. AOS#1 Ground Water

AOS#1 ground water samples were collected during the RI and Supplemental RI field programs. Sample locations are presented on **Figure 6**. Three shallow wells, one intermediate, and one deep well were installed in AOS#1 as part of the RI. These wells were sampled as part of the RI field program in May 2003 and August 2003. Samples collected as part of the RI were analyzed for VOCs, SVOCs, pesticides, PCBs, inorganics including major cations and anions. The RI ground water data are provided on **Tables 163 through 168**.

One round of ground water samples was collected during the Supplemental RI in AOS#1. Samples collected as part of the Supplemental RI were analyzed for VOCs, SVOCs, pesticides, PCBs, inorganics including major cations and anions, alkalinity, hardness, ammonia, TKN, and CBOD. The Supplemental RI ground water data are provided on **Tables 169 through 174**.

AOS#1 Shallow Ground Water

Summaries of shallow ground water sample locations and analyses performed during the RI and Supplemental RI at AOS#1 are provided in **Tables 26 and 27**, respectively. Summary statistics are provided on **Table 184** for shallow ground water chemical parameters detected at AOS#1. Chemical parameters that were detected in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included as CPOIs and included in **Table 4.22**.

Table 4.22. *Detected AOS #1 Shallow Ground Water CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (μg/L)						
Benzene	9	4	0.51	1.16	2.10	2
Toluene	9	4	0.25	7.80	17.6	2
Acetone	9	7	4.00	12.4	24.0	0
Carbon disulfide	9	3	0.23	1.13	2.90	0
Ethylbenzene	9	3	0.13	0.19	0.24	0
Xylenes, Total	3	3	0.52	0.61	0.73	0
1,4-Dichlorobenzene	3	2	0.20	0.23	0.26	0
2-Butanone	9	2	2.03	2.08	2.12	0
Isopropylbenzene	3	2	0.11	0.12	0.13	0
Semivolatile Organic Compounds (μg/L)						
Phenol	9	8	1.40	82.2	230	8
2-Methylphenol	9	6	1.80	3.03	4.20	6
Naphthalene	9	7	1.90	14.8	38.0	5
4-Methylphenol	3	2	22.0	33.0	44.0	2
Bis(2-ethylhexyl)phthalate	9	7	1.00	2.76	6.70	1
Acenaphthene	9	7	1.60	4.64	7.70	0

Table 4.22. *Detected AOS #1 Shallow Ground Water CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Fluorene	9	7	1.20	3.40	4.80	0
Phenanthrene	9	7	2.00	5.39	9.50	0
Fluoranthene	9	5	0.97	1.29	2.00	0
Anthracene	9	3	1.30	1.47	1.80	0
Pyrene	9	3	1.10	1.33	1.70	0
2-Methylnaphthalene	9	7	1.50	2.74	4.70	NA
3&4-Methylphenol	6	6	1.10	9.52	17.0	NA
Dibenzofuran	9	5	1.20	1.50	1.80	NA
Carbazole	9	4	1.00	1.43	2.30	NA
Inorganic Compounds (mg/L)						
Chloride	9	9	1,800	4,723	11,700	9
Sodium	9	9	910	1,922	4,620	9
Iron	9	9	0.17	6.96	43.0	7
Manganese	9	7	0.11	1.74	5.11	6
Barium	9	9	0.19	0.68	2.12	2
Lead	9	3	0.01	0.02	0.03	1
Magnesium	9	8	0.70	14.1	33.6	0
Sulfate	9	7	3.50	23.2	88.0	0
Cyanide	9	4	0.015	0.019	0.023	0
Chromium	7	3	0.002	0.006	0.01	0
Mercury	9	3	0.00004	0.0002	0.0004	0
Copper	9	2	0.006	0.01	0.02	0
Calcium	9	9	400	1,004	1,940	NA
Potassium	9	9	19.0	56.5	101	NA
Aluminum	9	6	0.12	0.83	2.23	NA
Nickel	9	3	0.002	0.004	0.006	NA
Ammonia	1	1	17.0	17.0	17.0	NA

Notes:
1 – Exceeds NYSDEC Class GA ground water standards and guidance values.
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

Three shallow wells were installed in AOS#1 and include:

- HB-HB-18S
- HB-HB-19S
- HB-HB-20S

The highest concentrations of BTEX in AOS#1 shallow ground water were detected in the southwest corner of AOS #1 at well HB-HB-18S (**Figure 89**). Naphthalene and PAHs in the shallow ground water had similar concentrations between the three wells (**Figures 92 and 95**). Phenols tended to have higher concentrations at in wells HB-HB-18S and HB-HB-19S than at HB-HB-20S (**Figure 98**). Mercury was detected in HB-HB-19S and HB-HB-20S. The constituents detected in the shallow ground water are likely related to soil concentrations in this area that appear to have been influenced by historic East Flume effluent discharges. This area has likely been impacted by Harbor Brook discharges and this area also appears to have historically received fill. The nature and source of the fill materials is unknown. Overall distribution and concentrations of CPOIs are not consistent when comparing samples from different events. This suggests that concentrations in shallow ground water may be influenced by recharge.

AOS#1 Intermediate Ground Water

Summaries of intermediate ground water sample location and analyses performed during the RI and Supplemental RI at AOS#1 are provided in **Tables 26 and 27**, respectively. Summary statistics are provided on **Table 185** for intermediate ground water chemical parameters detected at AOS#1. Chemical parameters that were detected in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included as CPOIs and included in **Table 4.23**.

Table 4.23. *Detected AOS #1 Intermediate Ground Water CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (μg/L)						
Acetone	3	2	49.0	89.5	130	1
Chloroethane	3	2	4.84	5.57	6.30	1
2-Butanone	3	3	17.8	30.9	41.0	0
1,4-Dichlorobenzene	1	1	0.43	0.43	0.43	0
2-Hexanone	3	1	1.96	1.96	1.96	0
Benzene	3	1	0.35	0.35	0.35	0
Chlorobenzene	3	1	0.11	0.11	0.11	0
Ethylbenzene	3	1	0.11	0.11	0.11	0
Toluene	3	1	0.20	0.20	0.20	0
Xylenes, Total	1	1	0.21	0.21	0.21	0
4-Methyl-2-pentanone	3	1	2.11	2.11	2.11	NA
Semivolatile Organic Compounds (μg/L)						
Phenol	3	2	2.00	2.45	2.90	2
Naphthalene	3	2	1.10	15.1	29.0	1
4-Methylphenol	1	1	68.0	68.0	68.0	1
1,4-Dichlorobenzene	2	2	1.20	2.10	3.00	1
Bis(2-ethylhexyl)phthalate	3	2	3.80	4.00	4.20	0
Phenanthrene	3	2	2.00	2.20	2.40	0
Acenaphthene	3	1	2.20	2.20	2.20	0
Di-n-butyl phthalate	3	1	3.70	3.70	3.70	0
2-Methylnaphthalene	3	2	1.50	2.65	3.80	NA
3&4-Methylphenol	2	2	130	140	150	NA
Inorganic Compounds (mg/L)						
Chloride	3	3	19,000	35,033	43,600	3
Barium	3	3	1.30	1.95	2.30	3
Iron	3	3	2.10	13.7	22.9	3
Magnesium	3	3	160	240	283	3
Sodium	3	3	13000	20,950	26,650	3
Manganese	3	3	0.28	0.67	0.88	2
Copper	3	2	0.13	0.22	0.30	1
Lead	3	1	0.03	0.03	0.03	1
Sulfate	3	2	114	138	162	0
Chromium	3	1	0.03	0.03	0.03	0
Mercury	3	1	0.0002	0.0002	0.0002	0
Zinc	3	1	0.12	0.12	0.12	0
Calcium	3	3	490	795	1,010	NA
Potassium	3	3	55.0	106	184	NA
Ammonia	1	1	93.0	93.0	93.0	NA
Aluminum	2	1	1.73	1.73	1.73	NA
Vanadium	3	1	0.008	0.008	0.008	NA

Table 4.23. *Detected AOS #1 Intermediate Ground Water CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]

Notes:
1 – Exceeds NYSDEC Class GA ground water standards and guidance values.
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

HB-HB-20I is the only well in the intermediate zone in AOS #1. BTEX, naphthalene, and PAHs were detected in the intermediate ground water (**Figures 90, 93, and 96**). Phenols are the primary CPOIs in ground water from this well (**Figure 99**). The high values of inorganic compounds, namely Na, Ca, Cl, Fe, and Mg, are associated with native brine and Solvay waste. Mercury was detected in one of the three sampling events at this well (**Figure 102**). The mercury at this location is likely related to historic discharges from the East Flume related to the formation of the ILWD.

AOS#1 Deep Ground Water

Summaries of deep ground water sample location and analyses performed during the RI and Supplemental RI at AOS#1 are provided in **Tables 26 and 27**, respectively. Summary statistics are provided on **Table 186** for deep ground water chemical parameters detected at AOS#1. Chemical parameters that were detected in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included as CPOIs and included in **Table 4.24**.

Table 4.24. *Detected AOS #1 Deep Ground Water CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (μg/L)						
Chloroethane	3	3	4.30	14.1	32.6	2
Acetone	3	2	14.0	25.5	36.9	0
2-Butanone	3	1	10.9	10.9	10.9	0
2-Hexanone	3	1	6.28	6.28	6.28	0
Toluene	3	1	0.53	0.53	0.53	0
4-Methyl-2-pentanone	3	1	1.29	1.29	1.29	NA
Semivolatile Organic Compounds (μg/L)						
3&4-Methylphenol	2	1	1	1	1	0
Inorganic Compounds (mg/L)						
Chloride	3	3	100,000	112,333	112,000	3
Sulfate	3	3	2,880	2,993	3,100	3
Magnesium	3	3	552	594	620	3
Manganese	3	3	1.81	1.92	2.10	3
Sodium	3	3	62,000	67,520	75,520	3
Iron	3	3	0.29	5.49	9.89	2
Chromium	3	1	0.12	0.12	0.12	1
Barium	3	3	0.10	0.12	0.13	0
Copper	3	2	0.09	0.11	0.14	0
Calcium	3	3	2,900	2,900	2,900	NA
Potassium	3	3	357	466	580	NA
Aluminum	2	1	1.52	1.52	1.52	NA

Notes:
1 – Exceeds NYSDEC Class GA ground water standards and guidance values.
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

Only one exceedence for organic CPOIs, chloroethane specifically, have been detected in the deep ground water at HB-HB-20D. The high values of inorganic compounds, namely Na, Ca, Cl, Fe, and Mg, are associated with native brine. The deep ground water does not appear to be influenced by upgradient sources associated with the Penn-Can Property due to the lack of organic compounds detected in the ground water and the native brine signature of the water.

4.3.5. AOS#2 Ground Water

AOS#2 ground water samples were collected during the RI and Supplemental RI field programs. Sample locations are presented on **Figure 6**. One intermediate well was installed in AOS#2 as part of the RI. This well was sampled as part of the RI field program in May 2003 and August 2003. Samples collected as part of the RI were analyzed for VOCs, SVOCs, pesticides, PCBs, inorganics including major cations and anions. The RI ground water data are provided on **Tables 163 through 168**.

One round of ground water samples was collected during the Supplemental RI in AOS#2. Samples collected as part of the Supplemental RI were analyzed for VOCs, SVOCs, pesticides, PCBs, inorganics including major cations and anions, alkalinity, hardness, ammonia, TKN, and CBOD. The Supplemental RI ground water data are provided on **Tables 169 through 174**.

AOS#2 Intermediate Ground Water

Summaries of intermediate ground water sample location and analyses performed during the PSA, RI, and Supplemental RI at AOS#2 are provided in **Tables 26 and 27**, respectively. Summary statistics are provided on **Table 187** for intermediate ground water chemical parameters detected at AOS#2. Chemical parameters that were detected in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included as CPOIs and included in **Table 4.25**.

Table 4.25. *Detected AOS #2 Intermediate Ground Water CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (μg/L)						
Benzene	3	3	850	908	960	3
Ethylbenzene	3	3	240	273	300	3
o-Xylene	2	2	87.0	104	120	2
Toluene	3	2	11.6	16.8	22.0	2
Xylenes, m & p	2	2	91.0	111	130	2
Styrene	3	2	3.04	7.52	12.0	1
Xylenes, Total	1	1	92.7	92.7	92.7	1
1,1-Dichloroethane	3	1	0.25	0.25	0.25	0
Acetone	3	1	1.16	1.16	1.16	0
Carbon disulfide	3	1	0.11	0.11	0.11	0
Chlorobenzene	3	1	1.27	1.27	1.27	0
Isopropylbenzene	1	1	14.5	14.5	14.5	NA
Semivolatile Organic Compounds (μg/L)						
Naphthalene	3	3	1,100	1,700	2,200	3
2,4-Dimethylphenol	3	3	45.0	148	200	2
Bis(2-ethylhexyl)phthalate	3	1	7.90	7.90	7.90	1
Phenol	3	1	9.00	9.00	9.00	1
Acenaphthene	3	2	2.60	3.30	4.00	0
Acenaphthylene	3	2	5.00	5.10	5.20	0
2-Methylnaphthalene	3	1	3.50	3.50	3.50	NA
Pesticides (μg/L)						

Table 4.25. *Detected AOS #2 Intermediate Ground Water CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
4,4'-DDD	3	1	0.02	0.02	0.02	0
Inorganic Compounds (mg/L)						
Chloride	3	3	3,910	4,427	4,700	3
Iron	3	3	1.80	6.36	12.5	3
Manganese	3	3	0.31	0.42	0.55	3
Sodium	3	3	2,360	2,737	3,000	3
Chromium	3	3	0.004	0.05	0.14	1
Magnesium	3	3	21.0	37.2	64.0	1
Lead	3	2	0.009	0.06	0.10	1
Copper	3	1	1.23	1.23	1.23	1
Sulfate	3	3	120	170	205	0
Barium	3	3	0.21	0.24	0.28	0
Cyanide	3	3	0.02	0.03	0.04	0
Zinc	3	1	0.03	0.03	0.03	0
Calcium	3	3	329	366	398	0
Potassium	3	3	29.0	32.0	35.1	NA
Aluminum	2	2	1.40	5.75	10.1	NA
Nickel	3	2	0.002	0.05	0.09	NA
Vanadium	3	1	0.002	0.002	0.002	NA

Notes:
1 – Exceeds NYSDEC Class GA ground water standards and guidance values.
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

HB-HB-21I is the only well on AOS #2. Total BTEX concentrations in this well are similar to the concentrations detected in the Railroad Area (HB-HB-08I). Total BTEX intermediate ground water concentrations are presented on **Figure 90**.

Naphthalene and total PAH concentrations were also similar to the concentrations detected in the Railroad Area. Naphthalene and total PAH concentrations in intermediate ground water are presented on **Figures 93 and 96**, respectively. Total phenol concentrations were lower than at the Railroad Area. Concentrations for each of these CPOIs have decreased from historic data to the 2007 sampling event. Mercury was also not detected at HB-HB-08I. The CPOIs found in well HB-HB-21I may be related to previous activities at the Penn-Can Property.

4.3.6. SYW-12 Ground Water

SYW-12 subsurface soil samples were collected during the Supplemental RI field program. Sample locations are presented on **Figure 8**. Ground water screening samples were collected from nine locations (HB-GWS-01 through HB-GWS-09). These samples were analyzed for VOCs, SVOCs, pesticides, PCBs, inorganics, hardness, and alkalinity. The ground water screening data are presented on **Tables 188 through 193**. One round of ground water samples was collected during the Supplemental RI in SYW-12. Samples collected as part of the Supplemental RI were analyzed for VOCs, SVOCs, pesticides, PCBs, inorganics including major cations and anions, alkalinity, hardness, ammonia, TKN, and CBOD. The Supplemental RI ground water data are provided on **Tables 194 through 199**.

SYW-12 Shallow Ground Water

A summary of shallow ground water sample locations and analyses performed during the Supplemental RI at SYW-12 are provided in **Table 27**. Summary statistics are provided on **Table 200**

for shallow ground water chemical parameters detected at SYW-12. Chemical parameters that were detected in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included as CPOIs and included in **Table 4.26**.

Table 4.26. *Detected SYW-12 Shallow Ground Water CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (μg/L)						
Isopropylbenzene	9	3	0.23	1.91	5.25	1
Xylenes, Total	9	3	0.45	5.41	15.2	1
Ethylbenzene	9	1	14.8	14.8	14.8	1
1,2-Dichlorobenzene	9	4	0.12	0.16	0.21	0
Chlorobenzene	9	4	0.17	0.25	0.30	0
Acetone	9	3	1.31	1.44	1.57	0
1,4-Dichlorobenzene	9	2	0.10	0.22	0.34	0
Carbon disulfide	9	2	0.11	0.115	0.12	0
Semivolatile Organic Compounds (μg/L)						
Acenaphthene	9	5	1.40	11.4	41.0	1
4-Methylphenol	9	1	2.00	2.00	2.00	1
4-Nitrophenol	9	1	1.10	1.10	1.10	1
Naphthalene	9	1	170	170	170	1
Anthracene	9	2	1.20	2.10	3.00	0
Bis(2-ethylhexyl)phthalate	9	2	1.10	1.20	1.30	0
Fluorene	9	2	2.70	7.35	12.0	1
Phenanthrene	9	2	5.50	11.3	17.0	0
Pyrene	9	2	1.00	1.45	1.90	0
Inorganic Compounds (mg/L)						
Chloride	9	9	380	2,893	6,100	9
Iron	9	9	3.80	13.2	23.0	9
Sodium	9	9	250	1,700	3,400	9
Manganese	9	9	0.27	0.56	1.10	8
Magnesium	9	9	23.0	52.8	110	5
Barium	9	9	0.12	0.49	1.30	2
Chromium	9	4	0.009	0.05	0.16	1
Lead	9	4	0.005	0.02	0.04	1
Copper	9	5	0.002	0.008	0.01	0
Zinc	9	3	0.02	0.03	0.04	0
Mercury	9	2	0.00008	0.0001	0.00012	0
Calcium	9	9	220	463	970	NA
Nickel	9	9	0.002	0.01	0.06	NA
Potassium	9	9	9.00	27.8	69.0	NA
Aluminum	9	8	0.04	0.64	1.80	NA
Vanadium	9	4	0.002	0.0026	0.003	NA
Ammonia	3	3	5.50	25.5	36.0	NA

Notes:
1 – Exceeds NYSDEC Class GA ground water standards and guidance.
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

Detected shallow ground water CPOIs are discussed below. The distribution of selected CPOIs are presented for the shallow ground water on **Figure 104** (total BTEX), **Figure 105** (total PAHs), and **Figure 106** (chloride and sodium).

There are few exceedances of the groundwater Class GA standards and guidance values for the organic constituents suggesting that organic constituents detected in surface and subsurface soils are generally not mobilizing to groundwater. The well with the highest concentration of BTEX and PAHs was HB-B-04W located in the center portion of the Site adjacent to Onondaga Lake. This area was filled, but the nature of the material used for fill is unknown. However, it is possible that material from the current Onondaga Creek channel was placed in this area when it was widened and/or deepened to allow for barge traffic. Furthermore, it is possible that materials dredged from the southern portion of Onondaga Lake may have been disposed of in this area. In addition, this area may have been influenced by potential upgradient sources as well

Inorganics detected in shallow ground water at SYW-12 include sodium and chloride, and the highest concentrations of sodium and chloride were detected at HB-MW-23.

4.3.7. Ground Water Nature and Extent Summary

Shallow Ground Water

Organic CPOIs are found in the shallow ground water in the areas adjacent to Onondaga Lake that are likely influenced by historic East Flume discharges. The DSAs also received spoils materials during the installation of the diffuser building water intake pipe and these materials are likely affecting ground water quality within these areas. The areas adjacent to Harbor Brook, AOS#1 and Wetland Area WL2, are also likely influenced to some degree by Harbor Brook discharges. The nature of the organic compounds found in the ground water is related to the compounds found in the soils, and the changes in concentrations that are observed over the various sampling events appear to fluctuate seasonally in relation to recharge.

One well also appears to be impacted by high concentrations of organic CPOIs on Wastebed B in the Lakeshore Area (HB-WB-BU). This well is not located in an area where sediments associated with historic East Flume discharges would have been deposited. Since the bottom of the screen of this well is located at the fill/marl contact, it is likely that water samples from these wells reflect the quality of ground water in the upper part of the marl unit or intermediate ground water zone. It is likely that the water at this location is being influenced by upgradient sources at the Penn Can Property.

The mercury observed in the shallow ground water is also generally found in the low lying areas along the lakeshore that have likely been impacted by historic East Flume discharges that formed the ILWD. These concentrations do not appear to fluctuate seasonally. Many of the inorganic CPOIs appear to be related primarily to constituents dissolved from the Solvay waste located on the Site.

Intermediate Ground Water

In general, the highest organic CPOIs found in the intermediate ground water are found at the southeast quadrant of the Wastebed B/Harbor Brook Site, specifically the eastern portion of the Penn-Can Property, the northeastern Railroad Area, and eastern AOS #2. The CPOIs found in ground water in these areas are likely related to the DNAPL associated with the subsurface soils. The DNAPL is likely related to historic activities associated with the Barrett facilities, including storage tanks. The organic CPOIs in the intermediate ground water on the Lakeshore Area vary by location and by sampling event. This zone may be an interface zone between the native brine and the upgradient ground water. Inorganic CPOIs vary in a similar fashion to the organic CPOIs in the intermediate ground water. The primary source of the inorganic CPOIs is believed to be the native brine and leachate from Solvay waste.

Deep Ground Water

The highest concentrations of organic CPOIs in the deep ground water are found on the Penn-Can Property. The CPOIs found in ground water in this area are likely related to the DNAPL associated with the subsurface soils. The DNAPL is likely related to historic activities associated with the Barrett facilities, which included storage tanks. The deep wells along the lakeshore (HB-HB-05D and HB-HB-20D) do not contain detected concentrations of Site related organic contaminants. The native brines appear to be effectively reducing hydraulic gradients sufficiently enough to limit the flow of deep ground water from the Penn-Can Property to the lake. The extent of horizontal migration of the coal tar-like DNAPL within the deep ground water zone is theoretically dependent on the density of the native brine combined with the relatively low density of the coal tar-like DNAPL, the viscosity of the coal tar-like DNAPL, and the volume of the DNAPL release. The chemical and physical properties are discussed in greater detail within Section 4.11.1 and the fate and transport of the coal tar-like DNAPL is discussed in section 6.3. The primary sources of the inorganic CPOIs in the deep ground water zone are believed to be the native halite brine along the lakeshore and leachate from Solvay waste on the Penn-Can Property.

Vertical Extent of Ground Water Impacts

The vertical extent of ground water impacts at the Wastebed B/Harbor Brook site varies amongst the different areas of the Site, but is to a large extent dependent upon the distribution of DNAPL at the Site. The following section describes the vertical extent of ground water impacts and relates the impacts to ground water flow and the distribution of NAPL at the site. Concentrations of BTEX, naphthalene, phenol and PAHs are used as the primary constituents to discuss the vertical extent because they represent the majority of the site constituents impacting ground water. **Figures 89 through 100** present the ground water results for these constituents by ground water zone.

The Penn-Can property is an area of ground water recharge where there is a component of downward ground water flow. This area is the source of much of the NAPL encountered at the site. NAPL is present from near the ground surface to the top of till. Impacted ground water extends from the intermediate ground water zone to the deep ground water zone in this area. The shallow ground water shows no impact to low concentration impacts. Well nests HB-HB-12S/I/D and HB-HB-14S/D provide a representation of the vertical extent of ground water impacts in this area. The vertical extent of ground water impacts generally correlates to the vertical extent of NAPL. The relatively limited shallow groundwater impacts likely reflect ground water recharge that has limited contact with the deeper NAPL.

The vertical extent of ground water impacts in the Railroad Area, represented by well nest HB-HB-8S/I/D, is primarily confined to the intermediate ground water zone. Shallow ground water in this area, which represents ground water recharge, shows no impact to low concentrations. The deep ground water, located below the silt and clay confining layer, shows no impact to low concentration impacts. This distribution of ground water impacts is again consistent with the distribution of the coal –tar DNAPL. In the railroad area DNAPL is present in the marl, but not in the shallow or deep ground water zones. Shallow and intermediate ground water flow in the railroad area is generally horizontal to downward except in the immediate vicinity of Harbor Brook where there is an upward ground water flow as the intermediate ground water discharges to the brook. It should be noted that the brook is lined with stone block in this area and water enters the brook at the seams between the stone blocks. Therefore, shallow ground water will not tend to encounter the DNAPL in the intermediate ground water zone and as a result shows limited impacts. The intermediate ground water is in contact with the DNAPL and the ground water concentrations are elevated.

Wastebed B covers a relatively large area and shows some variability with regards to the vertical extent of ground water impacts. For the majority of the wastebed, the deep ground water has not been impacted as evidenced by ground water quality results at HB-HB-4D, HB-HB-5D, and HB-HB-1D. The vertical extent of ground water impacts generally includes the shallow ground water zone with some portions of the wastebed also showing intermediate ground water impacts (HB-HB-4S, HB-HB-2S/I, HB-HB-5S/I, and HB-HB-1S). Across much of the wastebed ground water flow is generally horizontal to slightly downward between the shallow and intermediate ground water zones. Therefore the vertical extent of ground water impacts likely reflects a combination of upgradient (Penn-Can) ground water and ground water interaction with NAPL and impacted soils in wastebed B.

The SYW-12 area only has shallow monitoring wells. Given its location in a low area adjacent to Onondaga Lake, ground water flow is expected to be generally horizontal to upward. Consequently, the vertical extent of ground water impacts from the site can be expected to reflect the vertical extent of impacted soils on the site.

4.4. Surface Water Characterization

Three rounds of surface water samples were collected; one round during the PSA and two rounds during the RI. Surface water sample locations are presented on **Figure 7**. Samples collected as part of the PSA were analyzed for VOCs, SVOCs, pesticides, PCBs, and inorganics. The PSA surface water data are provided on **Tables 201 through 205**. RI round 1 samples were analyzed for VOCs, SVOCs, pesticides, PCBs, inorganics, high resolution mercury, and other parameters (*i.e.*, bicarbonate, carbonate, chloride, hardness, sulfate, alkalinity, and pH) and the data are provided on **Tables 206 through 212**, respectively. RI round 2 samples were analyzed for VOCs, SVOCs, pesticides, PCBs, inorganics, and other parameters (*i.e.*, bicarbonate, carbonate, chloride, hardness, sulfate, alkalinity, and pH) and the data are provided on **Tables 213 through 218**, respectively. East Flume surface water was not collected as part of this RI. However, East Flume surface water data are collected as part of the State Pollution Discharge Permit

Surface water was collected from Harbor Brook, the Penn-Can Property ditch, the Railroad Area ditches, and the I-690 drainage ditch. A summary of the surface water sample locations and analyses performed during the PSA and RI are provided in **Tables 28 and 30**, respectively.

Surface water sampling locations and selected CPOIs including total BTEX, naphthalene, total PAHs, total phenols, and mercury are presented on **Figure 107**. A brief description of the analytical results for the PSA and the RI is presented below. For the purposes of nature and extent discussion below, the surface water samples from the PSA and RI have been combined for each of the five sub-areas.

4.4.1. Lakeshore Area (I-690 Drainage Ditch)

Two surface water samples (HB-HBSW-12 and HB-HBSW-13) were collected from the drainage ditch adjacent to I-690 during the PSA. No surface water was collected at location HB-HBSW-11 because it was dry. Two samples were collected from three proposed locations within the drainage ditch on the Lakeshore Area adjacent to I-690 during the first round of RI sampling. No samples were collected during the second round of sampling because they were dry.

Summary statistics are provided on **Table 219** for surface water constituents detected in the I-690 drainage ditch. Detected constituents of potential interest are listed below in **Table 4.27**. Constituents that were detected at in at least twenty percent of the samples or exceeded standards or guidance

values discussed in Section 5 of this report in at least one of the samples were included in the list below.

Table 4.27. *Detected I-690 Drainage Ditch Surface Water CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (µg/L)						
Benzene	5	5	9.60	50.3	130	4
Toluene	5	5	28.0	112	270	2
Xylenes, Total	2	2	77.0	189	300	2
Ethylbenzene	5	5	2.90	9.44	21.0	1
Xylenes, m & p	3	3	25.0	64.3	140	1
1,2,4-Trimethylbenzene	2	2	16.0	41.5	67.0	1
Naphthalene	1	1	580	580	580	1
o-Xylene	3	3	11.0	25.3	53.0	0
Styrene	5	5	3.10	9.90	22.0	0
Acetone	5	3	11.0	13.3	17.0	0
1,3,5-Trimethylbenzene	2	2	6.00	16.0	26.0	0
2-Butanone	5	2	1.00	1.50	2.00	0
Semivolatile Organic Compounds (µg/L)						
2-Methylnaphthalene	5	5	19.0	67.8	160	5
Fluorene	5	5	2.20	12.7	27.0	5
Naphthalene	5	5	160	622	1,400	5
Phenol	5	5	17.0	300	700	5
Acenaphthene	5	5	3.40	12.2	25.0	4
Phenanthrene	5	5	2.50	13.8	27.0	4
2,4-Dimethylphenol	5	3	2.50	6.97	11.0	2
2-Methylphenol	5	5	8.90	66.4	97.0	NA
3&4-Methylphenol	5	5	7.00	119	210	NA
Carbazole	5	5	5.00	19.0	30.0	NA
Dibenzofuran	5	5	4.10	16.7	35.0	NA
Acenaphthylene	5	4	2.20	7.43	11.0	NA
Pesticides (µg/L)						
4,4'-DDD	5	1	0.21	0.21	0.21	1
Inorganic Compounds (mg/L)						
Cyanide	5	2	0.04	0.05	0.07	2
Aluminum	5	1	0.11	0.11	0.11	1
Lead	5	3	0.004	0.005	0.006	0
Mercury (High Resolution)[3, 4]	3	3	25.0	91.8	157	0
Chromium	5	2	0.007	0.009	0.011	0
Copper	5	2	0.007	0.009	0.01	0
Iron	5	2	0.011	0.013	0.015	0
Nickel	5	2	0.002	0.0022	0.0024	0
Vanadium	5	2	0.002	0.003	0.004	0
Beryllium	5	1	0.0001	0.0001	0.0001	0
Mercury[4]	5	1	0.0005	0.0005	0.0005	0
Selenium	5	1	0.003	0.003	0.003	0
Barium	5	5	0.03	0.06	0.10	NA
Calcium	5	5	80.9	266	542	NA
Magnesium	5	5	0.23	1.72	3.85	NA
Potassium	5	5	12.0	14.9	16.7	NA
Sodium	5	5	360	511	662	NA
Chloride	3	3	873	881	896	NA
Sulfate	3	3	97.7	117	130	NA

Table 4.27. *Detected I-690 Drainage Ditch Surface Water CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]

Notes:
1 – Exceeds NYSDEC Class C Surface Water standards and guidance values.
2 – Mean concentration values have been rounded.
3 - High resolution mercury is presented in units of ng/L.
4 – Mercury does not exceed the Aquatic (Chronic) or A(C) Class C surface water standard; however, the mercury levels may exceed Class C standards for Protection of Human Health [H(FC)] and Protection of Wildlife (W). Additional screening of mercury was completed as part of the Human Health and Ecological Risk Assessments.
NA = Not applicable as no criteria available.

The VOCs detected at the Lakeshore Area included 1,2,4- and 1,3,5-trimethylbenzene, 2-butanone, styrene, naphthalene, and BTEX at detected concentrations ranging from 1 μg/L to 1,500 μg/L. Predominant SVOCs detected included 2-methylnaphthalene, naphthalene, carbazole, dibenzofuran, phenols and assorted PAHs at detected concentrations ranging from 2.2 μg/L to 1,400 μg/L. The only pesticide detected was 4,4'-DDD. It was detected during the first round of RI surface sampling at location HB-HBSW-13 at a concentration of 0.21 μg/L. PCBs were not detected in any of the surface water samples. Inorganics were detected in both of the samples including barium, chromium, lead, mercury and cyanide. Mercury was detected in each of the samples that were analyzed using the high resolution analysis method.

The VOCs and SVOCs detected within the drainage ditch surface water are likely related to run-off from I-690 and sediments within the drainage ditch. However, this ditch likely receives radial shallow ground water flow from Wastebed B and from beneath I-690, especially during times of high water.

4.4.2. Penn-Can Property

Three surface water samples (HB-HBSW-01 through HB-HBSW-03) were collected from the drainage swale adjacent to the CSX mainline on the southern side of the Penn-Can Property during the PSA. Three samples were collected from three locations within the drainage ditch on the southern side of the Penn-Can Property during the first round of RI sampling. No samples were collected during the second round because the locations were dry.

Summary statistics are provided on **Table 220** for surface water constituents detected in the Penn-Can Property ditch. Detected constituents of potential interest are listed below in **Table 4.28**. Constituents that were detected at in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included in the list below.

Table 4.28. *Detected Penn-Can Property Surface Water CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (μg/L)						
Naphthalene	3	2	12.0	171	330	1
1,2,4-Trimethylbenzene	3	2	0.50	5.75	11.0	0
Benzene	6	2	0.80	3.90	7.00	0
Ethylbenzene	6	2	0.10	3.55	7.00	0
Toluene	6	2	2.00	2.50	3.00	0
Xylenes, Total	3	2	2.00	7.00	12.0	0

Table 4.28. *Detected Penn-Can Property Surface Water CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Acetone	6	2	11.0	12.5	14.0	NA
1,3,5-Trimethylbenzene	3	1	0.20	0.20	0.20	NA
Semivolatile Organic Compounds (μg/L)						
2-Methylnaphthalene	6	1	5.00	5.00	5.00	1
Acenaphthene	6	1	23.0	23.0	23.0	1
Fluorene	6	1	19.0	19.0	19.0	1
Phenanthrene	6	1	14.0	14.0	14.0	1
Naphthalene	6	1	350	350	350	1
Phenol	6	2	4.00	4.00	4.00	0
Benzoic acid	3	2	2.00	3.00	4.00	NA
Inorganic Compounds (mg/L)						
Iron	6	6	0.08	2.15	11.4	3
Cyanide	6	2	0.01	0.02	0.03	3
Aluminum	6	2	0.11	0.72	1.33	2
Arsenic	6	3	0.003	0.008	0.01	0
Chromium	6	3	0.0015	0.0022	0.0026	0
Mercury (High Resolution)[3, 4]	3	3	3.60	16.8	33.2	0
Nickel	6	3	0.001	0.002	0.003	0
Selenium	6	3	0.002	0.0021	0.0023	0
Barium	6	6	0.009	0.04	0.10	NA
Calcium	6	6	36.7	84.0	196	NA
Magnesium	6	6	4.84	14.6	24.8	NA
Potassium	6	6	5.90	7.54	8.93	NA
Sodium	6	6	53.0	73.4	84.5	NA
Manganese	6	5	0.02	0.40	1.80	NA
Chloride	3	3	46.8	60.3	71.9	NA
Sulfate	3	3	95.5	127	154	NA

Notes:
1 – Exceeds NYSDEC Class C Surface Water standards and guidance values.
2 – Mean concentration values have been rounded.
3 - High resolution mercury is presented in units of ng/L.
4 – Mercury does not exceed the Aquatic (Chronic) or A(C) Class C surface water standard; however, the mercury levels may exceed Class C standards for Protection of Human Health [H(FC)] and Protection of Wildlife (W). Additional screening of mercury was completed as part of the Human Health and Ecological Risk Assessments.
NA = Not applicable as no criteria available.

VOC CPOIs detected during the PSA included 1,2,4- and 1,3,5-trimethylbenzene, acetone, naphthalene, and BTEX at concentrations ranging from 0.5 μg/L to 330 μg/L. No VOCs were detected during the RI sampling. SVOC CPOIs detected during the PSA included 2-methylnaphthalene, benzoic acid, naphthalene, phenols, and assorted PAHs at concentrations ranging from 1 μg/L to 350 μg/L. No SVOCs were detected during within the RI samples. No pesticides or PCBs were detected in the PSA or RI surface water samples. Inorganics were detected in both of the samples including arsenic, barium, chromium and cyanide. Mercury was not detected in any of these samples using conventional laboratory analysis. Mercury was detected in each of the samples that were analyzed using the high resolution analysis method.

The VOCs and SVOCs detected within this drainage ditch surface water are likely impacted by run-off the adjacent Penn-Can Property. This ditch is likely impacted to some extent by radial shallow ground water flow the Penn-Can Property during times of high water.

4.4.3. Railroad Area

One surface water sample (HB-HBSW-05) was collected from the southern drainage ditch running through the center of the Railroad Area during the PSA. Two samples were collected from two locations (HB-HBSW-04 and HB-HBSW-05) within the Railroad Area during round 1 of the RI. Location HBSW-04 was not sampled during round 2 of the RI because it was dry.

Summary statistics are provided on **Table 221** for surface water constituents detected in the Railroad Area ditch. Detected constituents of potential interest are listed below in **Table 4.29**. Constituents that were detected at in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included in the list below.

Table 4.29. *Detected Railroad Area Surface Water CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (μg/L)						
1,2,4-Trimethylbenzene	1	1	0.20	0.20	0.20	0
Benzene	4	1	0.30	0.30	0.30	0
Naphthalene	1	1	4.00	4.00	4.00	0
Toluene	4	1	0.80	0.80	0.80	0
Xylenes, Total	1	1	0.80	0.80	0.80	0
Semivolatile Organic Compounds (μg/L)						
Benzo(a)anthracene	4	1	1.60	1.60	1.60	1
Benzo(a)pyrene	4	1	2.00	2.00	2.00	1
Bis(2-ethylhexyl)phthalate	4	1	5.20	5.20	5.20	1
Phenanthrene	4	1	1.30	1.30	1.30	0
Pyrene	4	2	1.60	2.30	3.00	0
Benzo(b)fluoranthene	4	1	1.60	1.60	1.60	NA
Benzo(g,h,i)perylene	4	1	1.90	1.90	1.90	NA
Benzo(k)fluoranthene	4	1	1.60	1.60	1.60	NA
Chrysene	4	2	1.10	1.55	2.00	NA
Fluoranthene	4	2	1.70	2.70	3.70	NA
Indeno(1,2,3-cd)pyrene	4	1	1.40	1.40	1.40	NA
Inorganic Compounds (mg/L)						
Aluminum	4	4	0.11	0.93	2.13	4
Iron	4	4	0.16	1.77	3.70	3
Cyanide	4	1	0.01	0.011	0.012	1
Lead	4	3	0.004	0.02	0.04	0
Zinc	4	3	0.02	0.04	0.07	0
Copper	4	2	0.01	0.02	0.023	0
Mercury (High Resolution)[3, 4]	2	2	2.70	13.1	23.5	0
Arsenic	4	1	0.003	0.003	0.003	0
Chromium	4	1	0.004	0.004	0.004	0
Nickel	4	1	0.002	0.002	0.002	0
Selenium	4	1	0.003	0.003	0.003	0
Vanadium	4	1	0.001	0.001	0.001	0
Calcium	4	4	56.8	133	186	NA
Magnesium	4	4	27.2	35.5	47.6	NA
Potassium	4	4	3.73	8.90	12.0	NA
Sodium	4	4	63.4	618	902	NA
Chloride	3	3	104	745	1,180	NA
Sulfate	3	3	77.0	208	289	NA
Barium	4	3	0.07	0.08	0.09	NA
Manganese	4	3	0.14	0.24	0.38	NA

Table 4.29. *Detected Railroad Area Surface Water CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]

Notes:
1 – Exceeds NYSDEC Class C Surface Water standards and guidance values.
2 – Mean concentration values have been rounded.
3 - High resolution mercury is presented in units of ng/L.
4 – Mercury does not exceed the Aquatic (Chronic) or A(C) Class C surface water standard; however, the mercury levels may exceed Class C standards for Protection of Human Health [H(FC)] and Protection of Wildlife (W). Additional screening of mercury was completed as part of the Human Health and Ecological Risk Assessments.
NA = Not applicable as no criteria available.

VOCs detected in the PSA samples included 1,2,4-trimethylbenzene, naphthalene, benzene, toluene and xylene at concentrations ranging from 0.2 µg/L to 4 µg/L. No VOCs were detected in the samples collected during the RI field program. No SVOCs were detected in the PSA surface water sample (HB-HBSW-05) collected at the Railroad Area. During Round 1 of the RI, detected SVOCs included chrysene, fluoranthene, and pyrene were detected in sample HB-HBSW-05 at concentrations of 1.1 µg/L, 1.7 µg/L, and 1.6 µg/L, respectively. During Round 2 of the RI, SVOCs detected in sample HBSW-05 included bis(2-ethylhexyl)phthalate and assorted PAHs at concentrations ranging from 1.3 µg/L to 5.2 µg/L. No pesticides or PCBs were detected in the PSA or RI surface water samples collected at the Railroad Area. Predominant inorganics were detected included arsenic, barium, chromium, lead and cyanide. Mercury was not detected in any of these samples using conventional laboratory analysis. Mercury was detected in each of the samples that were analyzed using the high resolution analysis method.

The drainage ditch that contains sampling location HB-HBSW-04 appears to transport mainly surface water run-off and likely has little interaction with shallow ground water in the area. Location HB-HBSW-05 is located in a ditch on the southern portion of the Site. This ditch appears to be fed by ground water since it appears to flow year round. The source of the water is likely from the south; the elevation increases steadily to the south from this ditch. Surface water at HB-HBSW-05 is likely impacted to some extent by radial ground water flow from the south to some extent. The concentrations of surface water constituents detected in both ditches are likely impacted by sediments in these ditches.

4.4.4. Harbor Brook Surface Water

Five surface water samples were collected from five locations within Harbor Brook during the PSA. Four of the samples (HB-HBSW-06 through HB-HBSW-09) collected are considered Site samples and one sample (HB-HBSW-10) is considered an upstream sample. Samples were collected from five locations within Harbor Brook for each round of sampling the RI.

Summary statistics are provided on **Table 222** for surface water constituents detected in Harbor Brook. Detected constituents of potential interest are listed below in **Table 4.30**. Constituents that were detected at in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included in the list below.

Table 4.30. *Detected Harbor Brook Surface Water CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]

Table 4.30. *Detected Harbor Brook Surface Water CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (μg/L)						
Naphthalene	5	4	0.80	12.2	27.0	2
Toluene	15	8	0.30	1.48	4.00	0
Benzene	15	6	0.10	1.17	4.00	0
Xylenes, Total	5	5	0.30	1.62	4.00	0
Xylenes, m & p	10	3	1.20	1.43	1.60	0
1,2,4-Trimethylbenzene	5	2	0.90	0.95	1.00	0
cis-1,2-Dichloroethene	15	5	0.20	0.24	0.30	NA
Acetone	15	3	3.00	3.00	3.00	NA
1,3,5-Trimethylbenzene	5	2	0.30	0.35	0.40	NA
Semivolatile Organic Compounds (μg/L)						
Naphthalene	15	6	5.20	375	2,200	2
2-Methylnaphthalene	15	5	1.00	22.6	98.0	2
Acenaphthene	15	2	25.0	26.0	27.0	2
Fluorene	15	2	4.80	8.40	12.0	2
Phenanthrene	15	3	2.10	9.53	24.0	1
Benzo(a)anthracene	15	1	1.00	1.00	1.00	1
Benzo(a)pyrene	15	1	1.20	1.20	1.20	1
Bis(2-ethylhexyl)phthalate	15	1	7.80	7.80	7.80	1
Inorganic Compounds (mg/L)						
Aluminum	15	6	0.02	0.38	1.69	4
Iron	15	15	0.08	0.98	12.3	1
Chromium	15	5	0.0049	0.0054	0.006	0
Mercury (High Resolution)[3, 4]	5	5	1.40	4.94	12.7	0
Nickel	15	5	0.0008	0.0011	0.0014	0
Barium	15	15	0.05	0.07	0.13	NA
Calcium	15	15	181	240	286	NA
Magnesium	15	15	34.1	43.7	50.6	NA
Manganese	15	15	0.017	0.025	0.059	NA
Potassium	15	15	2.97	3.33	3.76	NA
Sodium	15	15	124	162	198	NA
Sulfate	10	10	246	383	474	NA
Chloride	9	9	239	275	321	NA

Notes:
1 – Exceeds NYSDEC Class C Surface Water standards and guidance values.
2 – Mean concentration values have been rounded.
3 - High resolution mercury is presented in units of ng/L.
4 – Mercury does not exceed the Aquatic (Chronic) or A(C) Class C surface water standard; however, the mercury levels may exceed Class C standards for Protection of Human Health [H(FC)] and Protection of Wildlife (W). Additional screening of mercury was completed as part of the Human Health and Ecological Risk Assessments.
NA = Not applicable as no criteria available.

VOCs detected during the PSA included styrene, acetone, naphthalene, 1,2,4- and 1,3,5-trimethylbenzene and BTEX at concentrations ranging from 0.1 μg/L to 29 μg/L. VOCs detected within RI surface water samples collected during the two rounds included benzene, toluene, and xylenes at concentrations ranging from 1.2 μg/L to 1.6 μg/L. SVOCs detected within Harbor Brook PSA samples included 2-methylphenol and 2-methylnaphthalene at concentrations ranging from 0.1 μg/L to 0.2 μg/L. Detected SVOCs within RI samples included, 2-methylnaphthalene, dibenzofuran, naphthalene, phenol, and assorted PAHs at concentrations of these compounds ranged from 1.1 μg/L to 2,200 μg/L. No pesticides or PCBs were detected in the PSA or RI samples collected from Harbor

Brook itself. A variety of inorganic compounds were detected within Harbor Brook. Mercury was not detected in any of these samples using conventional laboratory analysis methods. Mercury was detected in each of the samples that were analyzed using the high resolution analysis method.

Harbor Brook flows through the western side of Syracuse. Harbor Brook also receives surface water run-off from each of the on-Site ditches discussed above. The lower reach of Harbor Brook from the lake to the first culvert likely interacts with shallow ground water. Harbor Brook surface water is likely impacted by multiple sources including:

- Harbor Brook sediment
- On-site drainage ditches discharging to the brook
- Ground water interaction with Harbor Brook
- Upstream inputs

4.4.5. East Flume Surface Water

East Flume surface water data were collected as part of the New York State Pollution Discharge Elimination System (SPDES) program under permit number NY0002275 at Outfall 015. The outfall was located at a weir that separates the upper East Flume from the lower East Flume. Data collected during the same time period as the surface water samples collected during the RI for this Site is provided in **Appendix R** as Table 1. Flow data from Outfall 015 is provided in **Appendix R** as Table 2. The East Flume was abandoned as part of on-going remedial efforts.

The former East Flume received storm water from the P.A. Sewer and Main Sewer, which both flow from the Village Solvay through the former Main Plant Site and Willis Avenue Site. These sewers are likely infiltrated by ground water on these sites that in turn flowed into the East Flume impacting surface water within the flume. The East Flume was also likely impacted by radial ground water flow from the Lakeshore Area of the Site, in particular the DSAs.

4.5. Sediment Characterization

Sediment samples were collected during the PSA, CSX supplemental sampling, RI, Supplemental RI, and Harbor Brook Sediment IRM (BBL, 2001). Samples collected as part of the PSA were analyzed for VOCs, SVOCs, pesticides, PCBs, inorganics, PCDD/PCDFs, and percent solids. The PSA sediment data are provided on **Tables 223 through 230**. Samples collected as part of the CSX supplemental sampling were analyzed for VOCs, SVOCs, pesticides, PCBs, inorganics, PCDD/PCDFs, and percent solids. The CSX supplemental sampling sediment data are provided on **Tables 231 through 238**. Samples collected as part of the RI were analyzed for VOCs, SVOCs, pesticides, PCBs, inorganics, PCDD/PCDFs, TOC, and percent solids. The RI sediment data are provided on **Tables 239 through 246**. Samples collected as part of the Supplemental RI were analyzed for VOCs, SVOCs, pesticides, PCBs, inorganics, and percent solids. The Supplemental RI sediment data are provided on **Tables 247 through 252**. Sediment samples collected were collected in Harbor Brook in January and February 2001 by Blasland, Bouck & Lee in conjunction with the Harbor Brook Sediment IRM (BBL, 2001). The data for these samples is included in **Appendix E**.

Sediment samples were collected from the East Flume during two phases of the Willis Avenue RI. Phase 2 East Flume sediment samples were analyzed for VOCs, SVOCs, pesticides, PCBs, inorganics, PCDD/PCDFs, TOC, and percent solids. The Phase 2 East Flume sediment data are provided on **Tables 253 through 260**. The NYSDEC collected samples concurrently during Phase 2

and analyzed the samples for VOCs, SVOCs, PCBs, and inorganics. The NYSDEC Phase 2 East Flume sediment data are provided on **Tables 261 through 264**. Phase 3 East Flume sediment samples were analyzed for VOCs, SVOCs, pesticides, PCBs, inorganics, PCDD/PCDFs, TOC, and percent solids. The Phase 3 East Flume sediment data are provided on **Tables 265 through 272**. The NYSDEC collected samples concurrently during Phase 3 and analyzed the samples for VOCs, SVOCs, pesticides, PCBs, inorganics, PCDD/PCDFs, TOC, and percent solids. The NYSDEC Phase 3 East Flume sediment data are provided on **Tables 273 through 280**.

4.5.1. Lakeshore Area Sediment

For the purposes of nature and extent discussion below the I-690 drainage ditch sediment data from the PSA and RI are combined. Summary statistics are provided on **Table 281** for sediment constituents detected in the I-690 drainage ditch. Detected constituents of potential interest are listed below in **Table 4.31**. Constituents that were detected at in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included in the list below.

Table 4.31. *Detected I-690 Drainage Ditch Sediment CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (µg/kg)						
Benzene	9	7	4.00	1,059	2,000	6
Toluene	9	8	7.10	2,878	5,500	3
Xylenes, m & p	6	5	4.30	6,721	13,000	2
Naphthalene	3	3	210	48,070	110,000	2
Xylenes, Total	3	3	120	4,573	9,100	1
Ethylbenzene	9	7	10.0	684	1,400	0
o-Xylene	6	5	4.30	2,341	4,600	0
1,2,4-Trimethylbenzene	3	3	41.0	1,947	4,300	0
Isopropylbenzene	3	1	29.0	29.0	29.0	0
Acetone	9	6	18.0	66.0	160	NA
Styrene	9	6	3.00	1,341	2,500	NA
1,3,5-Trimethylbenzene	3	3	110	777	1,600	NA
p-Isopropyltoluene	3	2	4.00	10.5	17.0	NA
n-Propylbenzene	3	1	24.0	24.0	24.0	NA
Semivolatile Organic Compounds (µg/kg)						
Chrysene	9	7	100	844	1,700	7
Naphthalene	9	7	880	70,740	150,000	6
Benzo(b)fluoranthene	9	6	110	918	1,600	6
Phenol	9	6	470	1,545	2,400	6
2-Methylnaphthalene	9	7	280	16,126	45,000	5
Fluorene	9	7	200	4,300	13,000	5
Benzo(a)pyrene	9	6	78.0	795	1,500	5
Benzo(k)fluoranthene	9	5	150	792	1,400	5
Benzo(a)anthracene	9	4	86.0	657	1,500	3
Phenanthrene	9	7	570	5,987	18,000	2
Indeno(1,2,3-cd)pyrene	9	2	170	240	310	2
Acenaphthene	9	7	150	4,050	12,000	1
Fluoranthene	9	8	170	2,308	9,100	0
Pyrene	9	7	180	2,101	6,800	0
Anthracene	9	4	120	1,058	2,000	0
Bis(2-ethylhexyl)phthalate	9	3	720	1,773	2,400	0
Acenaphthylene	9	7	95.0	3,479	11,000	NA
Carbazole	9	7	120	4,811	14,000	NA

Table 4.31. *Detected I-690 Drainage Ditch Sediment CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Dibenzofuran	9	6	150	3,363	13,000	NA
3&4-Methylphenol	9	5	280	1,042	2,000	NA
2-Methylphenol	9	3	200	500	750	NA
2,4-Dimethylphenol	9	2	160	340	520	NA
Benzo(g,h,i)perylene	9	2	190	310	430	NA
Dibenzo(a,h)anthracene	9	2	68.0	82.0	96.0	NA
Dioxins/Furans (ng/kg)						
Total TEQ	9	9	0.001	6.18	23.3	NA
Pesticides (μg/kg)						
4,4'-DDD	9	1	7.00	7.00	7.00	1
4,4'-DDE	9	1	5.00	5.00	5.00	1
4,4'-DDT	9	1	8.00	8.00	8.00	1
PCBs (μg/kg)						
Aroclor-1260	9	3	50.0	127	260	3
Aroclor-1248	9	1	300	300	300	1
Aroclor-1254	9	1	90.0	90.0	90.0	1
Inorganic Compounds (mg/kg)						
Mercury	9	9	0.27	0.58	0.75	9
Copper	9	9	12.6	26.8	51.0	7
Lead	9	9	5.90	62.5	145	6
Cadmium	9	4	0.76	0.99	1.20	4
Chromium	9	9	9.40	78.2	534	3
Zinc	9	9	48.9	101	207	3
Nickel	9	5	4.60	11.5	20.9	2
Manganese	9	9	56.0	182	350	0
Arsenic	9	7	2.30	3.94	5.2	0
Aluminum	9	9	1,070	3,293	7,300	NA
Barium	9	9	14.4	59.8	90.4	NA
Calcium	9	9	236,000	304,222	393,000	NA
Iron	9	9	1,580	4,814	12,700	NA
Magnesium	9	9	6,940	21,000	52,900	NA
Sodium	9	9	657	1,297	2,590	NA
Cyanide	9	6	1.50	6.96	15.6	NA
Vanadium	9	5	8.30	11.9	15.9	NA
Potassium	9	4	260	513	648	NA
Beryllium	9	3	0.10	0.19	0.26	NA
Selenium	9	3	0.40	0.49	0.59	NA
Cobalt	9	2	2.00	2.80	3.60	NA

Notes:
1 – Exceeds NYSDEC Technical Guidance for Screening Contaminated Sediments (1999). Screening values calculated using mean TOC of 7.15%.
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

Benzene, toluene, naphthalene, and xylenes were detected at concentrations exceeding guidance values in *Technical Guidance for Screening Contaminated Sediments* (NYSDEC, 1999). Other VOCs (acetone and styrene in particular) were detected but did not exceed the guidance values. Total BTEX values ranged from 15.7 μg/kg (HB-HBSED-13 [0.5-1 ft]) to 25,460 μg/kg (HB-HBSED-12 [0.5-1 ft]) **(Figure 108)**. The sources of the VOCs in Lakeshore Area sediment are most likely surface runoff from I-690 **(Figure 16)** and shallow ground water from the Lakeshore Area **(Figures 38 and 39)**. Additionally, DNAPL has been observed in subsurface samples collected on-site **(Figure 109)**. DNAPL distribution is discussed below in Section 4.11.

Twelve SVOCs were detected above the guidance values in *Technical Guidance for Screening Contaminated Sediments* (NYSDEC, 1999) and consisted mostly of PAHs. Phenol is also detected above the guidance values. PAHs were detected in every sediment sample collected from Lakeshore Area and total PAH concentrations ranged from 170 µg/kg (HB-HBSED-13 [0-0.5 ft]) to 264,400 µg/kg (HB-HBSED-12 [0-0.5 ft]) **(Figure 108)**. As with VOCs, sources for these PAHs and phenol are likely I-690 surface runoff and shallow ground water. Additionally, DNAPL has been observed in subsurface samples collected on-site **(Figure 109)**. DNAPL distribution is discussed below in Section 4.11.

PCBs and pesticides were detected exceeding guidance values **(Table 4.31)**. These constituents included Aroclors 1260, 1248, and 1254, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT. Total PCBs for HB-HBSED-11 and HB-HBSED-12 are presented on **Figure 108**. As with VOCs, the source for these constituents is likely I-690 surface runoff.

Total TEQs were calculated for all nine samples collected from Lakeshore Area sediment samples **(Figure 108)**. These values ranged from 0.001 ng/kg (HB-HBSED-13[0-0.5 ft]) to 23.3 ng/kg (HB-HBSED-11 [0.5-1 ft]). The source for the PCDD/PCDFs is likely I-690 surface runoff.

Inorganic compounds were detected at concentrations exceeding guidance values in *Technical Guidance for Screening Contaminated Sediments* (NYSDEC, 1999). These included mercury, copper, lead, cadmium, chromium, zinc, and nickel. Mercury concentrations are presented on **Figure 108**. Inorganics were detected in all nine sediment samples. Sources for the inorganics are likely I-690 surface runoff and shallow ground water.

4.5.2. Penn-Can Property Sediment

For the purposes of nature and extent discussion below the Penn-Can Property drainage ditch sediment data from the PSA and RI are combined. Summary statistics are provided on **Table 282** for sediment constituents detected in the Penn-Can Property drainage ditch. Detected constituents of potential interest are listed below in **Table 4.32**. Constituents that were detected at in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included in the list below.

Table 4.32. *Detected Penn-Can Property Sediment CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (µg/kg)						
Xylenes, Total	3	2	1.00	3.00	5.00	0
1,2-Dichlorobenzene	3	1	6.00	6.00	6.00	0
1,4-Dichlorobenzene	3	1	2.00	2.00	2.00	0
Naphthalene	3	1	470	470	470	0
Acetone	8	6	10.0	36.8	74.0	NA
2-Butanone	8	3	6.30	9. 70	14.0	NA
p-Isopropyltoluene	3	1	1.00	1.00	1.00	NA
Semivolatile Organic Compounds (µg/kg)						
Benzo(a)anthracene	7	7	94.0	1,302	3,200	7
Benzo(b)fluoranthene	7	7	96.0	1,442	3,500	7
Chrysene	7	7	97.0	1,388	3,400	7
Benzo(a)pyrene	7	6	270	1,613	3,900	6
Benzo(k)fluoranthene	7	6	170	1,378	3,300	6

Table 4.32. *Detected Penn-Can Property Sediment CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Indeno(1,2,3-cd)pyrene	7	6	180	1,025	2,400	6
Fluorene	7	5	130	614	1,000	3
2-Methylnaphthalene	7	7	77.0	375	670	0
Fluoranthene	7	7	200	2,683	6,700	0
Naphthalene	7	7	95.0	995	2,000	0
Phenanthrene	7	7	130	1,359	3,200	0
Pyrene	7	7	190	1,869	4,100	0
Acenaphthene	7	6	130	463	800	0
Anthracene	7	6	110	673	1,500	0
Dibenzofuran	7	7	76.0	742	1,600	NA
Acenaphthylene	7	6	110	513	1,400	NA
Benzo(g,h,i)perylene	7	6	180	982	2,200	NA
Dibenzo(a,h)anthracene	7	5	75.0	425	860	NA
Carbazole	7	4	170	297.5	460	NA
Di-n-butyl phthalate	7	2	100	125	150	NA
Dioxins/Furans (ng/kg)						
Total TEQ	7	7	1.33	23.6	82.4	NA
Pesticides (μg/kg)						
4,4'-DDE	7	2	3.00	3.00	3.00	2
4,4'-DDD	7	1	10.0	10.0	10.0	1
PCBs (μg/kg)						
Aroclor-1260	7	3	30	40	50	3
Inorganic Compounds (mg/kg)						
Mercury	7	5	0.05	0.37	0.86	3
Copper	7	7	3.70	13.9	35.1	2
Lead	7	7	6.90	20.2	57.0	1
Manganese	7	7	91.3	285	664	1
Arsenic	7	6	2.30	4.90	8.80	1
Chromium	7	7	2.70	5.74	11.8	0
Zinc	7	7	10.7	42.5	109	0
Nickel	7	4	1.80	5.15	10.8	0
Aluminum	7	7	566	1,390	3,250	NA
Barium	7	7	16.4	66.4	96.2	NA
Calcium	7	7	102,000	318,714	413,000	NA
Iron	7	7	2,070	4,919	11,500	NA
Magnesium	7	7	5,920	8,434	13,600	NA
Sodium	7	7	261	533	696	NA
Potassium	7	5	213	373	680	NA
Vanadium	7	4	1.70	5.28	11.8	NA
Beryllium	7	3	0.09	0.14	0.24	NA
Cyanide	7	2	2.80	3.40	4.00	NA

Notes:
1 – Exceeds NYSDEC Technical Guidance for Screening Contaminated Sediments (1999). Screening values calculated using mean TOC of 7.15%.
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

No VOCs were detected at concentrations exceeding guidance values in *Technical Guidance for Screening Contaminated Sediments* (NYSDEC, 1999). Acetone was detected in nearly all seven sediment samples. The sources of the VOCs to the Penn-Can Property sediment are most likely surface runoff **(Figure 16)** and shallow ground water **(Figures 38 and 39)**. Historical operations on the Penn-Can Property included production of asphalt emulsions and some coal tar based products

used in road construction. Additionally, DNAPL has been observed in subsurface samples collected on-site **(Figure 109)**. DNAPL distribution is discussed below in Section 4.11.

Seven SVOCs were detected above the guidance values in *Technical Guidance for Screening Contaminated Sediments* (NYSDEC, 1999) and consisted solely of PAHs. The PAHs were detected in every sediment sample collected and total PAH concentrations ranged from 2,307 µg/kg (HB-HBSED-02 [0-0.5 ft]) to 41,700 µg/kg (HB-HBSED-03 [0-0.5 ft]) **(Figure 108)**. As with VOCs, sources for these PAHs are likely surface runoff and shallow ground water and are related to historical operations on the Penn-Can Property. Additionally, DNAPL has been observed in subsurface samples collected on-site **(Figure 109)**. DNAPL distribution is discussed below in Section 4.11.

PCBs and pesticides were detected exceeding guidance values at all three sample locations but were not consistent throughout all samples **(Table 4.32)**. These constituents included Aroclor 1260, 4,4'-DDD, and 4,4'-DDE; total PCBs are presented on **Figure 108**. The sources for these constituents is likely surface runoff and may be related to equipment utilized during on-site production operations.

Total TEQs were calculated for all seven samples collected from the Penn-Can Property sediment samples **(Figure 108)**. These values ranged from 1.3 ng/kg (HB-HBSED-03 [0.5-1 ft]) to 82.4 ng/kg (HB-HBSED-01 [0-0.5 ft]). The source for the PCDD/PCDFs is likely surface runoff and may be related to equipment utilized during on-site production operations.

Inorganic compounds were detected at concentrations exceeding guidance values in *Technical Guidance for Screening Contaminated Sediments* (NYSDEC, 1999). These included mercury, copper, lead, manganese, and arsenic. Mercury concentrations are presented on **Figure 108**. Inorganics were detected in all nine sediment samples. Sources for the inorganics are likely I-690 surface runoff and shallow ground water and may be related to equipment utilized during on-site production operations.

4.5.3. Railroad Area Sediment

For the purposes of nature and extent discussion below the Railroad Area drainage ditch sediment data from the PSA and RI are combined. Summary statistics are provided on **Table 283** for sediment constituents detected in the Railroad Area drainage ditches. Detected constituents of potential interest are listed below in **Table 4.33**. Constituents that were detected at in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included in the list below.

Table 4.33. *Detected Railroad Area Sediment CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (µg/kg)						
1,4-Dichlorobenzene	2	1	7.00	7.00	7.00	0
Acetone	6	5	6.00	45.0	86.0	NA
2-Butanone	6	3	12.0	16.7	20.0	NA
Carbon disulfide	4	1	2.20	2.20	2.20	NA
Semivolatile Organic Compounds (µg/kg)						
Benzo(b)fluoranthene	6	6	63.0	4,721	12,000	5
Chrysene	6	6	59.0	5,472	15,000	5
Benzo(a)anthracene	6	5	390	5,644	13,000	5
Benzo(a)pyrene	6	5	400	6,016	14,000	5
Benzo(k)fluoranthene	6	5	370	4,156	11,000	5

Table 4.33. *Detected Railroad Area Sediment CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Indeno(1,2,3-cd)pyrene	6	5	250	3,648	9,000	5
Phenanthrene	6	5	540	6,830	15,000	2
Fluorene	6	3	460	1,020	1,500	2
Fluoranthene	6	6	89.0	11,080	31,000	0
Pyrene	6	6	79.0	8,850	24,000	0
Anthracene	6	5	100	1,742	4,000	0
Acenaphthene	6	4	58.0	642	1,200	0
2-Methylnaphthalene	6	3	110	117	130	0
Bis(2-ethylhexyl)phthalate	6	3	61.0	3,420	6,700	0
Naphthalene	6	3	140	157	180	0
1,4-Dichlorobenzene	6	2	86.0	98.0	110	0
Benzo(g,h,i)perylene	6	5	290	3,962	10,000	NA
Carbazole	6	5	63.0	703	1,600	NA
Dibenzo(a,h)anthracene	6	5	87.0	1,238	3,200	NA
Acenaphthylene	6	4	64.0	961	2,100	NA
Dibenzofuran	6	4	81.0	303	780	NA
Dioxins/Furans (ng/kg)						
Total TEQ	6	6	0.22	12.9	42.9	NA
Pesticides (µg/kg)						
4,4'-DDD	6	1	45.0	45.0	45.0	1
4,4'-DDE	6	1	4.00	4.00	4.00	1
PCBs (µg/kg)						
Aroclor-1254	6	2	200	430	660	2
Aroclor-1260	6	1	10.0	10.0	10.0	1
Inorganic Compounds (mg/kg)						
Arsenic	6	6	3.80	7.10	9.60	5
Copper	6	6	6.00	69.0	147	4
Lead	6	6	16.6	101	201	4
Mercury	6	6	0.05	1.32	6.50	4
Chromium	6	6	9.00	23.5	41.3	3
Nickel	6	6	4.50	14.0	21.1	3
Zinc	6	6	21.5	136	269	3
Cadmium	6	3	1.10	1.23	1.30	3
Manganese	6	6	33.1	198	305	0
Aluminum	6	6	1,650	4,640	7330	NA
Barium	6	6	36.4	69.0	120	NA
Calcium	6	6	77,900	181,750	312,000	NA
Iron	6	6	2,900	10,693	17,400	NA
Magnesium	6	6	16,100	23,217	35,300	NA
Sodium	6	6	677	2,106	5,730	NA
Vanadium	6	6	6.20	15.3	23.1	NA
Potassium	6	4	167	967	1,490	NA
Selenium	6	3	1.90	2.60	3.00	NA
Beryllium	6	2	0.22	0.32	0.41	NA
Cobalt	6	2	1.60	3.20	4.80	NA

Notes:
1 – Exceeds NYSDEC Technical Guidance for Screening Contaminated Sediments (1999). Screening values calculated using mean TOC of 7.15%.
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

No VOCs were detected at concentrations exceeding guidance values in *Technical Guidance for Screening Contaminated Sediments* (NYSDEC, 1999). Acetone was detected in nearly all five

sediment samples, and 2-butanone was detected in half of the samples. The sources of the VOCs to the Railroad Area sediment are most likely surface runoff **(Figure 16)** and shallow ground water **(Figures 38 and 39)**. The original source of these constituents is unknown; no known historical uses have been identified for the Railroad Area.

Eight SVOCs were detected above the guidance values in *Technical Guidance for Screening Contaminated Sediments* (NYSDEC, 1999) and consisted solely of PAHs. The PAHs were detected in every sediment sample collected and total PAH concentrations ranged from 290 μg/kg (HB-HBSED-04 [0-0.5 ft]) to 166,000 μg/kg (HB-HBSED-05 [0-0.5 ft]) **(Figure 108)**. Sources for these PAHs to the sediment are likely surface runoff and shallow ground water and are likely related to the DNAPL observed in subsurface samples **(Figure 109)**. DNAPL distribution is discussed below in Section 4.11.

PCBs and pesticides were detected exceeding guidance values at both sample locations **(Table 4.33)**. These constituents included Aroclor 1260, Aroclor 1254, 4,4'-DDD, and 4,4'-DDE; total PCBs are presented on **Figure 108**. The source to the sediments for these constituents is likely surface runoff with no identifiable origin.

Total TEQs were calculated for all six samples collected from the Railroad Area sediment samples **(Figure 108)**. These values ranged from 0.22 ng/kg (HB-HBSED-04 [0.5-1 ft]) to 42.9 ng/kg (HB-HBSED-05 [0-0.5 ft]). The source for the PCDD/PCDFs is likely surface runoff with no identifiable origin.

Inorganic compounds were detected at concentrations exceeding guidance values in *Technical Guidance for Screening Contaminated Sediments* (NYSDEC, 1999). These are arsenic, copper, lead, mercury, chromium, nickel, zinc, and cadmium. Mercury concentrations are presented on **Figure 108**. Inorganics were detected in all six sediment samples. Sources for the inorganics are likely surface runoff and shallow ground water with no identifiable origin.

4.5.4. AOS#2

Summary statistics are provided on **Table 284** for sediment constituents detected in AOS#2. Detected constituents of potential interest are listed below in **Table 4.34**. Constituents that were detected at in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included in the list below.

Table 4.34. *Detected AOS #2 Sediment CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (μg/kg)						
Benzene	2	2	2.60	3.30	3.90	0
Acetone	2	2	9.60	22.3	35.0	NA
Carbon disulfide	2	2	4.20	4.55	4.90	NA
2-Butanone	2	1	4.90	4.90	4.90	NA
Semivolatile Organic Compounds (μg/kg)						
Benzo(a)anthracene	2	2	910	1,055	1,200	2
Benzo(a)pyrene	2	2	960	1,130	1,300	2
Benzo(b)fluoranthene	2	2	830	1,015	1,200	2
Benzo(k)fluoranthene	2	2	1,000	1,100	1,200	2
Chrysene	2	2	1,100	1,300	1,500	2

Table 4.34. *Detected AOS #2 Sediment CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Indeno(1,2,3-cd)pyrene	2	2	740	820	900	2
Anthracene	2	2	230	475	720	0
Bis(2-ethylhexyl)phthalate	2	2	430	445	460	0
Fluoranthene	2	2	2,300	3,300	4,300	0
Phenanthrene	2	2	1,500	3,100	4,700	0
Pyrene	2	2	1,800	2,450	3,100	0
Fluorene	2	1	210	210	210	0
Benzo(g,h,i)perylene	2	2	850	925	1,000	NA
Dibenzo(a,h)anthracene	2	2	220	245	270	NA
Dibenzofuran	2	2	400	420	440	NA
Di-n-butyl phthalate	2	1	220	220	220	NA
Dioxins/Furans (ng/kg)						
Total TEQ	2	2	0.62	0.64	0.67	NA
Inorganic Compounds (mg/kg)						
Copper	2	2	20.6	22.6	24.6	2
Lead	2	2	65.3	73.7	82.0	2
Manganese	2	2	499	516	532	2
Mercury	2	2	0.16	0.165	0.17	2
Chromium	2	2	7.40	8.35	9.30	0
Zinc	2	2	65.8	68.6	71.4	0
Arsenic	2	1	2.20	2.20	2.20	0
Nickel	2	1	8.10	8.10	8.10	0
Aluminum	2	2	1,700	2,410	3,120	NA
Barium	2	2	576	618	659	NA
Calcium	2	2	311,000	327,500	344,000	NA
Iron	2	2	15,700	16,200	16,700	NA
Magnesium	2	2	5,120	6,260	7,400	NA
Potassium	2	2	444	574	704	NA
Sodium	2	2	2,060	2,195	2,330	NA
Cyanide	2	1	3.08	3.08	3.08	NA

Notes:
1 – Exceeds NYSDEC Technical Guidance for Screening Contaminated Sediments (1999). Screening values calculated using mean TOC of 7.15%.
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

No VOCs were detected at concentrations exceeding guidance values in *Technical Guidance for Screening Contaminated Sediments* (NYSDEC, 1999). Acetone, benzene, and carbon disulfide were detected in both sediment samples. Total BTEX concentrations are presented on **Figure 108**. The sources of the VOCs to the AOS #2 sediment are most likely surface runoff **(Figure 16)** and shallow ground water **(Figures 38 and 39)**. The original source of these constituents is unknown; no known historical uses have been identified for the AOS #2. However, the low concentrations may indicate atmospheric deposition as the primary source.

Six SVOCs were detected above the guidance values in *Technical Guidance for Screening Contaminated Sediments* (NYSDEC, 1999) and consisted solely of PAHs. The PAHs were detected in every sediment sample collected and total PAH concentrations ranged from 12,440 µg/kg (HB-HBSED-18 [0-0.5 ft]) to 21,600 µg/kg **(**HB-HBSED-18 [05-1 ft]; **Figure 108)**. Sources for these PAHs to the sediment are likely surface runoff and shallow ground water and are likely related to the DNAPL observed in subsurface samples **(Figure 109)**. DNAPL distribution is discussed below in Section 4.11.

No PCBs and pesticides were detected in AOS #2 sediment **(Table 4.34)**. Total TEQs were calculated for both samples **(Figure 108)**, with values ranging from 0.62 ng/kg (HB-HBSED-18 [0.5-1 ft]) to 0.67 ng/kg (HB-HBSED-18 [0-0.5 ft]). Sources for the PCDD/PCDFs are likely surface runoffand upstream sources including CSO.

Inorganic compounds were detected at concentrations exceeding guidance values in *Technical Guidance for Screening Contaminated Sediments* (NYSDEC, 1999). These are copper, lead, manganese, and mercury. Mercury concentrations are presented on **Figure 108**. Inorganics were detected in both sediment samples. Sources for the inorganics are likely surface runoff and shallow ground water.

4.5.5. Harbor Brook

For the purposes of nature and extent discussion below the Harbor Brook sediment data from the PSA, CSX supplemental sediment sampling, RI, Supplemental RI, and Harbor Brook Sediment IRM (BBL, 2001) are combined. The sediment data was separated into categories of surface sediment (0 to 2 ft) and subsurface sediment (> 2 ft).

Harbor Brook Surface Sediment

Summary statistics are provided on **Table 285** for surface sediment constituents detected in Harbor Brook. Detected constituents of potential interest are listed below in **Table 4.35**. Constituents that were detected at in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included in the list below.

Table 4.35. *Detected Harbor Brook Surface Sediment CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (µg/kg)						
Benzene	31	21	3.00	4,256	29,000	15
Ethylbenzene	31	28	3.10	4,010	24,000	11
Xylenes, m & p	31	28	3.50	14,491	240,000	10
Toluene	31	21	5.00	8,964	88,000	6
o-Xylene	31	26	2.30	5,705	74,000	5
Chlorobenzene	31	11	1.60	22,352	240,000	4
Acetone	31	10	27.0	352	1,200	NA
2-Butanone	31	9	1.80	21.8	55.0	NA
Semivolatile Organic Compounds (µg/kg)						
Benzo(a)anthracene	32	31	470	9,602	56,000	31
Chrysene	32	31	550	9,724	54,000	31
Benzo(a)pyrene	32	30	770	8,756	53,000	30
Benzo(b)fluoranthene	32	30	580	6,632	35,000	30
Benzo(k)fluoranthene	32	30	530	7,318	42,000	30
Indeno(1,2,3-cd)pyrene	32	29	660	4,738	28,000	29
Fluorene	32	30	85.0	17,947	110,000	28
Naphthalene	32	31	110	55,200	400,000	26
Phenanthrene	32	32	510	45,160	260,000	23
2-Methylnaphthalene	32	26	92.0	20,456	210,000	18
Acenaphthene	32	31	110	19,197	91,000	15
Anthracene	32	30	130	12,195	72,000	11
Phenol	32	5	490	1,312	2,300	5
Fluoranthene	32	32	870	27,290	130,000	3
1,2-Dichlorobenzene	32	4	270	2,943	5,900	3

Table 4.35. *Detected Harbor Brook Surface Sediment CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
1,4-Dichlorobenzene	32	4	560	11,390	29,000	3
Pyrene	32	31	730	20,953	100,000	2
1,3-Dichlorobenzene	32	2	950	1,275	1,600	2
1,2,4-Trichlorobenzene	32	2	3,400	5,750	8,100	1
Bis(2-ethylhexyl)phthalate	32	19	110	1,395	4,000	0
Benzo(g,h,i)perylene	32	29	680	4,940	29,000	NA
Dibenzofuran	32	29	130	16,899	100,000	NA
Carbazole	32	27	90.0	3,091	11,000	NA
Acenaphthylene	32	26	73.0	4,255	51,000	NA
Dibenzo(a,h)anthracene	32	23	160	1,929	11,000	NA
Dioxins/Furans (ng/kg)						
Total TEQ	19	19	0.45	22.9	188	NA
Pesticides (μg/kg)						
Dieldrin	32	1	11.0	11.0	11.0	1
PCBs (μg/kg)						
Aroclor-1260	32	16	67.0	532	3,700	16
Aroclor-1254	32	4	130	335	810	4
Aroclor-1248	32	1	120	120	120	1
Inorganic Compounds (mg/kg)						
Copper	28	28	20.1	93.7	308	28
Lead	27	27	43.7	218	753	27
Mercury	31	30	0.08	4.39	52.0	26
Zinc	31	31	49.8	220	497	24
Cadmium	31	24	0.27	2.01	19.2	19
Chromium	31	31	7.00	53.6	211	18
Nickel	31	31	6.00	20.8	64.4	16
Arsenic	31	29	1.60	4.16	8.10	6
Silver	31	6	0.32	2.30	9.80	3
Manganese	31	31	153	224	366	0
Aluminum	31	31	2,210	3,875	5,890	NA
Barium	31	31	21.4	131	332	NA
Calcium	31	31	72,900	179,587	340,000	NA
Iron	31	31	4,160	10,665	21,200	NA
Magnesium	31	31	6,620	13,799	59,100	NA
Potassium	31	31	147	626	1,210	NA
Vanadium	31	30	5.10	12.1	25.9	NA
Sodium	31	24	693	1,762	4,140	NA
Cobalt	31	23	0.97	6.52	21.2	NA
Selenium	31	19	0.89	1.97	4.90	NA
Beryllium	31	12	0.10	0.34	1.90	NA
Thallium	31	8	0.25	1.48	4.90	NA

Notes:
1 – Exceeds NYSDEC Technical Guidance for Screening Contaminated Sediments (1999). Screening values calculated using mean TOC of 7.15%.
2 – Mean concentration values have been rounded.
Includes data from the PSA, CSX supplemental sampling, RI, Supplemental RI, and Harbor Brook Sediment IRM.
NA = Not applicable as no criteria available.

Benzene, toluene, ethylbenzene, xylenes, and chlorobenzene were detected at concentrations exceeding guidance values in *Technical Guidance for Screening Contaminated Sediments* (NYSDEC, 1999). Other VOCs were detected but did not exceed the guidance values. Total BTEX values ranged from 13.4 μg/kg (HB-HBSED-14 [0-0.33 ft]) to 455,000 μg/kg (HB-T-5-3 [0-0.5 ft]) **(Figure 108)**.

Total chlorobenzenes (TCB) are also presented on **Figure 108**. The sources of the VOCs in Harbor Brook surface sediments are most likely surface runoff **(Figure 16)**, shallow ground water **(Figures 38 and 39)**, and upstream sources including combined sewer overflow (CSO). Additionally, DNAPL has been observed in subsurface samples along Harbor Brook and in sediment samples, which may contribute to the VOC concentrations especially BTEX constituents. DNAPL chemistry and distribution are discussed below in Section 4.10.

Nineteen SVOCs were detected above the guidance values in *Technical Guidance for Screening Contaminated Sediments* (NYSDEC, 1999) and consisted mostly of PAHs. Phenol and chlorinated benzenes were also detected above the guidance values. Total PAH values ranged from 9,148 µg/kg (HB-HBSED-14 [0-0.33 ft]) to 1,232,500 µg/kg (HB-S-1 [0-0.5 ft]) **(Figure 108)**. The sources of the SVOCs in Harbor Brook sediment are most likely surface runoff **(Figure 16)**, shallow ground water **(Figures 38 and 39)**, CSO, and upstream sources. Additionally, DNAPL has been observed in subsurface samples along Harbor Brook and in sediment samples, which likely contributes to the SVOC concentrations **(Figure 108)**. DNAPL chemistry and distribution are discussed below in Section 4.10.

PCBs and pesticides were detected exceeding guidance values **(Table 4.35)**. These constituents are Aroclors 1260, 1254, and 1248, and dieldrin. Total PCBs for Harbor Brook sediments are presented on **Figure 108**. The sources of the PCBs in Harbor Brook sediment are most likely surface runoff **(Figure 16)** and/or transport from on-Site soils/sediments, and upstream sources including CSO.

Total TEQs were calculated for most samples collected from Harbor Brook sediment samples **(Figure 7)**. These values ranged from 0.45 ng/kg to 188 ng/kg. The sources of the PCDD/PCDFs in Harbor Brook sediment are most likely surface runoff **(Figure 16)** and/or transport from on-Site soils/sediments, and upstream sources including CSO.

Inorganic compounds were detected at concentrations exceeding guidance values in *Technical Guidance for Screening Contaminated Sediments* (NYSDEC, 1999). These are copper, lead, mercury, zinc, cadmium, chromium, nickel, and arsenic. Mercury concentrations are presented on **Figure 108**. Inorganics were detected in all 31 sediment samples. The sources of the inorganicss in Harbor Brook sediment are most likely surface runoff **(Figure 16)**, shallow ground water **(Figures 38 and 39)**, and upstream sources including CSO.

Harbor Brook Subsurface Sediment

Summary statistics are provided on **Table 286** for subsurface sediment constituents detected in Harbor Brook. Detected constituents of potential interest are listed below in **Table 4.36**. Constituents that were detected at in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included in the list below.

Two samples were excluded from the Harbor Brook subsurface sediment summary statistics below. Summary statistics for HB-T-3-OIL and HB-T-5-OIL were compiled in a separate section immediately following this section.

Table 4.36. *Detected Harbor Brook Subsurface Sediment CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (µg/kg)						

Table 4.36. *Detected Harbor Brook Subsurface Sediment CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Benzene	50	40	2.00	2,788	23,000	25
Toluene	50	35	1.80	9,960	110,000	13
Ethylbenzene	50	30	2.30	6,679	83,000	13
Xylenes, m & p	47	30	1.80	18,863	200,000	11
o-Xylene	47	29	2.20	6,862	70,000	7
Chlorobenzene	50	2	220	710	1,200	1
Xylenes, Total	3	2	1,500	8,750	16,000	1
Isopropylbenzene	3	2	560	700	840	0
Acetone	50	26	15.0	106	1,200	NA
Carbon Disulfide	50	23	2.00	18.0	75.0	NA
2-Butanone	50	16	4.40	862	13,000	NA
Methylene chloride	50	10	66.0	3,546	30,000	NA
Semivolatile Organic Compounds (µg/kg)						
Chrysene	49	30	66.0	4,936	36,000	28
Benzo(a)anthracene	49	30	67.0	5,427	39,000	27
Naphthalene	49	33	56.0	129,878	1,300,000	24
Fluorene	49	31	63.0	23,404	210,000	23
Benzo(a)pyrene	49	23	61.0	2,862	15,000	21
Benzo(k)fluoranthene	49	22	60.0	2,326	12,000	20
2-Methylnaphthalene	49	30	67.0	50,203	450,000	18
Benzo(b)fluoranthene	49	18	100	3,201	16,000	18
Indeno(1,2,3-cd)pyrene	49	16	110	1,397	7,200	16
Phenanthrene	49	37	77.0	45,055	480,000	15
Acenaphthene	49	29	59.0	18,356	180,000	11
Anthracene	49	28	100	13,745	100,000	10
Phenol	49	9	160	4,701	12,000	9
Fluoranthene	49	37	72.0	17,822	170,000	2
Pyrene	49	36	84.0	12,938	110,000	2
1,4-Dichlorobenzene	49	1	1,200	1,200	1,200	1
Dibenzofuran	49	28	79.0	22,587	190,000	NA
Acenaphthylene	49	26	63.0	14,176	110,000	NA
Carbazole	49	24	69.0	3,446	12,000	NA
3&4-Methylphenol	49	19	53.0	2,538	12,000	NA
Benzo(g,h,i)perylene	49	18	65.0	2,216	13,000	NA
Dibenzo(a,h)anthracene	49	14	55.0	778	3,800	NA
Dioxins/Furans (ng/kg)						
Total TEQ	28	28	0.002	3.00	49.8	NA
Pesticides (µg/kg)						
Heptachlor	49	2	2.90	3.10	3.30	2
4,4'-DDT	49	1	18.0	18.0	18.0	1
PCBs (µg/kg)						
Aroclor-1260	49	4	92.0	897	2,000	4
Aroclor-1254	49	1	170	170	170	1
Aroclor-1248	49	1	394	394	394	1
Inorganic Compounds (mg/kg)						
Lead	50	40	1.70	66.3	552	20
Mercury	48	38	0.01	1.15	7.10	20
Copper	50	37	1.60	43.9	250	20
Antimony	50	15	3.20	7.78	14.3	15
Nickel	50	49	2.50	10.0	48.4	9
Zinc	50	28	16.5	100	441	9
Manganese	50	50	111	325	723	8
Arsenic	50	23	1.40	5.69	14.5	8

Table 4.36. *Detected Harbor Brook Subsurface Sediment CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Chromium	50	34	2.30	19.9	253	3
Cadmium	50	11	0.17	0.92	4.90	3
Silver	50	6	0.25	0.65	1.60	1
Aluminum	50	50	867	3,656	11,000	NA
Barium	50	50	39.0	102	752	NA
Calcium	50	50	42,000	252,586	366,000	NA
Iron	50	50	2,570	8,627	29,000	NA
Magnesium	50	50	3,040	8,456	18,600	NA
Sodium	50	50	908	10,921	37,200	NA
Potassium	50	46	198	557	2,000	NA
Vanadium	50	46	0.91	8.71	24.0	NA
Selenium	50	44	0.27	2.47	5.90	NA
Cobalt	50	41	1.10	4.33	16.2	NA
Beryllium	50	38	0.12	0.48	2.00	NA
Thallium	50	12	0.35	0.76	1.90	NA

Notes:
1 – Exceeds NYSDEC Technical Guidance for Screening Contaminated Sediments (1999). Screening values calculated using mean TOC of 7.15%.
2 – Mean concentration values have been rounded.
Includes data from the PSA, CSX supplemental sampling, RI, Supplemental RI, and Harbor Brook Sediment IRM.
NA = Not applicable as no criteria available.

Benzene, toluene, ethylbenzene, xylenes, and chlorobenzene were detected at concentrations exceeding guidance values in *Technical Guidance for Screening Contaminated Sediments* (NYSDEC, 1999). Other VOCs were detected but did not exceed the guidance values. Total BTEX values ranged from 2 µg/kg (HB-T-2-3 [4.4-5.4 ft]) to 446,000 µg/kg (HB-T-3-2 [5.4-6.4 ft]) **(Figure 108)**. Total chlorobenzenes (TCB) are also presented on **Figure 108**. The sources of the VOCs in Harbor Brook subsurface sediment are most likely surface runoff **(Figure 16)**, shallow and intermediate ground water **(Figures 38 through 41)**, CSO, and upstream sources. Additionally, DNAPL has been observed in subsurface samples along Harbor Brook and in sediment samples, which may contribute to the VOC concentrations. DNAPL distribution is discussed below in Section 4.10.

Seventeen SVOCs were detected above the guidance values in *Technical Guidance for Screening Contaminated Sediments* (NYSDEC, 1999) and consisted mostly of PAHs. Phenol and 1,4-dichlorobenzene were also detected above the guidance values. Total PAH values ranged from 94 µg/kg (HB-T-3-2 [10-13.9 ft]) to 3,185,000 µg/kg (HB-T-4-2 [1.5-3 ft]) **(Figure 108)**. The sources of the SVOCs in Harbor Brook sediment are most likely shallow and intermediate ground water **(Figures 38 through 41)**, CSO, and upstream sources. Additionally, DNAPL has been observed in subsurface samples along Harbor Brook and in sediment samples, which most likely contributes to the SVOC concentrations **(Figure 109)**. DNAPL distribution is discussed below in Section 4.10.

PCBs and pesticides were detected exceeding guidance values **(Table 4.36)**. These constituents are Aroclors 1260 and 1254, 4,4'-DDT, and heptachlor. Total PCBs for Harbor Brook subsurface sediments are presented on **Figure 108**. The sources of the PCBs in Harbor Brook sediment are most likely CSO and upstream sources.

Total TEQs were calculated for most samples collected from Harbor Brook sediment samples **(Figure 108)**. These values ranged from 0.002 ng/kg (HB-T-5-1 [10-12.3 ft]) to 49.8 ng/kg (HB-T-1-2 [1.5-

4.4 ft]). The sources of the PCDD/Fs in Harbor Brook sediment are most likely surface runoff **(Figure 16)**, CSO, and upstream sources.

Inorganic compounds were detected at concentrations exceeding guidance values in *Technical Guidance for Screening Contaminated Sediments* (NYSDEC, 1999). These are copper, lead, mercury, antimony, nickel, zinc, arsenic, manganese, cadmium, chromium, and silver. Mercury concentrations are presented on **Figure 108**. Inorganics were detected in all 52 sediment samples. The sources of the metals in Harbor Brook sediment are most likely surface runoff **(Figure 16)**, shallow and intermediate ground water **(Figures 38 through 41)**, CSO, and upstream sources.

Harbor Brook Subsurface DNAPL/Sediment

Summary statistics are provided on **Table 287** for two subsurface DNAPL/sediment samples from Harbor Brook. Detected constituents of potential interest are listed below in **Table 4.37**. Constituents that were detected at in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included in the list below.

The samples (HB-T-3-OIL [4.1-6.86 ft] and HB-T-5-OIL [4.43-14.43 ft]) were collected from intervals that had observable DNAPL in the subsurface sediments.

Table 4.37. *Detected Harbor Brook Subsurface DNAPL/Sediment CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (µg/kg)						
Ethylbenzene	2	2	190,000	995,000	18,000,000	2
o-Xylene	2	2	260,000	1,530,000	2,800,000	2
Toluene	2	2	380,000	2,390,000	4,400,000	2
Xylenes, m & p	2	2	750,000	4,225,000	7,700,000	2
Benzene	2	1	1,100,000	1,100,000	1,100,000	1
Styrene	2	2	70,000	885,000	1,700,000	NA
Semivolatile Organic Compounds (µg/kg)						
2-Methylnaphthalene	2	2	30,000,000	31,000,000	32,000,000	2
Acenaphthene	2	2	6,000,000	6,250,000	6,500,000	2
Anthracene	2	2	4,700,000	4,900,000	5,100,000	2
Benzo(a)anthracene	2	2	1,700,000	1,800,000	1,900,000	2
Chrysene	2	2	1,500,000	1,600,000	1,700,000	2
Fluoranthene	2	2	7,200,000	7,750,000	8,300,000	2
Fluorene	2	2	11,000,000	11,500,000	12,000,000	2
Naphthalene	2	2	89,000,000	93,000,000	97,000,000	2
Phenanthrene	2	2	21,000,000	22,000,000	23,000,000	2
Pyrene	2	2	5,100,000	5,400,000	5,700,000	2
Acenaphthylene	2	2	7,800,000	8,050,000	8,300,000	NA
Carbazole	2	2	1,700,000	1,700,000	1,700,000	NA
Dibenzofuran	2	2	9,800,000	10,400,000	11,000,000	NA
Dioxins/Furans (ng/kg)						
Total TEQ	2	1	1.63	1.63	1.63	NA
Pesticides (µg/kg)						
4,4'-DDT	2	2	1,700	1,700	1,700	2
Inorganic Compounds (mg/kg)						
Manganese	2	2	2.60	10.2	17.8	0
Copper	2	1	0.44	0.44	0.44	0
Nickel	2	1	1.70	1.70	1.70	0
Aluminum	2	2	55.6	146	236	NA

Table 4.37. *Detected Harbor Brook Subsurface DNAPL/Sediment CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Calcium	2	2	2,970	13,035	23,100	NA
Iron	2	2	115	398	681	NA
Magnesium	2	2	125	287	449	NA
Sodium	2	2	4,880	5,330	5,780	NA
Barium	2	1	7.90	7.90	7.90	NA
Selenium	2	1	1.40	1.40	1.40	NA

Notes:
1 – Exceeds NYSDEC Technical Guidance for Screening Contaminated Sediments (1999). Screening values calculated using mean TOC of 7.15%.
2 – Mean concentration values have been rounded.
Includes data from the PSA, CSX supplemental sampling, RI, Supplemental RI, and Harbor Brook Sediment IRM.
NA = Not applicable as no criteria available.

Benzene, toluene, ethylbenzene, and xyleneswere detected at concentrations exceeding guidance values in *Technical Guidance for Screening Contaminated Sediments* (NYSDEC, 1999). Styrene was also detected but does not have a guidance value to compare to. Total BTEX values ranged from 1,580,000 µg/kg (HB-T-5-OIL [4.43-14.43 ft]) to 17,800,000 µg/kg (HB-T-3-OIL [4.1-6.86 ft]) **(Figure 108)**. The source of these constituents in Harbor Brook sediment are related to the DNAPL observed at the sampling locations. The DNAPL is believed to have originated at the Penn-Can property.

Ten SVOCs were detected above the guidance values in *Technical Guidance for Screening Contaminated Sediments* (NYSDEC, 1999) and consisted of PAHs. Acenaphthylene, carbazole, and dibenzofuran were also detected but do not have guidance values to compare to. Total PAH values ranged from 185,000,000 µg/kg (HB-T-5-OIL [4.43-14.43 ft]) to 202,000,000 µg/kg (HB-T-3-OIL [4.1-6.86 ft]) **(Figure 108)**. The source of these constituents in Harbor Brook sediment are related to the DNAPL observed at the sampling locations. The DNAPL is believed to have originated at the Penn-Can property.

4,4'DDT was the only pesticide detected that exceeded its guidance value **(Table 4.37)**. Total TEQs were calculated for both DNAPL/sediment samples, and only HB-T-3-OIL had detected PCDD/Fs (total TEQ = 1.63 ng/kg). The source of these parameters is most likely upstream sources including CSO.

Inorganic compounds were detected but did not exceed guidance values in *Technical Guidance for Screening Contaminated Sediments* (NYSDEC, 1999). These are manganese, copper, nickel, aluminum, calcium, iron, magnesium, sodium, barium, and selenium. The sources of the metals are most likely shallow and intermediate ground water **(Figures 38 through 41)** and upstream sources including CSO.

4.5.6. East Flume

For the purposes of nature and extent discussion below, the two phases of Willis Avenue RI and Onondaga Lake RI data are combined. Summary statistics are provided on **Table 288** for sediment constituents detected in the East Flume. Detected constituents of potential interest are listed below in **Table 4.38**. Constituents that were detected at in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included in the list below.

Table 4.38. *Detected East Flume Sediment CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (μg/kg)						
Benzene	31	25	8.00	309	5,500	13
Chlorobenzene	31	31	7.00	17,283	460,000	10
Xylenes, Total	31	28	2.00	1,115	15,000	2
Toluene	31	26	3.00	365	4,600	2
1,3-Dichlorobenzene	8	6	5.10	33,375	200,000	1
Ethylbenzene	31	15	3.00	14.5	65.0	0
1,2-Dichlorobenzene	8	8	13.0	181	540	0
1,4-Dichlorobenzene	8	8	15.0	173	380	0
1,2,4-Trimethylbenzene	8	6	6.70	22.9	47.0	0
Naphthalene	6	5	24.0	115	260	0
Isopropylbenzene	8	4	6.10	18.0	34.0	0
Pentachlorobenzene	10	10	10.0	30.4	67.0	NA
1,3,5-Trimethylbenzene	8	8	2.50	15.6	45.0	NA
Carbon disulfide	13	8	5.00	12.8	41.0	NA
2-Butanone	13	7	7.00	23.4	41.0	NA
Acetone	13	7	17.0	73.7	130	NA
sec-Butylbenzene	9	7	2.30	508	3,500	NA
p-Isopropyltoluene	8	6	2.30	12.5	30.0	NA
Semivolatile Organic Compounds (μg/kg)						
1,4-Dichlorobenzene	23	23	33.0	63,996	1,000,000	14
Benzo(b)fluoranthene	13	13	100	90,038	720,000	13
Benzo(k)fluoranthene	13	13	96.0	32,739	270,000	13
Chrysene	13	13	100	82,189	650,000	13
1,2-Dichlorobenzene	23	23	18.0	15,107	120,000	12
Benzo(a)anthracene	13	13	63.0	56,361	460,000	12
Benzo(a)pyrene	13	13	74.0	59,415	480,000	12
Hexachlorobenzene	23	11	37.0	219	1,300	11
Indeno(1,2,3-cd)pyrene	13	13	41.0	32,902	230,000	10
Fluorene	13	10	28.0	13,317	95,000	6
Naphthalene	13	11	71.0	11,936	94,000	5
Phenanthrene	13	13	70.0	87,547	780,000	4
Phenol	13	4	68.0	1,022	3,300	4
Fluoranthene	13	13	140	121,171	990,000	2
Pyrene	13	13	170	160,392	1,300,000	2
Bis(2-ethylhexyl)phthalate	13	12	240	42,858	290,000	2
Anthracene	13	8	120	28,341	160,000	2
2-Methylnapnthalene	13	7	71.0	6,252	39,000	2
Acenaphthene	13	6	66.0	18,363	85,000	2
1,3-Dichlorobenzene	23	9	5.00	1,631	14,000	1
1,2,3-Trichlorobenzene	10	6	9.00	787	3,700	0
1,2,4-Trichlorobenzene	15	5	71.0	802	1,800	0
1,2,4-Trimethylbenzene	1	1	6,400	6,400	6,400	0
Benzo(g,h,i)perylene	13	13	40.0	39,981	280,000	NA
1,2,3,4-Tetrachlorobenzene	10	10	28.0	104	240	NA
1,2,4,5-Tetrachlorobenzene	10	10	9.00	45.8	150	NA
1,3,5-Trichlorobenzene	10	9	5.00	2,086	15,000	NA
Carbazole	13	8	54.0	16,718	93,000	NA
Di-n-octyl phthalate	13	8	31.0	8,039	37,000	NA
Dibenzofuran	13	6	120	16,703	80,000	NA
1-Methylnaphthalene	5	5	7.00	2,027	4,600	NA
Dibenzo(a,h)anthracene	13	5	1,700	25,460	72,000	NA

Table 4.38. *Detected East Flume Sediment CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
3&4-Methylphenol	8	4	130	4,558	16,000	NA
Acenaphthylene	13	4	61.0	421	1,400	NA
4-Methylphenol	5	2	200	225	250	NA
3-Ethyltoluene	1	1	400	400	400	NA
Dioxins/Furans (ng/kg)						
Total TEQ	21	20	16.6	147	794	NA
Pesticides (μg/kg)						
Hexachlorobenzene	8	8	13.0	26.9	58.0	8
4,4'-DDE	21	6	8.40	25.2	65.0	6
Methoxychlor	21	4	42.0	111	180	4
4,4'-DDD	21	1	34.0	34.0	34.0	1
Heptachlor epoxide	21	1	63.0	63.0	63.0	1
Endrin ketone	13	4	43.0	86.0	150	NA
PCBs (μg/kg)						
Aroclor-1260	31	11	35.0	402	3,380	11
Aroclor-1248	31	10	39.0	312	2,400	10
Aroclor-1254	31	6	200	357	660	6
Inorganic Compounds (mg/kg)						
Mercury	31	31	0.81	2.42	7.50	31
Copper	23	23	8.80	55.0	114	19
Zinc	23	22	95.4	314	643	18
Lead	23	23	15.2	55.1	110	17
Arsenic	13	13	8.00	14.7	24.6	13
Chromium	23	23	8.10	24.7	44.1	11
Nickel	23	21	4.60	15.2	23.3	11
Cadmium	23	10	0.73	1.22	1.60	10
Silver	13	7	0.44	292	2,040	1
Manganese	13	13	181	236	315	0
Calcium	23	23	152,000	265,336	355,000	NA
Magnesium	23	23	3,370	13.232	25,400	NA
Sodium	23	23	11.5	3,712	8,240	NA
Chloride	15	15	441	5,060	11,700	NA
Aluminum	13	13	1.90	3,940	6,260	NA
Barium	13	13	131	178	268	NA
Cobalt	13	13	1.90	5.49	10.2	NA
Iron	13	13	2,520	10,667	18,900	NA
Potassium	13	13	193	685	1,010	NA
Vanadium	13	13	1.60	24.6	105	NA
Beryllium	13	12	0.11	0.38	0.57	NA
Selenium	13	8	0.82	2.24	2.80	NA
Cyanide	12	5	0.56	2.71	7.00	NA

Notes:
1 – Exceeds NYSDEC Technical Guidance for Screening Contaminated Sediments (1999). Screening values calculated using mean TOC of 6.29%.
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

Benzene and chlorobenzene were detected at concentrations exceeding guidance values in *Technical Guidance for Screening Contaminated Sediments* (NYSDEC, 1999). Other detected VOCs that were detected but did not exceed the guidance values include toluene, xylenes, and ethylbenzene **(Table 4.38)**. Total BTEX values ranged from 3 μg/kg (HB-S213 [0-0.6 ft]) to 18,100 μg/kg (HB-S214 [0-0.6 ft]) **(Figure 108)**. Total chlorobenzenes are also presented on **Figure 108**. A key source to the

East Flume sediments was historic inputs of industrial waste waters, including the former Main Plant and former Willis Avenue Chlorobenzene Plant.

Nineteen SVOCs were detected above the guidance values in *Technical Guidance for Screening Contaminated Sediments* (NYSDEC, 1999) and consisted mostly of PAHs and chlorinated benzenes. PAHs were detected in every sediment sample collected from the East Flume and total PAH concentrations ranged from 352 µg/kg (HB-S213 [0-0.6 ft]) to 6,705,000 µg/kg (HB-UEF-7 [0-0.5 ft]) **(Figure 108)**. Key sources to the East Flume sediments were historic inputs of industrial waste waters, including the former Main Plant and former Willis Avenue Chlorobenzene Plants, and urban runoff.

PCBs and pesticides were detected exceeding guidance values **(Table 4.38)**. These constituents included Aroclors 1260 and 1254, 4,4'-DDD, 4,4'-DDE, methoxychlor, and heptachlor epoxide. Total PCBs for are presented on **Figure 108**. Key sources of the PCBs/pesticides to the East Flume sediments were historic inputs of industrial waste waters, including the former Main and Willis Avenue Plants, and urban runoff.

Total TEQs were calculated for all nine samples collected from Lakeshore Area sediment samples **(Figure 108)**. These values ranged from 16.6 ng/kg to 794 ng/kg. One source of the PCDD/PCDfs to the East Flume sediments was historic inputs of industrial waste waters. The former Willis Avenue Chlorobenzene Plant and urban runoff (flow into the Main and PA Sewers) were main sources of PCDD/PCDFs in the East Flume.

Inorganic compounds were detected at concentrations exceeding guidance values in *Technical Guidance for Screening Contaminated Sediments* (NYSDEC, 1999). These are mercury, arsenic, cadmium, chromium, copper, lead, zinc, and nickel. Mercury concentrations are presented on **Figure 108**. Inorganics were detected in all sediment samples. One source to the East Flume sediments was historic inputs of industrial waste waters, including the former Main and Willis Avenue Plants.

The East Flume historically received input from surface runoff **(Figure 16),** shallow and intermediate ground water from the Lakeshore Area **(Figures 38 through 41)**, and some industrial waste water. The East Flume has been abandonded as part of on-going remedial efforts.

4.6. I-690 Catch Basin Characterization

During the RI, the I-690 catch basins associated with the storm sewer system in the vicinity of the Site were sampled. Four catch basins were to be sampled; however, catch basin HB-DR-73A had been removed and/or paved over and was not sampled. Sample locations are presented on **Figure 6**. During Round 1, storm water samples were collected from catch basins HB-DR-69 and HB-DR-72. No storm water sample was collected from HB-DR-70 due to lack of water. No storm water samples were collected during the second round of sampling due to a lack of water. Sediments were sampled during Rounds 1 and 2 from catch basins HB-DR-69, HB-DR-70, and HB-DR-72. Storm water samples were analyzed for VOCs, SVOCs, pesticides, PCBs, and inorganics. I-690 catch basin storm water data are presented in **Tables 289 through 293** for VOCs, SVOCs, pesticides, PCBs, inorganics, respectively. Sediment samples were analyzed for VOCs, SVOCs, pesticides, PCBs, inorganics, percent solids, and PCDD/PCDFs. I-690 catch basin sediment data are presented in **Tables 294 through 301** for VOCs, SVOCs, pesticides, PCBs, inorganics, PCDD/PCDFs, percent solids, and PCDD/PCDF toxic equivalence (TEQs), respectively.

4.6.1. I-690 Catch Basin Storm Water

Summary statistics are provided on **Table 302** for surface water constituents detected in the I-690 Catch Basins. Detected constituents of potential interest are listed below in **Table 4.39**. Constituents that were detected at in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included in the list below.

Table 4.39. *Detected I-690 Catch Basin Storm Water CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (μg/L)						
Acetone	2	2	6.60	10.3	14.0	0
Semivolatile Organic Compounds (μg/L)						
Bis(2-ethylhexyl)phthalate	2	2	2.80	2.90	3.00	2
Fluoranthene	2	1	1.00	1.00	1.00	0
Inorganic Compounds (mg/L)						
Aluminum	2	2	1.09	1.20	1.30	2
Iron	2	2	1.66	2.40	3.13	2
Chromium	2	2	0.012	0.014	0.016	0
Copper	2	2	0.0308	0.03085	0.0309	0
Lead	2	2	0.017	0.021	0.026	0
Zinc	2	2	0.68	1.04	1.41	0
Barium	2	2	0.045	0.054	0.062	0
Calcium	2	2	25.8	29.9	34.0	0
Magnesium	2	2	2.93	3.16	3.39	0
Manganese	2	2	0.07	0.11	0.15	0
Sodium	2	2	37.7	47.4	57.0	0
Potassium	2	1	2.01	2.01	2.01	0

Notes:
1 – Exceeds NYSDEC Class C surface water standards and guidance.
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

Acetone was the only detected VOC in the two storm water samples. It was detected in catch basins HB-DR-69 and HB-DR-72 at concentrations of 14 μg/L and 6.6 μg/L, respectively. Detected SVOCs included fluoranthene and bis(2-ethylhexyl)phthalate. Fluoranthene was detected in catch basin HB-DR-72 at a concentration of 1 μg/L. Bis(2-ethylhexyl)phthalate was detected in catch basins HB-DR-69 and HB-DR-72 at concentrations of 3 μg/L and 2.8 μg/L, respectively. No pesticides or PCBs were detected in these samples. Mercury was not detected in either sample. The constituents detected with the I-690 storm water are likely related to general roadway run-off.

4.6.2. I-690 Catch Basin Sediment

Summary statistics are provided on **Table 303** for sediments constituents detected in the I-690 catch basins. Detected constituents of potential interest are listed below in **Table 4.40**. Constituents that were detected at in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included in the list below.

Table 4.40. *Detected I-690 Catch Basin Sediment CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (μg/kg)						
Benzene	6	2	1.50	2.25	3.00	0
Ethylbenzene	6	2	4.50	4.75	5.00	0
o-Xylene	6	2	4.00	4.55	5.10	0
Toluene	6	2	11.0	11.5	12.0	0
Xylenes, m & p	6	2	6.10	8.55	11.0	0
2-Butanone	6	5	5.90	19.2	60.0	NA
Acetone	6	5	26.0	50.0	120	NA
Styrene	6	5	1.70	4.82	10.0	NA
4-Methyl-2-pentanone	6	3	1.90	7.80	18.0	NA
Carbon disulfide	6	2	1.70	3.40	5.10	NA
Chlorodibromomethane	6	1	7.50	7.50	7.50	NA
Methylene chloride	6	1	7.50	7.50	7.50	NA
Semivolatile Organic Compounds (μg/kg)						
Benzo(a)anthracene	6	5	1,100	1,580	2,000	5
Benzo(a)pyrene	6	5	1,100	1,660	2,000	5
Benzo(b)fluoranthene	6	5	1,100	1,840	2,400	5
Benzo(k)fluoranthene	6	5	960	1,512	1,900	5
Chrysene	6	5	1,600	2,340	2,800	5
Indeno(1,2,3-cd)pyrene	6	4	880	1,270	1,500	4
Phenanthrene	6	5	1,800	2,920	3,900	0
Pyrene	6	5	2,200	3,260	4,100	0
Anthracene	6	4	520	603	730	0
Bis(2-ethylhexyl)phthalate	6	4	4,200	6.600	11,000	0
Fluoranthene	6	4	3,000	4,625	6,100	0
Benzo(g,h,i)perylene	6	5	1,100	1,500	2,000	NA
Carbazole	6	4	460	553	680	NA
Di-n-butyl phthalate	6	2	500	800	1,100	NA
Dioxins/Furans (ng/kg)						
Total TEQ	6	6	0.34	3.95	11.8	NA
Inorganic Compounds (mg/kg)						
Chromium	6	6	62.2	73.7	89.6	6
Copper	6	6	51.9	77.3	99.5	6
Lead	6	6	54.8	71.3	107	6
Zinc	6	6	628	762	954	6
Nickel	6	6	15.1	20.2	29.8	4
Mercury	6	6	0.04	0.08	0.16	1
Cadmium	6	1	0.61	0.61	0.61	1
Arsenic	6	6	2.3	2.83	3.1	0
Manganese	6	6	294	328	365	0
Aluminum	6	6	2,400	2,962	4,140	NA
Barium	6	6	55.1	63.7	72.8	NA
Calcium	6	6	154,000	176,333	200,000	NA
Cyanide	6	6	2.78	7.12	13.8	NA
Iron	6	6	14,800	17850	21,300	NA
Magnesium	6	6	18,600	26,233	36,800	NA
Potassium	6	6	525	715	900	NA
Sodium	6	6	193	442.	812	NA
Vanadium	6	6	14.4	19.4	24.0	NA
Cobalt	6	2	6.80	6.90	7.00	NA

Table 4.40. *Detected I-690 Catch Basin Sediment CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]

Notes:
1 – Exceeds NYSDEC Technical Guidance for Screening Contaminated Sediments (1999).
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

Detected VOCs in the catch basins included 2-butanone, 4-methyl-2-pentanone, acetone, benzene, carbon disulfide, ethylbenzene, styrene, toluene, and xylenes. None of the detected VOCs had concentrations exceeding the *NYSDEC Technical Guidance for Screening Contaminated Sediments* (1999) guidance values.

- Detected SVOCs in catch basin HB-DR-69 sediments included carbazole, di-n-butyl phthalate, bis(2-ethylhexyl)phthalate, and assorted PAHs at concentrations ranging from 570 µg/kg to 11,000 µg/kg.
- Detected SVOCs in catch basin HB-DR-70 sediments included bis(2-ethylhexyl)phthalate and assorted PAHs at concentrations ranging from 880 µg/kg to 4,600 µg/kg.
- Detected SVOCs in catch basin HB-DR-72 sediments included carbazole, di-n-butyl phthalate, bis(2-ethylhexyl)phthalate, and assorted PAHs at concentrations ranging from 500 µg/kg to 6,600 µg/kg.

Pesticides and PCBs were not detected in sediments collected from the three catch basins. Mercury was detected in catch basin HB-DR-69 sediments at concentrations of 0.07 mg/kg and 0.09 mg/kg. Mercury was detected in catch basin HB-DR-70 at concentrations of 0.04 mg/kg and 0.08 mg/kg. Mercury was detected in catch basin HB-DR-72 at concentrations of 0.05 mg/kg and 0.16 mg/kg.

Sediment samples collected from the I-690 catch basins were analyzed for PCDD/PCDFs using USEPA method 8290. Toxic equivalence concentrations (TEQs) were calculated using toxic equivalency factors (TEFs) from Van den Berg, *et al*. (2006). The predominant congeners were 1,2,3,4,6,7,8-HpCDD, 1,2,3,4,6,7,8-HpCDF, OCDF, and OCDD. OCDD concentrations were generally an order of magnitude higher than the other predominant congeners. The PCDD/PCDF congener concentrations relative to one another indicate that the PCDD/PCDFs are likely related to general urban background and are not indicative of a Site source.

4.7. Seep Characterization

Three seeps were identified during seep reconnaissance at the Site. The locations were designated HB-Seep-01, HB-Seep-02, and HB-Seep-03. Locations are provided on **Figure 6**. HB-Seep-01 water was sampled twice, and HB-Seep-03 water was sampled once. Water at HB-Seep-02 was not sampled because the seep was underneath the water in Onondaga Lake. Since no water could be collected at location HB-Seep-02, sediment was collected from 0 to 0.5 ft and 0.5 ft to 1 ft. Seep water samples were analyzed using USEPA methods for VOCs, SVOCs, pesticides, PCBs, and inorganics. Seep water data are provided in **Tables 304 through 308** for VOCs, SVOCs, pesticides, PCBs, and inorganics, respectively. Seep sediment samples were analyzed for VOCs, SVOCs, pesticides, PCBs, inorganics, and PCDD/PCDFs. Seep sediment data are provided in **Tables 309 through 316** for VOCs, SVOCs, pesticides, PCBs, inorganics, PCDD/PCDFs, percent solids, and PCDD/PCDFs TEQs, respectively.

4.7.1. Seep Waters

Summary statistics are provided on **Table 317** for seep water constituents detected at the Site. Detected constituents of potential interest are listed below in **Table 4.41**. Constituents that were detected at in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included in the list below.

Table 4.41. *Detected Seep Surface Water CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (μg/L)						
Benzene	3	2	190	195	200	2
Ethylbenzene	3	2	34.0	40.0	45.0	2
Toluene	3	2	320	365	410	2
o-Xylene	3	2	130	140	150	2
Xylenes, m & p	3	2	320	360	400	2
2-Butanone	3	1	7.50	7.50	7.50	NA
Acetone	3	1	68.0	68.0	68.0	NA
Chloroform	3	1	1.30	1.30	1.30	NA
Chloromethane	3	1	1.00	1.00	1.00	NA
Semivolatile Organic Compounds (μg/L)						
2-Methylnaphthalene	3	2	220	260	300	2
Acenaphthene	3	2	43.0	46.0	49.0	2
Fluorene	3	2	37.0	39.0	41.0	2
Naphthalene	3	2	1,900	2,000	2,100	2
Phenanthrene	3	2	65.0	68.0	71.0	2
Phenol	3	2	110	120	130	2
2,4-Dimethylphenol	3	1	12.0	12.0	12.0	1
Bis(2-ethylhexyl)phthalate	3	1	1.20	1.20	1.20	1
2-Methylphenol	3	2	73	91.5	110	NA
Acenaphthylene	3	2	45.0	50.0	55.0	NA
Carbazole	3	2	43.0	49.5	56.0	NA
Dibenzofuran	3	2	54.0	63.5	73.0	NA
3&4-Methylphenol	3	1	180	180	180	NA
Di-n-butyl phthalate	3	1	1.20	1.20	1.20	NA
Inorganic Compounds (mg/L)						
Aluminum	3	1	0.18	0.18	0.18	1
Lead	3	2	0.007	0.02	0.03	0
Mercury	3	2	0.0003	0.0004	0.0005	0
Mercury (High Resolution)[3]	2	2	5.30	170	334	0
Iron	3	1	0.23	0.23	0.23	0
Barium	3	3	0.02	0.08	0.11	0
Calcium	3	3	56.8	448	666	0
Potassium	3	3	12.5	15.5	17.6	0
Sodium	3	3	205	288	357	0
Chloride	3	3	335	500	628	0
Sulfate	3	3	116	141	176	0
Magnesium	3	1	2.74	2.74	2.74	0

Notes:
1 – Exceeds NYSDEC Class C surface water standards and guidance.
2 – Mean concentration values have been rounded.
3 - High resolution mercury is presented in units of ng/L.
NA = Not applicable as no criteria available.

Benzene, toluene, ethylbenzene, and xylenes were detected at concentrations exceeding NYSDEC Class GA ground water standards and guidance values. Other VOCs were detected but did not exceed

the guidance values. Total BTEX values ranged from non detect to 1,205 µg/L at HB-Seep-01 only. Shallow ground water is the most likely source of the VOCs in the seep surface water and the surrounding sediment.

Thirteen SVOCs were detected above the NYSDEC Class GA ground water standards and guidance values and consisted mostly of PAHs. Phenol and chlorinated benzenes were also detected above the guidance values. Total PAH values ranged from non detect to 2,612 µg/L at HB-Seep-01. Shallow ground water is the most likely source of the SVOCs in the seep surface water and the surrounding sediment.

Pesticides were detected exceeding guidance values and are presented in **Table 4.41**. Aluminum is the only inorganic exceeding the NYSDEC Class GA ground water standards and guidance values; however, most inorganics are observed in seep surface water samples. Shallow ground water is the most likely source of the pesticides and inorganics in the seep surface water and the surrounding sediment.

4.7.2. Seep Sediment

Summary statistics are provided on **Table 318** for seep water constituents detected at the Site. Detected constituents of potential interest are listed below in **Table 4.42**. Constituents that were detected at in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included in the list below. A sediment sample was collected from this one location (HB-Seep-02) because seep water could not be sampled since the area was submerged by Onondaga Lake.

Table 4.42. *Detected Seep Sediment CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (µg/kg)						
Benzene	2	2	3,700	3,950	4,200	2
Chlorobenzene	2	2	640	690	740	2
Toluene	2	2	7,200	8,300	9,400	2
Xylenes, m & p	2	2	5,900	7,750	9,600	1
Ethylbenzene	2	2	570	755	940	0
o-Xylene	2	2	2,100	2,450	2,800	0
Styrene	2	2	1,200	1,800	2,400	NA
Semivolatile Organic Compounds (µg/kg)						
1,2-Dichlorobenzene	2	2	1,400	1,900	2,400	2
1,4-Dichlorobenzene	2	2	3,000	3,800	4,600	2
2-Methylnaphthalene	2	2	4,200	4,650	5,100	2
Benzo(a)anthracene	2	2	420	810	1,200	2
Chrysene	2	2	670	985	1,300	2
Naphthalene	2	2	41,000	43,500	46,000	2
Phenol	2	2	24,000	25,000	26,000	2
Benzo(a)pyrene	2	1	1,100	1,100	1,100	1
Benzo(b)fluoranthene	2	1	860	860	860	1
Benzo(k)fluoranthene	2	1	940	940	940	1
Indeno(1,2,3-cd)pyrene	2	1	600	600	600	1
Acenaphthene	2	2	440	505	570	0
Anthracene	2	2	450	615	780	0
Fluoranthene	2	2	1,300	1,950	2,600	0
Phenanthrene	2	2	2,400	2,750	3,100	0
Pyrene	2	2	1,100	1,700	2,300	0

Table 4.42. *Detected Seep Sediment CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
1,2,4-Trichlorobenzene	2	1	460	460	460	0
2,4-Dimethylphenol	2	2	6,400	6,850	7,300	NA
2-Methylphenol	2	2	8,400	8,800	9,200	NA
3&4-Methylphenol	2	1	17,000	17,000	17,000	NA
Acenaphthylene	2	2	860	870	880	NA
Dibenzofuran	2	2	700	750	800	NA
Benzo(g,h,i)perylene	2	1	660	660	660	NA
Dioxins/Furans (ng/kg)						
Total TEQ	2	2	1.58	1.71	1.84	NA
Inorganic Compounds (mg/kg)						
Arsenic	2	2	6.20	6.90	7.60	2
Chromium	2	2	36.0	48.1	60.1	2
Copper	2	2	67.4	68.1	68.8	2
Lead	2	2	37.8	47.6	57.4	2
Mercury	2	2	4.10	7.00	9.90	2
Nickel	2	2	19.0	20.4	21.8	2
Manganese	2	2	276	293	309	0
Zinc	2	2	38.5	45.4	52.2	0
Aluminum	2	2	3,750	3,950	4,150	NA
Barium	2	2	3,830	4,355	4,880	NA
Calcium	2	2	306,000	321,000	336,000	NA
Iron	2	2	6,650	7,190	7,730	NA
Magnesium	2	2	12,600	14,050	15,500	NA
Sodium	2	2	3,980	4,255	4,530	NA

Notes:
1 – Exceeds NYSDEC Technical Guidance for Screening Contaminated Sediments (1999). Screening values calculated using mean TOC of 7.15%.
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

Benzene, toluene, ethylbenzene, and xylenes were detected at concentrations exceeding guidance values in *Technical Guidance for Screening Contaminated Sediments* (NYSDEC, 1999). Other VOCs were detected but did not exceed the guidance values. Total BTEX values ranged from 19,470 µg/kg to 26,940 µg/kg. VOCs in the seep sediment are likely related to historic East Flume discharges associated with the formation of the ILWD.

SVOCs detected above the guidance values in *Technical Guidance for Screening Contaminated Sediments* (NYSDEC, 1999) consisted of chlorinated benzenes and PAHs **(Table 4.42)**. Total PAH values had a mean of 58,525 µg/kg. SVOCs in the seep sediment are likely related to historic East Flume discharges associated with the formation of the ILWD.

No PCBs and pesticides were detected exceeding guidance values **(Table 4.42)**. Total TEQs were calculated for both samples collected from HB-Seep-02. PCDD/PCDFs in the seep sediment are most likely related to historic East Flume discharges associated with the formation of the ILWD.

Inorganic compounds were detected at concentrations exceeding guidance values in *Technical Guidance for Screening Contaminated Sediments* (NYSDEC, 1999). These are arsenic, chromium, copper, lead, mercury, and nickel. Inorganics in seep sediment are most likely related to historic East Flume discharges associated with the formation of the ILWD.

4.8. Penn-Can Drum Survey

As part of the Penn-Can Drum Survey, approximately 15 drums were identified on the eastern portion of the Penn-Can property. A 55-gallon drum was found that was deteriorated and partially filled with tar. A sample of the tar was collected and submitted to the laboratory for chemical analyses. A second drum with dried tar material was also identified during the survey. No analytic sample was collected from this drum. The PSA drum survey tar sample is presented on **Tables 93 through 98** for VOCs, SVOCs, pesticides, PCBs, inorganics, and percent solids, respectively. The tar sample location is presented on **Figure 6**.

The major constituents detected within the tar sample include BTEX, styrene, naphthalene, assorted PAHs, phenols, dibenzofuran, and carbazole. This area was regraded and used as a staging area by New York State Department of Transportation (NYSDOT) for the I-690 bridge replacement that was completed. It appears that the NYSDOT disposed of the 55-gallon drum as part of the regrading.

4.9. Soil Vapor Survey

Soil vapor data are included on **Tables 319 and 320**. The samples have also been separated into Lakeshore Area soil vapor samples, Penn-Can Property soil vapor samples, and Penn-Can Property sub-slab vapor samples. Summary statistics are provided on **Tables 321, 322, and 323** for soil vapor constituents detected in Lakeshore Area soil vapor, Penn-Can Property soil vapor, and Penn-Can sub-slab vapor, respectively. The soil vapor survey did not include indoor air sampling, and this will be evaluated during the Human Health Risk Assessment and feasibility study, and a sampling work plan will be submitted under a separate cover, if required.

For purposes of this discussion, the chemical compounds found in soil vapor at the Wastebed B/Harbor Brook Site have been classified into the four categories. They are petroleum compounds, solvents, freons, and degradation products.

4.9.1. Lakeshore Area Soil Vapor

Detected constituents of potential interest are listed below in **Table 4.43**. Constituents that were detected at in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included in the list below.

Table 4.43. *Detected Lakeshore Area Soil Vapor CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (μg/m^3)						
Benzene	9	9	2.00	13.9	35.0	1
Tetrachloroethene	9	9	0.69	55.2	390	1
Trichloroethene	9	8	0.49	1.15	2.70	1
1,2,4-Trimethylbenzene	9	9	6.00	17.7	46.0	0
Acetone	9	9	11.0	13.2	18.0	0
Ethylbenzene	9	9	1.70	5.48	17.0	0
n-Hexane	9	9	0.68	4.88	25.0	0
o-Xylene	9	9	2.50	7.92	19.0	0
Toluene	9	9	36.0	1,126	4,100	0
Xylenes, Total	9	9	6.80	26.5	57.0	0
1,3,5-Trimenthylbenzene	9	8	1.90	6.86	16.0	0
Dichlorodifluoromethane	9	8	1.80	2.48	3.60	0

Table 4.43. *Detected Lakeshore Area Soil Vapor CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Naphthalene	9	8	6.60	88.3	190	0
Styrene	9	8	1.60	10.3	38.0	0
trans-1,2-Dichloroethene	9	8	0.56	2.14	4.10	0
Trichlorofluoromethane	9	8	0.97	1.51	2.20	0
Carbon disulfide	9	7	0.41	12.2	74.0	0
Methylene chloride	9	6	0.35	0.43	0.53	0
2-Butanone	9	4	0.72	1.24	1.90	0
4-Methyl-2-pentanone	9	4	0.58	0.78	1.20	0
Chloroform	9	4	0.50	0.60	0.79	0
Chloromethane	9	4	0.73	0.89	1.20	0
1,1,2-Trichlorotrifluoroethane	9	2	0.78	0.82	0.86	0
1,4-Dichlorobenzene	9	2	0.61	1.91	3.20	0
Chlorobenzene	9	2	1.50	4.65	7.80	0
cis-1,2-Dichloroethene	9	2	0.77	1.29	1.80	0
n-Heptane	9	9	0.58	4.71	29.0	NA
4-Ethyltoluene	9	8	1.70	3.61	8.00	NA
2,2,4-Trimethylpentane	9	7	0.47	3.02	16.0	NA
Cyclohexene	9	5	0.91	1.37	2.00	NA
2-Hexanone	9	2	0.50	0.50	0.50	NA

Notes:
1 – Exceeds OSWER Target Deep Soil Gas Guidance Values (10^{-4}, 10^{-5}, and 10^{-6} RF)
2 – Mean concentration values have been rounded
NA = Not applicable as no criteria available.

Petroleum related compounds detected at the Site include trimethylbenzenes, benzene, ethylbenzene, xylenes, naphthalene, and toluene. Solvents detected at the Site include acetone, methylene chloride, tetrachloroethene, carbon disulfide, and trichloroethene. Detected degradation compounds are *cis*-1,2-dichloroethene, and *trans*-1,2-dichloroethene. Freons detected at the Site include dichlorodifluoromethane, trichlorofluoromethane, and 1,1,2-trichlorotrifluoromethane.

The compounds that exceed the OSWER Target Deep Soil Gas Guidance Values (10^{-4}, 10^{-5}, or 10^{-6} RF) are benzene, tetrachloroethene, and trichloroethene. Petroleum related compound are the dominant component of the exceedances. However, petroleum related compounds, solvents, degradation products and freons were detected in the majority of these samples. Elevated concentrations were detected at HB-VI-05, HB-VI-06, HB-VI-09, HB-VI-10, and HB-VI-11. This is likely related to the presence of DNAPL in the subsurface **(Figure 110)** near HB-VI-09, HB-VI-10, and HB-VI-11, and the proximity and influence of the ILWD on locations HB-VI-05 and HB-VI-06. Distribution of DNAPL is discussed below in Section 4.10. The presence of these constituents in the soil vapor samples indicate the potential for vapor intrusion into future on-Site structures.

4.9.2. Penn-Can Property Soil Vapor

Detected constituents of potential interest are listed below in **Table 4.44**. Constituents that were detected at in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included in the list below.

Table 4.44. *Detected Penn-Can Property Soil Vapor CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (μg/m^3)						

Table 4.44. *Detected Penn-Can Property Soil Vapor CPOIs.*

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Benzene	14	14	0.62	488,378	1,200,000	10
Chloroform	14	9	3.50	384	1,700	6
Trichloroethene	14	8	0.49	23.6	64.0	6
Naphthalene	14	13	0.96	32,131	220,000	5
Tetrachloroethene	14	13	1.30	372	2,300	5
1,2,4-Trimenthylbenzene	14	14	1.30	7,056	51,000	4
1,3,5-Trimenthylbenzene	14	12	1.70	3,764	20,000	4
Ethylbenzene	14	12	1.00	8,062	48,000	4
Toluene	14	13	6.90	190,279	970,000	3
Styrene	14	13	0.39	19,856	130,000	2
Carbon tetrachloride	14	3	0.64	9.18	17.0	1
Acetone	14	14	6.20	15.7	36.0	0
Xylenes. Total	14	14	0.62	69,019	360,000	0
o-Xylene	14	13	1.50	17,714	100,000	0
Methylene chloride	14	12	0.92	4.76	6.40	0
n-Hexane	14	11	0.57	367	2,500	0
Carbon disulfide	14	10	3.30	59.4	300	0
trans-1,2-Dichloroethene	14	8	5.80	7.69	11.0	0
Dichlorodifluoromethane	14	7	2.40	6.00	8.60	0
Chlorobenzene	14	5	5.40	20.2	41.0	0
1,1,1-Trichloroethane	14	4	10.0	6,011	24,000	0
Trichlorofluoromethane	14	4	1.30	2.73	5.90	0
1,1-Dichloroethane	14	3	9.70	32.2	74.0	0
4-Ethyltoluene	14	11	1.60	1,107	4,400	NA
n-Heptane	14	10	0.75	670	4,000	NA
Cyclohexene	14	9	3.60	43.2	150	NA
2,2,4-Trimethylpentane	14	6	0.47	8.58	18.0	NA

Notes:
1 – Exceeds OSWER Target Deep Soil Gas Guidance Values (10^{-4}, 10^{-5}, and 10^{-6} RF)
2 – Mean concentration values have been rounded.
NA = Not applicable as no criteria available.

Petroleum related compounds detected at the Site include trimethylbenzenes, benzene, ethylbenzene, xylenes, naphthalene, and toluene. Solvents detected at the Site include acetone, 1,1,1-trichloroethane, methylene chloride, tetrachloroethene, carbon disulfide, and trichloroethene. Detected degradation compounds are 1,2-dichlroethane, *cis*-1,2-dichloroethene, and *trans*-1,2-dichloroethene. Freons detected at the Site include dichlorodifluoromethane and trichlorofluoromethane. A compound not categorized was chloroform, which is often associated with chlorinated water.

The following compounds exceeded the OSWER Target Deep Soil Gas Guidance Values (10^{-4}, 10^{-5}, or 10^{-6} RF): benzene, naphthalene, chloroform, trichloroethene, tetrachloroethene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, ethylbenzene, toluene, styrene, and carbon tetrachloride. Petroleum related compounds are the dominant component of the exceedances. However, petroleum related compounds, solvents, degradation products, and freons were detected in the majority of the samples. The constituents detected in soil gas are likely related to the presence of DNAPL in the subsurface (**Figure 110**) and the historic use of the area by Barrett Paving. Distribution of DNAPL is discussed below in Section 4.10. The presence of these constituents in the soil vapor samples indicate the potential for vapor intrusion into future on-Site structures.

4.9.3. Penn-Can Property Sub-Slab Vapor

Detected constituents of potential interest are listed below in **Table 4.45**. Constituents that were detected at in at least twenty percent of the samples or exceeded standards or guidance values discussed in Section 5 of this report in at least one of the samples were included in the list below.

Table 4.45. *Detected Penn-Can Property Sub-Slab Soil Vapor CPOIs*.

Parameter	No. of Samples	No. of Detects	Minimum Detected Conc.	Mean Detected Conc.[2]	Maximum Detected Conc.	No. of Exceedances[1]
Volatile Organic Compounds (μg/m^3)						
Benzene	4	4	2.50	15.3	38.0	4 / 0
Chloroform	4	2	35.0	67.5	100	2 / 0
Ethylbenzene	4	2	5.30	6.20	7.10	2 / 0
n-Hexane	4	3	4.60	15.5	30.0	1 / 1
1,2-Dichloroethane	4	1	1.20	1.20	1.20	1 / 0
Carbon tetrachloride	4	1	2.60	2.60	2.60	1 / 0
Acetone	4	4	11.0	245	770	NA / 0
Toluene	4	4	14.0	50.5	120	NA / 0
Xylenes. Total	4	4	9.10	13.7	18.0	NA / 0
1,2,4-Trimenthylbenzene	4	3	8.90	10.3	12.0	NA / 0
Carbon disulfide	4	3	1.50	4.97	9.20	NA / 0
n-Heptane	4	3	2.70	21.2	45.0	NA / 0
1,3,5-Trimenthylbenzene	4	2	3.10	4.20	5.30	NA / 0
4-Methyl-2-pentanone	4	2	1.00	37.0	73.0	NA / 0
Methylene chloride	4	2	3.50	3.90	4.30	0 / 0
o-Xylene	4	2	3.80	4.95	6.10	NA / 0
Trichlorofluoromethane	4	2	0.91	5.21	9.50	NA / 0
1,1,1-Trichloroethane	4	1	13.0	13.0	13.0	NA / 0
1,4-Dioxane	4	1	1.50	1.50	1.50	NA / 0
Dichlorodifluoromethane	4	1	2.60	2.60	2.60	NA / 0
Styrene	4	1	1.80	1.80	1.80	NA / 0
Cyclohexene	4	3	6.40	20.1	32.0	NA
4-Ethyltoluene	4	1	2.20	2.20	2.20	NA
cis-1,2-Dichloroethene	4	1	1.60	1.60	1.60	NA
Naphthalene	4	1	62.0	62.0	62.0	NA
Tetrachloroethene[3]	4	4	1.20	14.1	23.0	3 / 0 / 0
Trichloroethene[3]	4	1	5.70	5.70	5.70	1 / 1 / 0

Notes:
1 – Exceeds USEPA Region 9 Regional Screening Level for Industrial Air. Displayed as Cancer screening level exceedance / Noncancer screening level exceedance.
2 – Mean concentration values have been rounded.
3 – Tetrachloroethene and trichloroethene exceeds USEPA Tier 3 values with a 10-fold dilution risk range. Displayed as 0.1 dilution / No Dilution / 10 Dilution for exceedances.
NA = Not applicable as no criteria available.

Sub-slab samples (HB-HW-SS-01 to HB-HW-SS-04) had exceedances for benzene, chloroform, ethylbenzene, n-hexane, 1,2-dichloroethane, and carbon tetrachloride when compared to Region 9 Regional Screening Levels for industrial air. Tetrachloroethene and trichloroethene had exceedances the 10 μg/m^3 risk and 0.5 and 5 μg/m^3 risks, respectively. These samples were collected from below buildings on the Penn-Can Property. Similar to soil vapor samples, sub-slab samples were dominantly petroleum related compounds and solvents but included degradation products and freons. The constituents detected in sub-slab soil gas are likely related to the presence of DNAPL in the Penn-Can Property subsurface **(Figure 110)** and the historic use of the area by Barrett Paving. Distribution of DNAPL is discussed below in Section 4.10. The presence of these constituents in the sub-slab

samples indicated the potential for vapor intrusion into the former buildings; however, these buildings were demolished in October 2013.

4.10. DNAPL Recovery Evaluation Sampling

One DNAPL sample was collected from HB-HB-04S as part of the DNAPL recovery evaluation. The sample was submitted to the laboratory for VOC, SVOCs, viscosity (cP), viscosity (cSt), density (g/mL), and interfacial tension (mN/m). The data are presented on **Tables 324 through 326**. The major constituents detected in this sample include naphthalene, BTEX (predominantly xylenes), methylene chloride, and assorted PAHs. The extent of DNAPL is discussed below and the recovery and transport of DNAPL is discussed in Section 6.2 of this report.

4.11. Nature and Extent of DNAPL, DNAPL-Stained Soils, and Other Visibly Contaminated Materials

DNAPL and stained soils were encountered in soil borings and test pits advanced during the PSA, RI, Harbor Brook Sediment IRM (BBL, 2001), Wastebed B/Harbor Brook IRM, I-690 Limited Investigation, and the Supplemental RI. In general, there are seven areas of DNAPL, DNAPL-stained soils, or other visibly contaminated materials were encountered on the Wastebed B/Harbor Brook and SYW-12 Sites and include:

- Coal tar like DNAPL associated with the Penn-Can Property
- Asphalt material identified at HB-HB-11 from approximately 3.5 to 5 ft bgs
- Stained soils associated with AOS#1 and Wetland Area WL2
- Tar-like material in Test Pit HB-TP-18 identified at approximately 4 ft bgs
- Chlorobenzene DNAPL
- “Black-stained organic material” associated with the DSAs
- Black “Sludge Material” in SYW-12

The extent of these areas is discussed below in greater detail.

4.11.1. Coal Tar Like DNAPL

The first area of DNAPL is found primarily on the Penn-Can Property and downgradient of the Penn-Can Property on Wastebed B, the railroad area, AOS#2, beneath Harbor Brook, and in the western portion of AOS#1. This DNAPL has a naphthalene chemical signature and will be described as a “coal tar like DNAPL”. The physical characteristics and chemistry of this DNAPL are provided on **Tables 324 through 326**. The coal tar like DNAPL and DNAPL-staining on the Penn-Can Property are most likely associated with the former facility operations, which may specifically include numerous tanks, process lines, ditches, and waste tile drains. The approximate extent of DNAPL found in the fill is presented on **Figure 109**. Cross sections were developed to better characterize the extent of DNAPL, DNAPL-stained material, and the subsurface lithology. The location of the cross sections is presented on **Figure 18**. Cross sections are included as **Figures 19 through 27**. It should be noted that an “asphalt material” with elevated PID readings was identified in boring HB-HB-11 approximately 3.5 to 5 ft bgs. However, no DNAPL was identified in the boring and this location is not included within the extent of DNAPL in fill (**Figure 109**).

The coal tar like DNAPL has also been found in the marl unit, which lies below the fill unit and above the underlying clay and silt unit. It is likely that the source of this DNAPL is also related to the former facility operations. This DNAPL has migrated vertically downward from the fill into the marl and has then migrated horizontally across much of the eastern portion of the Penn-Can Property. **Figure 109** illustrates where DNAPL appears to have migrated in the marl (green hatching). Cross-sections A-A', B-B' and I-I' **(Figures 19, 20 and 27)** illustrate the vertical extent of DNAPL (green) and staining (orange). It is likely that the DNAPL migrated horizontally through coarser layers (often in shell rich layers) in the marl. The texture of the marl typically fines downward into a confining silt and clay layer, which may have prevented the DNAPL from moving down to the bottom of the marl.

The coal tar like DNAPL was observed in the deep unit on the Penn-Can Property in the coarse sand above the till/bedrock unit in the following locations: HB-HB-14D, HB-HB-13D, HB-SB-74, HB-SB-75, HB-SB-76, and HB-SB-79. The solid yellow in **Figure 111** illustrates the interpreted extent of this DNAPL in the deep unit. The DNAPL observed in borings to the eastern portion of the Penn-Can Property (HB-HB-13D) was likely transmitted via the coarser sands, which extend below the silt and clay layer at this location. HB-HB-13D is down slope of the suspected source area on the Penn-Can Property. Soil borings HB-SB-75, HB-SB-76, and HB-HB-14D identify a portion of the Penn-Can Property where fill and marl overly till. These borings also indicate that DNAPL may have a pathway to the deep unit. Therefore, DNAPL likely traveled down the sloping till surface to the southeast. This is supported by the presence of DNAPL at HB-HB-13D decreasing over time in the well, as well as decreasing concentrations at this location likely related to the decrease in DNAPL.

The coal tar like DNAPL was also encountered in coarse lenses of the marl on the Lakeshore Area beneath the eastern portion of Wastebed B, beneath Harbor Brook, and in the western portion of AOS#1. This DNAPL likely migrated from the Penn-Can Property. The extent of the coal tar type DNAPL in the marl is indicated as the green hatched area in **Figure 109,** and the vertical extent is indicated in cross section D-D' of **Figure 22.** The gradient of the marl unit and the driving DNAPL head on the Penn-Can Property were the most likely factors controlling the DNAPL migration. The site data suggest that the DNAPL is either not migrating because DNAPL has reached residual saturation under the existing conditions, or migration is limited where residual saturation has not been reached. This is supported by the lack of DNAPL migration into Site monitoring wells under static ground water conditions. The mobility of this DNAPL is also addressed in the Section 6.2.

4.11.2. Stained Soils Associated with AOS#1 and Wetland Area WL2

Black stained material identified on the Site is the black tarry staining found in the shallow fill material on the Lakeshore Area (Wetland WL2) and AOS #1. The approximate extent of the stained soils is presented **Figure 112**. The staining in the shallow fill in these areas is often tarry in appearance and is composed of PAHs. The stained fill material is entrained in the fill and occurs above the marl, which suggests that the stained material has a different origin than the coal tar like DNAPL observed in the marl on Wastebed B (orange in **Figures 21, 22, 23, and 24**).

The presence of the staining distributed throughout much of the fill material and at a higher elevation than the marl suggests that the staining did not migrate to the fill from the marl. In addition, this material is similar in appearance and chemical composition to the "Black Organic Material" encountered in DSA #1 and DSA #2 during the PSA, RI, Supplemental RI, and Willis Avenue RI field programs. This suggests that this material may be related to historic East Flume discharges that formed the ILWD.

However, based on review of historical aerial photography and site borings, it appears that fill may also have been deposited in these low-lying areas some time between 1959 and 1967. The nature of fill materials that may have been placed in this area are unknown. This stained material appears to be adsorbed to and entrained in the sediments and fill.

4.11.3. Tar-like Material in Test Pit HB-TP-18

A small area of black tar-like material was observed during the excavation of test pit HB-TP-18. The black tar-like material was located approximately 4 ft bgs in the Solvay waste. This material appeared to be isolated to this location. The source of this material is unknown but is likely related to historic operations at the Barrett Paving facility, related to the undigested sewage sludge placed on the eastern portion of Wastebed B during the 1950's and early 1960's, or was co-disposed with the solvay waste during the operation of Wastebed B.

4.11.4. Chlorobenzene DNAPL

Chlorobenzene DNAPL was observed in boring HB-SB-01 from 34 to 36 ft bgs. The chlorobenzene DNAPL is related to operations at the former Willis Avenue plant. The chlorobenzene DNAPL is a dense NAPL which sinks in water. **Table 4.46** below provides the basic physical characteristics of the chlorobenzene DNAPL (GT Engineering, 1995). The chemical composition of the DNAPL is provided below in **Table 4.47**. Honeywell is currently operating a DNAPL collection system along the lakeshore to the west of this location. The chlorobenzene DNAPL is described in detail within the Willis Avenue RI Report (O'Brien & Gere, 2002a).

Table 4.46. *Chlorobenzene DNAPL Physical Characteristics*

Parameter (Method)	**Result**
Viscosity (ASTM Method D445)	
at 55 ºF	0.998 cs
at 75 ºF	0.86 cs
Specific Gravity	
at 55 ºF	1.18
at 75 ºF	1.17
Electrical Conductivity (ASTM D2624)	490 pS/m
pH	6.7
Vapor Pressure	
at 32 ºF	6.4 torr
at 50 ºF	12.0 torr
at 75 ºF	26.0 torr
at 100 ºF	56.0 torr
at 125 ºF	108.0 torr
at 150 ºF	200.0 torr
at 175 ºF	350.0 torr

Notes:
Source: GT Engineering, 1995

Table 4.47. *Chlorobenzene DNAPL Chemical Composition*.

Compound	Percent (%) by Weight
Chlorobenzene	42
1,4-Dichlorobenzene	25

1,2-Dichlorobenzene	20
Benzene	3.8
1,3-Dichlorobenzene	< 1
Trichlorobenzene	< 1
Notes: Source: GT Engineering, 1995	

4.11.5. "Black-Stained Organic Material" Associated with the DSAs

The black stained organic material was encountered in the shallow fill in borings and test pits along the Upper and Lower (former) East Flume **(Figure 113)** in DSA #1 and DSA #2. The origin of this material is believed to be dredge material from the former East Flume and Onondaga Lake that was generated during the installation of the diffuser building intake pipe. This material is similar in chemical characteristics to the stained material in AOS #1 and the wetland areas near the mouth of Harbor Brook except that chlorobenzenes tend to be more prevalent. This material is believed to be related to historic East Flume discharges and the ILWD. This dredge material was likely impacted by the chlorobenzene DNAPL found in the marl on the Willis Avenue Site and the extreme western portion of the lakeshore of the Harbor Brook Site prior to placement in the DSAs. The black stained organic material in the dredge material is entrained in the material and sorbed to the sediments. Migration of this stained material is not expected under current site conditions.

4.11.6. SYW-12 Sludge-Like Material

A similar type of black stained sludge or "tarry material" was observed in borings at SYW 12. This material may be from potential upgradient sources such as the former Marley Property or Oil City. A petroleum hydrocarbon analysis completed during the Supplemental RI detected fuel oil #6 and lubricating oil constituents. The former Onondaga Creek channel and Iron Pier area were also on this site prior to the re-routing of the stream to its present day course. These areas have been filled by others; however, the nature of the fill is unknown. Based on historic maps and aerial photos, this area appears to have been filled between 1915 and 1926. Based on the 1946 NYSDOH document, dredge materials from the barge canal terminal which were observed (in August 1946) being placed along the southern shore of Onondaga Lake which may have included SYW-12. Furthermore, it is possible that materials dredged from the southern portion of Onondaga Lake may have been disposed of in this area. In addition, the current Onondaga Creek channel adjacent to the former MGP site was widened and/or may have been deepened to allow for barge traffic. It is unknown whether any of these materials were disposed of at SYW-12. These dredge materials may have been impacted by the former adjacent MGP plant, Oil City, or other sources. An additional investigation has been undertaken to identify the extent and the source of the "tarry material" observed in borings at SYW 12, and the results of this investigation will be provided under separate cover.

It should also be noted that PXE and PTE were detected in stained soils at the Site. These compounds suggests potential influence from Semet material. It is unknown how PXE and PTE reached the site; however, this material may have been placed with dredge materials placed along the southern lakeshore of Onondaga Lake (NYSDOH, 1946). **Figure 114** presents the areas and depths where black stained tarry material was encountered.

4.12. Polychlorinated Naphthalenes and TICs

Polychlorinated naphthalenes (PCNs) were included in the Methods 8270C SVOA for the RI and Supplemental RI. No PCNs were identified on the USEPA target parameter list or tentatively

identified compound (TIC) sheets (**Appendix S**); however, multiple unknown compounds and unknown hydrocarbons were included on the TIC sheets. Laboratory standards are not available for PCNs, so the RI and Supplemental RI samples were not run against a known standard for PCNs.

A literature search was performed to identify the expected retention time or time intervals for the PCN congeners. Based on this search, the expected retention time ranges could be:

- Sewage sludge: di-CN = 3.7 min.; tetra-CN = 8.6 min. (Crompton, 2003)
- PCN congeners from commercial sources: 0.528 min. (mono-CN) to 4.03 min. octa-CN (Lei *et al*., 1999; Falandysz *et al*. 2001)
- Sediment and biota (fish tissue): tetra-CN = 10 to 16 min.; penta-CN = 16 to 21 min.; hexa-CN = 21 to 24.8 min; hepta-CN = 24.8 to 29.5 min.; and octa-CN = 29.5 to 47 min. (Järnberg *et al*., 1993)

The scientific literature presents a wide range of possible chromatographic retention times for these compounds. Unknown compounds were observed with retention times within the ranges listed above. This may indicate the presence of PCNs, but other compounds have retention times in the above ranges so these compounds could not be definitively identified as PCNs.

5. Comparison of Analytical Results to Applicable Standards and/or Guidance Values

This section presents a comparison of analytical results to applicable standards and/or guidance values. The following media were screened:

- Surface Soils (< 2 ft bgs)
- Subsurface Soils (> 2 ft bgs)
- Shallow Ground Water
- Intermediate Ground Water
- Deep Ground Water
- Surface Water
- Sediment
- Soil Vapor

5.1. Comparison of Soil Concentrations to Screening Guidance

Soil analytical results for the Site were compared to *USEPA Soil Screening Guidance* (USEPA, 1996) and NYCRR Part 375-6 Unrestricted Use Soil Cleanup Objectives (SCOs), which are currently promulgated standards. Soil screening values of 20 dilution attenuation factor (DAF) and 1 DAF were taken directly from USEPA Soil Screening Guidance for the ground water migration pathway. 20 DAF is the default value used to account for natural processes. 1 DAF is a more conservative value for cases where there is no dilution between source and receptor.

NYSDEC criteria were taken directly from the Unrestricted Use Soil Cleanup Objectives (SCOs) located in NYCRR Part 375-6 except for inorganic compounds that the cleanup objective was listed as SB (site background). In absence of Site-specific background data, the lowest of three available background values was used. Background values were obtained from *Soil Chemistry of Hazardous Materials* (Dragun, 1988) and *Background of 20 Elements in Soils with Special Regard for NYS* (McGovern, 1988) and are listed in **Table 327**. *Geotechnical Behavior of Solvay Waste* (Kulhawy, 1977) is used to provide general concentrations of inorganic compounds in Solvay waste, which is not background soil but present on-site.

The guidance values are included in the analytical results tables for surface soils (**Tables 41 through 91, Tables 93 through 98, and Tables 103 through 112**) and subsurface soils (**Tables 41 through 58, Tables 68 through 76, Tables 83 through 91, Tables 114 through 119, Tables 133 through 138, and Tables 144 through 149**). Constituents with at least one detected concentration in a surface soil sample are presented on **Tables 92, 99, 100, 101, 102, and 113** for the Lakeshore Area, Penn-Can Property, Railroad Area, AOS#1, AOS#2, and SYW-12, respectively. Constituents with at least one detected concentration in a subsurface soil sample are presented on **Tables 139 through 143 and Table 150** for the Lakeshore Area, Penn-Can Property, Railroad Area, AOS#1, AOS#2, and SYW-12, respectively.

Constituents with non-detect concentrations (reported as the detection limit) and elevated detection limits are presented on **Tables 328, 329, 330, 331, 332, and 333** for surface soils in the Lakeshore Area, Penn-Can Property, Railroad Area, AOS#1, AOS#2, and SYW-12, respectively. Constituents with non-detect concentrations (reported as the detection limit) and elevated detection limits are

presented on **Tables 334, 335, 336, 337, 338, and 339** for subsurface soils in the Lakeshore Area, Penn-Can Property, Railroad Area, AOS#1, AOS#2, and SYW-12, respectively.

Soil samples collected for TCLP analysis during the PSA and Willis Avenue RI are compared with RCRA guidance values provided in 40 CFR Part 261. The guidance values are included on analytic results **Tables 120 through 132**. There were no exceedances observed for the TCLP analytical results when compared to the Part 261 guidance values.

5.2. Comparison of Ground Water Concentrations to Standards and Guidance Values in 6 NYCRR Part 703 and NYSDEC TOGS 1.1.1. Ambient Water Quality Standards and Guidance Values

Shallow, intermediate, and deep ground water results were compared to class GA standards and guidance obtained from *6NYCRR Part 703* and *NYSDEC TOGS 1.1.1 Ambient Water Quality Standards and Guidance Values* (NYSDEC, 1998). The principal organic contaminant (POC) criteria were used for compounds meeting the POC description found in TOGS 1.1.1 and for which a specific standard was not available. Guidance values, if available, were used for compounds for which standards have not been assigned. The standards or guidance values are included in the ground water analytical results tables (**Tables 151 through 174 and Tables 194 through 199**). Constituents with a detected concentration in at least one ground water sample are presented on:

- **Tables 175, 176, and 177** for shallow, intermediate, and deep Lakeshore Area ground water wells
- **Tables 178, 179, and 180** for shallow, intermediate, and deep Penn-Can Property ground water wells
- **Tables 181, 182, and 183** for shallow, intermediate, and deep Railroad Area ground water wells
- **Tables 184, 185, and 186** for shallow, intermediate, and deep AOS#1 ground water wells
- **Table 187** for intermediate AOS#2 ground water wells
- **Table 200** for shallow SYW-12 ground water wells.

Constituents with non-detect concentrations (reported as the detection limit) and elevated detection limits for ground water samples are presented on:

- **Tables 340, 341, 342, 343, and 344** for shallow ground water wells for the Lakeshore Area, Penn-Can Property, Railroad Area, AOS#1, and SYW-12
- **Tables 345, 346, 347, 348, and 349** for intermediate ground water wells for the Lakeshore Area, Penn-Can Property, Railroad Area, AOS#1, and AOS#2
- **Tables 350, 351, 352, and 353** for deep ground water wells for the Lakeshore Area, Penn-Can Property, Railroad Area, and AOS#1.

5.3. Comparison of Surface Water Concentrations to Standards and Guidance Values in 6 NYCRR Part 703 and NYSDEC TOGS 1.1.1. Ambient Water Quality Standards and Guidance Values

Surface water results were compared to class C surface water standards obtained from 6 NYCRR Part 703 and NYSDEC TOGS 1.1.1 Ambient Water Quality Standards and Guidance Values (NYSDEC, 1998). For compounds which contain multiple class C standards for various water uses, the lowest

(most conservative) value was used for comparison. A mean hardness value of 575 mg/L was used to calculate the standards for cadmium, chromium, copper, lead, nickel, and zinc. Guidance values, if available, were used for compounds for which standards have not been assigned. The standards are included in the surface water analytical results tables (**Tables 201 through 218**). Constituents with a detected concentration in at least one surface water sample are listed in **Tables 219 through 222** for the Lakeshore Area (I-690 Drainage Ditch), Penn-Can Property, Railroad Area, and Harbor Brook, respectively. Constituents with non-detect concentrations (reported as the detection limit) and elevated detection limits in surface water samples are presented on **Tables 354 through 357** for the Lakeshore Area (I-690 Drainage Ditch), Penn-Can Property, Railroad Area, and Harbor Brook, respectively.

5.4. Comparison of Sediment Concentrations to Guidance Values from Technical Guidance for Screening Contaminated Sediments (NYSDEC 1999)

Sediment results were compared to screening values obtained from Technical Guidance for Screening Contaminated Sediments (NYSDEC, 1999). Consistent with the procedure utilized for the ERA, total organic carbon values of 7.15% and 6.29% were used to calculate criteria for organic compounds. The value of 7.15% was derived from the mean value observed for Harbor Brook and applied to Harbor Brook, I-690 Drainage Ditch, Penn-Can Property, Railroad Area, and AOS #2. The value of 6.29% was derived from the mean value observed for East Flume (upper and lower) and applied to those sediments only. The analytical results were compared to the human health bioaccumulation and benthic chronic screening values to account for a wide range of potential receptors. The guidance values are included in the sediment analytical results tables (**Tables 223 through 280**). Constituents with a detected concentration in at least one sediment sample are listed in **Tables 281 through 288** for the Lakeshore Area (I-690 Drainage Ditch), Penn-Can Property, Railroad Area, AOS #2, Harbor Brook, and East Flume, respectively. Constituents with non-detect concentrations (reported as the detection limit) and elevated detection limits in sediment samples are presented on **Tables 358 through 365** for the Lakeshore Area (I-690 Drainage Ditch), Penn-Can Property, Railroad Area, AOS #2, Harbor Brook surface sediment, Harbor Brook subsurface sediment, Harbor Brook subsurface DNAPL/sediment, and East Flume, respectively.

5.5. Comparison of I-690 Catch Basin Storm Water and Sediment Concentrations to Standards and Guidance Values

5.5.1. Storm Water

Storm water results were compared to Class C surface water standards obtained from 6 NYCRR Part 703 and NYSDEC TOGS 1.1.1 Ambient Water Quality Standards and Guidance Values (NYSDEC, 1998). For compounds which contain multiple class C standards for various water uses, the lowest (most conservative) value was used for comparison. A mean hardness value of 575 mg/L was used to calculate the standards for cadmium, chromium, copper, lead, nickel, and zinc. Guidance values, if available, were used for compounds for which standards have not been assigned. The standards or guidance for Class C surface water are included in the storm water analytical results tables (**Tables 289 through 293**). Constituents with a detected concentration in at least one storm water sample are listed in **Table 302**. Constituents with non-detect concentrations (reported as the detection limit) and elevated detection limits in storm water samples are presented on **Table 366**.

5.5.2. Sediment

Sediment results were compared to screening values obtained from Technical Guidance for Screening Contaminated Sediments (NYSDEC, 1999). Consistent with the procedure utilized for the ERA, a total organic carbon value of 7.15% was used to calculate criteria for organic compounds. This value was derived from the mean value observed for Harbor Brook. The analytical results were compared to the human health bioaccumulation and benthic chronic screening values to account for a wide range of potential receptors. The standards are included in the sediment analytical results tables (**Tables 294 through 301**). Constituents with a detected concentration in at least one sediment sample are listed in the **Table 303**. Constituents with non-detect concentrations (reported as the detection limit) and elevated detection limits in catch-basin sediment samples are presented on **Table 367**.

5.6. Comparison of Seep Water and Sediment Concentrations to Standards and Guidance Values

5.6.1. Seep Water

Analytical results were compared to Class C surface water standards obtained from 6 NYCRR Part 703 and NYSDEC TOGS 1.1.1 Ambient Water Quality Standards and Guidance Values (NYSDEC, 1998). For compounds which contain multiple class C standards for various water uses, the lowest (most conservative) value was used for comparison. A mean hardness value of 1,680 mg/L was used to calculate the standards for cadmium, chromium, copper, lead, nickel, and zinc. Guidance values, if available, were used for compounds for which standards have not been assigned. The standards or guidance are included in the seep water analytical results tables (**Tables 304 through 308**). Constituents with a detected concentration in at least one seep water sample are listed in the **Table 317**. Constituents with non-detect concentrations (reported as the detection limit) and elevated detection limits in seep water samples are presented on **Table 368**.

5.6.2. Seep Sediment

Analytical results were compared to screening values obtained from Technical Guidance for Screening Contaminated Sediments (NYSDEC, 1999). Consistent with the procedure utilized for the ERA, a total organic carbon value of 7.15% was used to calculate criteria for organic compounds. This value was derived from the mean value observed for Harbor Brook. The analytical results were compared to the human health bioaccumulation and benthic chronic screening values to account for a wide range of potential receptors. The standards are included in the seep sediment analytical results tables (**Tables 309 through 316**). Constituents with a detected concentration in at least one seep sediment sample are listed in **Table 318**. Constituents with non-detect concentrations (reported as the detection limit) and elevated detection limits in seep sediment samples are presented on **Table 369**.

5.7. Comparison of Soil Vapor and Sub-Slab Vapor Data to Screening Guidance and Screening Levels

Soil vapor analytical results for the Lakeshore Area and Penn-Can property were compared to *OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)* (USEPA, 2002). Soil vapor samples were compared to OSWER $1x10^{-4}$, $1x10^{-5}$, and $1x10^{-6}$ Generic Screening Levels (Target Deep Soil Gas Concentration to Target Indoor Air Concentration Where the Soil Gas to Air Attenuation Factor=0.01). The guidance values are included with the analytical results for soil vapor on **Table 319**. Constituents with a detected concentration in a soil vapor sample at the Lakeshore Area and

Penn-Can Property are presented on **Tables 321 and 322**, respectively. Constituents with non-detect concentrations (reported as the detection limit) and elevated detection limits in Lakeshore Area and Penn-Can Property soil vapor sample are presented on **Tables 370 and 371**, respectively.

Sub-slab vapor analytical results for the Penn-Can Property were compared to the *USEPA Region 9 Regional Screening Levels for Industrial Air* (USEPA, 2009) for cancer and noncancer screening levels. The exceptions to this are trichloroethene (TCE) and tetrachloroethene (PCE), which were compared to USEPA Tier 3 indoor air values from the USEPA's toxicity hierarchy (5 $\mu g/m^3$ and 100 $\mu g/m^3$, respectively). Per the NYSDEC comments on the November 2007 RI Report, a risk range for these parameters were based on a 10-fold dilution. The risk ranges for TCE and PCE used for comparison are 0.5 $\mu g/m^3$, 5 $\mu g/m^3$, and 50 $\mu g/m^3$ and 10 $\mu g/m^3$, 100 $\mu g/m^3$, and 1000 $\mu g/m^3$, respectively. The screening levels are included with the analytical results for Penn-Can Property sub-slab soil vapor on **Table 320**. Constituents with a detected concentration or detected concentration in at least one Penn-Can Property sample are presented on **Table 323**. Constituents with non-detect concentrations (reported as the detection limit) and elevated detection limits in at least one Penn-Can Property sub-slab soil vapor sample are presented on **Table 372**.

5.8. Preliminary Chemical Parameters of Interest (CPOIs)

The preliminary CPOIs are based on the screening performed in Section 4 and above in this section. The Site constituents were considered to be preliminary CPOIs if one of the following criteria was exceeded:

- The constituent was detected in 20% or more of the samples
- The constituent exceeded screening or guidance values in at least one sample
- The constituent is a known bioaccumulator.

The 20% criterion above allows for the inclusion of constituents that are not known bioaccumulators and that do not currently have screening or guidance values associated with them, such as PXE and PTE, to be included in the preliminary CPOI list. The preliminary CPOIs were updated based on the results of the risk assessments performed at the Site. The preliminary CPOIs for the Site include the following constituents in **Table 5.1**

Table 5.1. *Preliminary CPOIs*.

VOCs	Naphthalene
2-Butanone	Nitrobenzene
2-Hexanone	Pentachlorophenol
1,2-Dichlorobenzene	Phenanthrene
1,3-Dichlorbenzene	Phenol
1,4-Dichlorobenzene	Pyrene
1,1-Dichloroethane	1,2,3-Trichlorobenzene
4-Methyl-2-pentanone	1,2,4-Trimethylbenzene
1,1,1-Trichloroethane	1,2,3,4-Tetrachlorobenzene
1,2,3-Trichlorobenzene	1,2,4,5- Tetrachlorobenzene
1,2,4-Trichlorobenzene	1,3,5-Trichlorobenzene
1,2,4-Trimethylbenzene	Di-n-octyl phthalate
1,3,5-Trimethylbenzene	3-Ethyltoluene
Acetone	1,1'-Biphenyl
Benzene	PXE
Bromoform	PTE
Carbon disulfide	1-Methylnaphthalene

Table 5.1. *Preliminary CPOIs*.	
Chlorobenzene	2,2'-Oxybis(1-Chloropropane)
Chloroethane	2,4,6-Dichlorophenol
Chloroform	2,4-Dinitrotoluene
cis-1,2-Dichloroethene	2,6-Dinitrotoluene
Ethylbenzene	2-Nitroaniline
Isopropylbenzene	3,3'-Dichlorobenzidine
Hexachlorobutadiene	3-Nitroaniline
Methylene chloride	4,6-Dinitro-2-methylphenol
n-Propylbenzene	4-Chloro-3-methylphenol
Naphthalene	4-Chloroaniline
Styrene	4-Chlorophenyl phenyl ether
sec-Butylbenzene	4-Nitroaniline
Tetrachloroethene	Bis(2-chloroethyoxy)methane
Toluene	Butylbenzl phthalate
Trichloroethene	Hexachloroethane
Vinyl chloride	n-Hexadecane
o-Xylene	N-Nitroso-di-n-propylamine
Xylenes, m & p	**Pesticides**
Xylenes, Total	4,4'-DDD
p-Isopropyltoluene	4,4'-DDE
Bromomethane	4,4'-DDT
Tert-Butylbenzene	Alpha-Chlordane
Pentachlorobenzene	Aldrin
1,1,2,2-Tetrachloroethane	Dieldrin
1,1,2-Trichloroehtane	Endrin
1,2-Dichloroethane	Methoxyclor
1,2-Dichloropropane	Alpha-BHC
Bromodichloromethane	Endrin ketone
Carbon tetrachloride	Heptachlor
Chlorodibromomethane	Heptachlor epoxide
cis-1,3-Dichlorpropene	Hexachlorobenzene
Dodecane	Beta-BHC
Trans-1,3-Dichloropropene	Delta-BHC
4-Chlorotoluene	Atrazine
4-Methyl-2-pentanone	Endosulfan I
Chloromethane	Endosulfan II
Cyclohexane	Endosulfan Sulfate
Hexadecane	Endrin Aldehyde
Methyl tert butyl ether	Toxaphene
n-Butylbenzene	Gamma-BHC (Lindane)
SVOCs	n-Dodecane
2-Chlorophenol	Methoxychlor
4-Chloroaniline	**PCBs and Dioxins/Furans**
1,2-Dichlorobenzene	Aroclor-1260
1,3-Dichlorbenzene	Aroclor-1254
1,4-Dichlorobenzene	Aroclor-1242
1,2,4-Trichlorobenzene	Aroclor-1248
2,4-Dimethylphenol	Aroclor-1016
2,4-Dichlorophenol	Aroclor-1268
2,4- Dinitrophenol	Assorted PCDD/PCDFs (Total TEQ)
2-Methylnaphthalene	**Inorganics**
2-Methylphenol	Aluminum
3&4-Methylphenol	Ammonia
4-Methylphenol	Antimony
2-Nitrophenol	Arsenic
4-Nitrophenol	Barium

Table 5.1. *Preliminary CPOIs*.	
1,2,4-Trichlorobenzene	Beryllium
2,4,5-Trichlorophenol	Cadmium
Acenaphthene	Calcium
Acenaphthylene	Chloride
Anthracene	Chromium
Benzo(a)anthracene	Cobalt
Benzo(b)fluoranthene	Copper
Benzo(a)pyrene	Cyanide
Benzo(k)fluoranthene	Iron
Benzo(g,h,i)perylene	Lead
Benzoic acid	Magnesium
Benzyl alcohol	Manganese
Bis(2-chloroethyl)ether	Methyl Mercury
Bis(2-ethylhexyl)phthalate	Mercury
Carbazole	Nickel
Chrysene	Potassium
Dibenzo(a,h)anthracene	Selenium
Dibenzofuran	Silver
Di-n-butyl phthalate	Sodium
Fluoranthene	Sulfate
Fluorene	Thallium
Hexachlorobenzene	Vanadium
Indeno(1,2,3-cd)pyrene	Zinc

6. Constituents Fate, Persistence, and Transport

The nature and extent of constituents in various media was described in Section 4. The sources of these constituents was discussed in previous sections.

The most frequently detected compounds in soils, ground water and sediment at the Wastebed B/Harbor Brook Site and additional areas of study are benzene, chlorinated benzenes, naphthalene, assorted PAHs, phenolic compounds and mercury. PCBs and PCDD/PCDFs are also discussed in this section. Discussion of possible migration mechanisms for these compounds is discussed in terms of each of these primary compounds, and the relationship of respective potential sources and fate.

Based on data generated during completion of the PSA, RI, Supplemental RI, and other Site investigations, and the physical characteristics of the site, the following potential transport mechanisms were evaluated:

- Transport of constituents from soils to surface water bodies via surface water run-off
- Ground water transport of constituents to Harbor Brook and Onondaga Lake
- Transport of DNAPL
- Transport of constituents to Onondaga Lake via surface water (*i.e.*, dissolved and particulate bound CPOIs in Harbor Brook and former East Flume)
- Vapor migration of volatile constituents
- Wind-borne particulate migration of constituents

The fate and transport mechanisms presented in this section should be viewed within the framework of the ongoing East Flume and Wastebed B/Harbor Brook IRMs.

6.1. Transport of Constituents from Soils to Surface Water Bodies via Storm Water Runoff

Transport of constituents from soils to surface water bodies via surface water runoff may occur from areas in close proximity to Onondaga Lake, Harbor Brook, and the drainage ditches. Surface water drainage is presented on **Figures 16 and 17**. However, the majority of the Site is well vegetated and covered with porous fill materials of varying thickness. Limited transport from the Lakeshore Area, DSA #1, and DSA #2 is expected, because vegetation limits scouring of soils and porous fill materials promote infiltration and evapotranspiration rather than overland flow. There is also little topographic relief in these areas to promote significant transport through overland flow.

The Penn-Can Property does have a greater potential for the transportation of surface soils to surface water bodies due to the higher topographic relief and the relative lack of vegetative cover. In comparison to some of the other transport mechanisms discussed in this section, this transport mechanism is believed to play a minor role in the transport of CPOIs.

6.2. Ground Water Transport of Constituents

6.2.1. Organic Compound Transport in Ground Water

Organic compounds most frequently detected in ground water were benzene, chlorinated benzenes, PAHs, phenols, and naphthalene. CPOIs were detected in the shallow, intermediate, and deep

aquifers, with the highest concentrations observed in the shallow and intermediate aquifers. In general, the ground water CPOIs are associated with the DNAPL and stained soils found on the Site. There may also be other residual source materials within the fill on the Site. This section will discuss the CPOIs in ground water transport in terms of their respective units.

In general, ground water from both the shallow and intermediate zones on the Site historically discharged to Harbor Brook and Onondaga Lake. The impacts of Site ground water on Onondaga Lake are being addressed as part of the remediation of Onondaga Lake. In addition, shallow and intermediate ground water discharges to Onondaga Lake and Harbor Brook have been mitigated by the collection systems that were installed as part of the Wastebed B/Harbor Brook IRM and by the abandonment of the East Flume which previously received discharges of shallow ground water.

The shallow ground water typically moves downward to the intermediate unit or discharges to surface water bodies, such as Onondaga Lake, Harbor Brook, and Site drainage ditches. Shallow ground water along the lakeshore moves towards the lake. Shallow ground water from the Penn-Can Property may move downward into the intermediate unit and towards the lakeshore or Harbor Brook, depending on the hydraulic gradient.

Typically, intermediate ground water from the Penn-Can Property moves north towards Onondaga Lake with a small portion of ground water that moves towards Harbor Brook. As discussed in Section 3, the intermediate ground water under the Lakeshore Area is a mixing zone between the native deep halite brines under the lake, recharge from shallow ground water, and upgradient intermediate ground water.

In general, limited ground water flow occurs in the deep ground water zone as discussed in Section 3 due to the dense native brines near the shore of the lake, which limit the migration of less dense ground water from upgradient areas of the site. No CPOIs were detected in deep wells situated near the lakeshore in either the 2003 or 2007 sampling events with the exception of HB-HB-16D. Trace CPOI concentrations were detected in HB-HB-16D in the 2003 sampling rounds with concentrations typically < 10 μg/L with a naphthalene (concentrations of 31 μg/L and 55 μg/L) dominant signature. It should be noted that deep ground water at the western end of the Lakeshore Area (wells HB-HB-01D and HB-WA-03D) has historically shown minor impacts from chlorinated benzenes and mercury.

The initial sampling events at HB-HB-16D in 2003 indicates that CPOIs such as naphthalene may have been mobilized during drilling procedures, which is not uncommon even when drilling using double cased methods. Following well installation and subsequent sampling in 2003, ground water conditions have likely stabilized. The 2007 deep ground water data shows a drop in CPOI concentrations with most constituents dropping to non-detect, including naphthalene. Furthermore, the ground water has a distinct native brine signature, similar to other Lakeshore Area deep wells, with a high Na/Ca ratio (17.2, 18.1, and 19) for all events. Since the native brine is well over 10,000 years old, this indicates that CPOIs were likely mobilized through drilling activities; the deep ground water along the lakeshore is not likely affected by CPOIs and is not part of the transport of CPOIs to Onondaga Lake.

CPOIs were detected in the deep ground water zone on the Penn-Can Property and the eastern portion of the Railroad Area. The coal tar-like DNAPL from Penn-Can Property is the most likely source of CPOIs in ground water given the interpreted DNAPL plume and the absence of the silt and clay aquitard under the small portion of the Penn-Can Property. As discussed in the Section 6.3, ground

water movement towards Harbor Brook may be limited to the presence of the coarse lenses of the deep unit, while the dense brines limit deep ground water movement towards the lake.

Ground water transport occurs predominantly in the shallow aquifer in SYW-12 with discharges to Onondaga Lake. The detected organic CPOIs were benzene, chlorinated benzenes, PAHs, phenols, and naphthalene; however, these were observed at lower concentrations than for Lakeshore Area and other sub-sites (**Figures 104 and 105**). While the concentrations are low, the source of these CPOIs is believed to be the fill materials at the Site. It is also possible that constituents in shallow ground water are related to potential upgradient sources discussed above.

6.2.2. Transport of PCBs and PCDD/PCDFs in Ground Water

Transport of PCBs and PCDD/PCDFs via ground water is not a viable transport mechanism due to the strong affinity of these compounds to sorb to particulate matter and their very low water solubilities (ATSDR, 1997). However, the presence of organic co-solvents enhances the mobility of PCBs and PCDD/PCDFs. **Figures 59 and 80** present the distribution of PCBs in surface and subsurface soils, respectively. These figures show that PCBs were detected Site-wide in soils. However, there was only one PCB detection in ground water, which was Aroclor 1254 at HB-HB-11S in May 2001 (0.3 μg/L). This well was installed in March 2001 and is screened in fill containing asphalt-type material. The PCBs are likely related to this fill material. It is believed that this PCB detection is likely an isolated occurrence since it has not been detected in any of the more recent sampling events.

6.3. Transport of DNAPL

In addition to soluble constituents in ground water, DNAPL and stained soils were encountered in soil borings and test pits advanced during the PSA, RI, the Harbor Brook Sediment IRM (BBL, 2001), Wastebed B/Harbor Brook IRM, I-690 Bridge Replacement Investigation, and the Supplemental RI. Cross-sections were developed to better characterize the extent of DNAPL and the subsurface lithology at the Site. The location of the cross sections is presented on **Figure 18**. Cross sections are included as **Figures 19 through 27**.

The migration of DNAPL in these areas is controlled by several factors including:

- The density, viscosity, interfacial tension, and volume of the product
- The horizontal and vertical permeability/porosity of the subsurface materials
- The moisture content of the subsurface soils
- The presence or lack of confining units or confining lenses within units.

6.3.1. Coal Tar-like DNAPL

The coal tar-like DNAPL associated the Penn-Can Property are most likely associated with the former facility operations, which included numerous tanks, process lines, ditches and waste tile drains. The extent of DNAPL found in the fill is noted as the blue hatched area in **Figure 109**. The coal tar-like DNAPL has also been found in the marl unit, which lies below the fill unit and above the underlying clay and silt unit. It is likely that the source of this DNAPL is also related to the former facility operations. Facility operations included the manufacture of various asphalt emulsions and some coal tar based products used in road construction. The historic facility layout including storage tanks, various operations buildings and waste drains is presented on **Figures 2 and 5**. The tanks at the site have all been removed and fill was added and the property was regraded to current conditions as

part of the plant decommissioning. The addition of fill and regrading subsequent to former operations is likely why DNAPL is not seen in the majority of the upper fill at the Penn-Can Property (Figures 19, 20, and 27). The vertical distribution of DNAPL observed in wells and borings located on the Penn-Can Property and the Site history suggest that this is the most likely source for the DNAPL. Historical features such as the earthen drains and ditches leading towards Harbor Brook are no longer present and appear to have been covered with fill material. These features may have transmitted DNAPL across surface features. These surface features may have also presented multiple points of entry for DNAPL to move into the subsurface.

This DNAPL has migrated vertically downward from the original fill material into the marl and horizontally across much of the eastern portion of the Penn-Can Property. **Figure 109** illustrates where DNAPL appears to have migrated in the marl (green hatching). Cross-sections A-A', B-B' and I-I' **(Figures 19, 20, and 27)** illustrate the vertical extent of DNAPL (green) and staining (orange). It is likely that the DNAPL migrated horizontally through coarser layers (often in shell rich layers) in the marl. The texture of the marl becomes increasingly fine grained with depth, which may have prevented the DNAPL from moving down to the bottom of the marl.

The coal tar-like DNAPL was observed in the deep zone on the Penn-Can Property in the coarse sand above the till/bedrock unit in the following locations: HB-HB-14D, HB-HB-13D, HB-SB-74, HB-SB-75, HB-SB-76, and HB-SB-79. The solid yellow in **Figure 111** presents the approximate extent of this DNAPL in the deep unit. The DNAPL observed in borings to the east of the Penn-Can Property at HB-HB-13D was probably transmitted by the coarser sands, which extend below the silt and clay layer at this location. HB-HB-13D is down slope of the suspected source area on the Penn-Can Property. Soil borings HB-SB-75, HB-SB-76, and HB-HB-14D identify a small portion of the Penn-Can Property where fill and marl overly till. These borings also indicate that DNAPL may have a pathway to the deep unit. DNAPL likely traveled down the sloping till surface to the southeast.
Subsurface soil samples collected at the Penn-Can Property from within the DNAPL source area in the fill/Solvay waste and migrating DNAPL in the marl and deeper zones exhibit similar chemical signatures. BTEX compounds and PAHs (especially naphthalene) were observed in soil samples collected from Solvay waste at locations HB-SB-81, HB-SB-78, HB-SB-76, and HB-GP-32A. By comparison, the subsurface soil samples collected within the marl (*i.e.*, HB-HB-17D, HB-SB-77, HB-HB-12D, HB-SB-73, HB-SB-74, and HB-GP-35) also exhibited detected concentrations of BTEX compounds and PAHs (especially naphthalene). HB-HB-13D (80 to 84 ft bgs) also had a similar chemical signature and was located near a deeper approximate DNAPL extent (**Figure 25 and 26**).

However, current geologic and hydrogeologic Site data indicates that the coarse material acting as preferential pathway for DNAPL migration is discontinuous. This may limit the migration of DNAPL found at the top of till at the Penn-Can Property. The limited mobility of this DNAPL is also addressed in the Section 6.3.2 below.

The coal tar-like DNAPL was also encountered in coarse lenses of the marl on the Lakeshore Area beneath the eastern portion of Wastebed B. This DNAPL likely migrated from the Penn-Can Property. The extent of the coal tar-like DNAPL in the marl is indicated as the green hatched area in **Figure 109.** The gradient of the marl unit and the driving DNAPL head on the Penn-Can Property were the most likely factors controlling the DNAPL migration.

Coal tar-like DNAPL was also found in the marl unit in the northeastern Railroad Area, as well as in AOS #2 adjacent to Harbor Brook. This DNAPL likely migrated from the Penn-Can Property and is an extension of the DNAPL in that marl. The marl unit extends eastward from the Penn-Can Property,

under the Railroad Area, and towards Harbor Brook. The driving DNAPL head on the Penn-Can Property and the hydraulic gradient in the intermediate unit **(Figures 40 and 41)** may facilitate the migration of DNAPL towards Harbor Brook.

DNAPL is migrating into the sediments and water column of Harbor Brook. Cross sections D-D' and I-I'**(Figure 22 and 27)** illustrate where DNAPL is found in the brook sediments. Ground water elevations at the Site suggest the potential for ground water to discharge to the brook. In most cases, DNAPL does not obey the same laws of migration as ground water. However, when the density of the DNAPL and the density of ground water are similar, the laws of migration are also likely to be similar. At the Site, the ground water has higher density (as indicated by the specific gravity 1.01-1.04 in the Intermediate) than fresh water. Preliminary calculations using equation 5-22 on page 5-20 of *DNAPL Site Evaluation* (Cohen and Mercer, 1993) suggest that the upward vertical hydraulic potential exists to prevent downward migration of DNAPL into the subsurface in the vicinity of Harbor Brook. While specific information for hydraulic potential beneath the brook itself are not known, a preliminary calculation of hydraulic gradients from HB-HB-08I to Harbor Brook is comparable to the gradients needed to prevent downward migration of DNAPL.

(Equation 5-22)

$$i_h = (\rho_n - \rho_w) / \rho_w$$

$$.0366 = (1.047-1.01)/1.01$$

where ρ_n = density of DNAPL

ρ_w = density of ground water at HB-HB-08I

I_h = gradient needed to overcome downward migration

Compared to the gradient from HB-HB-08I where:

$$I = (h_2 - h_1) / l$$

$$.0375 = (369.5-362)/200$$

where h_2 = ground water elevation in HB-HB-08I

where h_1 = ground water elevation in entering bottom of Harbor Brook

l = horizontal distance from HB-HB-08I

The two gradients presented here are similar and support potential for the transportation of subsurface DNAPL into Harbor Brook. It should also be noted that "vertical containment of low density DNAPLs such as coal tar and creosote is generally much more feasible than denser DNAPLs such as highly chlorinated solvents" *DNAPL Site Evaluation* (Cohen and Mercer, 1993). Lastly, while no documentation formally exist for the migration of DNAPL into the surface waters of Harbor Brook, field personnel have on occasion observed blebs of DNAPL rising to the surface sediment of Harbor Brook from the bottom sediments.

It should be noted that visual differences were noted in the coal tar-like DNAPL beneath Harbor Brook and the areas upgradient of the brook. For example, the DNAPL beneath Harbor Brook appeared to be reddish-brown in color beneath Harbor Brook (location T-4-2), dark brown (location HB-GP-07 31-32 ft bgs), brownish-black (HB-GP-32A 14-18 ft bgs), black (HB-GP-32A 20-24 ft bgs).

6.3.2. Coal Tar-Like DNAPL Recovery

The DNAPL recovery tests discussed in Sections 2.1.16 and 4.11 illustrate that limited coal tar-like DNAPL recovery is expected from any of the four wells tested in DNAPL-impacted areas. Predicted DNAPL recovery is expected to be limited to the radius around the recovery well where the hydraulic influence of pumping is sufficient to remobilize the DNAPL. DNAPL recovery during the tests was limited to two wells: HB-HB-04S and HB-HB-13D. Of those two, HB-HB-04S was the only well to produce measurable quantities of DNAPL. The recovered DNAPL was submitted to the laboratory for analyses including VOCs, SVOCs, viscosity (cP), viscosity (cSt), density, and interfacial tension as stated in section 4.10. The coal tar-like DNAPL consisted predominantly of naphthalene (14% by volume), phenanthrene (4.1% by volume), other PAHs (approx. 9% by volume, and xylene (1% by volume). The density was measured to be 1.047 g/mL. The physical characteristics and chemistry of this DNAPL are provided on **Tables 324 through 326**. HB-HB-12I and HB-HB-02I were also tested for DNAPL mobility in this pilot study. No observable DNAPL was induced from the surrounding DNAPL-impacted area over the course of the test.

The potential quantity that may be removed using an intermittent "purging" method can not be quantified at this time. The quantity of recoverable DNAPL is governed by its mobility and the hydraulic influence of the recovery well pumping. The extent of the radius of pumping influence is dependent on local hydrogeologic properties. Pumping tests performed on test wells on the Site in the summer of 2005 exhibited limited hydraulic influence on surrounding shallow wells. A water level change of 0.3 feet was observed in HB-HB-04S during the pump test while pumping on HB-TW-03 30 feet away.

6.3.3. Chlorobenzene DNAPL

Chlorobenzene DNAPL was observed in boring HB-SB-01 from 34 to 36 ft bgs. The chlorobenzene DNAPL is related to operations at the former Willis Avenue plant. The chlorobenzene NAPL is a dense NAPL (DNAPL), which sinks in water. The chemical and physical properties of the chlorobenzene DNAPL are presented in Section 4.11.4. The density of the chlorobenzene DNAPL ranged from 1.117 g/mL to 1.239 g/mL. The chlorobenzene DNAPL viscosity is 0.998 cS, which is lower than the coal tar-like DNAPL viscosity (11.86 cS). This indicates that the chlorobenzene DNAPL is likely more mobile in the Site subsurface soils than the coal tar-like NAPL discussed above. This DNAPL is mobile to some extent and Honeywell is currently operating a DNAPL collection system along the lakeshore to the west of this location.

6.3.4. "Black-Stained Organic Material" Associated with the DSAs

The black stained organic material was encountered in the shallow fill in borings and test pits along the former Upper and Lower East Flume **(Figure 113)** in DSA#1 and DSA#2. The origin of this material is believed to be from historic East Flume discharges related to the ILWD and likely dredge material from Onondaga Lake and the East Flume (now abandoned) associated with the installation of the diffuser building intake pipe. This material is similar in chemical characteristics to the stained material in AOS#1 and the wetland areas near the mouth of Harbor Brook except that chlorobenzenes tend to be more prevalent.. The black stained organic material in the dredge material is entrained (*i.e.*, part of the soil matrix) in the material and sorbed to the sediments. Migration of this stained material that is part of the soil matrix is not expected under current site conditions. However, constituents associated with these stained soils could potentially be leaching into shallow ground water.

6.3.5. Black Stained Material

Black stained material identified on the Site is the black tarry staining found in the shallow fill material on the Lakeshore Area and AOS #1. The extent of this material is presented on **Figure 112**. The stained fill material is entrained in the fill and occurs above the marl. This stained material is not considered mobile under existing conditions. However, constituents could potentially be leached from this material into shallow ground water.

6.3.6. SYW-12 Sludge-Like Material

A similar type of black stained sludge or "tarry material" was observed in borings at SYW-12. This material may be from potential upgradient sources such as the former Marley Property or Oil City. A petroleum hydrocarbon analysis completed during the Supplemental RI detected fuel oil #6 and lubricating oil constituents. The former Onondaga Creek channel and Iron Pier area were also on this site prior to the re-routing of the stream to its present day course. These areas have been filled by others; however, the nature of the fill is unknown. Based on historic maps and aerial photos, this area appears to have been filled between 1915 and 1926. Based on the 1946 NYSDOH document, dredge materials from the barge canal terminal which were observed (in August 1946) being placed along the southern shore of Onondaga Lake which may have included SYW-12. Furthermore, it is possible that materials dredged from the southern portion of Onondaga Lake may have been disposed of in this area. In addition, the current Onondaga Creek channel adjacent to the former MGP site was widened and/or may have been deepened to allow for barge traffic. It is unknown whether any of these materials were disposed of at SYW-12. These dredge materials may have been impacted by the former adjacent MGP plant, Oil City, or other sources. An additional investigation has been undertaken to identify the extent and the source of the "tarry material" observed in borings at SYW 12, and the results of this investigation will be provided under separate cover.

It should also be noted that PXE and PTE were detected in stained soils at the Site. These compounds suggests potential influence from Semet material. It is unknown how PXE and PTE reached the site; however, this material may have been placed with dredge materials placed along the southern lakeshore of Onondaga Lake (NYSDOH, 1946). **Figure 114** presents the areas where black stained tarry material was encountered. This tarry material is not considered mobile under existing conditions. However, constituents could potentially be leached from this material into shallow ground water.

6.4. Transport of Constituents to Onondaga Lake via Surface Water

Surface water flow paths to Onondaga Lake via Harbor Brook and seasonally flooded wetlands adjacent to the lake, as well as from the East Flume historically, provide transport pathways for constituents to Onondaga Lake **(Figures 16 and 17)**. The CPOIs can be transported as dissolved compounds within the water column or via adsorption to suspended sediment. Resuspended sediment can also enter the flow of a water body due to resuspension from normal flow or turbulence from high stream flows within the water column. Ground water advection into Harbor Brook can be a mechanism for transport of dissolved compounds. The seasonally flooded wetlands adjacent to the lake, Site drainage ditches, and Harbor Brook have similar transport mechanisms.

6.4.1. Surface Water Transport via Harbor Brook

Harbor Brook receives surface water inputs **(Figures 2 and 6)** from:

- five drainage ditches (one on Lakeshore Area [I-690 Drainage Ditch], two on Railroad Area, one on Penn-Can Property, and one on AOS #2),
- two seasonally flooded wetlands near its mouth (Wetland Area WL2 and AOS#1), and
- storm water overflow from the Metropolitan Wastewater Treatment Plant Combined Sewer Overflow (CSO).

A full description is presented in Section 1. The Penn-Can Property and Railroad Area drainage ditches are situated adjacent to wetland areas. Harbor Brook also receives input from shallow and intermediate ground waters from the Site.

The surface water flowing into the brook from the above inputs is generally seasonal. The wetlands and drainage ditches do not maintain a consistent pool of standing water throughout the year, except the southern one on the Railroad Area and one on AOS #2. Based on this, CPOIs predominantly enter the Harbor Brook water column as dissolved compounds and particulate matter due to ground water input and surface water from the CSO, AOS #2 drainage ditch, and southern Railroad Area drainage ditches. However, the seasonal ditches (i.e., Penn-Can ditch and the I-690 ditch) likely have an impact to Harbor Brook as well when flowing. This impact may be equal to or greater than the impacts from the upgradient ditches due to surface water CPOIs tend to be one to two orders of magnitude higher in the seasonal ditches.

The sediments and surface water (when present) of the I-690 and Penn-Can Property drainage ditches and the ground water contained elevated concentrations of predominant constituents (**Figures 107 and 108**). This corresponded to elevated concentrations of the CPOIs in the surface water and sediments of Harbor Brook north of I-690 (BBL, 2001) and may indicate a greater impact from the seasonal ditches than the ditches entering upstream as discussed above. Conversely, the drainage ditches on the Railroad Area and AOS #2 drainage ditch contained lower constituent concentrations than the surface water concentrations of the I-690 and Penn-Can Property drainage ditches but similar sediment concentrations. Based on this and the lower concentrations of CPOIs in brook surface water, Harbor Brook sediments act to retain a large portion of the constituents, with the rest entering Onondaga Lake.

6.4.2 Recent Surface Water Transport via East Flume

Prior to its abandonment in 2012, the former East Flume (**Figure 2**) received its surface water inputs from adjacent seasonally flooded wetlands and local industrial and municipal sources. A full description is presented in Section 1. Shallow and intermediate ground waters also entered the East Flume.

A dam marked the eastern boundary of the upper East Flume and prevented surface water from flowing freely into the lower East Flume. This caused the UEF to act as a depositional area for any sediment entering the UEF. The UEF was subject to seasonal overflow of its boundaries. The surrounding wetland area is also seasonally flooded. Based on this, transport mechanisms for constituents from the East Flume to Onondaga Lake included seasonal overland flow and flow through the former LEF of surface water and suspended sediment.

Sediment concentrations for constituents in the former UEF are elevated, which indicates depositional behavior for suspended sediment (**Figure 108**). Surface water data was not collected for the UEF and LEF, as well as sediment data for all constituents in the LEF. It can be inferred that some transport of constituents did occur via the surface water of the LEF as dissolved and sediment-bound constituents. The extent of this transport mechanism could not be determined. During the seasonal UEF overflow,

constituents were transported to Onondaga Lake due to the short distance to the shore; however, it was likely that the vegetation between the UEF and lake limited the amount of sediment entering Onondaga Lake.

6.4.3. Surface Water Transport Via Wetlands Surface Water

The seasonally flooded wetlands adjacent to Onondaga Lake, including WL1, WL2, WL3, WL4, and WL7 **(Figure 12)** and SYW-12 (**Figure 13**), are situated slightly upgradient of the lake. This change in grade would facilitate surface water flow towards the lake. The surface soils contain elevated concentrations of constituents in each wetland (**Figures 56 through 65**). The vegetative cover in these areas includes large areas of *phragmites* and/or trees and grass; this cover could limit the flow of surface water towards the lake, Harbor Brook, or former East Flume and scouring/resuspension of surface soils. Additionally, their presence could enhance deposition of constituent-bearing particulates so these areas retain more constituents than they transport into their respective water bodies. As discussed in Section 5.1 for storm water runoff, this transport mechanism could play a minor role in the transport of constituents to Onondaga Lake.

6.5. Wind-Borne Particulate Migration of Constituents

Surface soils may be eroded via wind, and particulate-bound constituents could potentially be carried off-site. Wind-borne particulate migration most effect constituents that sorb strongly to particulate matter, such as PCBs or metals. This transport mechanism is feasible for the eastern portion of Penn-Can Property and the western portion of the Railroad Area, both of which are sparsely vegetated. For the remainder of the Site, this transport mechanism is unlikely due to the dense vegetation.

6.6. Vapor Migration of Volatile Constituents

Volatile constituents in Site soils and ground waters can vaporize, migrate through soil, and enter the atmosphere or the buildings on-Site. Currently, the only building on-site is the former diffuser building on the Lakeshore Area. Several buildings were on the Penn-Can Property until October 2013, when they were demolished, and the aboveground storage tanks were removed in 2004.

Vapor migration on the Penn-Can Property is possible due to the presence of VOCs within the surface and shallow subsurface soils and shallow and intermediate ground water. Surface and shallow subsurface are typically fill material or fill and Solvay waste, with a water table in the shallow subsurface soils. Additionally, DNAPL has been observed in the Solvay waste and marl and constitutes a potential source of VOCs in soil vapor. A more detailed discussion of subsurface layers and ground water conditions are presented in Sections 3.3.2 and 3.3.5, respectively.

Currently, the property is not being used. Until recently, it was being used by Spano Container Corporation for the management and storage of equipment. There is a paved area that formerly had an office, garage, storage building, and unused structure situated on it, but the majority of the property is either covered with crushed stone or vegetated. The office was a one-story brick building that was occupied during business hours, heated by a natural gas furnace, concrete foundation (some cracks present), and an external air conditioning unit. The storage building was not heated or cooled, and was permanently open to the outside. The main garage contained both a garage and a small office area. The building was heated with suspended electric heaters; however, the truck bay area that was open to the outside periodically throughout the day via the bay doors contained an oil furnace to supplement the electric heat. The grey building adjacent to the storage building was an unused

structure and contained no heating or cooling systems. VOCs were detected in the sub-slab samples collected from the office, garage, and unused structure, which indicate the potential for vapor intrusion to the on-site structures.

On-site storage tanks were present but were removed in 2004. These tanks were used to store asphalt emulsions for paving.

Vapor migration in the Lakeshore Area is possible due to the presence of VOCs in the surface and shallow subsurface soils, as well as shallow ground water migration towards Onondaga Lake. The surface and shallow subsurface soils are typically fill material or fill and Solvay waste, with a shallow water table due to the presence of the lake. Based on samples collected from this area, VOCs are present along the length of the Lakeshore Area in the surface and subsurface materials and the shallow and intermediate ground water. Additionally, there is DNAPL present in the eastern and western portions of this area. Further discussion on subsurface layers and ground water conditions are presented in Sections 3.3.2 and 3.3.5, respectively. The only building currently present is the former diffuser building near the former East Flume, and this building is unoccupied. However, vapor intrusion could impact any future structure constructed on the Lakeshore Area.

6.7. Constituent Fate and Persistence

Analytical results obtained during the RI suggest that certain process constituents are being leached from the soil. Compounds detected in soils and ground water at the greatest frequency included benzene, toluene, chlorinated benzenes, phenolic compounds, PAHs, and mercury. Other compounds detected included PCBs and PCDD/PCDFs. A coal tar-like DNAPL was encountered in the Penn-Can Property, Lakeshore Area, and northeastern corner of the Railroad Area.

Table 373 shows the relevant environmental fate data for the potentially site-related compounds detected during the investigation. This table gives the water solubility, K_{oc}, K_{ow}, and aquatic degradation rates for these compounds, where K = coefficient, OC = organic carbon, and OW = octanol-water partition. The K_{oc} values for these compounds are rough estimates of their mobility in soil. **Table 6.1** shows the relationship between K_{oc} and mobility:

Table 6.1. *Relationship between K_{oc} and mobility.*

K_{oc}	Mobility Class (examples)
0 – 50	Very High (acetone)
50 – 150	High (benzene, TCE, tetrachloroethane, trichloroethane, dichloroethene, vinyl chloride)
150 – 500	Medium (chlorobenzene)
500 - 2,000	Low (dichlorobenzene, naphthalene)
2,000 - 5,000	Slight
greater than 5,000	Immobile (benzo(a)anthracene, benzo(a)pyrene, PCBs)

Note:
Source: (Swann, RL, *et al.*, 1985)

6.7.1. BTEX Fate and Persistence

Benzene, toluene, and xylenes were produced at the benzol facility, and benzene was used at the Willis Avenue Plant in the production of chlorinated benzenes. These compounds are also used in many other industrial processes including the manufacturing of other chemicals, some rubbers, paints, paint thinners, lubricants, pesticides, fuel oil, and cleaning solvents. Additionally, asphalt production at Barrett Paving may have contributed to the current BTEX concentrations.

BTEX compounds tend to partition to vapor and are lost through volatilization. Benzene has the highest affinity for the vapor phase of these four compounds. The other compounds tend to go the vapor phase but with less affinity. Benzene in soils will also readily leach into ground water (ATSDR, 2006).

BTEX compounds are subject to chemical and microbial degradation once in ground water. Metabolites of benzene include phenol and methylated phenols (Howard, 1990), benzoic acid, benzyl alcohol, carbon dioxide, cyclohexanone, and methane. Ethylbenzene also degrades slowly in anaerobic conditions but degrades quickly in aerobic conditions.

Biological sampling results from 2002 along the Willis/Semet Lakeshore presented in the *Draft Willis Avenue/Semet Tar Beds Site Pre Design Report*, and pilot tests indicate biodegradation of BTEX is occurring via microbial fermentation; however, this environment may not be conducive for natural attenuation (Parsons, 2003). The report notes that this natural attenuation may be degrading BTEX in deep ground water. However, the report also indicates that natural attenuation is not a stand-alone alternative for complete mitigation of BTEX. Alternatives are discussed in the Pre Design Report including enhanced *in situ* bioremediation combined with engineering solutions proposed by barrier wall placement.

Little comparison can be drawn from similar testing at adjacent sites. While some component of deep ground water under the Penn-Can Property includes BTEX compounds, a large component of the CPOIs in this area are PAHs.

6.7.2. Chlorinated Benzene Fate and Persistence

Chlorinated benzenes were produced at the Willis Avenue Plant from 1906 to 1977. These compounds are likely associated with historic East Flume discharges and the subsequent formation of deltaic deposits that now made up the area around the former upper and lower East Flume, and the ILWD in Onondaga Lake. Materials excavated and dredged from these deposits during the installation of the diffuser building intake pipe were also placed in the DSAs.

Chlorinated benzene compounds are subject to chemical and microbial degradation in ground water. A number of bacteria and fungi found in the environment are capable of degrading chlorobenzene and mineralizing it. The products of this biodegradation are 2-chlorophenol and 4-chlorophenol (Howard, 1989). It should be noted that degradation of chlorobenzene is generally slow. Dichlorobenzenes are slowly degraded in aerobic conditions and are not expected to be degraded in anaerobic conditions. 1,2,4-trichlorobenzene degrades slowly in both aerobic and anaerobic conditions (Howard, 1989).

6.7.3. Phenols Fate and Persistence

Phenol is used in the production of bisphenol-A and the production of phenolic resins, as well as xylenols (ATSDR, 2008). Phenols are also associated with petroleum and phenolic compounds at the

Site may be associated with the Barrett Paving operation. They may be present as a breakdown product of benzene.

Phenol is relatively mobile in ground water. Phenol in water and soil is degraded by abiotic reactions and microbial activity to a number of compounds, including carbon dioxide and methane. Phenol will degrade in both anaerobic and aerobic conditions (ATSDR, 1998).

6.7.4. PAHs Fate and Persistence

PAHs are often associated with industrial processes and combustion processes, such as wood burning and exhaust from automobiles. Likely sources of PAHs vary depending on location in the Wastebed B/Harbor Brook Site. Along the lakeshore, DSA #1, DSA #2, and wetland areas were likely impacted by the historic East Flume discharges and materials associated with the ILWD , and sediments currently flowing down Harbor Brook and historically from the East Flume. AOS #1 and Penn-Can Property likely contain PAHs due to the historic Barrett Paving operations on the Penn-Can Property. The eastern portion of the Lakeshore Area was also impacted by this operation. SYW-12 has potentially been impacted by multiple sources as discussed above in Section 6.3.6. However, the disposal and/or transport of the PAHs, lubricating oil, and fuel oil #6 is not clear especially since the shallow ground water at the site is relatively unimpacted by PAHs.

PAHs tend to bind to soil in the environment, especially soils with high organic carbon content. PAHs can be broken down aerobically and this can be a significant in the degradation process of these constituents. These compounds tend to be persistent in the environment especially in anaerobic conditions. They do not readily evaporate in soil and ground water.

6.7.5. Mercury Fate and Persistence

Mercury is present in the environment in inorganic and organic forms. Inorganic mercury exists in three valence states: mercuric (Hg^{2+}), mercurous (Hg^{+}), and elemental (Hg^{0}) mercury (Nriagu, 1979). Inorganic mercuric compounds are strongly retained in soils containing an organic component, whereas soils (particularly subsurface soils) lacking organic matter may allow the translocation and leaching of the Hg, with ground water transport as the dominant mechanism. However, the mobility of mercury may be enhanced by the conversion to Hg^{0}, which results in the vaporization of Hg and potential evasion into the atmosphere.

The abiotic and biotic transformation of inorganic Hg within the soil can form the organic mercuric compounds (methylmercury (MeHg), dimethylmercury). Organic mercurials have a higher mobility subsequent to methylation as they are only partially inactivated by strong adsorption to the soil material, with dimethylmercury evading to the atmosphere more rapidly than MeHg and leaching occurring in permeable soils. Additionally, other soil mechanisms have been observed that prevent the accumulation of organic mercurials (*i.e.*, demethylation). Organic mercuric compounds generally make up less than 1% of the total Hg present in the soil. Methylmercury at SYW-12 represented approximately 0.4% of the total mercury present and the remainder of the Wastebed B/Harbor Brook Site had methylmercury concentrations that represented approximately 0.2% of the total mercury present.

6.7.6. PCBs Fate and Persistence

PCBs were often associated with capacitors, transformers, and hydraulic fluids. PCBs were also used as flame retardants, inks, adhesives, paints, pesticide extenders, plasticizers, polyolefin catalyst carriers, surface coatings, wire insulators, and metal coatings (ATSDR, 2004).

PCBs are hydrophobic compounds that have a strong affinity to bind to soils. PCBs degrade naturally in the environment via anaerobic dechlorination and aerobic degradation (Abramowicz *et al*., 1993); however, the amount of PCB loss is minimal. Anaerobic bacteria typically attack the higher chlorinated PCB congeners through reductive dechlorination resulting in lower chlorinated, ortho-substituted PCB congeners. The less chlorinated PCB congeners are suitable substrates for oxidative degradation by a wide range of aerobic organisms. Anaerobic processes in subsurface strata account for a majority of PCB degradation. Half-lives of approximately three years have been documented (Abramowicz *et al*., 1992).

Site PCBs were likely associated with materials disposed from the adjacent Willis Avenue Chlorobenzene Site. Aroclor 1260, Aroclor 1254, and Aroclor 1248 were detected at the Site. These are high molecular weight PCBs that are strongly hydrophobic and tend to bind to solids. These compounds are expected to be persistent for many years in Site soils.

6.7.7. PCDD/PCDFs Fate and Persistence

PCDD/PCDFs at the Site are likely attributed to several sources including:

- Electrolytic generation of chlorine gas from brine using graphite electrodes (chloralkali process) at the former Willis Avenue Plant
- Catalyzed chlorination of benzene at the former Willis Avenue Plant
- Combustion of chlorobenzenes during a 1930's fire at the former Willis Avenue Plant
- General anthropogenic background processes (*e.g.*, fossil fuel emissions, automobile exhaust, and other processes).

PCDD/PCDFs are stable hydrophobic and lipophilic compounds, which are highly persistent in the environment. Leaching of PCDD/PCDFs to ground water is not likely due to their low water solubilities and affinity to become sorbed to soils (ATSDR, 1997). However, the mobility of PCDD/Fs can be enhanced in the presence of organic solvents. Degradation of PCDD/PCDFs occurs rapidly via photolysis in aqueous solution within surficial materials (1 to 3 cm in depth). However, decomposition occurs slowly in soils as photolysis in this medium is limited by light penetration. Half-lives of 9 to 15 years for surface soils and 25 to 100 years for subsurface soils have been estimated (Paustenbach *et al.*, 1992). These compounds are likely to persist for several decades within Site soils.

6.7.8. Fate and Persistence of Site Compounds Found in Soil Vapor

For purposes of this discussion, the chemical compounds found in soil vapor at the Wastebed B/Harbor Brook Site have been classified into the four categories. They are petroleum compounds, solvents, freons, and degradation products.

Petroleum compounds, such as benzene, are expected to biodegrade with time. The vapor intrusion pathway for these compounds may not be complete, because these compounds often biodegrade within the vadose zone.

In contrast to the petroleum compounds, the chlorinated solvents that were found would not be expected to degrade as rapidly and would remain in the subsurface for a much longer time period. TCE and PCE, for example, would be expected to adhere to soils and remain there. TCE and PCE are common chlorinated aliphatic industrial organic solvents used in degreasing operations.

Transformation by-products are also found in association with TCE and PCE without any known source other than from reductive dechlorination. Dechlorinated byproducts include 1,1-dichloroethane and *cis*-1,2- dichloroethene indicating that some degradation has occurred at the Site.

Freon 11 and Freon 12 were also detected on-site. Freon is heavier than air and only slightly soluble in water. Freon may have been used as a refrigerant at the Willis Avenue Chlorobenzene Site. Because degradation processes in soils are insignificant, freon vapors are likely to persist for long periods of time.

Based on the above discussion, the high vapor pressure of many of the compounds detected, preventative measures will need to be taken to prevent the intrusion of vapors into buildings that may be constructed on-site. Such measures may include the use of a vapor barrier and installation of a venting system.

7. Wetland Delineation

7.1. Wastebed B / Harbor Brook Wetland Delineation

Fifteen discrete wetland habitats were identified at the site totaling approximately 16.3 acres. A map of the wetlands delineated as part of this effort is presented as **Figure 12**. A list of the identified wetlands by area and their approximated size is presented below.

- Lakeshore
  - WL1 – 7.14 acres
  - WL2 – 2.76 acres
  - WL3 – 1.67 acres
  - WL4 – 0.49 acres
  - WL5 – 0.26 acres
  - WL6 – 0.35 acres
  - WL7 – 1.0 acres
- Penn-Can Property
  - WPC1 – 0.21 acres
  - WPC2 – 0.35 acres
  - WPC3 – 0.33 acres
- Railroad Area
  - WRR1 – 0.046 acres
  - WRR2 – 0.21 acres
  - WRR3 – 1.21 acres
  - WRR4 – 0.19 acres
  - WRR5 – 0.04 acres

The Upper East Flume (now abandoned) was determined not to be an ACE jurisdictional water body due to its anthropogenic origin, current uses as industrial discharge and detention pond, and lack of hydric soils. However, at NYSDEC's request, this area was delineated, using the methods described herein, during the July 2003 field efforts. Based on the data gathered as part of that effort, the fringe areas of the flume were identified as wetland habitats, totaling approximately 1 acre of wetland (included in the total wetland acres presented above). The full results of the delineation are presented in the *Jurisdictional Wetland Delineation Report* (O'Brien & Gere, 2003).

7.2. SYW-12

NYS-regulated Wetland SYW-12 is located along the eastern shoreline of Onondaga Lake north of the mouth of Onondaga Creek and northwest of Carousel Mall. SYW-12 consists of several wetland cells, with the two largest cells located between Ley Creek and Onondaga Creek and immediately north of Ley Creek. SYW-12 is recognized by the NYSDEC as a Class I wetland. It covers approximately 41 acres and has a vegetative cover containing common reed and an area of floodplain deciduous forest. It is likely that SYW-12 is considered a Class I NYSFW because of its size, location within an urban area, proximity to Onondaga Lake, and the presence of unique habitat characteristics. [Portions of SYW-12, not included in this assessment, have been documented as salt marsh habitat by the New York Natural Heritage Program (NYSDEC/TAMS, 2002)]. Based on the characteristics

required for Class I NYSFW, as listed in 6 NYCRR 664, NYS-regulated wetlands that contain at least 4 of the 17 Class II characteristics are considered to be Class I NYSFWs.

Based on the USFWS NWI, the northern portion of SYW-12, near Ley Creek, is depicted as PEM1Cs (a palustrine system dominated by emergent vegetation with some broad-leaved deciduous vegetation, some seasonal flooding, and spoils materials in the substrate). An area on the southern portion of the wetland and along the lakeshore is also depicted as PEM1Cs. Lacustrine habitat is indicated on the NWI mapping (**Figure 10**); however, these habitats are associated with the open waters of Onondaga Lake.

As agreed by the NYSDEC, the September 2004 study area for this wetland included only the portion of the wetland located primarily south of Ley Creek and south and west of the railroad tracks.

The portion of SYW-12 delineated and identified by O'Brien & Gere, consists of approximately 17 acres south of Ley Creek and south and west of the railroad tracks along the northeastern shoreline of Onondaga Lake. Onondaga Lake forms the western border of this wetland. An abrupt rise in topography (*i.e.*, berm and railroad bed) defines the eastern border of the wetland, and Ley Creek defines the northern boundary. The delineated wetland boundary (**Figure 13**) somewhat matches the depicted NYSFW mapped boundary for the southern portion of SYW-12 (**Figure 11**). The delineated wetland is a combination of a monoculture stand of common reed and forested floodplain that comprise an overstory of predominantly cottonwoods. Wetland soils were indicated via presence of low matrix chroma and coarse sands with organic streaking of the soil strata. Wetland hydrology was indicated by the presence of saturated soils, drift lines, watermarks, and drainage patterns.

Soils mapped for this wetland cell included Ma and C.F.L. (cut and fill lands) soils. *Ma* soils consist predominantly of bed areas of chemical waste, which may or may not be covered with vegetation (USSCS, 1977), as noted above. C.F.L. soils vary widely within Onondaga County (USSCS, 1977).

The result of the function and value assessment indicates that the principal functions/values for the delineated portion of SYW-12 are:

- ground water recharge/discharge
- floodflow alteration
- sediment/toxicant retention
- sediment/shoreline stabilization
- wildlife habitat.

An ecological survey was completed for SYW-12. The dominant vegetation observed in this wetland were common reed and cottonwood. Other species observed near this wetland include bittersweet nightshade, jewelweed (*Impatiens* sp.), box elder, and pokeweed (*Phytolacca americana*). The primary wildlife species observed were songbirds. Double-crested cormorant (*Phalacrocorax auritus*), mallard, and gulls (*Larus* spp.) were observed transiting the SYW-12 area.

As part of the October 22, 2008 site investigations, the area south of Ley Creek was quantitatively assessed. Two wetlands (WL 2 and WL 3) were identified south of Ley Creek and West of the CSX main line railroad tracks (**Figure 13**). WL 2 is a 1.1 acre triangular shaped area bordered on two sides by railroad tracks and by a dirt access road on the third side. The delineated wetland is a monoculture of common reed. Wetland soils were indicated via the presence of low chroma colors with organic streaking of the soil strata. Wetland hydrology was indicated by the presence of saturated soils and

drainage patterns, with observed standing water in the central portion of the wetland. WL 3 is a 0.26-acre narrow strip of common reed bordered by railroad tracks and a dirt road. Soils were saturated in the upper 12 inches and exhibited low-chroma colors. O'Brien & Gere biologists were accompanied by a representative from the NYSDEC for the portion of the field effort conducted on October 22, 2008.

As part of the October 22, 2008 site investigations, two additional areas in the vicinity of the mouth of Ley Creek were visited by the field team. A qualitative assessment of areas north of Ley Creek resulted in the conclusion that, if delineated, the wetland boundary would be similar to the NYSDEC-mapped boundaries (**Figure 11**). That is, an emergent wetland exists between the railroad tracks and Onondaga Lake Parkway starting near the north bank of Ley Creek and extending westward.

During the October 22, 2008 site visit, the NYSDEC and O'Brien & Gere representatives also surveyed the riparian area along the south bank of Ley Creek. The riparian area was dominated by common reed, but upland species such as bittersweet nightshade, grape vine, common buckthorn, and poplar species were present. Additionally, hydric soils and hydrology were not present at this site. Both parties agreed that this site did not fully meet wetland criteria and, therefore, did not require delineation.

8. Baseline Risk Assessments

Potential Human and ecological receptors are discussed in the NYSDEC-approved Wastebed B/Harbor Brook Site Human Health Risk Assessment Revised Report (O'Brien & Gere, 2009) and the Wastebed B/Harbor Brook Site Baseline Ecological Risk Assessment Revised Report (O'Brien & Gere, 2011). A brief risk assessment summary is provided below. It should be noted that completed and on-going IRMs at the site have mitigated or will mitigate many of the potential risks identified in these documents.8.1 Human Health Risk Assessment

The Wastebed B/Harbor Brook Site revised Human Health Risk Assessment was submitted under separate cover to the NYSDEC on October 16, 2009 and approved by the NYSDEC on May 19, 2010. The HHRA evaluated potential receptors for two exposure areas including the main portion of the site and SYW-12. The main portion of the site includes Harbor Brook, Lakeshore Area (including Wastebed B, the East Flume, Dredge Spoils Areas #1 and #2, wetlands along Onondaga Lake, and the I-690 drainage ditch), the Penn-Can property, Railroad Area, AOS #1, and AOS #2. A hypothetical potable water source area (Site-wide) was also evaluated.

This HHRA considered exposure pathways for a variety of human receptors at the main portion of the site under both current conditions and future scenarios. The following receptors were considered:

- current/future adult and older child trespassers
- current/future utility, drainage ditch, surveillance, and railroad workers
- current/future commercial/industrial workers
- current/future adult and child recreational visitors
- future construction workers, and
- future child and adult residents.

Based on current conditions and anticipated future scenarios at SYW-12, the following current receptor pathways were identified:

- current/future adult and child recreational visitor
- current/future utility and railroad worker
- current/future utility worker
- future construction worker
- future commercial/Industrial worker
- future adult and child residents

Exposure media considered in both current and future scenarios include soil, sediment, surface water, ground water, fish tissue, and ambient air. The use of ground water at the Site for potable applications was also considered within the HHRA even though it was considered hypothetical, and extremely unlikely.

Cancer risks and non-cancer hazards were quantified for the reasonable maximum exposure and central tendency scenarios. The regulatory range for acceptable cancer risk is 10^{-6} to 10^{-4}, whereas non-cancer hazards are considered acceptable if they are below 1. This study presents the total risk and hazard for each receptor summed over all media, pathways, and constituents, and identifies the exposure media and constituents that contribute most significantly to the total risks and hazards.

The HHRA indicated that cancer risks and non-cancer hazards were within acceptable limits for the Surveillance Worker, Drainage Ditch Worker, and Railroad Worker. Cancer risks and/or non-cancer hazards exceeded the acceptable regulatory thresholds for the adult and child trespassers, utility workers, commercial/industrial workers, adult and child recreators, construction workers, and potential future adult and child residents under the reasonable maximum exposure (RME) scenarios. Although future use of ground water for potable water is unlikely, potential future exposure to ground water as potable water by residents and commercial/industrial workers was evaluated and found to pose unacceptable cancer risks and non-cancer hazards. The risk drivers by receptor are:

- current/future adult and child trespassers – PCBs, dioxins/furans, methylmercury, and PAHs
- current/future utility workers – PAHs, dioxins/furans, chromium, and 1,4-dichlorobenzene
- current/future commercial/industrial workers – PAHs and benzene
- current/future adult and child recreators - PCBs, PAHs, and dioxins/furans
- future construction workers - PAHs, dibenzofuran, and manganese
- future adult and child residents - PAHs, benzene, and 1,2,4-Trimethylbenzene

The greatest cancer risk posed to current receptors is 2×10^{-3} for the adult trespasser and the greatest non-cancer hazard is 30 for the same receptor. The greatest cancer risk and non-cancer hazard posed to a potential future receptor is for the future child resident. The cancer risk of 7×10^{-1} is driven primarily by exposure to ground water as a drinking water source and to surface soil. The non-cancer hazard of 8×10^{2} is also driven primarily by exposure to ground water as a drinking water source and to surface soil. The use of ground water at the Site for potable applications is considered hypothetical and is extremely unlikely for several reasons: 1) the area is supplied by municipal water from Onondaga County Water Authority (OCWA); 2) the yield of the overburden ground water unit is inadequate for water supply wells; and 3) the high salinity of the deep aquifer (3,000 mg/l chloride) precludes its use as drinking water.

8.2 Baseline Ecological Risk Assessment

The Wastebed B/Harbor Brook revised Baseline Ecological Risk Assessment (BERA) was submitted under separate cover to the NYSDEC on August 11, 2014 and approved by the NYSDEC on August 15, 2014. Potential ecological receptors included both aquatic and terrestrial wildlife utilizing the East Flume, Onondaga Lake and Harbor Brook, upland areas of the Site, and wetland portions of the Site. Potential aquatic receptors included plants, benthic invertebrates, fish, and higher level predators (*e.g.*, belted kingfisher, great blue heron, and mink). Potential terrestrial receptors include plants, ground dwelling invertebrates, small mammals (*e.g.*, white footed mouse and rabbits), birds (*e.g.*, American robin), larger mammals (*e.g.*, deer) and avian and mammalian predators (*e.g.*, red-tailed hawk, red fox).

The Site was divided into the following four exposure areas to be further evaluated in the BERA in accordance with Steps 4 through 7 of ERAGS:

- Main Site Exposure Area consists of the terrestrial portion of the Lakeshore Area, Penn-Can Property, and Railroad Area, including the delineated wetlands not contiguous with Onondaga Lake.
- Aquatic Exposure Area consists of the East Flume, Harbor Brook, and Site Ditches.
- Lakeshore Wetland Exposure Area consists of the delineated wetlands located contiguous to Onondaga Lake on the Lakeshore Area portion of the Site.

- SYW-12 Exposure Area consists of the 40-acre area located at the northeastern corner of Onondaga Lake which includes approximately 18 acres of delineated wetland.

The primary means of assessing potential ecological risk included evaluation of community-level effects via benchmark screening of the Site media constituent of concern (COC) concentrations and evaluation of upper trophic-level effects via food chain modeling and hazard quotient calculation.

Several literature references were used to identify ecological screening levels, including criteria documents as well as guidance documents. The screening values were chosen based on NYSDEC and USEPA direction and guidance and included:

- Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision. Table 1. (Efroymson *et al*. 1997a).
- Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Processes: 1997 Revision. Table 1- Earthworms, Table 2- Microorganisms and Microbial Processes (Efroymson *et al*. 1997b).
- Ecological Screening Values for Surface Water, Sediment, and Soil (Friday 1998).
- Eco-SSLs (USEPA 2009a).
- Part 375 Environmental Remediation Program. 6NYCRR Part 375 Subpart 375-6.6 (NYCRR 2006).
- National Recommended Ambient Water Quality Criteria (USEPA 2009a).
- Technical and Operational Guidance Series Number (TOGS) 1.1.1. New York State Ambient Water Quality Standards and Guidance Values (NYSDEC 1998b).
- ECO Update: Ecotox Thresholds (USEPA 1996a).
- NYSDEC's Technical Guidance for Screening Contaminated Sediments (NYSDEC 1999).
- Sediment Quality Standards, WAC 172-204-320 (Washington State Department of Ecology 2007).
- Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario (Persaud *et al.* 1993).

Risks to ecological receptors are summarized for each of the four exposure areas below.

Main Site Exposure Area
The ecological risk for the Main Site Exposure Area is associated with terrestrial exposure to plants, soil invertebrates, insectivorous birds, insectivorous mammals, carnivorous mammals, and predatory birds.

- The risk to terrestrial plants and soil invertebrates is driven by metals (chromium, mercury, and silver and chromium, respectively).
- Insectivorous bird (American robin) and mammal (short-tailed shrew) risks are driven by potential bioaccumulation of COCs with hazard quotients (HQs) exceeding one, including metals, methyl mercury, and hexachlorobenzene.
- Risk to carnivorous mammals is driven by COCs with HQ values in exceedance of one but is primarily driven by bioaccumulation of dioxin equivalent compounds in prey items.
- The potential risks from COCs to the red-tailed hawk are driven by the COCs with HQ values greater than one; however, overall risk to predatory birds are low, as indicated by No Observed Adverse Effects Level (NOAEL)-based HQs no greater than 12 and most Lowest Observed Adverse Effect Level (LOAEL)-based HQs less than or equal to one.

Aquatic Exposure Area
For the Aquatic Exposure Area, Harbor Brook/Site Ditches and the East Flume were evaluated separately for potential ecological receptors aquatic organisms, benthic invertebrates, and fish. Additional receptors for the aquatic exposure pathway included upper trophic level receptors (mink, belted kingfisher, and great blue heron).

Harbor Brook/Site Ditches

- For the protection of aquatic organisms, thirteen COCs (six metals, three SVOCs, and four VOCs) had exposure point concentrations (EPCs) and average concentrations that exceeded surface water screening values, and only three COCs only marginally exceeded the screening criteria.
- Potential risk to the benthic invertebrate community from exposure to sediment is driven by multiple classes of compounds due to exceedances of screening criteria in each of the constituent categories.
- Potential risk to fish is primarily driven by dissolved levels of pesticides and SVOCs (mostly PAHs) in surface water and multiple categories of constituents exceeding screening levels in sediments.

East Flume

- No COCs had either EPCs or average concentrations that exceeded the surface water screening values for the protection of aquatic organisms.
- Potential risk to the benthic community is driven primarily by PAHs in sediment.
- Potential risk to the fish community is driven primarily by PAHs in sediment.

Belted Kingfisher (Piscivorous Birds)
Fifteen COCs (one metal, total PCBs, eleven SVOCs, and one VOC) had NOAEL-based HQs greater than one and two COCs (total PCBs and one SVOC) had LOAEL-based HQs greater than one. Although butylbenzyl phthalate had a NOAEL-based HQ greater than ten, unacceptable risk to piscivorous birds from these COCs is unlikely because they were detected in one of 55 samples and one of 41 samples, respectively, in the exposure area.

Great Blue Heron (Piscivorous Birds)

Seven COCs (total PCBs, five SVOCs, and one VOC) had NOAEL-based HQs greater than one, and one COC (butylbenzyl phthalate) had a LOAEL-based HQ greater than one. Unacceptable risk to piscivorous birds from these COCs is not expected due to their low detection frequency.

Mink (Piscivorous Mammals)
Risk to the mink is driven by fourteen constituents (two metals, total PCBs, two pesticides, six SVOCs, and three VOCs) with HQs greater than one but primarily via dibenzo(a,h)anthracene and total PCBs through the ingestion of prey items that may bioaccumulate these constituents. However, the prey body burden concentrations may be overestimated because the induction of MFO enzymes can result in lower concentrations than might be expected based on the physical properties of dibenzo(a,h)anthracene.

Lakeshore Wetland Exposure Area
The Lakeshore Wetland Exposure Area includes delineated wetlands contiguous with Onondaga Lake in the Lakeshore Area of the Site. Potential ecological receptors for the wetland exposure pathway include terrestrial plants, soil invertebrates, aquatic organisms, benthic invertebrates, fish, and upper trophic level receptors including the mink, belted kingfisher, and great blue heron.

- Based on exceedances of screening criteria for the protection of terrestrial plants, potential risk posed to the plant community is driven by metals.
- Potential risk to the soil invertebrate community is driven primarily by metals.
- Based on exceedances of screening criteria for the protection of aquatic organisms, potential risk posed to the aquatic organisms is driven primarily by dissolved levels of metals and SVOCs.
- Potential risk to the benthic invertebrate community is driven by multiple classes of compounds due to exceedances of screening criteria in multiple categories of constituents.
- Based on exceedances of screening criteria for the protection of fish, potential risk is driven primarily by metals and SVOCs.
- Risk posed to piscivorous birds (belted kingfisher and great blue heron) is driven by the COCs (four metals, one pesticide, and 11 SVOCs) with HQ values greater than one; however, overall risk to piscivorous birds is considered low with LOAEL-based HQs less than five and few NOAEL-based HQs greater than one resulting from modeled bioaccumulation in prey items.
- Risk to the mink is driven by the COCs with HQ values in exceedance of one, primarily PAHs and BEHP through the ingestion of prey items, which may bioaccumulate these constituents. In fish, for instance, the induction of MFO enzymes in response to benzo(a)pyrene exposure, results in a reduction in body burdens over time (McCarthy *et al.* 2003). BEHP also has been shown to be metabolized by higher organisms resulting in lower bioaccumulation than might be expected by its high K_{ow} value (USEPA 1979; Johnson *et al.* 1977; Staples *et al.* 1997; Wofford *et al.* 1981). Using these additional lines of evidence, it is likely that risk posed to piscivorous mammals is low to moderate.

SYW-12 Exposure Area

Potential ecological receptors of the approximately 40-acre SYW-12 Exposure Area include terrestrial plants, soil invertebrates, benthic invertebrates, fish, and upper trophic level receptors including the red fox, short-tailed shrew, American robin, red-tailed hawk, and mink. Additionally, shallow groundwater was assessed for effects to aquatic organisms and fish due to its discharge to surface water.

- Based on exceedances of screening criteria for the protection of terrestrial plants, potential risk posed to the plant community is driven by metals, particularly chromium because its average concentration throughout the exposure area exceeded screening criteria.
- Potential risk to the soil invertebrate community at the SYW-12 Exposure Area is driven primarily by chromium.
- Based on exceedances of screening criteria for the protection of aquatic organisms, potential risk posed to the aquatic organisms is driven primarily by dissolved levels of metals, particularly mercury and barium, and SVOCs, particularly benzo(a)pyrene, in shallow groundwater that may potentially discharge to local surface waters.
- Based on exceedances of screening criteria for the protection of fish, potential risk posed to fish is driven primarily by dissolved pesticides and to a lesser extent by benzo(a)pyrene and barium (for shallow groundwater), and calcium (for sediment), potentially discharging to local surface waters.
- Risk to insectivorous mammals (American robin) is primarily by metals (particularly chromium), BEHP, and hexachlorobenzene bioaccumulation in prey items.
- Risk to insectivorous mammals (short-tailed shrew) is driven primarily by chromium and hexachlorobenzene exposure through bioaccumulation in prey items.
- Risk to carnivorous mammals (red fox) is driven by each of the COCs with HQ values in exceedance of one; however, such risk is considered low due to only minor exceedances of both NOAEL and LOAEL toxicity reference values.

- For predatory birds (red-tailed hawk), three COCs had NOAEL-based HQs greater than one, all of which were metals, and no COCs had LOAEL-based HQs that exceeded one; risk is identified for this community based on COCs with HQs greater than one.
- For piscivorous mammals (mink), four COCs (three metals and the mammalian dioxin equivalent) had NOAEL-based HQs greater than one, and one COC (chromium) had a LOAEL-based HQ that exceeded one; risk is identified for this community based on COCs with HQs greater than one.

Because of the uncertainties summarized in the BERA, none of the risk calculations presented in the report should be interpreted as precise measures of the true risk. Rather, all values should be interpreted as uncertain estimates. Because many (but not all) of the approaches for dealing with uncertainty are more likely to overestimate than underestimate the risk values above should generally be thought of as high-end estimates of the true risk, and actual risks are probably somewhat lower than the calculated values.

A full discussion of the BERA evaluation and conclusions is presented in the approved report (O'Brien & Gere 2011). Risk management considerations are also included in the BERA. These are activities conducted as part of the East Flume and Wastebed B/Harbor Brook IRMs at the Site that are expected to minimize the potential for ecological receptors to be exposed to contaminated sediment, groundwater, and surface water. Therefore, potential adverse effects to ecological receptors of the East Flume, Harbor Brook and Site Ditches, and Lakeshore Wetland Exposure Area may be minimized or potentially eliminated as part of ongoing remedial efforts. Following completion of the IRMs, associated restoration of habitat impacted by remedial activities is expected to provide habitat of significantly greater function and value than what currently exists.

9. Conceptual Site Model

The conceptual site model (CSM) was developed according to the guidelines presented in *Data Quality Objectives for Remedial Response Activities* (USEPA, 1987). The information presented herein is based on the data obtained during the PSA, RI, Supplemental RI, Harbor Brook Sediment IRM (BBL, 2001), Wastebed B/Harbor Brook IRM, I-690 Limited Investigation, and Wastebed B Geotechnical Investigation. The CSM is presented on **Figures 115 and 116**.

The source areas for the Wastebed B/Harbor Brook Site and SYW-12 are discussed in Sections 4 and 6 above, while the preliminary CPOIs are presented in Section 4. A discussion of the fate and transport of the CPOIs is in Section 6. The human and ecological risk assessments and receptors are discussed in Sections 2.3.1 and 2.3.2 (respectively) and the revised HHRA and BERA reports submitted under separate cover.

10. Conclusions and Preliminary remedial action objectives (RAOs)

10.1. Conclusions

Review of the data collected during the PSA, RI, Supplemental RI, and other investigations suggests that the sources of contamination at the Site are related to historical activities at the Penn-Can Property, Willis Avenue Chlorobenzene Site, historic East Flume discharges, Solvay waste disposal, the likely co-disposal of coke plant waste products, the placement of fill materials in several areas (AOS#1, DSA#1 and #2, wetland area #2, and SYW-12) at the Site, potential upgradient sources to SYW-12 as discussed above, and undigested sewage sludge placed on the eastern portion of Wastebed B by Onondaga County and the City of Syracuse during the late 1950s and early 1960s. Based on the investigations conducted, the following conclusions have been developed.

- The Site geology consists of seven distinct layers including fill, Solvay waste, marl, silt and clay, silt and fine-grained sand/basal sand and gravel, till, and bedrock.
- The marl layer pinches out to the south away from the lake.
- The silt and clay confining unit pinches out beneath the Penn-Can Property which provided a pathway for the downward migration of DNAPL.
- The Site has three distinct ground water zones including:
  - a shallow zone that includes the fill layer and underlying Solvay waste (when present);
  - an intermediate zone that consists of a fine-grained marl layer; and
  - a deep zone that encompasses the silt and fine grained sand deposits and the basal sand and gravel deposits.
- Shallow and intermediate ground water generally flow towards and discharges into Onondaga Lake.
- A small component of ground water flows radially outward and discharges to surface water bodies (on-site drainage ditches and Harbor Brook and historically to the East Flume).
- Horizontal hydraulic conductivities for the three ground water zones are
  - shallow zone ranges from 10^{-3} to 10^{-5} cm/sec,
  - intermediate zone ranges from 10^{-4} to 10^{-5} cm/sec, and
  - deep zone ranges from 10^{-3} to 10^{-5} cm/sec.
- CPOIs at the Site include BTEX, chlorinated benzenes, naphthalene and assorted PAHs, phenolic compounds, PCBs, PCDD/PCDFs, and inorganics.
- CPOIs in soil vary between the sub-areas:.
  - Chlorinated benzenes and mercury tend to be more prevalent on the western portion of the lakeshore area near the former East Flume.
  - Chlorinated benzenes are more prevalent in soils impacted by historic East Flume discharges.
  - Naphthalene and assorted PAHs tend to be more prevalent on the eastern portion of the lakeshore area, AOS#1, and the Penn-Can Property than other portions of the main site.
  - Assorted PAHs are prevalent in SYW-12 soils, and analytical results indicated that lubricating oil and fuel oil #6 are present as well.
- CPOIs are randomly distributed within the materials deposited in areas DSA#1, DSA#2, wetland areas along the lakeshore (WL2 through WL4), AOS#1, and SYW-12.
- CPOIs in shallow and intermediate ground water were similar throughout the Site, with dominant CPOIs of BTEX, PAHs and naphthalene, phenolic compounds, and inorganics.

- Chlorinated benzenes were also observed in Lakeshore Area shallow and intermediate ground water wells.
- Deep ground water CPOIs on the Penn-Can Property and Railroad Area include BTEX, naphthalene, assorted PAHs, phenolic compounds, and inorganics.
- Deep ground water at the eastern end of the Lakeshore Area (HB-HB-20D) is not currently impacted by Site-related constituents; however, coal tar-like DNAPL is located upgradient in the deep ground water.
- Deep ground water at the western end of the Lakeshore Area (HB-HB-01D) has historically shown minor impacts from chlorinated benzenes and mercury.
- CPOIs in surface water include BTEX, PAHs, and inorganics. Individual VOCs and SVOCs differ between surface water bodies.
- CPOIs in sediment are typically BTEX (particularly benzene), chlorinated benzenes, PAHs, PCDD/PCDFs, PCBs, and inorganics. Acetone is also observed in Penn-Can Property, Railroad Area and AOS #2 sediments and is likely a degradation product of benzene.
- The nature and extent of DNAPL at the Site is well-defined.
  - The source of the coal tar-like DNAPL is related to historic activities on the Penn-Can Property (Barrett Paving).
  - The source of the chlorobenzene DNAPL in HB-SB-01 on the western portion of the Lakeshore Area is related to operations at the former Willis Avenue Chlorobenzene Plant and historic East Flume discharges.
- The coal tar-like DNAPL occurs:
  - in the fill, marl and deep (coarse sand above the till) units on the Penn-Can Property,
  - in the marl unit on the eastern portion of the Lakeshore Area,
  - in the eastern portion of the Railroad Area,
  - beneath Harbor Brook, and
  - in the western portion of AOS #1.
- Stained soils are observed in DSA #1, DSA #2, wetland areas WL2 through WL4, and AOS #1, , which are most likely related to historic discharges from the East flume associated with the ILWD.
- The lubricating oil and Fuel Oil #6 constituents indicate that potential upgradient sources such as the Marley property and/or Oil City may have impacted SYW-12.
- The former Onondaga Creek and Iron Pier area were historically filled by others; however, the origin of this fill is unknown.
- Stained soils and “tarry” soils at SYW-12 may be related to materials used to fill the former Onondaga Creek channel (former Iron Pier area) and potential upgradient sources as discussed above. An additional investigation was undertaken to identify the extent and the source of the “tarry material” observed in borings at SYW 12, and the results of this investigation are provided under separate cover (O’Brien & Gere, 2014).
- The presence of PXE and PTE in SYW-12 soils suggests potential influence from Semet material.
- The nature and extent of the spoils material and stained soils are well defined.
- Current Site conditions indicate that constituents associated with the stained soils have the potential for CPOIs to be leached from these materials.
- Constituent concentrations exceeding media-specific criteria indicate potential impacts to Site receptors.
- Elevated detection limits within all media data that are above guidance values suggest potential impacts to Site receptors.

The nature and extent of CPOIs are well defined, and no further site characterization is warranted.

10.2 Risk Assessment Summary

Potential Human and ecological receptors are discussed in the NYSDEC-approved *Wastebed B/Harbor Brook Site Human Health Risk Assessment Revised Report* (O'Brien & Gere, 2009) and the *Wastebed B/Harbor Brook Site Baseline Ecological Risk Assessment Revised Report* (O'Brien & Gere, 2011). A brief risk assessment summary is provided below. It should be noted that completed and on-going IRMs at the site have mitigated or will mitigate many of the potential risks identified in these documents.

10.2.1. Human Health Risk Assessment

The HHRA indicated that cancer risks and non-cancer hazards were within acceptable limits for the Surveillance Worker, Drainage Ditch Worker, and Railroad Worker. Cancer risks and/or non-cancer hazards exceeded the acceptable regulatory thresholds for the adult and child trespassers, utility workers, commercial/industrial workers, adult and child recreators, construction workers, and potential future adult and child residents under the reasonable maximum exposure (RME) scenarios.

The greatest cancer risk posed to current receptors is 2×10^{-3} for the adult trespasser and the greatest non-cancer hazard is 30 for the same receptor. The greatest cancer risk and non-cancer hazard posed to a potential future receptor is for the future child resident. The cancer risk of 7×10^{-1} is driven primarily by exposure to ground water as a drinking water source and to surface soil. The non-cancer hazard of 8×10^{2} is also driven primarily by exposure to ground water as a drinking water source and to surface soil. The use of ground water at the Site for potable applications is considered hypothetical and is extremely unlikely for several reasons: 1) the area is supplied by municipal water from OCWA; 2) the yield of the overburden ground water unit is inadequate for water supply wells; and 3) the high salinity of the deep aquifer (3,000 mg/l chloride) precludes its use as drinking water.

10.2.2. Baseline Ecological Risk Assessment

Multiple methods were utilized within the BERA to evaluate potential exposures and related risks posed to Site ecological receptors. Lines of evidence were developed for the BERA based on toxicological effects, receptor exposures, and field observations at the Site. Average and upper bound detected constituent concentrations in Site surface soil, sediment, surface water, and groundwater were screened against appropriate criteria to evaluate risk to terrestrial plants, soil invertebrates, aquatic organisms, wildlife, benthic invertebrates, and fish. Potential risk to upper trophic level receptors was modeled as an additional line of evidence in this assessment, including the American robin, short-tailed shrew, red fox, red-tailed hawk, belted kingfisher, great blue heron, and mink, based on conservative assumptions in the determination of uptake factors for prey items. These lines of evidence indicate that adverse ecological effects were identified at each of the trophic levels examined.

The site was evaluated as four separate exposure areas that included the main site, aquatic areas (East Flume, Harbor Brook, and site ditches), lakeshore wetlands, and SYW-12. Risks to terrestrial ecological receptors were primarily driven by metals, assorted SVOCs, assorted VOCs, assorted pesticides, and dioxin equivalents, . Risks to aquatic receptors were driven primarily by metals, PCBs, assorted SVOCs, assorted VOCs, and dioxin eqivalents.

10.3. Preliminary remedial action objectives (RAOs)

Based on the results of the PSA, RI, Supplemental RI, IRMs, geotechnical investigation, I-690 Limited Investigation, and previous studies, the following list of preliminary RAOs has been developed.

- Restore, to the extent practicable, ground water quality to levels that meet state and federal water quality standards, and/or guidance.
- Eliminate, to the extent practicable, unacceptable risks to human receptors associated with direct contact to soils, ground water, surface water and sediment, and inhalation of soil vapors.
- Prevent or minimize, to the extent practicable, adverse ecological impacts to biota from ingestion/direct contact with soil/fill material/Solvay waste/sediment/surface water causing toxicity or impacts from bioaccumulation through the terrestrial food chain. This was partially addressed as part of the East Flume IRM in accordance with Order on Consent #D-7-0002-01-09, the Wastebed B/Harbor Brook IRM in accordance with Order on Consent #D7-0008-01-09, and the Outboard Area IRM in accordance with Order on Consent #D7-0008-01-09..
- Reduce, to the extent practicable, the level of contaminants in Harbor Brook, on-site ditches, and wetlands surface water and sediment to attain surface water ARARs and sediment remedial goals to be protective of fish, wildlife, and the resources on which they depend.
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- Eliminate, to the extent practicable, the migration of COPCs via ground water, surface water, and sediment to Harbor Brook and Onondaga Lake. (This will be addressed as part of the Wastebed B/Harbor Brook IRM in accordance with Order on Consent #D-7-0008-01-09).
- Eliminate, to the extent practicable, the migration of soil vapor contaminants to indoor air at concentrations that result in unacceptable health risks.
- Collect, remove, or remediate *in situ*, to the extent practicable, DNAPL within Site soil and sediments.

The preliminary RAOs were not required to be updated based on the findings of the approved Site risk assessments.

10.4. Future Activities

Feasibility Study deliverables have been submitted for NYSDEC review. Subsequent to NYSDEC approval of the RI Report, the Feasibility Study (FS) will be advanced. Two separate FS documents, one for SYW-12 and one for the remainder of the Wastebed B/Harbor Brook Site, will be submitted in consideration of property ownership and stakeholder complexities associated with SYW-12, which may affect the FS schedule for SYW-12, and to allow the FS for the remainder of the Wastebed B/Harbor Brook Site to proceed in an unencumbered fashion.

Soils generated as part of the East Flume IRM, Upper Harbor Brook IRM, the East and West Wall installation, and outboard area removals have been placed on Wastebed B. The Wastebed B/Harbor Brook Materials Management, Grading, and Disposal Plan was submitted on March 15, 2013 and subsequently approved by the NYSDEC on March 21, 2013. It is anticipated that additional outboard material will be placed on wastebed B during the winter of 2013/2014. Once this material has been placed then the existing pile will be shaped per the grading plan and covered with 2 ft of material.This material will be evaluated in the FS process.

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