New York State Electric & Gas Corporation

Former Transit Street Manufactured Gas Plant
Lockport, New York

FINAL REMEDIAL INVESTIGATION REPORT

August 2007

Prepared For:
New York State Electric & Gas Corporation
18 Link Drive
Binghamton, New York

URS Corporation - New York
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Buffalo, New York 14203

REMEDIAL INVESTIGATION REPORT

NYSEG – TRANSIT STREET SITE

SITE #9-32-098

LOCKPORT, NEW YORK

PREPARED FOR:

NEW YORK STATE ELECTRIC & GAS

KIRKWOOD INDUSTRIAL PARK

BINGHAMTON, NEW YORK 13902

PREPARED BY:

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77 GOODELL STREET

BUFFALO, NEW YORK 14203

AUGUST 2007

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ATTACHMENTS

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ATTACHMENT I	IRM REPORT

ABBREVIATIONS

Agencies

FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSDOS	New York State Department of State
NYSDOT	New York State Department of Transportation
NYSOPRHP	New York State Office of Parks, Recreation, and Historic Preservation
SCS	Soil Conservation Service
SHPO	State Historic Preservation Officer
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USDA	United States Department of Agriculture
USGS	United States Geological Survey

Units of Measure

A	ampere
amsl	above mean sea level
bgs	below ground surface
C	Celsius, Centigrade
cfs	cubic feet per second
cm	centimeter

El.	elevation
F	Fahrenheit
fps	feet per second
g	gram
gpm	gallons per minute
GW	gigawatt
GWh	gigawatt-hour
hp	horsepower
Hz	hertz, cycles per second
k	kilo (prefix for one thousand)
kg	kilogram
km	kilometer
kV	kilovolt
kVA	kilovolt-ampere
kW	kilowatt
kWh	kilowatt-hour
L	liter
m	meter
m	milli (prefix for one-thousandth)
M	mega (prefix for one million)
µ	micro (prefix for one-millionth)
µg	microgram
µm	micron
mg	milligram
mgd	million gallons per day

ml	milliliter
mm	millimeter
mV	millivolt
MV	megavolt
mVA	millivolt-ampere
MVA	megavolt-ampere
MW	megawatt
NGVD29	National Geodetic Vertical Datum of 1929
NTU	Nephelometric Turbidity Unit
ppb	parts per billion
ppm	parts per million
V	volt
W	watt
Wh	watt-hour

Regulatory

ADA	Americans with Disabilities Act
CFR	Code of Federal Regulations
NEPA	National Environmental Policy Act
RCRA	Resource Conservation and Recovery Act
SEQRA	State Environmental Quality Review Act
SPDES	State Pollution Discharge Elimination System
TAGM	Technical and Administrative Guidance Memorandum
TOGS	Technical and Operational Guidance Series

Environmental

ASP	Analytical Services Protocol

BOD	Biochemical Oxygen Demand
BTEX	benzene, toluene, ethylbenzene, xylenes
CC	coal carbonization
CO	coke oven
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CPC	contaminant of potential concern
CWG	carburetted water gas
DCA	dichloroethane
DCE	dichloroethene
DNAPL	dense non-aqueous phase liquid
DO	dissolved oxygen
ELAP	Environmental Laboratory Approval Program
LEL	lowest effect level
LNAPL	light non-aqueous phase liquid
MNA	monitored natural attenuation
MS	matrix spike
MSD	matrix spike duplicate
MTBE	methyl tertiary butyl ether
NAPL	non-aqueous phase liquid
NOD	natural oxidant demand
ORP	oxidation-reduction potential
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PEL	Probable Effect Level

PID	photoionization detector
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RAGS	Risk Assessment Guidance for Superfund
RSCO	Recommended Soil Cleanup Objective
SCGs	New York State Standards, Criteria, and Guidelines
SEL	Severe Effect Level
SVOC	Semi-volatile Organic Compound
TAL	Target Analyte List
TCA	trichloroethane
TCE	trichloroethene
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total Dissolved Solids
TEL	Threshold Effect Level
TIC	tentatively identified compound
TOC	Total Organic Carbon
VOC	Volatile Organic Compound

Miscellaneous

ASTM	American Society for Testing and Materials
AES	Atlantic Environmental Services, Inc.
DEIS	Draft Environmental Impact Statement
EA	Environmental Assessment
EDR	Environmental Data Resources, Inc.

EIS	Environmental Impact Statement
FS	Feasibility Study
FSP	Field Sampling Plan
FWIA	Fish and Wildlife Impact Analysis
HEAST	Health Effects Assessment Summary Tables
HHEA	Human Health Exposure Assessment
HHRA	Human Health Risk Assessment
IC/EC	institutional controls/engineering controls
ID	inside diameter
IRIS	Integrated Risk Information System
META	META Environmental, Inc.
MGP	Manufactured Gas Plant
NYSEG	New York State Electric & Gas
Order	Order on Consent
PPE	personal protective equipment
PVC	polyvinyl chloride
RI	Remedial Investigation
RTE	Rare, Threatened, and Endangered
RQD	Rock Quality Designation
SCBA	self-contained breathing apparatus
Site	NYSEG’s former MGP site on State Road in Lockport, Niagara County, New York (Site ID 9-32-109)
SMP	Site Management Plan
STL	Severn Trent Laboratories
SU	Standard Unit
TBC	to be considered (criteria)

UCL95	95 Percent Upper Confidence Level
URS	URS Corporation
USCS	Unified Soil Classification System
UST	Underground Storage Tank
VC	vinyl chloride
WCC	Woodward-Clyde Consultants
WWTP	wastewater treatment plant

EXECUTIVE SUMMARY

On behalf of NYSEG (New York State Electric & Gas Corporation), URS Corporation (URS) presents this Remedial Investigation (RI) Report for NYSEG's Transit Street Former Manufactured Gas Plant (MGP) site in the City of Lockport, Niagara County, New York. This RI Report is being submitted to the New York State Department of Environmental Conservation (NYSDEC) as required under the Order on Consent (#DO-0002-9309) between NYSEG and the NYSDEC, dated March 25, 1994. Work for this RI was completed in general accordance with the NYSDEC-approved Remedial Investigation Work Plan, dated November 2004. All of the data required to achieve the project objectives for the Transit Street site have been obtained and the overall objective has been met, i.e., to gather data of sufficient quality and quantity to characterize the site such that remedial options for the site can be evaluated.

SITE DESCRIPTION AND HISTORY

The Transit Street former MGP site is approximately one acre in size, and is located in the City of Lockport, New York. The former MGP operated from 1851 to 1927 as a manufacturing plant for gas generated from coal. The site included three gasholders, tar tanks, and a storage building, which were demolished between 1928 and 1948. Currently, the site is a NYSEG electrical substation and contains a transformer area, switch house, and storage building. A locked 8-foot-high chain link fence encloses the entire property, with four gates allowing access to the property. Previous investigations of the site include: a site screening conducted by Woodward-Clyde Consultants, Inc. (WCC) from 1982 through 1985; a supplementary investigation performed by Atlantic Environmental Services, Inc. (AES) from 1991 through 1995; and an air monitoring survey by Galson Corporation in 1992. The results of the previous investigations indicate that the soil and overburden/bedrock groundwater at the site, and possibly the surface water and sediment in the New York State Barge Canal, have been impacted by MGP-related contaminants. Two additional open spill sites not associated with the Transit Street former MGP operations were also identified within ¼ mile of the Transit Street site. The spills were gasoline releases from past operations of nearby gas stations.

SCOPE OF THE RI

The RI was conducted from January through June 2005. Field activities included: drilling of soil borings and monitoring well installations; well development; packer and slug testing; establishment of transects and qualitative characterization of sediments within the New York State Barge Canal; surface soil, subsurface soil, groundwater, surface water, sediment, and non-aqueous phase liquid (NAPL) sampling; decommissioning of monitoring wells; and inspection of the Lockport Main Interceptor Tunnel. Following completion of the RI, NYSEG/URS submitted an *Interim Summary Data Report* to the NYSDEC in September 2005. Pursuant to responses from the NYSDEC on the *Interim Summary Data Report*, a *Remedial Investigation Work Plan Addendum* was developed in February 2006. Field tasks included in the addendum were completed in March and April 2006, and consisted of: retrofitting nine of the existing bedrock monitoring wells to shorter screened intervals and performing a soil vapor intrusion investigation, including collection of soil vapor/air samples. A

Qualitative Human Health Exposure Assessment and Fish and Wildlife Impact Analysis were also completed for the site.

CONCLUSIONS

Geology and DNAPL

The site is underlain by fill materials and reworked native soils. Thickness of overburden at the site ranges from approximately 10 feet along Transit Street to 20 feet in the eastern portion of the site. For the entire investigation area, the overburden thickness ranges from approximately 1.2 to 51 feet. Southeast of the site, at the upgradient off-site SMW-01S and SMW-01D well cluster, the overburden is 51 feet thick. North of the site, adjacent to the New York State Barge Canal, the overburden is approximately eight feet thick. Fill materials typically were characterized as brown to red brown, silt, clayey silt, and silty clay with varying amounts of coal fragments, degraded concrete, and brick fragments. Native soils consist of red brown silty fine sand with some coarse gravel. The bedrock surface forms a ridge along Transit Street that slopes steeply to the west, and only slightly towards the north and east. Very few vertical fractures were observed during the RI field activities, but some are reported to be present in the area. Several vertical joint sets trending approximately west to east were observed in the rock face within the New York State Barge Canal. Two inclined borings advanced in 1983 during the WCC investigation also confirmed the presence of near-vertical joints beneath the site. The 1995 AES report indicates regionally significant joint sets trending N40E and N84E have been measured at the site; the latter set could be inducing contaminant migration towards the north and the New York State Barge Canal. Groundwater in the overburden lies within the fill between six to nine feet below ground surface (bgs). Southeast and upgradient of the site where the overburden is significantly thicker, the groundwater is much deeper at approximately 21 to 25 feet bgs. North of the site, as the overburden thins out between the site and the New York State Barge Canal, some of the overburden wells have a very thin saturated zone or are seasonally dry. Groundwater in the overburden and all bedrock units (i.e., shallow, intermediate, and deep) flows northwest toward the New York State Barge Canal. Groundwater in the bedrock tends to discharge into the New York State Barge Canal.

Visible coal tar dense non-aqueous phase liquid (DNAPL) was observed in soils at several locations beneath the western portion of the Transit Street site extending northward beneath LaGrange Street and the Mobil Gas Station. DNAPL within the overburden was not noted in the soil south or east of the site boundary, or along the west side of Transit Street, or north of the New York State Barge Canal. Coal tar DNAPL was noted within the fractures of bedrock cores at several of the monitoring well locations during the RI, and appears to have advanced within the bedrock primarily north and west of the site. It was also detected in all bedrock monitoring wells installed directly north of the site. DNAPL stains have been observed at the base of the New York State Barge Canal north of the site, which is indicative of former discharges. There were no active DNAPL discharges observed. In the deep bedrock, DNAPL was not observed when coring north of the canal at location BMW-04-10. However, during well development at this location, a few tiny coal tar blebs entered the well indicating coal tar DNAPL is present in the vicinity. To the west, some component of the coal tar DNAPL is migrating into the unlined Shaft #3 of the Main Interceptor Tunnel (it was observed lining the eastern side of the shaft walls). Also within the tunnel, at approximately 75 feet below grade north of the site, coal tar DNAPL seeps were observed on the north side of the tunnel, in the vicinity of where DNAPL stains were observed emanating into the New York State Barge Canal. DNAPL was seen in several fractures west-southwest, north, east and northeast of the site. The horizontal and vertical extent of DNAPL in the bedrock appears to have been fully delineated during this investigation. DNAPL was observed to accumulate in only one well, BMW-04-11 at recoverable quantities. Traces of DNAPL (at unrecoverable quantities) were also observed in nine other wells. To date, 13.59 liters of DNAPL have been recovered from well BMW-04-11. Source DNAPL samples were sent to META Environmental, Inc. (META) for environmental forensic analyses, which indicate that the samples contain pyrogenic material from a carburetted water gas (CWG) process (i.e., coal tar).

Surface Soil

The major findings of the surface soil sampling conducted as part of the RI indicate that several semivolatile organic compounds (SVOCs), primarily polycyclic aromatic hydrocarbons (PAHs), exceeded standards, criteria, and guidance values (SCGs). The samples were collected adjacent to Transit and LaGrange Streets and PAHs detected are likely attributable to urban sources, such as vehicle exhaust. Beryllium, chromium, copper, iron, mercury, nickel, and zinc were at concentrations that exceeded SCGs in at least one of the surface soil samples collected during the RI. Total cyanide was detected in one of the surface soil samples, at location SS-08. This sample was sent to a Clarkson University laboratory for further analysis to determine the amount of free cyanide and the various cyanide species present. Very little of the cyanide detected is composed of the more toxic free cyanide. There are no SCGs for cyanide in soils. Polychlorinated biphenyls (PCBs) and total recoverable phenolics were not detected in any of the surface soil samples. There were no surface soil data available for previous investigations.

Subsurface Soil

The major findings of the subsurface soil sampling that was part of previous investigations or during the RI indicate that volatile organic compounds (VOCs), primarily benzene, toluene, ethylbenzene, and xylene (BTEX), were detected in the subsurface soil samples at concentrations above SCGs. The most frequently detected VOC was toluene. The highest concentration detected for total BTEX during the RI, 181.4 milligrams per kilogram (mg/kg), was located at GB-09 (from 10-12 feet bgs). GB-09 was advanced in the northwest corner of the Transit Street site. Concentrations of several SVOCs, primarily PAHs, exceeded their respective SCG at one or more locations. Six of the 47 RI samples reported total PAHs above 500 mg/kg. Four samples were from within the fenced-in substation and the other two were north of the substation property. Five samples collected as part of previous investigations reported concentrations of PAHs above 500 mg/kg, and the highest concentrations were observed along the western portion of the site near the three wooden sumps. Arsenic, barium, beryllium, cadmium, chromium, copper, iron, mercury, nickel, selenium, and zinc were detected at concentrations that exceeded SCGs in at least one of the subsurface soil samples collected. Arsenic, cadmium, calcium, copper, lead, magnesium, mercury, and zinc were at concentrations above the Eastern United States background concentrations during both the previous investigations and the RI. PCBs were only detected in two samples collected during the RI and in two samples collected during previous investigations. All PCB concentrations were below SCGs. Total cyanide was detected in 12 of the 48 samples collected during the RI, and eight of the 18 samples collected during previous investigations. The highest concentrations detected during the RI were in the approximate vicinity of the former tar sumps. During previous investigations, the highest concentrations were from locations along the northern property boundary, between the approximate locations of the former offices and the 15,000 and 50,000 cubic foot gasholders. The majority of the cyanide was found to exist as stable iron cyanide complexes and not as free cyanide. These iron cyanide complexes are not known to be of toxicological concern. Total recoverable phenolics were detected in only one of the subsurface soil samples collected during the RI, and in six of the samples collected during previous investigations. There is no established SCG for total recoverable phenolics in soils. The affected volume of soil with total PAHs above 500 ppm was determined to be approximately 5,447 cubic yards, of which 524 cubic yards are saturated (i.e., below the water table). The affected volume of soils impacted with tars/DNAPLs is approximately 18,000 cubic yards, of which 1,182 cubic yards are saturated.

Groundwater

Groundwater quality was assessed on two occasions during the RI. First, during bedrock monitoring well installation, packer test groundwater samples were collected from discrete intervals to assess the vertical extent of dissolved phase contamination. Second, at the conclusion of the drilling program in June 2005, groundwater samples were collected from wells monitoring the overburden and the shallow, intermediate, and deep bedrock. VOCs detected at concentrations exceeding SCGs in the packer test samples consist primarily of BTEX. Other VOCs that were at concentrations exceeding SCGs include 1,2-dichloroethene(cis), isopropylbenzene, methyl tertiary-butyl ether (MTBE), styrene, and vinyl chloride. VOC concentrations appear to decrease with depth. VOCs detected at concentrations exceeding SCGs in the overburden/bedrock interface monitoring wells consist primarily of BTEX. The highest total BTEX concentrations in samples collected during the RI were located north (downgradient) of the site. BTEX was not detected in the upgradient and side gradient monitoring well samples. SVOCs detected above SCGs in the overburden/interface monitoring well samples collected during the RI were located north (downgradient) of the site. As in the VOC results, SVOC concentrations decrease with depth. No SVOCs were observed at concentrations exceeding SCGs in the upgradient and side gradient monitoring well samples collected during the RI. No PCBs were detected in the overburden/interface monitoring well samples collected during the RI. Arsenic, cadmium, chromium, iron, lead, magnesium, manganese, nickel, and sodium were at concentrations exceeding SCGs in one or more overburden/interface monitoring well samples collected during the RI or during previous investigations. Total cyanide was noted in four overburden/interface wells from samples collected during the RI at concentrations below its SCG. Total recoverable phenolics were detected at concentrations above SCGs in 6 of the 12 overburden/bedrock interface well samples collected during the RI, but were not detected in the upgradient, side gradient, or distant downgradient locations.

In the shallow and intermediate bedrock monitoring well samples collected during the RI or previous investigations, VOCs detected at concentrations exceeding SCGs consist primarily of BTEX. VOCs exceeding SCGs include 1,2-dichloroethene(cis), isopropylbenzene, MTBE, styrene, tetrachloroethene, trichloroethene, and vinyl chloride. The highest total BTEX concentrations (22,000 micrograms per liter [µg/L] and 14,700 µg/L in wells MW-07 and MW-03, respectively) were detected on site in the vicinity of the former coal tar sumps. The chlorinated VOCs were all observed in well MW-15, which is located northeast of the site and is likely impacted by non-MGP related sources of contaminants. MTBE was detected in several wells; however, MTBE is not associated with MGP waste. During the RI, the highest concentration of total SVOCs (78,975 µg/L) was at location MW-07, 31,000 µg/L of which was naphthalene. MW-07 is located along the western boundary of the site. No PCBs were detected in the shallow or intermediate bedrock monitoring well samples collected during the RI. Total cyanide was detected in several of the shallow and intermediate bedrock well RI samples, but the concentrations were all below the SCG. Total recoverable phenolics were detected above the SCG in nine of the shallow and intermediate bedrock well samples during the RI, and the highest concentration was in MW-07. Cadmium, chromium, copper, iron, lead, magnesium, manganese, nickel, selenium, sodium, and zinc were detected at concentrations exceeding SCGs in one or more of the shallow and intermediate bedrock monitoring well samples collected during the RI.

VOCs detected at concentrations exceeding SCGs in the deep bedrock monitoring well samples collected during the RI or previous investigations consist primarily of BTEX. Other detected VOCs exceeding SCGs include cyclohexane, isopropylbenzene, MTBE, styrene, and vinyl chloride. The highest total BTEX concentrations during the RI (2,360 µg/L and 787 µg/L in wells BMW-04-09 and MW-02, respectively) were detected west of the site nearby the New York State Barge Canal. Low concentrations of BTEX in wells BMW-04-10 and BMW-04-13 indicate the dissolved phase plume in the deep bedrock extends beneath the New York State Barge Canal, although low levels of chlorinated VOCs at these locations indicate impacts by other sources as well. Overall, SVOC concentrations were much lower than those in the shallow and intermediate bedrock groundwater. No SVOCs were detected in the deep bedrock monitoring well BMW-04-13 located west of the site on the other side of the New York State Barge Canal. No PCBs were observed in the deep bedrock monitoring well samples collected during the RI. Chromium, iron, lead, magnesium, manganese, nickel, sodium, and zinc were detected at concentrations exceeding SCGs in one or more RI deep bedrock monitoring well samples. Total cyanide was detected in two of the five deep bedrock well samples collected during the RI, but the concentrations were all below the SCG. Total recoverable phenolics were detected at a concentration above the SCG in only one deep bedrock well sample.

The groundwater contamination in the overburden is relatively contained around the site and extends into the Reid Petroleum Property where the dissolved phase plume co-mingles with another source associated with the gas station. Contaminants within the overburden have migrated with the groundwater downward into fractures in the shallow and intermediate bedrock, and have migrated through the fractures (secondary porosity). Groundwater contamination in the bedrock aquifer appears to be much more widespread vertically and laterally, and is also impacted with fuel-related contaminants in the vicinity of the gas station. In the shallow and intermediate bedrock, the New York State Barge Canal appears to be the receptor of the groundwater passing through the site. In the deep bedrock, it is possible that some component of groundwater flow migrates beneath the canal and some component may migrate upwards and discharge into the canal. Trace quantities of MGP-related contaminants were detected in bedrock wells located on the north/west side of the canal and this area probably represents the northern extent of dissolved-phase groundwater contamination.

Surface Water and Sediment

The major findings of the surface water sampling performed as part of the RI indicate that no VOCs were detected at concentrations above SCGs. During the RI, SVOCs were not detected in any surface water at any concentration. SVOCs, primarily carcinogenic PAHs (cPAHs) but also some phenolic compounds, exceeded SCGs in several samples from previous investigations. During the RI, PCBs were not detected in any surface water at any concentration. The concentrations of iron in five of the surface water samples collected during the RI exceeded the SCG, but all metals concentrations were below SCGs in samples from previous investigations. The concentration of total recoverable phenolics at one upstream location exceeded the SCG for this parameter and, therefore, is likely not site-related.

The major findings of the sediment sampling during the RI indicate that benzene was detected in one of the 53 sediment samples collected during the RI, at a concentration below the SCGs for all categories of protection. Toluene, ethylbenzene, and xylene were not observed in any of the sediment samples collected during the RI. Acetone was the only VOC detected in the three sediment samples collected during previous investigations. SCGs for VOCs were not derived for the historical sediment samples because they are dependent on the total organic carbon (TOC) content of each individual sample, and TOC data were not available. Several SVOCs, primarily PAHs, were detected in sediment samples collected during the RI. Reported concentrations of benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene exceeded their respective SCGs for the Human Health Bioaccumulation Level of Protection at one or more locations. All reported SVOC/PAH concentrations were below the SCGs for the Wildlife Bioaccumulation Level of Protection. Benzo(a)anthracene exceeded the SCG for the Benthic Aquatic Life Acute Toxicity Level of Protection at one or more locations. Benzo(a)anthracene, bis(2-ethylhexyl)phthalate, phenanthrene, and fluorene exceeded their respective SCGs for the Benthic Aquatic Life Chronic Toxicity Level of Protection at one or more locations. It was determined that sediments at locations SED-06, SED-08, SED-16, SED-17, SED-18, and SED-25, which are located downgradient of the site along the eastern portion of the canal, have likely been impacted by waste generated during operations at the Transit Street former MGP site, because DNAPL was observed seeping into the canal near these locations. The presence of SVOCs/PAHs at the remaining sediment locations are likely due, at least in part, to other sources not related to former site operations. The sediments in the canal at locations adjacent to the State Road former MGP site also do not appear to be impacted by MGP-related waste. 4,6-Dinitro-2-methylphenol was the only SVOC detected in the three sediment samples collected during previous investigations. SCGs for SVOCs were not derived for the historical sediment samples because they are dependent on the TOC content of each individual sample, and TOC data were not available. PCB compounds (Aroclors 1242, 1248, 1254, and/or 1260) were detected in all of the sediment samples collected during the RI. Reported concentrations of Aroclors 1242, 1248, 1254, and 1260 exceeded their respective SCGs for the Human Health Bioaccumulation, Wildlife Bioaccumulation, and Benthic Aquatic Life Chronic Toxicity Levels of Protection at one or more locations. Aroclor 1242 also exceeded the SCG for the Benthic Aquatic Life Acute Toxicity Level of Protection. The presence of PCBs in the sediments does not appear to be related to operations at the Transit Street former MGP site. Arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc were detected at concentrations that exceeded the lowest effect level (LEL) SCGs in one or more of the sediment samples collected during the RI or previous investigations. Copper, lead, manganese, mercury, nickel, silver, and zinc were at concentrations that exceeded the severe effect level (SEL) SCGs in one or more of the sediment samples collected during the RI or previous investigations. The presence of these metals in the sediments does not appear to be related to operations at the Transit Street former MGP site. Total cyanide was observed in four of the 53 sediment samples collected during the RI, all of which were from locations adjacent to/downgradient of the Transit Street site. Cyanide was not detected in the sediments collected upstream or downstream of the site. The majority of the cyanide detected was determined to exist as stable iron cyanide complexes. There are no established SCGs for cyanide. Cyanide was not detected in any of the sediment samples collected during previous investigations. Total recoverable phenolics were not detected in any of the RI sediment samples.

To assess the potential sources of PAH contamination in the sediment samples, DNAPL, soil, sediment, and groundwater samples were sent to META, a laboratory specializing in environmental forensics analyses. Site history, along with forensic procedures such as PAH distribution/diagnostic ratio analyses and weathering patterns, was examined during the forensics analysis. Based on the PAH distributions, diagnostic ratios, and observed weathering patterns, META concluded that all three DNAPL samples submitted for analysis contained PAH ratios consistent with CWG tar. These samples were collected from monitoring well locations BMW-04-11 and MW-02. BMW-04-11 is located along LaGrange Street just outside the northern perimeter of the Transit Street site. MW-02 is located northwest of the site along the eastern edge of the New York State Barge Canal. The CWG tar in the sample collected from location MW-02 appeared to be more weathered, and also contained severely weathered gasoline. Only two of the soil samples, GB-07 (5.0-5.2 feet) and GB-08 (12-14 feet), appeared to be impacted by CWG tar, as the forensics results were similar to those of the three DNAPL samples. However, some differences were noted that might have been due to weathering, mixing of PAH sources, and/or differences in tar composition.

The remaining soil samples submitted for forensics analysis had hydrocarbon fingerprints and diagnostic PAH ratios consistent with coal carbonization (CC) or coke oven (CO) derived materials and/or urban background. The soils from the State Road site were more variable and different than those from the Transit Street site, and were likely impacted by multiple sources of contaminants. Based on a comparison of the sediment data to the data for the DNAPL and soil samples described above, META concluded that none of the sediment samples collected from the New York State Barge Canal appear to be impacted by CWG tar or related PAH sources. Rather, the sediments all contain varying mixtures of pyrogenic, petrogenic, and biogenic PAH sources, which is consistent with sediments in many urban waterways. META also concluded that sediment samples SED-06 (0-1 feet), SED-14 (0.5-1.5 feet), SED-15 (0.5-1.5 feet), and SED-24 (0-1 feet) appeared to contain PAHs from the same source as the soil samples collected from the State Road site.

CONCEPTUAL SITE MODEL

The horizontal extent of the contamination in the overburden is generally limited to the MGP-related structures and extends across LaGrange Street into the Reid Petroleum property (i.e., Mobil Gas Station). DNAPL is likely pooled on the bedrock, and entered the bedrock through fractures. It has been transported along the top of bedrock and through bedrock fractures to the New York State Barge Canal and the City of Lockport interceptor tunnel. DNAPL stains were observed by URS personnel in the rock cut of the New York State Barge Canal north of the site. It was also observed in the subsurface at the gas station (Reid Petroleum Site) immediately north of the Transit Street site when underground storage tanks (USTs) were removed and replaced. The former MGP structures (particularly the former gasholders and tar sumps) appear to be the primary potential source areas of contamination at the site. Former releases of MGP-related contaminants from the source areas could potentially have: remained in surface/subsurface soil and/or bedrock within and near the former MGP structures (the former gasholder pad and tar sumps); migrated downward into groundwater contained in the overburden and/or shallow bedrock beneath the site; or migrated laterally via shallow and intermediate bedrock groundwater transport and discharged into the New York State Barge Canal.

QUALITATIVE HUMAN HEALTH EXPOSURE ASSESSMENT

Under the current and future use scenarios, inhalation of soil vapor is considered a viable, potentially complete exposure pathway. Under these scenarios, direct contact with sediment is considered a viable, potentially complete exposure pathway. However, under the current and future use scenarios, the exposure pathways for surface soil, subsurface soil, air, surface water, and groundwater are considered to be incomplete. The qualitative human health exposure assessment (HHEA) for the Transit Street site identified 75 contaminants of potential concern (CPCs) in the groundwater, surface water, sediment, surface soil, subsurface soil, and soil vapor/air samples, which include the iron cyanide complexes for which no SCGs exist. Twenty-two of these CPCs are classified by United States Environmental Protection Agency (USEPA) as carcinogens in the SmartTOX database.

FISH AND WILDLIFE IMPACT ANALYSIS (FWIA)

The FWIA used information collected during URS's 2005 field investigation, together with data from previous investigations, to assess impacts to fish and wildlife in the immediate and surrounding areas. The results of the FWIA Step I analysis indicate that the only potential ecological resources that may be impacted by contamination associated with the Transit Street Former MGP site are a few nearby wetlands; however, there are no direct connections between the site and these areas. The Pathway Analysis (FWIA Step II.A) indicated that site-related contaminants are potentially migrating to the adjacent canal. In the Criteria-specific Analysis (FWIA Step II.B), it was determined that some chemicals/analytes were reported at concentrations above sediment quality standards. It is likely that MGP-related constituents are mixed with contaminants attributable to urban sources. However MGP-related DNAPL was observed in the canal east of the Transit Street bridge crossing, and a few sediment samples in this area appear to show greater MGP impacts. Based on the findings of this stepwise assessment, no additional ecological evaluation at the Transit Street Former MGP site is warranted.

RECOMMENDATIONS

Based upon the analytical results from the current and previous investigations, a Feasibility Study should be conducted to evaluate remedial alternatives for the site. In addition, NYSEG should develop a site management plan (SMP) to identify institutional controls and engineering controls (IC/ECs) for future use. The SMP would be developed to establish the controls and procedures necessary to manage contaminated soils and groundwater that may be encountered during maintenance or future activities, including the procedures for soil characterization and handling; health and safety of the workers and the community; disposal/reuse in accordance with applicable regulations and procedures; and maintenance of restrictions to "restricted-commercial use".

1.0 INTRODUCTION

On behalf of New York State Electric & Gas Corporation (NYSEG), URS Corporation (URS) is pleased to present the New York State Department of Environmental Conservation (NYSDEC) with this *Remedial Investigation (RI) Report* for NYSEG's Transit Street Former Manufactured Gas Plant (MGP) Site in the City of Lockport, Niagara County, New York. The location of the former MGP site is shown in Figure 1-1. The NYSDEC's identification number for the Transit Street site is 9-32-098. This RI Report is being submitted to the NYSDEC as required under the Order on Consent (#DO-0002-9309) between NYSEG and the NYSDEC, dated March 25, 1994. Work for this RI was completed in general accordance with the NYSDEC-approved *Remedial Investigation Work Plan* dated November 2004, and *Remedial Investigation Work Plan Addendum* dated February 2006. The RI Work Plan was developed to also include investigation activities at the nearby State Road Former MGP site (Figure 1-2). An RI Report for the State Road Former MGP has been submitted separately (March 2006), although some information collected during the State Road RI has been used to supplement data collected for the Transit Street RI.

The purpose of the RI at the NYSEG Transit Street Former MGP site is to characterize the horizontal and vertical extent of MGP-related contamination at the site and vicinity, and to provide the necessary data to assess remedial alternatives for a Feasibility Study (FS). The technical approach and scope was developed to address data gaps identified from review of previous investigations and to meet NYSDEC's regulatory requirements stated in the Order on Consent (Order).

The field tasks for the Transit Street former MGP site as described in the Work Plan were completed between January 2005 and June 2005. Because of the complexity in determining the horizontal and vertical extent of contamination associated with the Transit Street site, additional field tasks beyond those described in the Work Plan were required to meet the overall project objectives. A separate *Remedial Investigation Work Plan Addendum* describing the additional field tasks (February 2006) was developed. These additional tasks were completed in March and April 2006.

The remainder of this section discusses the purpose of this report, the site background, the scope of the current investigation, and the organization of this report.

1.1 Purpose of Report

The purpose of the RI was to evaluate the extent of MGP-related contaminants in the soil and groundwater at and near the site, and to gather data of sufficient quality and quantity to characterize the site such that remedial options for the site could be evaluated using a sound technical basis. As specified in the Order, NYSEG is required to develop and implement a Remedial Investigation and Feasibility Study that addresses health and environmental hazards and potential hazards attributable to the site for which NYSEG is a responsible party under New York State law.

The specific objectives for the RI were to:

- Review and compile contaminant distribution and other relevant background data from available historic documents for the site.
- Refine the site hydrologic and geologic model.
- Delineate the horizontal and vertical extent of MGP-related contaminants, including non-aqueous phase liquids (NAPLs), in site soil and bedrock sufficiently to evaluate potential risk to human health and the environment.
- Characterize the groundwater quality in the overburden and shallow bedrock (Gasport Dolomite and Decew Dolomite) groundwater regimes.
- Characterize the groundwater quality in the deeper portions of the bedrock (Rochester Shale).
- Delineate the horizontal and vertical extent of the previously identified groundwater contaminant plume in the overburden and shallow bedrock groundwater regimes.

- Evaluate the impacts of site contaminants to surface water and sediments in the New York State Barge Canal.

- Complete a Fish and Wildlife Impact Analysis through Step IIB.

- Identify potential pathways for human exposures as part of a qualitative exposure assessment.

- Identify potential non-site related contaminant contributions to soil and groundwater at, and adjacent to, the site.

- Determine if data collected during the course of the RI indicate that vapor phase MGP-related contaminants have the potential to affect the quality of soil gas and/or indoor air on private properties proximate to the site.

1.2 Site Background

This section provides a site description, a brief history of MGP operations at the site, and a summary of previous investigations. The information described below was either provided by NYSEG or learned through our review of publicly available documents.

1.2.1 Site Description and History

The Transit Street site is just under an acre in size and is the location of a former MGP that operated circa 1851 to 1927. Much of the following site history has been gathered from reports on previous investigations conducted at the site (see Section 1.2.2). During the first seven years of operation, the facility reportedly used whale oil as a feedstock. Circa 1857-1859, manufactured gas production by coal carbonization began. In the coal carbonization process, bituminous coal was heated in a sealed chamber, causing the distillation of gas from coal and the formation of coke. Carburetted water gas (CWG) was probably produced at the site beginning in 1914, as evidenced by the addition of a water gas department and oil tanks to the 1914 Sanborn Map. Carburetted water gas is fuel gas made from water (as steam) and enriched for candlepower by light "oils" recovered from gas-making residual tars and light petroleum oils. CWG was created by passing steam through a bed of incandescent coke or coal, resulting in “blue gas”. This was then passed through two chambers containing hot firebrick into which oil was sprayed and the oil cracked into gaseous hydrocarbons and tar. Tars produced during coal carbonization were high in phenols and base neutral organics, whereas tars produced by CWG processes contained much lower amounts of these compounds. Typically, substantial amounts of cyanide and ammonia were produced by coal carbonization, but only trace amounts of cyanide resulted from CWG processes.

The locations of the former MGP structures, as shown on Figure 1-3, are based on Sanborn maps from 1886 to 1928 and the site history presented in the Atlantic Environmental Services, Inc. (AES) *Supplemental Site Investigation* Report from January 1995. In 1886, site structures included a plant building made up of retorts, an engine room, and purifiers in the western part of the site. Three gas-holders were located in the north-central portion of the site. Two private residences were present on what is now the easternmost extent of the site. The westernmost gasholder was removed some time between 1892 and 1898. Between 1898 and 1903, one of the adjacent private residences east of the site was removed and the site boundary was extended eastward to Saxton Street. The other residence, with the addition of a storage shed, was incorporated into the southeastern corner of the site. A new gasholder was added to the eastern portion of the site between 1898 and 1903. The 1909 Sanborn map lists the capacity of the three gasholders as 18,000 cubic feet for the westernmost holder, 50,000 cubic feet for the central holder, and 150,000 cubic feet for the easternmost holder. An electrical department and storage building replaced the dwelling and storage building in the southeastern corner of the site.

The 1914 Sanborn map indicates the addition of water gas equipment in the southeastern part of the site and three oil tanks between the plant building and the water gas department along the southern site boundary. The water gas department was reportedly relocated from the southeast corner of the site to the southwest corner of the site by 1919. The storage shed remained in the southeastern part of the site and a total of five oil tanks were located along the southern site boundary. The 18,000 cubic foot gasholder and the storage shed in the southeastern site corner were removed between 1919 and 1928, according to the 1928 Sanborn Map. A coal pit with northern and southern retaining walls was located in the southeastern corner of the site and a coal bucket runway extended from the coal pit to the plant. According to the AES report, the last year of gas production at the Transit Street site is believed to be 1927, based on recollection of present and former employees. All of the MGP structures were removed from the site between 1928 and 1948, according to the 1948 Sanborn Map. The dismantling procedures are unknown.

The State Road site is the location of the former State Road Tar Works, which operated circa 1900-1911 as a processing plant for tar generated at the Transit Street Former MGP. No information is available to determine if there were any subsurface structures such as pipes or conduits between the Transit Street site and the State Road site. Both sites are currently owned by NYSEG. The Transit Street site is currently an electrical substation and contains a transformer area, switch house, and storage building.

The City of Lockport has a sewer system that utilizes tunnels excavated in bedrock as interceptor sewers. The Main Interceptor Tunnel extends along the northern shoulder of State Road to South Transit Street, along South Transit Street one block to what was formerly Buffalo Street, under the New York State Barge Canal near St. Mary's Church, and on to Williams Street, where it joins a pipeline connecting it to the sewage disposal plant on Jackson Street (Figure 1-2). The Main Interceptor Tunnel is excavated in bedrock (the Lewiston Member of the Rochester Shale) and is 8,526 feet long. It is 6 to 9 feet high and approximately 75 feet below grade near the State Road and Transit Street sites, approximately 65 feet below the top of bedrock. An access shaft is situated near the State Road and Transit Street sites. The tunnel was investigated as part of the Transit Street RI and observations are discussed later in the report.

1.2.2 Previous Investigations

Previous investigations of the Transit Street site include a site screening conducted by Woodward-Clyde Consultants, Inc. (WCC) from 1982 through 1985, a supplementary investigation performed by Atlantic Environmental Services, Inc. (AES) from 1991 through 1995, and an air monitoring survey by Galson Corporation in 1992.

Below is a list of documents provided by NYSEG, followed by a summary of the findings of the activities performed. Figure 1-4 presents map depicting historical sampling locations.

1. Investigation and Assessment of the Lockport Coal Tar Site: Task 1 Report, Preliminary Site Evaluation, prepared by Woodward-Clyde Consultants, Inc., November, 1982.

    - A preliminary site evaluation was performed at the Transit Street site by WCC in 1982. The evaluation consisted of a literature review, site reconnaissance, and geophysical surveys. The results of the report indicated that the bedrock surface ranges in depth from 2 feet to 23 feet in the study area and slopes generally towards the New York State Barge Canal, and the bedrock contains northeast and northwest striking joint sets that perhaps influence the flow of groundwater and infiltration water.

2. Investigation and Assessment of the Lockport Coal Tar Site: Task 2 Report, Boring and Well Installation, prepared by Woodward-Clyde Consultants, Inc., February 1983.

    - An investigation of the Transit Street site was performed by WCC in 1983. Four bedrock wells (MW-1 through MW-4), two bedrock/overburden interface wells (IW-1 and IW-2), and three borings (B-1 through B-3) were installed to monitor groundwater conditions and to determine subsurface conditions. It was determined from the investigation that bedrock groundwater flow is towards the New York State Barge Canal to the north-northwest. Coal tar contaminated soils were observed at MW-3 from 4 to 12 feet, sampled from 8 to 10 feet and sent for analysis. Compounds present in the soil included fluoranthene (17 parts per million [ppm]), pyrene (13 ppm), naphthalene (63 ppm) and phenathracene (38 ppm). Oil coated rock was observed below the Gasport Member at depths ranging from 30 to 38 feet in all borings except B-1 and MW-4.

3. Results of Groundwater Sampling, Lockport Coal Tar Site, prepared by Woodward-Clyde Consultants, Inc., August 25, 1983, revised September 9, 1983.

- WCC conducted two rounds of groundwater sampling on February 2-3, 1983 and May 4, 1983. Monitoring wells MW-1 through MW-4 and IW-2 were sampled during both events. Seep 1 and Seep 2 samples and a soil sample from the substation site were collected and analyzed during the February 1983 event.

4. Investigation and Assessment of the Lockport Coal Tar Site: Task 3 Report, Boring and Well Installation and First Round Groundwater Sampling, prepared by Woodward-Clyde Consultants, Inc., February 1984.

    - A Task 3 field investigation was performed by WCC in 1984. The program included the drilling of six shallow auger borings (AB-1 through AB-6), excavation of five test pits (TT-1 through TT-5), installation of 13 monitoring wells (MW-5 through MW-17), drilling of two inclined bedrock cores (B-3-1 and B-3-2), permeability testing of 16 new and existing wells, and collection of three rounds of New York State Barge Canal water samples. Groundwater samples were collected and analyzed from all 19 wells.

    - Three wooden sumps were discovered during the excavation of TT-2. The sumps were approximately 7 feet by 5 feet by 3.5 feet, filled with a black liquid believed to be coal tar, and covered with stone slabs. Widespread coal tar contamination was observed in site soils. Low concentrations of polychlorinated biphenyls (PCBs) were detected in soil samples from TT-2/S-1, TT-2/S-2 and AB-4/S-1.

5. Results of Third Round Task 3 Groundwater Sampling, Lockport Coal Tar Site, prepared by Woodward-Clyde Consultants, Inc., July 31, 1984.

    - All 19 site wells were sampled. This event was during high water level conditions in the New York State Barge Canal.

6. Investigation and Assessment of the Lockport Coal Tar Site: Task 7 Report, Additional Investigations, prepared by Woodward-Clyde Consultants, Inc., November, 1984.

- Additional investigations of the Transit Street site were conducted by WCC in 1984. The then-current status of New York State Barge Canal water use was researched. Information concerning the location and construction of sewer lines, tunnels, and shafts in the site area was collected. Two additional wells (MW-18 and MW-19) were installed in an attempt to bound the northeastern extent of the plume. A minimum thickness of 30 inches of gasoline floating product was observed in well MW-17.

7. Results of Fourth Round Task 3 Water Sampling, Lockport Coal Tar Site, prepared by Woodward-Clyde Consultants, Inc., January 11, 1985.

   - Samples were collected from all on-site wells except MW-2. Surface water samples were collected from four points along the New York State Barge Canal at two depths per location.

8. Results of Fifth Round Task 3 Water Sampling, Lockport Coal Tar Site, prepared by Woodward-Clyde Consultants, Inc., January 11, 1985.

   - Samples were collected from all on-site wells except MW-2. Surface water samples were collected from four points along the New York State Barge Canal at two depths per location.

9. Summary Report: Investigations at the Lockport Coal Tar Site, Volume 1, prepared by Woodward-Clyde Consultants, Inc., February, 1985.

   - This report summarizes all Task 1, 2, 3 and 7 activities including all groundwater sampling results.

10. Task 5 Report: Conceptual Remedial Design Report for the Lockport Coal Tar Site, prepared by Woodward-Clyde Consultants, Inc., July, 1985.

    - This report compares various remedial alternatives for the site, including capping, slurry walls, grout curtain, removal, and pumping.

11. Transit Street MGP Site, Lockport, New York, Data Review Report, prepared by Atlantic Environmental Services, Inc.(AES), August, 1991.

    - AES reviewed all data from previous investigations at the Transit Street site in 1991. It was recommended that additional shallow borings, a soil gas survey, overburden monitoring well installation, sampling and analysis be performed in future investigations.

12. Environmental Assessment of Former Manufactured Gas Plant Site, Residential Air Monitoring Results, Lockport, New York, prepared by Galson Corporation, July 20, 1992.

    - Galson Corporation performed a residential air monitoring analysis in the vicinity of the Transit Street site in 1992. It was reported that no apparent link was observed between the coal tar contamination and indoor air quality. Results may have been affected by the nearby gas station, which was operational during the survey, and emitted gasoline odors that were quite noticeable in the proximity of the investigation.

13. Supplemental Site Investigation for Transit Street MGP Site, Lockport, New York, prepared by Atlantic Environmental Services, Inc., January 1995.

    - A site investigation was performed by AES at the Transit Street site in 1995. Field activities during the investigation included a soil gas survey, advancement of 44 shallow subsurface borings (SB-01 through SB-44), analysis of 17 soil samples, installation of 14 monitoring wells (SMW-1S, SMW-1D, SMW-3S, SMW-3D, SMW-4S, SMW-4D, SMW-5, SMW-6S, SMW-6D, and SMW-7 through SMW-11), subsurface soil sampling (10 samples from various depths at nine monitoring well locations), overburden permeability testing of five wells (SMW-3S, SMW-3D, SMW-4S, SMW-4D, and SMW-6D), groundwater sampling, air quality monitoring of nearby residences, and a site survey.

- MGP residuals were observed during drilling of wells SMW-6S, SMW-6D, and SMW-11.

- Overburden coal tar contamination was also defined at the site, except along the western edge, northwestern edge and the eastern side.

14. Removal/Reconstruction Activities, Reid Petroleum Site, LaGrange and Transit, Lockport New York, prepared by Acres International Corporation, April 1997.

    - Coal tar-impacted soils were encountered during construction activities in 1997 at the Reid Petroleum site. The site is a gas station property that Reid Petroleum owns, which is located directly north of the Transit Street former MGP, and bounded by LaGrange Street on the south, Transit Street on the west, Genesee Street on the north, and residential homes to the east. The zone of coal tar contamination was observed from six to eight feet below ground surface. A copy of the report is included in Attachment I.

1.2.3 Summary of Historical Analytical Data

Analytical data generated during previous investigations are presented and summarized in Tables 1-1 through 1-8 and Figures 1-5 through 1-8. For Figures 1-5 and 1-6, supplemental maps depicting each contaminant class are provided as Figures 1-5A through 1-5H and 1-6A through 1-6G.

Soil

The historical analytical results for soil samples from the Transit Street site are presented in Figures 1-5 and 1-5A through 1-5H. Figure 1-5 presents the total volatile organic compounds (VOCs), benzene, toluene, ethylbenzene, and xylenes (BTEX), semivolatile organic compounds (SVOCs), polycyclic aromatic hydrocarbons (PAHs), carcinogenic PAHs (cPAHs), non-carcinogenic PAHs (non-cPAHs), phenolics, and cyanide concentrations detected in each sample. Figures 1-5A through 1-5H graphically depict the range of concentrations of total VOCs, BTEX, SVOCs, PAHs, cPAHs, non-cPAHs, phenolics, and cyanide concentrations, respectively. Five groups of concentration ranges were chosen arbitrarily with each range reflected by a different color dot on the figures. A total of 33 soil samples, including three soil samples from two test pits, were collected from the Transit Street site. All historical analytical results are presented on Table 1-1, which includes New York State Standards, Criteria, and Guidelines (SCGs) for comparison. The SCGs are based on NYSDEC's Recommended Soil Cleanup Objectives (RSCOs) from *Technical and Administrative Guidance Memorandum* (TAGM) #4046, January 1994. A statistical summary table of the historical soil sample analytical results is included as Table 1-2.

The highest total VOC (553.2 milligrams per kilogram [mg/kg]), total BTEX (444.3 mg/kg), total SVOC (71,690 mg/kg), total PAH (71,690 mg/kg), total cPAH (6,890 mg/kg), and total non-cPAHs (64,800 mg/kg) results for subsurface soil were at test trench TT-02 at 5 feet below ground surface (bgs). Test trench TT-02 was located on the western side of the site (Figure 1-4). Three wooden sumps containing a coal tar-like substance were observed at test trench TT-02.

Tables 1-1 and 1-2 show exceedances of SCGs for VOCs in several subsurface soil samples from the Transit Street site that include BTEX compounds. Methylene chloride was also detected in one soil sample (SB-38) at concentrations that exceed SCGs.

Tables 1-1 and 1-2 also show that PAHs were detected in several soil samples at concentrations that exceed SCGs. Total SVOC concentrations above 500 mg/kg were detected in five subsurface soil samples (AB-04, TT-02, TT-05, SB-01, and SB-24) at the Transit Street site. As shown in Figure 1-5, these five soil samples were collected at locations near the former oil tanks, retorts, and coke storage area.

Tables 1-1 and 1-2 show that PCBs were detected at three subsurface soil sample locations. Aroclor 1260 was detected at 0.17 mg/kg in soil sample AB-04 (1.5 to 4.0 feet) and at 0.60 mg/kg in soil sample TT-02 (5 feet). Aroclor 1254 was detected at 0.29 mg/kg in soil sample TT-02 (1.0 to 2.0 feet). All detections for PCBs were well below the SCG of 10 mg/kg.

Several metals were detected in the soil samples collected from the Transit Street site. The metal concentrations were generally within one order of magnitude of their respective SCGs. The detected concentrations of copper, iron, and zinc were detected in two soil samples (SB-21 [1 to 3 feet] and SB-24 [0 to 1 feet]) at concentrations greater than one order of magnitude of their SCGs (Table 1-1). Sampling location SB-21 is near the former 50,000 cubic foot gasholder and SB-24 is near the west end of the former coal bucket runway.

Tables 1-1 and 1-2 show that a total of 18 soil samples were analyzed for cyanide. There is no established SCG for total cyanide in subsurface soil. The maximum detected concentration of cyanide was 79.2 mg/kg at SB-18 (2 to 4 feet). Six soil samples were also analyzed for total recoverable phenolics. The maximum detected concentration of total recoverable phenolics was 2,440 mg/kg at TT-02 (5 feet). Seventeen soil samples were analyzed for sulfide. The detected sulfide concentrations ranged from 7 mg/kg at samples SB-18 (2 to 4 feet) and SB-28 (6 to 8 feet) to 761 mg/kg at SB-24 (0 to 1.0 feet). There are no established SCGs for total recoverable phenolics or sulfide in subsurface soil.

Groundwater

Table 1-3 presents the previous groundwater analytical results for 122 groundwater samples and Figures 1-6 and 1-6A through 1-6G present the previous groundwater analytical data for the Transit Street site. Figures 1-6A through 1-6G graphically depict the range of concentrations of total VOCs, BTEX, SVOCs, cPAHs, non-cPAHs, phenolics, and cyanide concentrations, respectively. Five groups of concentration ranges were chosen arbitrarily with each range reflected by a different color dot on the figures. A statistical summary table of the historical groundwater analytical results is included as Table 1-4. Tables 1-3 and 1-4 include SCGs (Class GA standards and guidance values presented in NYSDEC *Technical and Operational Guidance Series 1.1.1 – Ambient Water Quality Standards & Guidance Values and Groundwater Effluent Limitations* [TOGS 1.1.1], March 1998, including subsequent revisions) for comparison. The groundwater data presented in Figures 1-6 and 1-6A through 1-6G only show the highest historical analytical result detected at each monitoring well location, during any of the previous investigations, for total VOCs, total BTEX, total SVOCs, total cPAHs, total non-cPAHs, phenolics, and cyanide.

Tables 1-3 and 1-4 show that the VOCs detected in the groundwater at concentrations that exceed SCGs include BTEX, styrene, 1-4 dichlorobenzene, methyl tert-butyl ether (MTBE), and 1,1-dichloroethane. Elevated concentrations of BTEX were detected at the two on-site wells MW-03 and MW-07, which are near the western property boundary of the site. Elevated BTEX in groundwater has also been detected at several off-site wells north of the site (MW-01, MW-02, MW-06, MW-10, MW-11, MW-12, MW-13, MW-15, MW-17, SMW-06S, SMW-06D, and SMW-11). The highest total VOC (54,100 micrograms per liter [μg/L]) and total BTEX (50,200 μg/L) concentrations were at well MW-17, which is approximately 150 feet north of the Transit Street site. Well MW-17 reportedly had at least 30 inches of gasoline product present in it in 1984 and is downgradient from the gas station that operated north of the site.

The groundwater samples show that SVOCs, including PAHs, have been detected in all of the monitoring wells associated with the Transit Street site with the exception of well SMW-01D, which is approximately 200 feet southeast of the site. The maximum detected concentration of total SVOCs of 413,700 μg/L was observed in monitoring well MW-07 (May 1984). MW-07 is located in the vicinity of the former location of the retorts. In general, total SVOC concentrations decrease from west to east and groundwater impacts associated with the SVOCs are at the north end of the site.

Table 1-3 and 1-4 show that the maximum detected concentration of total recoverable phenolics was 9.71 mg/L detected at well MW-10. As shown on Figure 1-6, well MW-10 is north of the site. In 1992, the groundwater samples from the SMW wells were analyzed for metals. Several metals were detected in the groundwater samples from wells SMW-01D, SMW-01S, SMW-04D, SMW-10, and SMW-11 at concentrations that exceeded their respective NYSDEC groundwater standards. The detected concentrations of antimony at 470 μg/L in well SMW-04D, iron at 3,910 μg/L in well SMW-11, and lead at 315 μg/L in well SMW-06S were the only concentrations that were greater than one order of magnitude above the groundwater standard.

Surface Water

Surface water samples were collected from six locations (CSL-01, CSL-02, CSL-03, CSL-04, SEEP 1, and SEEP 2) in the New York State Barge Canal during previous site investigations. Table 1-5 presents the previous surface water analytical results for the Transit Street site. A statistical summary table of historical surface water analytical results is included as Table 1-6. Figure 1-7 shows that there were two observed seeps (SEEP 1 and SEEP 2) into the New York State Barge Canal north of the Transit Street site and that the highest detected concentrations of BTEX and SVOCs were detected at SEEP 1. VOCs and SVOCs were not detected in the surface water samples from location CSL-04, which is four miles upstream of the State Road site. The September 1984 surface water samples exhibited the highest total PAH concentrations detected at locations CSL-01 through CSL-03.

Sediment

Sediment samples were collected from the New York State Barge Canal at the three locations (SE-01, SE-02, and SE-03) shown on Figure 1-8. As shown in Table 1-7, BTEX and PAHs were not detected in the three sediment samples that were collected in November 1990. However, acetone, 4,6-dinitro-2-methylphenol, and several metals were detected in the sediment samples. Organic compounds were not compared to criteria because total organic carbon (TOC) content would be needed to calculate criteria, and TOC data were not available. Metals detected in the sediment samples include arsenic, barium, beryllium, chromium, copper, iron, lead, magnesium, manganese, mercury, nickel, vanadium, and zinc. Metals were compared to the lowest and severe effect levels (LELs and SELs). Chromium, copper, iron, lead, manganese, mercury, nickel, and zinc were each detected at concentrations exceeding the LEL, in one or more samples. Zinc was also detected in sample SE-03 at 310 mg/kg, which exceeded the SEL of 270 mg/kg in sample SE-03. Higher concentrations of the metals were detected in the sediment samples SE-02 and SE-03 that are adjacent and downgradient of the State Road site.

1.2.4 Proximate Spill Sites

In order to characterize potential environmental impacts from alternate sources of contamination in the vicinity of the Transit Street site, URS contracted Environmental Data Resources, Inc. (EDR) to perform a corridor study for Lockport, New York (EDR 2005).

According to the NYSDEC Spill Records in the EDR report, there are two sites that are designated as open spill sites that are within ¼-mile of the NYSEG Transit Street Former MGP site, as presented Figure 1-9. The open spill locations nearby the Transit Street site are possible contaminant sources that may be contributing to the dissolved-phase groundwater plume. The first open spill location, Spill #9975727, is listed as the Former Dickies Donuts at 90 Walnut Street (Location #1 on Figure 1-9). On March 1, 2000, an unknown amount of gasoline was spilled, affecting the soils in the vicinity; the site is a former gas station and several former underground storage tanks (USTs) have since been removed.

The second open spill location, Spill #8807842, is the Stamp’s Atlantic Gas Station located at 100 South Transit Street (Location #2 on Figure 1-9). On December 27, 1988, approximately 1,500 gallons of gasoline were spilled, affecting groundwater and soils in the area. Explosive levels of gasoline vapors affected sanitary sewers, private houses located one block north of the Transit Street Former MGP site, and a restaurant located across the street from the Transit Street site. These facilities were evacuated, and the NYSDEC hired a contractor to direct a soil gas survey to determine the origin of the vapors. The soil gas survey implicated the Stamps Atlantic Gas Station, identifying gasoline leaking from on-site tanks as the source for products that contaminated groundwater and entered sanitary sewers in Lockport.

In January 1989 at the Stamps Atlantic Gas Station, free gasoline product was observed in a test trench at the site. Three monitoring wells and a recovery well were installed at the site, and approximately 470 gallons of product were removed. In March of 1989, four additional groundwater monitoring wells were installed. On November 9, 1989, a nearby house reported receiving gasoline fumes indoors. By January 1990, a total of 965 gallons of product had been removed since the spill. In August 1990, a dual pump recovery system was installed and, on

August 20, gasoline vapors were again detected in storm sewers and basements of various houses. In October 1990, a UST was hit during drilling. Approximately 1,000 gallons of water and 2,000 gallons of product were removed from the tank, which was then excavated out. During the excavation, 1,465 tons of contaminated soils were removed. By February 1991, the total amount of product recovered was 1,402 gallons. On August 16, 1991, a delivery truck spilled about 100 gallons of petroleum. A 6-inch-by-10-foot strip of contaminated soil was removed and drummed.

Matrix Environmental began remediation in June 1993 at the Stamps Atlantic Gas Station. They were contracted to rebuild the dual pump system in the recovery wells and install a low-profile air stripper for groundwater treatment. From June 1993 to January 1996, a total of 2,926,994 gallons of groundwater were extracted from the recovery wells and treated. From June 1993 to July 2001, 101.92 pounds of hydrocarbons were recovered during vapor extraction activities. In May 1997, a total of 17 soil samples were recovered from three soil borings that exhibited VOCs at concentrations ranging from 90.4 ppm to 404 ppm. Analytical results also showed the presence of BTEX in the soil.

In May 1998, Matrix Environmental began a subsurface investigation to delineate the extent of petroleum-impacted soils. In November 1998, they installed 11 four-inch-diameter vapor extraction points, 11 one-inch-diameter oxygen injection points, and 2 four-inch diameter groundwater-monitoring wells. In July 2001, a Biosolve® surfactant was injected into a recovery well in an attempt to solubilize and separate hydrocarbons into a water-based solution. In August 2001, 600 gallons of groundwater were extracted from the recovery well.

On February 9, 2005 at the Stamps Atlantic Gas Station, groundwater was collected from selected monitoring wells and submitted for laboratory analysis. Analytical results for groundwater concentrations of total BTEX and total MTBE from this historical groundwater collection event are presented on Table 1-8.

Total BTEX concentrations at monitoring wells at the Stamps Atlantic Gas Station site were relatively stable, remaining at concentrations above 10,000 μg/L, during the remedial efforts performed from February 2000 to February 2005, indicating remedial efforts have not been very effective. The extent of the original off-site gasoline product contamination plume was not entirely delineated during investigations, although on-site product seemed contained to the overburden and not the bedrock. Average depth to bedrock at the station is 32.8 feet bgs, according to an August 1997 subsurface boring program by Matrix Environmental Technologies, Inc. All monitoring and recovery wells at the spill site are overburden wells. Depth to groundwater varies from 10 to 20 feet below ground surface, and the historical groundwater flow direction is to the northwest.

1.3 Conceptual Site Model

URS has developed a conceptual site model based upon the RI results and the historical information reported as part of previous investigations (Figure 1-10). NAPL is likely pooled on the bedrock surface and enters the bedrock through fractures. NAPL is also transported along the top of bedrock and through bedrock fractures to the New York State Barge Canal. NAPL stains indicative of former seeps were observed by URS personnel in the rock cut of the New York State Barge Canal north of the site. NAPL was also observed in the subsurface at the gas station (Reid Petroleum Site) immediately north of the Transit Street site when USTs were removed and replaced. Additionally, contaminants from the site have the potential for downward migration into the interceptor tunnel and the Rochester Shale.

The former MGP structures (particularly the former gasholders and the former tar sumps) appear to be the primary potential source areas of contamination at the site. Secondary potential sources of contamination include coal tar DNAPL within the bedrock fracture network.

Former releases of MGP-related contaminants from the source areas could potentially have:

- Remained in surface/subsurface soil and/or bedrock within and near the former MGP structures (the former gasholder pad and tar sumps);
- Migrated as NAPL vertically and laterally through the bedrock fracture network;

- Migrated downward into groundwater contained in the overburden and/or shallow bedrock beneath the site; and/or

- Migrated laterally via the shallow bedrock groundwater and discharged into the New York State Barge Canal.

1.4 Scope of Work

The scope of work for the RI as outlined in the NYSDEC-approved Work Plan included the following elements:

1. Existing Monitoring Well Inspection
2. Soil Boring and Soil Sampling
3. Surface Soil Sampling
4. Bedrock Monitoring Wells Installation
5. Repairing, Replacing, and Abandoning Existing Damaged Monitoring Wells
6. Groundwater Sampling
7. Sediment Profiling/Surface Water and Sediment Sampling
8. Hydraulic Monitoring
9. Site Surveying
10. Inspection of Main Interceptor Tunnel
11. Fish and Wildlife Impact Analysis (through Step IIB)
12. Qualitative Risk Analysis
13. Analysis of Data and Preparation of Report

The procedures and field methods utilized during the RI were conducted in accordance with the RI Work Plan, Field Sampling Plan (FSP), and the Quality Assurance Project Plan (QAPP), dated November 2004. The remainder of this section discusses the investigation approach and the analytical program.

1.4.1 Investigation

The focus of the RI was to further define the extent of MGP-related wastes previously identified in soil and overburden and bedrock groundwater in and around the Transit Street site. Therefore, the scope of work was developed to fill data gaps identified from previous investigations. The results of this investigation will be used to select an appropriate remedial action to address significant risks to human health and the environment.

1.4.2 Analytical Program

Table 1-9 summarizes the laboratory analytical program for this investigation. This program was developed based on the background/historical data provided by NYSEG and our general knowledge of wastes and chemicals of interest at other MGP sites (ERT and Koppers Company, 1984; GRI, 1987). The compounds detected in samples collected during prior investigations at this site included VOCs, SVOCs (primarily PAHs, including cPAHs), PCBs, phenolics, cyanides, and metals.

Severn Trent Laboratories (STL-Amherst, NY), a New York State Department of Health (NYSDOH) Environmental Laboratory Approval Program (ELAP) – certified laboratory, analyzed most of the samples collected during the RI. STL provided Analytical Services Protocol (ASP) Category B deliverables package for analytical data. In addition to the analyses listed below, select sediment, surface soil, subsurface soil, groundwater, and NAPL samples were submitted to META Environmental, Inc. (META) for expanded PAH and environmental forensics analyses to determine the likely source of contamination (i.e., petroleum versus MGP). A limited number of subsurface soil samples were also analyzed for natural oxygen demand (NOD) by Carus Chemical Company (Peru, IL).

The subsurface (soil boring) samples collected during the RI were analyzed for Target Compound List (TCL) VOCs by United States Environmental Protection Agency (USEPA) Method SW8260B; TCL SVOCs by USEPA Method SW8270C; TCL PCBs by USEPA Method SW8082; Target Analyte List (TAL) metals by USEPA Methods SW6010B/SW7471A; total cyanide by USEPA Method SW9012A; and total recoverable phenolics by USEPA Method SW9065. Some of the subsurface soil samples also were analyzed for TOC by the USEPA Region II Lloyd Kahn Method. Select soil samples were analyzed for NOD to help determine if the site is a candidate for various in-situ remedial technologies.

The surface soil samples collected during the RI were analyzed for TCL SVOCs by USEPA Method SW8270C; TCL PCBs by USEPA Method SW8082; TAL metals by USEPA Methods SW6010B/SW7471A; total cyanide by USEPA Method SW9012A; and total recoverable phenolics by USEPA Method SW9065.

The sediment samples collected during the RI were analyzed for BTEX by USEPA Method SW8260B; TCL SVOCs by USEPA Method SW8270C; TCL PCBs by USEPA Method SW8082; TAL metals by USEPA Methods SW6010B/SW7471A; total cyanide by USEPA Method SW9012A; total recoverable phenolics by USEPA Method SW9065; and TOC by the USEPA Region II Lloyd Kahn Method.

In addition to the analyses listed above, surface soil, sub-surface soil, and sediment samples in which total cyanide was detected were sent to a laboratory operated by the Clarkson University Department of Civil and Environmental Engineering, (Potsdam, NY). These samples were analyzed for free cyanide (micro-diffusion technique) and iron cyanide complexes (ion chromatography technique). Cyanides are typically found at former MGP sites. However, they are typically not highly toxic free cyanide (as HCN) or cyanide salts (e.g., CdCN, ZnCN), but rather are stable iron-cyanide complexes that have little toxicity (ERT and Koppers Company, 1984). A significant potential source of cyanide exists in the form of spent oxide chips.

Surface water samples collected during the RI were analyzed for TCL VOCs by USEPA Method SW8260B; TCL SVOCs by USEPA Method SW8270C; TCL PCBs by USEPA Method SW8082; TAL metals by USEPA Methods SW6010B/SW7470A; and total recoverable phenolics by USEPA Method 420.2.

Groundwater samples collected during the RI packer testing were analyzed for TCL VOCs by USEPA Method SW8260B; TCL SVOCs by USEPA Method SW8270C; and total lead by USEPA Method SW6010B.

Groundwater samples collected from monitoring wells during the RI were analyzed for TCL VOCs by USEPA Method SW8260B; TCL SVOCs by USEPA Method SW8270C; TCL PCBs by USEPA Method SW8082; TAL metals by USEPA Methods SW6010B/SW7470A; total cyanide by USEPA Method SW9012A; and total recoverable phenolics by USEPA Method 420.2. Samples collected from approximately fifty percent of the monitoring well locations were also analyzed for dissolved iron by USEPA Method 6010B; total dissolved solids (TDS) by USEPA Method 160.1; chloride and sulfate by USEPA Method 300.0; nitrate and nitrite by USEPA Method 353.2; total alkalinity by USEPA Method 310.1; and sulfide by USEPA Method 376.2. These parameters were used to evaluate geochemical conditions in the subsurface that may affect or indicate the degree of natural attenuation processes occurring at the site.

Natural attenuation parameters were measured both within and outside suspected plume areas in order to define differences in the parameter values between zones of suspected degradation and zones of no contamination/activity. Measurement of these parameters was required in order to demonstrate that monitored natural attenuation has the potential to be a viable remedial technology component for this site.

Many of the compounds in coal tar and other organic byproducts from manufactured gas production are biodegradable. These hydrocarbons can be oxidized to carbon dioxide. The following parameters were measured to provide indications regarding whether naturally occurring biodegradation is occurring in the groundwater:

Parameter	Reason
Oxygen	Aerobic degradation removes oxygen, reducing this parameter.
Ferrous iron	Anaerobic reduction of ferric iron creates ferrous iron.

Nitrate	Nitrate is reduced to NO^{2-}, N_20, NO, NH^{4+}, or N_2, reducing this parameter.
Sulfate	Sulfate is reduced to H_2S, reducing this parameter.

Of these parameters, all but ferrous iron is the ultimate electron acceptor of various biological metabolic mechanisms used to oxidize MGP hydrocarbon contaminants.

In contrast to hydrocarbon attenuation, chlorinated organics are degraded through reductive dechlorination. The following parameters were measured to follow anaerobic reductive dechlorination of chlorinated organics:

Parameter	Reason
Chloride	Reductive dechlorination releases chloride to the aquifer.
Oxygen	Reductive dechlorination is exclusively an anaerobic procedure.
Redox Potential	This parameter measures the degree of reducing power within the aquifer.
Ferrous Iron	Under the reducing conditions needed, ferric iron is reduced to ferrous iron.
Sulfate, Nitrate	Sulfate and nitrate are electron acceptors used under anaerobic conditions. A localized depletion of these anions compared to background suggests the occurrence of active anaerobic metabolism.

Sulfide	Sulfide, like ferrous iron, is an indicator that reducing conditions may be sufficient to promote reductive dechlorination.

Portions of the Transit Street site may be candidates for in-situ remediation using techniques such as chemical oxidation, solvent flushing, or heating. To effectively evaluate the use of these technologies, URS thoroughly described the site lithology and contaminant distribution, including dense nonaqueous-phase liquid (DNAPL) distribution. In addition to conventional site characterization sampling and analyses, additional parameters were measured to assist in the evaluation of in-situ treatment technologies. Of the three technologies considered, only chemical oxidation is a destructive technology whose effectiveness relies on the chemical properties of the aquifer. To better evaluate the predicted effectiveness of this technology, the following parameters were analyzed:

Parameter	Reason
NOD (Soils)	The NOD measures the amount of naturally occurring organic and inorganic material that would compete with the contamination for oxidation reagents. This parameter should be measured in samples taken from uncontaminated areas (but with soil and groundwater otherwise similar to the contaminated areas) in order to estimate only the naturally occurring constituents contributing to oxygen demand.
Alkalinity	Certain oxidation reagents require low pH environments to be effective. This parameter helps evaluate how feasible it would be to adjust the pH to appropriate levels.
Total Dissolved Solids	High ionic strength can reduce oxidation reaction rates. This parameter is also useful for evaluating in-situ heating through electrical conduction.

Soil vapor/air samples collected during the RI were analyzed for VOCs by USEPA Method TO-15.

NAPL/liquid waste samples collected during the RI were analyzed for TCL SVOCs by USEPA Method SW8270C; TCL PCBs by USEPA Method SW8082; VOCs and toxicity characteristic leaching procedure (TCLP) VOCs by USEPA Method 8260B; reactive cyanide and sulfide by USEPA SW-846 Chapter 7, Section 3; ignitability by USEPA Method SW1020; pH by USEPA Method 150.1; percent sulfur by American Society for Testing and Materials (ASTM) Method D129-61; specific gravity by ASTM Method 1429; and kinematic viscosity by ASTM Method D445/6. Not all samples were analyzed for all parameters.

Aqueous investigative-derived waste samples collected during the RI were analyzed for total benzene and corrosivity (pH).

1.5 Report Organization

This report contains eight sections. Remedial investigation activities are provided in Section 2.0. Section 3.0 presents the physical characteristics of the study area, which includes a discussion of the local and regional geology and hydrogeology. Section 4.0 discusses the nature and extent of the contamination. Section 5.0 discusses contaminant fate and transport. The Qualitative Human Health Exposure Assessment and Fish and Wildlife Impact Assessment are provided in Sections 6.0 and 7.0, respectively. Section 8.0 summarizes the conclusions and recommendations. Section 9.0 lists the references used in the preparation of this report.

2.0 REMEDIAL INVESTIGATION AND FIELD ACTIVITIES

URS conducted the RI field investigation at the Transit Street site during the period of January 2005 through April 2006. URS completed the following activities during the investigation:

- 31 geoprobe soil borings (GB-01 through GB-27 and GB-40 through GB-43) were advanced.

- Three surface soil samples and 47 subsurface soil samples plus quality assurance/quality control (QA/QC) samples were collected for laboratory analysis. Due to limited sample volume, one subsurface soil sample was collected for analysis of TCL VOCs only. One sample was collected for analysis of total cyanide only due to the presence of possible purifier waste material. Ten subsurface soil samples were also collected for NOD and TOC analyses.

- Ten new bedrock-monitoring wells (BMW-04-01 through BMW-04-03 and BMW-04-08 through BMW-04-14) were installed:

  - One shallow bedrock monitoring well (BMW-04-08).

  - Five intermediate bedrock monitoring wells (BMW-04-01, BMW-04-02, BMW-04-11, BMW-04-12, and BMW-04-14).

  - Four deep bedrock monitoring wells (BMW-04-03, BMW-04-09, BMW-04-10, and BMW-04-13).

- Eight bedrock monitoring well replacements (MW-01, MW-02, MW-04, MW-06, MW-09, MW-10, MW-14, and MW-15) were installed.

- Three bedrock/overburden interface wells (IW-01, IW-02, and MW-10S), and four overburden well replacements (SMW-04S/D, SMW-09, SMW-10, and SMW-11) were installed.

- Seven former monitoring wells (MW-04, MW-06, MW-14, IW-02, SMW-04S, SMW-04D, and SMW-11) were found and decommissioned.

- Packer testing was conducted during monitoring well installation at BMW-04-01, BMW-04-03, BMW-04-09, and MW-15.

- Rising head and head slug tests were conducted on the newly installed monitoring wells, except those that were packer tested and those that had insufficient water.

- Well development/redevelopment was completed at all wells (new and existing).

- 41 groundwater samples plus QA/QC samples were collected for laboratory analysis. Four wells (SMW-05, SMW-07, SMW-08, and SMW-09) could not be sampled due to insufficient volume/dryness.

- A sediment probing and sampling program was completed in the New York State Barge Canal, which included the establishment of 21 sediment profile transects (TS-01 through TS-21) and the collection and analysis of approximately 53 sediment samples.

- NAPL collection and sampling was performed in monitoring wells that produced NAPL.

- A physical inspection and qualitative investigation of the Main Interceptor Sewer Tunnel was performed.

- Indoor air samples were collected from two residences and soil vapor samples were collected from three soil vapor implants installed along the southern property line of the NYSEG Substation.

- Nine bedrock monitoring wells were converted from open rock holes to standard wells by installing PVC screen and riser, sand, and bentonite, to reduce the open hole intervals and establish usable well pairs.

Each field activity is described in more detail in the sub-sections presented below.

2.1 Geoprobe® Soil Borings and Subsurface Soil Sampling

As part of the RI, 31 Geoprobe® soil borings were completed at the Transit Street site at the locations shown on Figure 2-1. The Geoprobe® borings were conducted by Geologic NY, Inc., of Homer, New York. The rationale for the boring locations is summarized in Table 2-1. Subsurface soil samples were collected continuously using 2–inch-diameter, 4-foot-long, MacroCore discrete samplers using a direct push (Geoprobe®) drill rig. The length of sample recovery, percent recovery, soil description, and screening results were recorded by a geologist on the boring logs (Appendix A).

All borings were advanced until refusal was encountered. Five borings, GB-01 through GB-03, GB-40, and GB-41, were advanced west of the site, across Transit Street. Eight borings, GB-09 through GB-16, were advanced within the NYSEG electrical substation, targeting the areas near former MGP structures as indicated on Table 2-1 and depicted on Figure 2-1. Five borings, GB-04 through GB-08, were advanced adjacent to and north of the site, along the south side of LaGrange Street. Thirteen borings, GB-17 through GB-27, GB-42 and GB-43, were advanced on Reid Petroleum's property and its adjacent right of way, north of the site, to further investigate site-related impacts observed during previous excavation work at the property. Contractors discovered MGP-impacted soils during construction activities to replace USTs on the Reid Petroleum property.

Subsurface soil samples were collected from the Geoprobe® soil borings for laboratory analysis. Up to two soil samples were selected from most of the borings. Generally, one sample was collected from the zone exhibiting the highest photoionization detector (PID) reading or visual and olfactory signs of contamination, whereas the other sample was collected from below the lowest observed zone of contamination or the bottom of the boring. If the PID or visual examination indicated no contamination, then only the bottom of boring sample was collected for analysis. Following completion, the borings were backfilled with bentonite pellets.

A total of 57 subsurface soil samples were collected. The samples plus applicable QA/QC samples were analyzed for some or all of the following analyses:

- TCL VOCs
- TCL SVOCs
- TCL PCBs
- total recoverable phenolics
- TAL metals
- total cyanide
- extended PAH profiles (i.e., typical 8270 PAHs plus additional derivative PAHs)
- TOC
- NOD

Table 2-2 summarizes the analyses performed on each sample collected. In general, samples for extended PAH, TOC, and NOD analyses were collected from the same depth interval as the other analyses; however, at several locations low sample recoveries necessitated collecting the samples from a slightly different interval. Due to low recovery, the sample from GB-18 (6.5 to 7.0 feet) was analyzed for TCL VOCs and extended PAHs only. Due to the presence of woodchips, the sample from GB-10 (6.0 to 6.2 feet) was analyzed for total cyanide only.

2.2 Surface Soil Sampling

Using stainless-steel trowels, three surface soil samples (SS-07 through SS-09) were collected from zero to two inches below the root layer during the investigation. Because the site is covered by concrete, asphalt, and gravel, the surface soil samples were collected from the grass meridian in the right-of-way adjacent to the site, along Transit Street and LaGrange Street. Table 2-1 summarizes the rationale for the sampling locations. Each of the surface soil samples was analyzed in the laboratory for TCL SVOCs, TCL PCBs, metals, total recoverable phenolics, and total cyanide.

2.3 Installation of Groundwater Monitoring Wells

Four overburden, three overburden/bedrock interface, and 18 bedrock groundwater monitoring wells were installed during the RI to replace or supplement previously existing groundwater monitoring wells at the site. All existing monitoring well locations are shown on Figure 2-2. At the first borehole advanced at each cluster, continuous split-spoon samples were collected through the overburden, described by a field geologist, visually inspected for the presence of NAPLs and screened with a PID for VOCs. The overburden soils were characterized according to the Unified Soil Classification System (USCS). The percent recovery, soil description, rock description, rock quality designation (RQD), depth of fractures, and other pertinent information were recorded on the boring log for each well (Appendix A).

2.3.1 Overburden Monitoring Wells

Four overburden groundwater monitoring wells were installed to replace previously existing wells that were either determined to be unusable or not found during this investigation. The overburden monitoring wells were drilled by either advancing a 6-inch-diameter air hammer and temporary casing or 4¼-inch hollow stem augers through the overburden until bedrock was encountered. The driller then installed a 2-inch inside diameter (ID) Schedule 40 polyvinyl chloride (PVC) screen and riser through the casing or augers, back-filled with appropriate amounts of sand and bentonite while removing the casing or augers, and grouted the riser to grade. Flush-mount road boxes were later installed. Well construction details are included in Appendix B.

2.3.2 Overburden/Bedrock Interface Monitoring Wells

Three overburden/bedrock interface monitoring wells (IW-1, IW-2, and MW-10S) were installed during the RI. IW-1 and IW-2 replaced previously existing wells IW-1 and IW2, respectively. The original IW-1 could not be located, and the original IW-2 was determined to be unusable. MW-10S is a new overburden/bedrock interface monitoring well that was installed based on observations of NAPL in the shallow bedrock during bedrock casing installation for replacement bedrock well MW-10.

The overburden/bedrock interface monitoring wells were drilled by advancing a 6-inch-diameter air hammer and temporary casing through the overburden until bedrock was encountered and continuing approximately 3 to 4 feet into the upper portion of bedrock. The driller installed 2-inch ID Schedule 40 PVC screen with a one-foot sump and riser through the casing or augers, back-filled with appropriate amounts of sand and bentonite while removing the casing, and grouted the riser to grade. The screens were 5 to 10 feet in length and therefore straddled the overburden bedrock interface. Flush-mount road boxes were later installed. Well construction details are included in Appendix B.

2.3.3 Bedrock Monitoring Wells

Bedrock monitoring wells (new locations and replacement wells) were installed to evaluate bedrock groundwater flow patterns and assess bedrock groundwater quality data. The wells were installed to various depths to monitor discrete bedrock intervals (i.e., shallow bedrock zone – Gasport/DeCew Members, intermediate bedrock zone – Burleigh Hill Member, and deep bedrock zone – Lewiston Member). Monitoring wells in the shallow and intermediate bedrock already existed on site from previous investigations, deep bedrock monitoring wells were installed during this investigation to determine the vertical extent of contamination, and additional shallow and intermediate wells were installed to delineate horizontal migration in these zones and determine vertical hydraulic gradients. The bedrock monitoring wells were drilled by advancing a 6-inch-diameter air hammer and temporary casing through the overburden until bedrock was encountered. The driller re-tooled the drill rig and cored the upper 5 feet of bedrock with an HQ core barrel (2.5-inch nominal core diameter and 3.8-inch nominal hole diameter). The core hole was then reamed to a nominal 6-inch-diameter using the 6-inch-diameter air hammer to create a rock-socket. A nominal 4-inch-diameter steel casing was lowered into the rock-socket and grouted in place. After the grout was allowed to cure for at least 24 hours, bedrock was continuously cored through the casing with an HQ core barrel to the desired total depth.

Packer testing was conducted during coring of the bedrock at BMW-04-01, BMW-04-03, BMW-04-09, and MW-15 to gather information regarding water yield, hydraulic properties of the bedrock, and the presence or absence of NAPL. After each boring was completed, a dual packer system with a dedicated PVC well screen was used to seal off approximately 15 feet of borehole per test. A data logger and pump were installed in the packed off zone. Water from the packed off zone was pumped from the well and then the well was allowed to recover while results were recorded. Discharge water was visually inspected for the presence/absence of NAPL and observations were recorded on the boring logs (Appendix A). Samples of the discharge water were submitted for analysis of TCL VOCs, TCL SVOCs, and total lead. All bedrock groundwater monitors were initially left as open rock holes with 4-inch steel risers. Flush-mount road boxes were later installed, except at MW-02, which was completed as a stick-up well. Well construction diagrams are included in Appendix B.

The road boxes or stick-up protective casings were replaced at all existing monitoring wells and lockable j-plugs with keyed alike locks were installed.

2.4 Well Development

After a minimum of 24 hours following installation, and in accordance with the FSP, the wells were developed using surging and pumping methods to remove fine-grained sediments from the borehole and improve the hydraulic communication between the well and the surrounding aquifer. Development continued until water was visibly free of suspended sediments. Development water was containerized in 55-gallon drums and transferred to temporary storage tanks for later off-site disposal. Well Development logs have been included as Appendix C.

2.5 Slug Testing

Slug testing was conducted in each installed monitoring well (with the exception of those which were packer tested) to estimate the horizontal hydraulic conductivity of the overburden and bedrock. Falling head tests were performed by recording the initial water level in the well, lowering a pressure transducer/datalogger into the well, inserting a decontaminated slug to raise the water level in the well, and recording the water level over time until it returned to the original static level. Rising-head tests were performed immediately following completion of the falling head test. With the slug already in the water column, the static water level was recorded; the slug was then removed, and water level readings were taken as the water level gradually returned to static condition. Test data and results are contained in Appendix D.

2.6 Surface Water and Sediment Investigation

The investigation activities surface water and sediment consisted of two phases, the qualitative investigation and the quantitative investigation, which are discussed in the following sections.

2.6.1 Qualitative Investigation

Between January 11 and 17, 2005, 14 transects (TS-01 through TS-14) were established within the New York State Barge Canal. Each transect is a perpendicular line established across the New York State Barge Canal along which sediments were characterized. Transects are identified from west to east beginning with TS-01 (west of the High Street Bridge) and continuing to TS-14 (east of the New York State Barge Canal locks). Their respective locations are shown on Figure 2-3. There is a distance of approximately 2,700 feet between TS-01 and TS-13 with an average spacing between individual transects of approximately 225 feet. There is an approximate distance of 1,270 feet between TS-13 and TS-14 and, therefore, approximately 3,970 feet between TS-01 and TS-14. Between TS-13 and TS-14 is New York State Barge Canal locks and a spillway, which prevented access in that interval.

The investigation was performed while the New York State Barge Canal water level was low. The New York State Barge Canal Corporation allows the New York State Barge Canal to drain during the winter months because there is no boating traffic, which allows them to perform maintenance on the locks and canal banks. During this period, there was still water flowing in the canal with depths of typically less than 2 feet; however, the water was greater than four feet deep in some areas of the canal and other areas where the sediments were not submerged. Since the majority of the study area had shallow water depths, the investigation was conducted on foot using chest-high waders and a boat to transport materials.

In general, sediment thickness was measured at 10-foot intervals along each transect using a ½-inch-diameter steel probe approximately 7 feet long. The probe was physically pushed until refusal was encountered and the depth from the top of the sediment was recorded. At each of the probing positions, sediment cores (up to approximately 4 feet in length) also were obtained using the type of 2-inch-diameter by 4-foot-long acetate liners that are typically used as liners in a Geoprobe® macrocore sampler. The liners were physically pushed into the sediment until refusal was obtained. The recovered cores were visually inspected and described. Sediment thickness and texture, visual observations including the presence and/or absence of sheens/odors, potential MGP-related and non-MGP-related sources of contamination, and water depth were recorded. The sediment cores also were screened using a MiniRAE PID to determine if any VOCs were present.

Four additional locations (BA-01 through BA-04) at the front of the old lock spillway (see Figure 2-3) were sampled using a bucket auger to evaluate sediment build up in this area. The auger was advanced in 0.5-foot increments until refusal was encountered. Samples were bagged in 0.5-foot intervals and later screened for headspace using a PID.

Additional sediment samples were collected using a bucket auger at the foot of the rock talus slope on the north side of the New York State Barge Canal at TS-11 and TS-12, and the south side of the New York State Barge Canal at TS-05 through TS-10 (labeled as BA-05 through BA-12 on Figure 2-3). Samples were collected at discrete one-foot depth intervals, placed in sealable plastic bags, allowed to warm up and screened for headspace with a PID. The objective of the qualitative investigation was to characterize the sediment in order to develop a quantitative investigation plan to narrow the focus for sampling. Therefore, no sediment samples collected during the qualitative investigation were retained for laboratory analysis.

2.6.2 Quantitative Investigation

Subsequent to the qualitative investigation and discussions with the NYSDEC, a letter was submitted to the Department on March 15, 2005 summarizing the findings of the investigation and presenting a proposed Sampling Plan for the quantitative investigation. The original Sampling Plan proposed the collection of 15 sediment samples and 7 surface water samples for laboratory analysis, with 5 of the sediment samples being sent for additional forensic analysis.

The NYSDEC responded with comments on April 5, 2005. In general, the NYSDEC requested, and URS/NYSEG agreed, that the following be conducted:

- Seven additional transects (TS-15 through TS-21),
- Additional sediment samples for forensic analyses,
- Additional sediment sampling locations,
- Vertical profiling at sediment sample locations, and
- Additional samples (at depth) in areas where sediment thickness exceeded two feet.

URS addressed the NYSDEC comments and submitted a revised Qualitative Assessment Summary and Sampling Plan to the NYSDEC on April 8, 2005. The various parts of the quantitative investigation are discussed below.

Additional Transects

Between April 9 and April 12, 2005, transects TS-15 through TS-17 were established between TS-12 and TS-13, beneath the “Big Bridge”. The “Big Bridge” is the approximately 400-foot-wide bridge that conveys West Main Street/Route 31 across the New York State Barge Canal. Transects TS-18 through TS-20 were established downstream from the New York State Barge Canal locks. TS-21 was established between TS-10 and TS-11 in the vicinity of observed

DNAPL stains in the south bedrock cut of the New York State Barge Canal. The DNAPL stains indicate that seeps occurred in the past. During the RI however, DNAPL was not observed to be actively seeping into the canal. Transect locations are presented on Figure 2-3. Sediment thickness was measured, and samples were collected and characterized along each new transect using the same procedures as had been used during the Qualitative Investigation.

Sediment Samples

Bucket augers were used to collect sediment samples from 36 separate locations (SED-01 through SED-36) as shown on Figures 2-3 and Figure 2-4. One sample (typically 0 to 1 foot in depth) was collected from the upper portion of the sediments at each location. If the sediments were thicker than two feet, an additional sample was collected from the sediment/bedrock interface (the New York State Barge Canal is excavated into rock in the study area). At several locations, where the sediment thickness was greater than three feet, an additional intermediate sample was collected between the “surface” and “top of bedrock samples”. The intermediate samples were submitted to the lab, but were held pending the results of the upper and lower samples. The sampling procedures indicated that the intermediate samples were to be analyzed if there were significant differences in analytical concentrations between the upper and lower samples. However, in as much as no significant differences were noted, the intermediate samples were never analyzed.

A total of 62 sediment samples were collected. Of these, 53 were submitted to STL and analyzed for BTEX, TCL SVOCs, PCBs, TAL metals, total phenols, total cyanide, and total organic carbon. Seven additional samples were submitted to STL and held, but never analyzed as discussed above. Sixty-two samples also were sent to META for forensic analyses and extended PAH profiles; 17 were actually analyzed, and the remaining 45 were held in cold storage but never analyzed because it was determined that the 17 analyzed samples provided sufficient information to perform a forensic analysis of the New York State Barge Canal sediments. The samples sent to META were collected from the same locations/depths as those sent to STL with the exception of two samples (VPSS-1, 1-1 foot, and VPSS-1, 1-2 feet), which were collected from a vertical profile location on the south side of the New York State Barge Canal on Transect TS-01 (see Figure 2-3). Table 2-3 summarizes the sediment samples collected, sediment characteristics, and analyses. PID readings were collected from the headspace of the sampling jars prior to sample shipment, at the end of each sampling day, and are also included on Table 2-3.

Surface Water Samples

Ten surface water samples were collected from the New York State Barge Canal at the locations shown on Figure 2-5. The samples were submitted to STL for analysis of TCL VOCs, TCL SVOCs, total phenols, TAL metals, and PCBs.

2.7 Hydraulic Monitoring and NAPL Observations

Several rounds of groundwater levels were collected and used to develop groundwater contour elevation maps during the investigation so that groundwater flow directions could be determined. All area wells were checked for depth to groundwater and thickness of accumulated NAPL, if any. Water levels were determined using an electronic water level indicator. NAPL was checked for using a weighted string. Results are discussed in Sections 3.0 and 4.0 and groundwater potentiometric surface maps are presented as Figures 3-11 through 3-26.

Samples of DNAPL were collected from bedrock monitoring wells at locations BMW-04-11 (on April 4, 2005 and June 14, 2005) and MW-02 (June 14, 2005) and sent to META for environmental forensic analyses, which included petroleum fingerprint and expanded PAH analyses. The April 2005 sample from BMW-04-11 was also analyzed for VOCs, TCLP VOCs, reactive cyanide and sulfide, ignitability, pH, percent sulfur, specific gravity, and kinematic viscosity. The June 2005 samples were also sent to STL for analysis of TCL SVOCs and PCBs.

2.8 Groundwater Sampling

All wells were purged and sampled in accordance with USEPA-approved low flow sampling guidelines. A Geopump 2 peristaltic pump or Grundfos Redi-flo 2 submersible pump was used at each well. The intake of the tubing or pump was set at the midpoint of the water column. The purging rates were maintained at a rate sufficient to prevent drawdown in excess of ten percent of the standing water column.

During purging, field personnel monitored temperature, pH, specific conductivity, dissolved oxygen (DO), oxidation-reduction potential (ORP), and turbidity using a multi-parameter meter connected to an in-line flow-through cell. A water level reading was collected in conjunction with water quality parameters. Water quality parameters were recorded at intervals of five minutes or less during purging. Samples were collected once parameters had stabilized over three recording intervals. The following criteria were used to determine if parameters were stable:

- pH within 0.10 SU
- Specific Conductivity within 3%
- DO within 10%
- Turbidity within 10%
- ORP within 10 millivolts (mV)

In addition, field personnel measured the concentration of ferrous iron present in the groundwater at several monitoring wells using a field ferrous iron test kit. The aliquot analyzed for ferrous iron was collected after the physiochemical parameters had stabilized. Ferrous iron measurements are recorded on the groundwater sampling data sheets included in Appendix E. All water quality instruments were calibrated according to manufacturers' specifications on a daily basis.

At all wells, groundwater sampling commenced immediately after purging without turning the pump off. The discharge tubing was disconnected or cut off from the flow-through cell prior to sampling to minimize cross-contamination. Containers used for TCL VOC analysis were filled first. Subsequently, the remaining sampling containers were filled in the following order: TCL SVOCs, total recoverable phenolics, cyanide, total TAL metals, and, if applicable, alkalinity, chloride, nitrite/nitrate, sulfate/sulfide, dissolved iron, total dissolved solids, and extended PAHs/fingerprint analyses (performed by META). The samples for dissolved iron analysis were field-filtered using a 0.45-micron (µm) in-line disposable filter.

The sample containers were wiped dry and properly labeled. The sample number, date, time, location, depth, type of analysis, preservative and sample collector's name was recorded on the sample labels and purge logs.

The samples were placed in coolers with sufficient bagged ice or ice packs to maintain a temperature of 4 degrees Celsius, or less, during shipment. Quality assurance samples, including duplicates, equipment rinsate blanks, and trip blanks, were collected as necessary in accordance with the procedures outlined in the site QAPP. All data relating to weather conditions, time of collection, sampling method, field observation, sample location, and analysis were recorded on the well purge log and/or in a field notebook. Copies of the well purge logs are provided in Appendix E.

2.9 Retrofitting of Bedrock Monitoring Wells

As discussed in Section 2.3, all bedrock groundwater monitors were initially constructed as open rock holes with 4-inch-diameter steel risers. Bedrock monitoring wells with open hole intervals longer than 30 feet in length were evaluated to determine if they needed to be retrofitted. After review of the groundwater sampling results and information collected during well installation, recommendations were made to retrofit several wells to effectively create shorter screened intervals to:

- Provide vertical hydraulic gradient data at well clusters,
- Minimize migration of dissolved phase contamination, and
- Limit the dilution of groundwater analytical results by collecting samples over shorter intervals.

Thirteen wells with long open hole intervals were evaluated. Nine of the bedrock groundwater monitoring wells were retrofitted based on the rationales presented on Table 2-4. Wells BMW-04-02 and BMW-04-03 were retrofitted because they were installed adjacent to and had overlapping open hole intervals with other wells; they were modified to make useable well pairs. Wells BMW-04-01, BMW-04-09, MW-02, MW-04, MW-09, MW-14 and, MW-15 were retrofitted primarily to decrease the open hole intervals, thereby reducing dilution from more transmissive bedrock zones, and minimizing potential cross-contamination between zones. MW-13, MW-18, and MW-19 were evaluated but not modified because they appear to be on the fringe of dissolved phase bedrock contamination. MW-03 was evaluated because its open hole overlaps a nearby well. However, DNAPL accumulates in the well with the existing construction and the potential for DNAPL recovery was determined to be important; therefore, the well was not retrofitted. The final construction details are reflected on the Well Construction Diagrams included in Appendix B.

2.10 Lockport Main Interceptor Tunnel Inspection

On October 3 and 4, 2005, URS performed a detailed inspection of the Main Interceptor Tunnel. During both days the following personnel were present:

- Steve Moeller – URS, Confined Space Entry Supervisor
- Andy Brayman – URS, Confined Space Entry Attendant
- Scott McCabe – URS, Confined Space Entrant
- Rob Murphy – URS, Confined Space Entrant
- Paul Lemley – City of Lockport Engineering Department, Observer
- Michael Seeloff – City of Lockport Fire Department Confined Space Rescue Team
- Joseph Prica – City of Lockport Fire Department Confined Space Rescue Team
- Michael Collette – City of Lockport Fire Department Confined Space Rescue Team

- Peter Richardson – City of Lockport Fire Department Confined Space Rescue Team
- Craig Butler – City of Lockport Fire Department Confined Space Rescue Team
- Kevin Pratt – City of Lockport Fire Department Confined Space Rescue Team
- Comet Flasher - Traffic Control Contractor

Comet Flasher closed off the easternmost southbound lane in South Transit Street each day. City of Lockport Fire Department Personnel were on site and ready to perform an emergency rescue if needed. Scott McCabe and Rob Murphy donned Level B personal protective equipment (PPE) and were lowered down the entrance shaft to the tunnel floor, which is approximately 72 feet below street level. There was approximately 1-2 feet of moving water throughout most of the tunnel.

During the first day, URS performed a rapid inspection of the tunnel by walking approximately 300 feet in each direction from the shaft entrance. This was done primarily to determine the general overall condition and safety of the tunnel for a planned more detailed inspection the following day. The second day, distances along the tunnel were measured off in 100-foot increments. URS inspected the tunnel from the entrance point to approximately 400 feet to the north and 600 feet to the south (Figure 2-6). The inspection was performed to determine if there were any potential MGP-related leaks or seeps of NAPL or other MGP residue impacting/migrating into the tunnel. Further distances were not obtained due to limitations on time (i.e., wearing self-contained breathing apparatus [SCBA] with 60-minute tanks) and radio communications (i.e., changes in tunnel direction limited radio communications to approximately 250 feet in each direction). URS recorded the entire section of the tunnel inspected on videotape. Selected representative photographs taken during the inspection are included in Appendix F.

2.11 <u>Soil Vapor Intrusion Investigation</u>

In March 2006, URS conducted a soil vapor intrusion investigation to:

- Determine if soil and groundwater contamination in the vicinity of the Transit Street Substation is resulting in the presence of indoor air contamination via vapor intrusion, and

- Determine to the extent practical, the nature and degree of soil gas contamination in the vicinity of the Transit Street Substation.

The study was initially developed to include sampling at five nearby residences. These area residences were selected by the NYSDEC, NYSDOH, and NYSEG based on proximity to the site. The study was to include sampling of indoor air, outdoor air and soil vapor at each of the residences to evaluate the potential exposure to site-related contaminants. However, access agreements could not be obtained from two of the homeowners (both south of the site), resulting in a revised proposal to sample the three residences north of the site, and collect sub-slab and soil vapor samples from the southern portion of the substation to evaluate whether soil vapor has been impacted in this area and, hence, potentially impacted residences south of the site. Also, during the investigation, access could not be obtained (during the winter heating months) at one of the three residences north of the site. Sample locations are shown on Figure 4-49 and the results are discussed in Section 4.0.

Samples were collected at two residences. One residence is a foreclosed property and is currently vacant; consequently, only a sub-slab soil vapor sample was collected there. For the other residence, the indoor air investigation program included the following: (1) an interview with the homeowner using air quality questionnaires developed by the NYSDOH; (2) a survey of household chemicals present and an evaluation of their potential to affect air sample results; (3) collection of one air sample from the breathing zone of the first floor and one air sample from the breathing zone of the basement area; (4) collection of one vapor sample from beneath the basement concrete slab; and (5) collection of an outdoor ambient air sample from an upwind location. Outdoor ambient air samples were collected from upwind locations central to the points sampled each day, at a rate of one per day of sampling, per sampling area. Two soil vapor points were installed and sampled along the southern fenceline of the site, near one of the residences south of the site. In addition, one sub-slab sample was collected from NYSEG’s maintenance warehouse building, which is also adjacent to one of the residences south of the site. As discussed above, these three locations were positioned and sampled because access agreements could not be obtained from the two residences south of the site.

All samples were collected using six-liter Summa® canisters equipped with flow regulators that were batch certified clean by the laboratory prior to re-use. The sample canisters were deployed after completion of the pre-sampling survey and were retrieved approximately 24 hours later. The samples were analyzed following USEPA Compendium Method TO-15 for VOCs, including the following n-alkane compounds: n-heptane, n-hexane, n-octane, n-pentane, n-decane, n-dodecane, n-undecane, n-nonane, and n-butane. In addition, the following compounds were searched for by the lab as tentatively identified compounds (TICs): butylcyclohexane, indane, indene, isopentane, 1,2,3-trimethylbenzene, 2,2,4-trimethylpentane, 2,3-dimethylheptane, and 2,3-dimethylpentane. Method TO-15 analyses were performed by STL-Knoxville, TN.

The completed air quality questionnaires developed by the NYSDOH and household inventories are included in Appendix G, along with the Summa Canister Sampling Field Data Sheets.

3.0 PHYSICAL CHARACTERISTICS OF THE STUDY AREA

This section discusses the physical characteristics of the study area including: surface features, groundwater use, demography and land use, soil, surface water hydrology, and geology and hydrogeology.

3.1 Surface Features

The site is situated in the City of Lockport, Niagara County, New York. The City of Lockport straddles the Niagara Escarpment, a north-facing feature supported by resistant rocks of the Lockport Group, and is bisected by the New York State Barge Canal (i.e., canal). The canal is an excavated channel, which cuts through the Niagara Escarpment in a northeast trending direction. The site lies approximately 200 feet east of the canal on a gently sloping parcel, bounded on the west by Transit Street, on the north by LaGrange Street, on the east by Saxton Street, and on the south by residential homes. Site topography today is likely similar to what it was when the MGP was present.

Current surface topography slopes gently from approximately 607 feet above mean sea level (amsl) on the eastern portion of the site to approximately 600 feet amsl at the site's western boundary along Transit Street; there is also a slight northerly dip to the surface topography. There are several small berms at the site that were installed as part of an emergency spill collection system designed to contain transformer oil in case of a release. North and west of the site, the topography also dips gently to the northwest. West of Transit Street and north of State Road the topography dips steeply to the northwest to approximately 575 feet amsl, were there is a large concrete pad adjacent to the canal. Due north of the site, on the north side of Genesee Street, the elevation adjacent to the canal is approximately 594 feet amsl. The canal itself has nearly vertical walls, and the bottom of the canal is floored in the Burleigh Hill Member of the Rochester Shale Formation at approximately 550 feet amsl.

The majority of the concrete pad associated with the former gasholder on the eastern half of the site is visible at the ground surface. There is a 65-by-25 foot warehouse building in the southeastern corner of the property, a substation grid/buss work occupies the central and western portion of the property, and small 25-by-25-foot substation control building lies at the property's northwest corner. The entire Transit Street property is enclosed by a locked 8-foot-high chainlink fence with access gates. There are two large gates for vehicular traffic, one at the southwest corner on Transit Street and the other at the northeast corner on LaGrange Street. There are also two small man gates adjacent to the large vehicle gate at the northeast corner, and the other at the northwest corner on the LaGrange Street side.

3.2 Area Groundwater Use

Several wells were identified within 3.11 miles of the site. The majority of these wells are part of an observation well network for the United States Geological Survey (USGS) Niagara Project (AES 1991). The remainder are water supply wells used for domestic or livestock purposes. There are no wells within a 1-mile radius of the site. The closest well to the site is located approximately 1.86 miles southeast and is used for domestic purposes. The primary source of drinking water for the City of Lockport is the East Branch of the Niagara River, which is located approximately 13 miles to the west. It is pumped from the river to the City of Lockport Water Treatment Plant where it is treated prior to distribution.

3.3 Demography and Land Use

The population of the City of Lockport is 22,279 according to the 2000 Census. The site is located in a mixed commercial/residential area in the southwest section of Lockport and is currently used by NYSEG for an electrical substation. Two residences are located directly adjacent to the site along its southern border, a church is located east of the site on the other side of Saxton Street, and in the next block north of the site there are three residences and a gas station (Figure 1-2). The site consists primarily of open gravel-covered land with permanent structures consisting of an electrical substation grid, a warehouse, and a substation control building.

3.4 Soil

The United States Department of Agriculture Soil Conservation Service (USDA-SCS) did not map the soils at the site, but they would likely have been listed as Cut and Fill Land (i.e., areas that have had the original soil stripped and removed or covered with soil materials to a depth of 3 feet or more). Soils in the vicinity are mapped as the Hilton and Cayuga Silt Loam, limestone substratum. The Hilton soils are moderately drained, medium-textured soils developed from calcareous glacial till. The Cayuga soils are moderately well-drained, medium-textured soils developed in glacio-lacustrine silts and clays. The permeability of the soils is reported to range from less than 0.63 to 2.0 inches per hour (USDA-SCS 1972).

The site is underlain by fill materials and reworked native soils. Thickness of overburden at the site ranges from approximately 10 feet along Transit Street to 20 feet in the eastern portion of the site. Southeast of the site, at the upgradient off-site SMW-01S and SMW-01D well cluster, the overburden is 51 feet thick. North of the site, adjacent to the New York State Barge Canal, the overburden is approximately 8 feet thick. Fill materials typically were characterized as brown to red brown, silt, clayey silt, and silty clay, with varying amounts of coal fragments, degraded concrete, and brick fragments, that ranged from 3 to 11 feet thick. Native soils, consisting of red brown silty fine sand with some coarse gravel, only were encountered in approximately two-thirds of the soil borings advanced during the present investigation. No native soils were encountered beneath much of the Reid Petroleum property, or beneath much of the western side of Transit Street.

3.5 Surface Water Hydrology

The site slopes slightly to the west and north and is surrounded by streets on three of its four sides. One former storm water drain was observed on the site property, set in the large concrete pad of the former gasholder. NYSEG personnel did not know its function or if it was connected to anything. There are no storm water drop inlets on LaGrange Street, but there are several along Transit Street. The nearest surface water body is the New York State Barge Canal located approximately 200 feet northwest of the site. The New York State Barge Canal is classified as a Class C surface water body by the NYSDEC. Class C surface water can be used for irrigation, food preparation, fishing, or primary and secondary contact recreation. Water is not withdrawn from the New York State Barge Canal for potable use. Numerous storm water drains from surrounding roadways and permitted Spill Discharge Elimination System (SPDES) outfalls discharge into the New York State Barge Canal.

Throughout the RI, some small scale ponding (i.e., one to two inches deep) was observed during wet periods at the northeast corner of the site. Water collects on top of the impermeable concrete pad of the former gasholder.

3.5.1 Site Drainage and Utilities

Utilities on and near the site include underground water, natural gas, sanitary and storm sewer, electric, and overhead electric and telephone. Underground water and sewer lines run west-east in Transit Street and Saxton Street; there are no water or sewer lines in LaGrange Street. There is underground electric along Transit Street, along LaGrange Street, and within the substation. Underground gas lines are present along Transit Street, LaGrange Street, and Saxton Street.

Site drainage features include the previously mentioned storm drain present in the former gasholder pad on the eastern portion of the site. It is unknown if, and where, this drain discharges. Site surface drainage may also be impacted by the berms that are part of the on-site emergency spill collection system. It appears that, during heavy rains, water generally follows site topography via sheet flow. The general absence of ponding indicates that water that does not flow off the site enters the permeable surface gravel.

3.5.1.1 Main Interceptor Tunnel

The main interceptor tunnel also runs adjacent to the west side of the site with an access shaft located in Transit Street near LaGrange Street. The tunnel is used to convey sanitary sewer water and storm water to the City wastewater treatment plant. The shaft and tunnel was inspected during the RI (Section 2.10). The shaft was unlined, allowing for groundwater flow down to the tunnel floor, which is approximately 72 feet below street level. The tunnel is gunite lined and observed to be in reasonably good condition, with the exception of three or four areas approximately 10 to 20 feet long, which had significant amounts of spalling primarily from the tunnel ceiling. There were approximately 1-2 feet of moving water throughout most of the tunnel. Observations of MGP impacts will be discussed in Section 4.0.

3.6 Geology and Hydrogeology

The geology and hydrogeology of the site and the immediate vicinity were investigated as part of the RI. Information obtained from previous investigations and various literature sources were used to help characterize the site geology and hydrogeology. The following subsections summarize the regional and site-specific geology and hydrogeology.

3.6.1 Regional Geology

The site lies in the Erie-Ontario Lowlands physiographic province of New York State, which is characterized by low plains with little relief (Broughton, et al., 1966). Glacial deposition and shoreline deposits have modified the topography of the province.

Regionally, the site lies on relatively flat, poorly drained lowland, termed the Tonawanda Plain. This area is located between two east-west trending, north cliff-facing escarpments, with the Niagara Escarpment to the north. The Niagara Escarpment, a major physiographic feature in Western New York, is underlain by the Lockport Dolomite, and is about 0.5 miles north of the site. Regionally, the rock dips to the south at approximately 40 feet per mile.

3.6.2 Site Geology

Glacial till and glacial-fluvial deposits underlie some portions of the Transit Street site. Site topography has been altered by excavation and fill placement. Tables 3-1 and 3-2 summarize the boring information and observations made during the RI. The soil and rock units penetrated are described below.

3.6.2.1 Overburden

As depicted on Figure 3-1, the thickness of overburden nearby the site ranges from approximately 1.2 to 51 feet.

- At the Transit Street Site, the overburden ranges from approximately 19 feet thick at the eastern end of the property to 10.7 feet thick at the western end of the property. The overburden generally consisted of 3 to 11 feet of brown to red brown, silty sand and clayey silts, with various amounts of gravel, slag, coal, wood, concrete, and possible purifier waste, i.e., wood chips (Fill). Beneath the fill material was red brown silty fine sand with varying amounts of gravel. Soil material became denser (Till) near the top of rock and boulders were encountered beneath much of the eastern end of the site. Shallow soils were typically moist and became saturated between six and nine feet bgs.

- Along the south side of LaGrange Street, the fill materials ranged from 7 to 11 feet thick, and were similar to those observed onsite, with the addition of wood chips observed in GB-04 and GB-05. The wood chips were red in color and did not develop a Prussian blue color after exposure to air, as would be typical of purifier waste. Beneath the fill, native materials consisted of red brown silty fine sand with varying amounts of gravel.

- On and adjacent to Reid's Petroleum property, the overburden consisted primarily of fill materials to top of rock (at 7 to 9.8 feet), except for along the eastern and southern property boundaries where native materials were observed overlying bedrock. Fill was predominantly red brown silty fine sand with a thick gravel and cobble layer encountered at depths from 2 to 6 feet in most borings. Wood chips were observed in the fill at GB-23, GB-26, and GB-43, which were similar to those observed elsewhere in the study area in color and texture. As was the case elsewhere, they did not develop the Prussian blue color typical of purifier waste upon exposure to air.

- Along the west side of Transit Street, across from the Transit Street site, overburden consisted of fill materials ranging in thickness from 5 feet to 10.8 feet, which contained brown, red brown, and gray brown, silt and clayey silt, with various amounts of sand, gravel, concrete, coal, and degraded concrete. Depth to bedrock could not be confirmed in this area and may not have been reached due to consistent refusals between 9.4 and 11.0 feet. It is unknown exactly what caused the refusals, but they may have been due to boulders. SMW-05 in the street nearby was reportedly advanced to 18.5 feet prior to encountering bedrock. Beneath the fill in borings GB-02 and GB-03, native materials consisting of red brown silty fine sand and varying amounts of coarse sand and gravel were observed.

3.6.2.2 Bedrock

The underlying bedrock at the site is flat-lying dolomite and shale of Silurian age. Rock unit descriptions and nomenclature used below are from Brett, et al., 1995, and have been modified based on site-specific conditions. A top of bedrock elevation map is presented as Figure 3-2. Several site cross-section transect line locations are indicated on Figure 3-3, and cross-sections are presented on Figures 3-4 to 3-8.

Gasport Dolomite - Gothic Hill Member

The Gothic Hill Member of the Gasport Dolomite of the Lockport Group is the uppermost bedrock unit observed beneath the site. It consists of thick- to massive-bedded, coarse-grained, dark olive-gray to light-pink dolomitic limestone that weathers to a light olive-gray. It generally contains abundant fragments of fossilized crinoid stems and corals. Laminations and cross bedding are generally common within the unit. The Gasport Dolomite ranges from not present (i.e., excavated away) to 17.3 feet thick at the site. A sharp contact separates the Gasport Member from the underlying DeCew Member of the Clinton Group.

DeCew Dolomite

The DeCew Dolomite consists of variably bedded, dark-gray to olive-gray, argillaceous to sandy, fine-grained dolomite that is non-fossiliferous. It weathers to a distinctive light olive-gray. The DeCew Member ranges from not present to 6.35 feet thick nearby the site. It grades into the Rochester Shale Member of the Clinton Group.

Rochester Shale - Burleigh Hill Member

The Rochester Shale is estimated to have a total thickness of approximately 60 feet to 90 feet in the site vicinity. The Rochester Shale is divided into two members: the upper Burleigh Hill Member and the Lewiston Member. The Burleigh Hill Member consists of rather uniform dark- to medium-gray, pale- and platy-weathering, highly calcareous shale to dolomitic mudstone. The Burleigh Hill contains a sparse fossil assemblage. It is considered to be a transitional unit between the overlying dolomitic units above and the Lewiston Shale below. The Burleigh Hill Member was observed to be approximately 40 feet thick at the site.

Rochester Shale - Lewiston Member

The Lewiston Member of the Rochester Shale consists of medium- to dark-gray, calcareous mudstone with interbedded fossiliferous lenses and beds. The Lewiston Member was never fully penetrated at the site, but is estimated to be up to 30-50 feet thick. There is a sharp contact between the Burleigh Hill and the Lewiston Members of the Rochester Shale, indicated by a thick bryozoan and brachiopod rich packstone (i.e., Unit E of the Lewiston Member).

The upper portion of the bedrock sequence (the Gasport, DeCew, and Burleigh Hill) is exposed in the sidewalls of the nearby New York State Barge Canal. The floor of the canal adjacent to the site is excavated in the Burleigh Hill Member.

Local Bedrock Dip and Fracture Patterns

The Transit Street site lies on a relatively flat local bedrock surface high as shown on Figure 3-2. Bedrock appears to be slightly higher beneath the southwest corner of the property and just south of the site. The bedrock surface elevation slopes steeply to the west, and slightly towards the north and east.

As shown on the cross-sections in Figures 3-4 to 3-8, locally the bedrock bedding planes/units generally dip slightly to the south and west, although there appears to be a localized low elevation at the contact between the Gasport Formation and the Decew Formation in the vicinity of MW-10.

While very few vertical fractures were observed during the recent drilling program, some are reported to be present in the area. Several vertical joint sets trending approximately west to east were observed in the rock face within the New York State Barge Canal. Two inclined borings (B-3-1 and B-3-2) advanced in 1983 during the Woodward Clyde investigation also confirmed the presence of near-vertical joints beneath the site. The 1995 AES report indicates regionally significant joint sets trending N40E and N84E have been measured at the site.

3.6.3 Site Hydrogeology

Overburden

The top of the groundwater in the overburden in the vicinity of the Transit Street site is generally within the fill between six to nine feet below the ground surface. Southeast and upgradient of the site where the overburden is significantly thicker, the groundwater is much deeper at approximately 21 to 25 feet bgs. North of the site as the overburden thins out between the site and the New York State Barge Canal, some of the overburden wells have a very thin saturated zone or are seasonally dry (i.e., SMW-07 and SMW-08). However, the saturated thickness appears to increase slightly behind the retaining wall adjacent to the New York State Barge Canal (i.e., in the vicinity of SMW-05 and SMW-09), indicating that the retaining wall may be acting as an aquitard in this area. Current monitoring well construction details are presented on Table 3-3. Figure 3-9 presents the unsaturated overburden thickness map. Figure 3-10 presents the saturated overburden thickness map. The saturated and unsaturated thickness maps were generated based on groundwater elevation data collected June 10, 2005.

Groundwater elevation data were collected on several different occasions and are presented on Table 3-4. The data were used to generate groundwater elevation contour maps for four separate dates: April 1, 2005, April 14, 2005, April 18, 2005, and June 10, 2005 (Figures 3-11 through 3-14, respectively). The hydraulic conductivity in the overburden, based on slug tests, ranged from 1.83 x 10^{-5} to 1.25 x 10^{-4} cm/sec.

Three monitoring wells, IW-01, IW-02, and MW-10S, were installed to monitor the overburden/bedrock interface (i.e., the screened interval straddles the top of bedrock surface). Hydraulic conductivity is significantly higher in these wells, ranging from 2.68 x 10^{-4} to 1.11 x 10^{-2} cm/sec.

Bedrock

For the purpose of this RI report and in conjunction with the RI report for the State Road site, the bedrock groundwater regime has been divided into three hydraulic zones corresponding to the shallow, intermediate, and deep bedrock units: (1) an upper zone comprised of Gasport/DeCew; (2) an intermediate zone consisting of the upper Rochester Shale (i.e., Burleigh Hill Member); and (3) a deep zone comprised of the lower portion of the Burleigh Hill Member and top of the Lewiston Member. Current monitoring well construction details are presented on Table 3-3.

Groundwater elevation data were collected on several different occasions and are presented on Table 3-4. The data were used to generate groundwater elevation contour maps for each zone on four separate dates, April 1, 2005 (Figures 3-15, 3-19, and 3-23), April 14, 2005 (Figures 3-16, 3-20, 3-24), April 18, 2005 (Figures 3-17, 3-21, and 3-25), and June 10, 2005 (Figures 3-18, 3-22, and 3-26). The New York State Canal Corporation controls the water elevation in the New York State Barge Canal. Typically, the canal water is lowered in the fall to a level approximately 15 feet below the water level maintained in the spring and summer. The canal is raised or lowered quickly, over a period of hours. A lock is located approximately 2,500 feet northeast of the site. The water level below the lock is approximately 50 feet lower than the water level in the canal adjacent to the site. April 1, 2005 data reflect groundwater levels in the bedrock zones when the New York State Barge Canal was at its winter level (approximately 551 feet amsl). April 14, 2005 data reflect groundwater levels one day after the New York State Canal Corporation raised the water level in the canal to 563.75 feet amsl (normal operating level). April 18, 2005 results reflect groundwater levels one week after the New York State Canal Corporation raised the canal water level. June 10, 2005 data reflect groundwater levels when the canal was at its high water level (approximately 564 feet amsl) and this date was just prior to the groundwater sampling round.

As indicated on the figures, bedrock groundwater flow in the shallow bedrock is toward the canal (northwest) for all four dates. Changes in the hydraulic gradient near the canal appear to be reflective of seasonal changes in the canal water elevation. It is apparent from the figures that the hydraulic gradient is highest during periods when the canal water elevation is at its seasonal low, indicating dewatering of the nearby bedrock units. Conversely, the hydraulic gradient is flatter when the canal water elevation is at its seasonal high. The effect is most apparent in monitoring wells situated near the canal walls.

Groundwater flow in the intermediate bedrock is also toward the canal (northwest) for all four dates. The hydraulic gradient was steepest on April 1, becoming progressively flatter on April 14, April 18 and June 10, in response to rising water levels in the canal. There is a fairly flat hydraulic gradient extending from the canal near Genesee and Walnut Streets to around the Reid Petroleum site (i.e., former Mobil station). This most likely represents an area of higher hydraulic conductivity and transmissivity. Immediately upgradient from the Transit Street site, a steep hydraulic gradient was noted throughout the monitoring. This most likely represents an area of lower hydraulic conductivity and transmissivity.

As in the shallow and intermediate bedrock, groundwater flow in the deep bedrock as shown on the figures is toward the canal (northwest) for all four dates. Lower hydraulic conductivities were typically measured in the deep bedrock as compared to the intermediate and shallow bedrock units described above. As indicated on the figures, rate of groundwater recovery is slowest in the areas of lower hydraulic conductivities. Groundwater in the bedrock tends to discharge into the New York State Barge Canal, which intersects the Lockport and Upper Rochester Formations.

Wells BMW-04-01, BMW-04-03, BMW-04-09, and MW-15 were packer tested during installation to obtain transmissivity/hydraulic conductivity information. The data were reviewed and are presented on Table 3-5. The packer test transmissivity results, sorted by depth and compared to RQD values, were plotted and are presented on Figure 3-27. Calculated transmissivity values range from 1.28 x 10^{-3} ft^2/sec to 9.92 x 10^{-6} ft^2/sec. The highest transmissivity was near the top of bedrock in BMW-04-01 from 25-45 feet bgs. The lowest values were indicated in BMW-04-01 from 60-70 feet and BMW-04-09 from 70-79 feet at 9.92 x 10^{-6} ft^2/sec to 1.07 x 10^{-5} ft^2/sec, respectively. Both of these wells terminate near or within the top of the Lewiston Member of the Rochester Shale. The transmissivity at BMW-04-03 from 57-72 feet bgs is somewhat higher at approximately 1.61 x 10^{-4} ft^2/sec. The RQD was lower here, especially at the transition between the Burleigh Hill Member and the Lewiston Member of the Rochester Shale between 60 and 65 feet bgs. This monitoring well is also very close to the New York State Barge Canal and in the direct vicinity of the Lockport Main Interceptor Sewer Tunnel, both of which may have impacted rock quality in the area (i.e., stress relief due to construction may have opened joints and bedding planes). The packer test analysis and calculations have been included in Appendix D.

All newly installed wells that were not packer tested were slug tested to determine their respective hydraulic conductivities. Results indicate conductivities range from approximately 1.32 x 10^{-8} cm/sec to 1.21 x 10^{-3} cm/sec and averaged 4.09 x 10^{-4} cm/sec. The analysis of slug test results has been included in Appendix D.

Vertical Hydraulic Gradients

The vertical hydraulic gradients for site well pairs on select dates are presented in Table 3-6. There is a downward vertical hydraulic gradient in nearly every cluster. Exceptions include the three overburden well clusters (SMW-01S/SMW-01D, SMW-03S/SMW-03D) and SMW-06S/SMW-06D. At these clusters, there appears to be a slightly upward gradient on nearly all dates. This indicates that the shallow overburden may be perched or a semi-confining layer may be present between the upper and lower overburden groundwater regimes.

4.0 NATURE AND EXTENT OF CONTAMINATION

This section discusses the current understanding of the nature and vertical and horizontal extent of contamination at the site based on data collected during this RI and previous investigations. The validated laboratory data for samples collected as part of the RI and validation summary report are included in Appendix H.

4.1 Applicable Standards, Criteria, and Guidance

For each medium, detected concentrations of individual contaminants were compared to applicable SCGs; the SCGs were determined as follows:

- The SCGs for soils are the RSCOs presented in NYSDEC TAGM #4046, January 1994 (including subsequent memorandums). The Eastern USA Background Concentrations (used for metals only) are also included for comparison.

- The SCGs for groundwater are the Class GA standards and guidance values presented in NYSDEC TOGS 1.1.1, March 1998 (including subsequent revisions).

- For surface water, the most stringent Class C surface water standards and guidance values (as presented in TOGS 1.1.1) for the various types of protection listed are included in the tables for comparison as the SCGs.

- For sediment, sample-specific SCGs for BTEX, SVOCs, and PCBs, based on the total organic carbon content of each sample, were calculated for the following levels of protection using the procedures provided in *Technical Guidance for Screening Contaminated Sediments*, Division of Fish, Wildlife, and Marine Resources, NYSDEC, 1999: Human Health Bioaccumulation, Wildlife Bioaccumulation, Benthic Aquatic Life Acute Toxicity, and Benthic Aquatic Life Chronic Toxicity. The SCGs for metals in sediment are the LEL and SEL listed in the referenced NYSDEC guidance document.

4.2 Soil Quality

This section discusses the analytical results for the surface and subsurface soil samples collected during the RI.

4.2.1 Surface Soil

The three surface soil samples collected during the RI were analyzed for SVOCs, PCBs, metals, total recoverable phenolics, and total cyanide. The analytical results are summarized and compared to SCGs in Table 4-1. A statistical summary of the detections in the surface soil is presented as Table 4-2. The statistical summary tables indicate:

- The SCGs;
- The number of detections, and the minimum and maximum detected concentrations;
- The corresponding sample location where the maximum detected concentration was found;
- The average and standard deviation of the detected concentrations;
- The 95 percent Upper Confidence Level (UCL95); and
- The total number of samples that exceeded the NYSDEC's SCG for each compound.

The distribution of total cPAHs, total non-cPAHs, total PAHs, and total SVOCs in the surface soils samples is depicted in Figure 4-1.

Volatile Organic Compounds

The three surface soil samples collected during the RI were not analyzed for VOCs due to their direct exposure to the atmosphere.

Semi-Volatile Organic Compounds

As shown in Tables 4-1 and 4-2, most of the SVOCs detected were PAHs. Several SVOCs, consisting entirely of cPAHs (i.e., benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, and dibenz(a,h)anthracene), exceeded their respective SCG in at least one of the three sample locations. The detected concentrations of total PAHs ranged from 23.4 mg/kg in sample SS-09 to 50.82 mg/kg in sample SS-07. The three samples were collected from the grass median between the sidewalk and the curb along Transit Street and LaGrange Street. Table 4-1 also shows the total cPAH values for each on-site surface soil sample collected during the RI. The detected concentrations of total cPAHs range from 11.81 in surface soil sample SS-09 to 23.64 mg/kg in surface soil sample SS-07. As shown in Table 4-2, most of the maximum detections were in sample SS-07, which was collected from alongside Transit Street. The distribution of SVOCs exceeding SCGs in surface soil samples collected during the RI is shown in Figure 4-2. These SVOCs are not likely site-related, rather they are most likely attributable to urban sources such as exhaust particulates from vehicular traffic.

Polychlorinated Biphenyls

No PCB compounds were detected in any surface soil sample collected during the RI.

Metals

As shown in Tables 4-1 and 4-2, beryllium, chromium, copper, iron, mercury, nickel, and zinc were detected at concentrations that exceeded the SCGs in at least one of the surface soil samples collected during the RI. In addition, the metals calcium, copper, lead, magnesium, nickel, and zinc were detected above their respective Eastern USA Background concentration ranges in at least one sample collected. Each metal that exceeded SCGs in the surface soil samples collected during the RI is shown in Figure 4-2. The number and concentrations of metals observed were generally comparable between the historical and RI samples.

Cyanide

Figure 4-3 shows the distribution of cyanides in the three surface soil samples. There is no established SCG for cyanide. As shown in Tables 4-1 and 4-2, total cyanide only was detected in sample SS-08 at a concentration of 1.1 mg/kg, from alongside Transit Street. The sample was sent to Clarkson University for further analysis to determine the amount of free cyanide and the various cyanide species present. The results are presented in the following table.

Location ID	Total Cyanide (STL) (mg/kg)	Total Cyanide (Clarkson) (mg/kg)	Free Cyanide (mg/kg)	Ferric/Ferrous Iron Cyanide Complex (mg/kg)	Unknown Iron Cyanide Complex (mg/kg)
SS-08	1.1	3.77	0.07	1.85	0.17

The differences in the total cyanide results (between the STL and Clarkson analyses) were likely due to the analytical method used. Very little of the cyanide detected is of the more toxic free cyanide variety.

Total Recoverable Phenolics

Total recoverable phenolics were not detected in the three surface soil samples collected during the RI.

Summary

The major findings of the surface soil sampling during the RI can be summarized as follows:

- Several SVOCs including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, and dibenz(a,h)anthracene exceeded their respective SCG in at least one sample location. These SVOCs are not likely site-related, rather they are most likely attributable to urban sources such as exhaust particulates from vehicular traffic.

- No PCBs were detected.
- Beryllium, chromium, copper, iron, mercury, nickel, and zinc were detected in the surface soil samples at concentrations that exceeded SCGs.
- Cyanide was detected at low concentrations in one of the surface soil samples.
- Total recoverable phenolics were not detected in the three surface soil samples.

4.2.2 Subsurface Soil

Forty-seven of the subsurface soil samples plus QA/QC samples were analyzed for VOCs, SVOCs, PCBs, total recoverable phenolics, metals. Due to low recovery, a sample from GB-18 (6.5-7.0 feet) was analyzed for VOCs only. Forty-eight samples were also submitted for analysis of total cyanide. Additionally, fourteen samples plus QA/QC samples were analyzed for extended PAH profiles and ten samples plus QA/QC samples were analyzed for TOC and NOD.

The analytical results are summarized and compared to SCGs in Table 4-3. A statistical summary of the detections in the subsurface soil is presented as Table 4-4. The distribution of total BTEX, VOCs, cPAHs, non-cPAHs, PAHs, and SVOCs in the subsurface soils samples is depicted in Figure 4-4. The distribution of all organic compounds exceeding SCGs in the subsurface soil samples is shown in Figure 4-5. Figure 4-6 shows the distribution of all metals exceeding SCGs in subsurface soil samples collected during the RI. The distribution of total cyanide in the subsurface soil samples is depicted on Figure 4-7.

Volatile Organic Compounds

As shown in Table 4-3 and 4-4, several VOCs, primarily BTEX compounds, were detected in 19 of the 48 subsurface soil samples at concentrations exceeding their respective SCGs. The most frequently detected VOC was toluene, which exhibited concentrations ranging from 0.002 to 41 mg/kg in 32 of the 48 samples collected and exceeded the SCG of 1.5 mg/kg in four of the samples. Xylene was detected at concentrations exceeding its SCG in 16 of the 48 samples collected. Besides the BTEX compounds, acetone and isopropylbenzene were the only other VOCs detected at concentrations exceeding their respective SCGs, in 2 and 3 samples, respectively. The highest concentration detected for total BTEX, 181.4 mg/kg, was located at GB-09 (from 10-12 feet bgs). The next four highest total BTEX concentrations were detected at GB-05, GB-14, GB-16, and GB-26. GB-09 was advanced in the northwest corner of the Transit Street site, in the footprint of the former purifier building, downgradient from the location of the former tar sumps. GB-05 and GB-26 were located just downgradient from GB-09, on the south and north sides of LaGrange Street, respectively. GB-14 and GB-16 were located at the western and southern edges of the former 150,000 cubic foot gasholder, respectively.

Semi-Volatile Organic Compounds

As shown in Tables 4-3 and 4-4 and depicted on Figure 4-4, several SVOCs, consisting primarily of PAHs, were detected in 45 of the 47 subsurface soil samples. Reported concentrations of 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, dibenzofuran, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene, exceeded their respective SCGs at one or more locations. Total SVOCs were detected above 500 mg/kg in six of the samples (GB-05, 6-8 feet, GB-09, 10-12 feet, GB-09, 12-13.8 feet, GB-15, 2-3 feet, GB-16, 0.5-1.5 feet, and GB-26, 9.5-10.75 feet). All of these samples, with the exception of GB-05 and GB-26, were from within the fenced-in substation. GB-05 was located in the grass median between the sidewalk and the street curb on the north side of the Substation property, and GB-26 was located across LaGrange Street, north of GB-05. GB-09 was advanced in the northwest corner of the Transit Street site, in the footprint of the former purifier building, downgradient from the location of the former tar sumps. GB-05 and GB-26 were located just downgradient from GB-09, on the south and north sides of LaGrange Street, respectively. GB-15 and GB-16 were located at the eastern and southern edges of the former 150,000 cubic foot gasholder, respectively.

The detected concentrations of total PAHs ranged from 0.026 mg/kg in subsurface soil sample GB-15 (from 18 to 19 feet bgs) to 1,759 mg/kg in subsurface soil sample GB-09 (from 12 to 13.8 feet bgs). Table 4-3 also shows the total cPAH values for each on-site subsurface soil sample collected during the RI. The detected concentrations of total cPAHs range from 0.021 mg/kg at boring GB-27 (in the sample collected from 11 to 12 feet bgs) to 201.4 mg/kg at boring GB-16 (in the sample collected from 0.5 to 1.5 feet bgs). As shown in Table 4-4, most of the maximum exceedances were detected in boring GB-09 (12 to 13.8 feet bgs) and boring GB-16 (0.5 to 1.5 feet). The distribution of SVOCs exceeding SCGs in subsurface soil samples is shown in Figure 4-5.

Polychlorinated Biphenyls

PCB compounds were detected in only two of the 47 samples. Aroclor 1248 and Aroclor 1254 were both detected at low concentrations in the sample from GB-16 from 0.5 to 1.5 feet bgs. Aroclor 1254 also was detected at a low concentration in GB-12 from 3 to 4 feet bgs. Both locations are within the substation boundary. No PCBs were detected in any sample at a concentration exceeding its SCG.

Metals

As shown in Table 4-3, barium, beryllium, chromium, copper, iron, mercury, nickel, and zinc were detected at concentrations that exceeded SCGs in at least one or more of the 47 subsurface soil samples collected during the RI. Each metal that exceeded SCGs in the subsurface soil samples is shown in Figure 4-6. The number and concentrations of metals observed were generally comparable between the historical and RI samples.

Cyanide

Eighteen historical subsurface soil samples were analyzed for total cyanide. As shown on Table 1-1 and Figure 1-5H, the detected total cyanide concentrations for the historical subsurface soil samples ranged from 0.35 mg/kg in boring MW-03 to 79.2 mg/kg in boring SB-18. Boring

SB-18 was advanced along the northern property boundary, between the approximate locations of the former offices and the 18,000 and 50,000 cubic foot gasholders.

Forty-eight samples collected during the RI were analyzed for total cyanide. Figure 4-7 shows the distribution of total cyanide in the soil samples. There is no established RSCO for cyanide. As shown in Table 4-4, total cyanide was detected in 12 of the 48 samples collected. Total cyanide was detected at concentrations ranging from 1.2 mg/kg in boring GB-08 (from 12 to 14 feet bgs) to 34.40 mg/kg in boring GB-10 (from 6 to 6.2 feet bgs). GB-10 was advanced in the approximate vicinity of the former tar sumps and this sample contained wood chips. Samples collected from soils just below wood chips indicated total cyanide concentrations of 3.1 mg/kg in GB-04 and 4.7 mg/kg in GB-05. The sample collected from GB-43 (from 5.0 to 5.5 feet bgs) included this material and total cyanide results were non-detect. This indicates that the wood chip material observed on the north side of LaGrange Street is not likely to be purifier waste. In general, detectable concentrations of total cyanide appear to be isolated to a narrow depth range from approximately 6 to 13.5 feet, with the exception of location GB-16 where it was observed at a shallower depth.

All soil samples in which cyanide was detected (in the samples analyzed by STL) during the RI were sent to Clarkson University for further analysis to determine the amount of free cyanide and the various cyanide species present. The results are presented in the following table.

Location ID	Total Cyanide (STL) (mg/kg)	Total Cyanide (Clarkson) (mg/kg)	Free Cyanide (mg/kg)	Ferric/Ferrous Iron Cyanide Complex (mg/kg)	Unknown Iron Cyanide Complex (mg/kg)
GB-04 (5.2-7.2)	3.1 J	79.7	0.10	65.1	0.51
GB-05 (6-8)	4.7	77.4	0.29	42.1	0.22
GB-07 (12.5-13.5)	2.2	0.10	ND	0.01	ND
GB-08 (12-14)	ND	0.10	ND	0.02	0.01
GB-09 (10-12)	7.9 J	77.6	0.09	75.2	0.26
GB-10 (6-6.2)	34.4	300	0.76	188	5.52
GB-10 (12.6-13.6)	4.9	1.56	ND	1.42	ND
GB-14 (8.5-9.5)	1.6 J	37.7	ND	32.7	ND
GB-16 (0.5-1.5)	1.3 J	0.15	ND	0.02	ND
GB-19 (7-9)	4.0 J	0.52	0.14	0.06	ND
GB-24 (9-9.8)	1.2 J	0.12	ND	0.03	0.01
GB-41 (9.5-10.5)	2.3 J	0.55	ND	0.41	0.03
GB-42 (8.5-10.5)	2.1 J	0.09	ND	0.01	ND

The differences in the total cyanide results between the STL and Clarkson analyses are likely due to the differences in the analytical methods used by the laboratories. The sample preparation procedures used by the Clarkson laboratory involve an alkaline digestion process that is generally not used by commercial environmental testing laboratories. Typically, this results in concentrations that are higher than those reported by the commercial laboratories (Ish Inc., May 2005). Other factors include sample homogeneity and variability introduced by subsampling.

In all samples except GB-19 (7 to 9 feet), the majority of the cyanide exists as iron cyanide complexes and not as free cyanide. The remaining unclassified cyanide (i.e., not free, ferric/ferrous iron, or unknown iron cyanide) can be attributed to limitations in the accuracy of the analytical method used and/or the possibility that the cyanide is bonded in other complexes which were not analyzed for.

Total Recoverable Phenolics

Total recoverable phenolics were detected in all six historical subsurface soil samples analyzed for the compound. It was present in five of the historical subsurface soil samples at concentrations ranging from 0.42 mg/kg at location AB-06 (from 12 to 15 feet bgs), to 8.4 mg/kg at location MW-03 (from 8 to 10 feet bgs). The sixth location, TT-02 (5 feet bgs), indicated a highly elevated concentration of 2,440 mg/kg. TT-02 was a test trench that, when excavated in 1983, was located in the vicinity of the former tar sumps. The sample from TT-02 was collected from the tarry material within the sumps, hence the highly elevated result. During the RI, total recoverable phenolics were detected only in sample GB-01 from 8.4 to 9.4 feet bgs at a concentration of 6.9 mg/kg. There is no established RSCO for total recoverable phenolics.

Summary

The major findings of the subsurface soil sampling during the RI can be summarized as follows:

- Several VOCs, primarily consisting of BTEX compounds, were detected in 19 of the 48 subsurface soil samples at concentrations exceeding their respective SCGs. The highest total BTEX concentrations were detected in the vicinity of and downgradient from the former purifier building (at locations GB-05, GB-09, and GB-26) and around the edges of the former 150,000 cubic foot gasholder (locations GB-14 and GB-16).

- Reported concentrations of 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, dibenzofuran, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene, exceeded their respective SCG at one or more locations. Total SVOCs were detected above

500 mg/kg in six of the samples (GB-05, 6-8 feet; GB-09, 10-12 feet; GB-09, 12-13.8 feet; GB-15, 2-3 feet; GB-16, 0.5-1.5 feet; and GB-26, 9.5-10.75 feet). The highest total SVOC concentrations were detected in the vicinity of and downgradient from the former purifier building (at locations GB-05, GB-09, and GB-26) and around the edges of the former 150,000 cubic foot gasholder (locations GB-15 and GB-16).

- No PCBs were detected in any sample at a concentration exceeding its SCG.

- Barium, beryllium, chromium, copper, iron, mercury, nickel, and zinc were detected at concentrations that exceeded SCGs in at least one or more, of the subsurface soil samples collected during the RI.

- The detected total cyanide concentrations for the historical subsurface soil samples ranged from 0.35 mg/kg in boring MW-03 to 79.2 mg/kg in boring SB-18. SB-18 was advanced along the northern property boundary, between the approximate locations of the former offices and the 18,000 and 50,000 cubic foot gasholders. Total cyanide was detected at concentrations ranging from 1.2 mg/kg in boring GB-08 (from 12 to 14 feet bgs) to 34.40 mg/kg in boring GB-10 (from 6 to 6.2 feet bgs) during the RI. The majority of the cyanide detected exists as iron cyanide complexes and not as free cyanide. The highest total cyanide concentrations based on both the STL and the Clarkson analyses were detected in the vicinity of and downgradient from the former purifier building (at locations GB-04, GB-05, and GB-09), around the edges of the former 150,000 cubic foot gasholder (location GB-14), and in the vicinity of the former tar sumps (GB-10).

- Total recoverable phenolics were detected in six of the historical subsurface soil samples at concentrations ranging from 0.42 mg/kg at location AB-06 to 2,440 mg/kg at location TT-02. However, during the RI, total recoverable phenolics were detected only in GB-01 from 8.4 to 9.4 feet bgs.

4.3 Groundwater Quality

Groundwater quality was assessed on two occasions during the RI. First, during bedrock monitoring well installation, packer test groundwater samples were collected from discrete intervals to assess the vertical extent of dissolved phase contamination. Second, at the conclusion of the drilling program in June 2005, groundwater samples were collected from wells monitoring the overburden and the shallow, intermediate, and deep bedrock.

4.3.1 Packer Test Groundwater Samples

The Packer test groundwater samples were submitted for analysis of VOCs, SVOCs, and lead only. Thirteen samples were collected from various intervals in the four wells that were packer sampled (i.e., BMW-04-01, BMW-04-03, BMW-04-09, and MW-15). These four locations were selected for packer testing to vertically characterize groundwater contamination based on their lateral distribution throughout the study area. The analytical results for the packer test groundwater samples collected during the RI are summarized in Table 4-5. A statistical summary of the detections in the packer test groundwater samples is presented as Table 4-6. SCGs are included in the tables for comparison. The distribution of total BTEX, VOCs, cPAHs, non-cPAHs, PAHs, and SVOCs in the packer test groundwater samples is presented on Figure 4-8. The distribution of individual compounds exceeding SCGs in the packer test samples is presented on Figure 4-9.

Volatile Organic Compounds

VOCs detected at concentrations exceeding SCGs in the packer test samples consist primarily of BTEX, but also include 1,2-dichloroethene(cis), isopropylbenzene, MTBE, styrene, and vinyl chloride. MTBE was detected in all five of the samples from BMW-04-09 at concentrations exceeding SCGs, ranging from 43 µg/L to 82 µg/L. BMW-04-09 is located approximately 270 feet west-southwest of the site. The chlorinated VOCs 1,2-dichloroethene(cis) and vinyl chloride were both detected in the shallow bedrock packer sample collected at MW-15, from 11 feet bgs to 40 feet bgs. The highest total BTEX concentration of 2,286 µg/L was detected in the 45-to-60-foot blind field duplicate packer sample at well BMW-04-01; the total BTEX concentration in the parent sample was 2,079 µg/L. BMW-04-01 is located on site and was advanced through a former gasholder pad on the eastern portion of the property. The next highest total BTEX concentration was detected in BMW-04-09 (from 42 to 56 feet) at 2,230 µg/L. This location appears to have impacts from at least two sources. NAPL from the Transit Street site is present and the presence of MTBE indicates another source is impacting groundwater in the vicinity. MTBE is a synthetic chemical commonly used as an additive to gasoline in the United States since the late 1970s and is not associated with MGPs. BTEX compounds were detected in all packer samples collected; however, the detections at MW-15 were much lower than elsewhere. In general, VOC concentrations appear to be highest between 40 and 60 feet bgs (within the Burleigh Hill Member of the Rochester Shale) and appear to decrease with depth.

Semi-Volatile Organic Compounds

SVOCs detected in the packer samples consisted primarily of non-cPAHs. Naphthalene was detected at the highest concentrations. The 42-to-56-foot packer sample at well BMW-04-09 contained the highest concentration of total SVOCs at 6,571 µg/L, 5,600 of which was naphthalene. No SVOCs were detected at concentrations exceeding SCGs in the 25-to-45-foot sample from the on-site well BMW-04-01, or in either of the packer samples collected from the downgradient MW-15. SVOC concentrations appear to decrease with depth.

Lead

Lead was detected in 5 of the 13 packer samples collected. The highest concentration of 8.3 µg/L, well below the SCG of 25 µg/L, was detected from 57 to 72 feet bgs at BMW-4-03.

Summary

The major findings of the packer test groundwater sampling during the RI can be summarized as follows:

- VOCs detected at concentrations exceeding SCGs in the packer test samples consist primarily of BTEX but also include 1,2-dichloroethene(cis), isopropylbenzene, MTBE, styrene, and vinyl chloride. BTEX compounds were detected in all packer samples collected, but the detections at MW-15 were much lower than elsewhere. VOC concentrations are highest in the upper Burleigh Hill Member of the Rochester Shale and appear to decrease with depth into the Burleigh Hill and Upper Lewiston Member of the Rochester Shale.

- SVOCs detected in the packer samples consisted primarily of non-cPAHs. The 42-to-56-foot packer sample at well BMW-04-09 contained the highest concentration of total SVOCs at 6,571 µg/L, 5,600 of which was naphthalene. SVOC concentrations appear to decrease with depth.

- Lead was detected in 5 of the 13 packer samples collected at concentrations well below the SCG of 25 µg/L.

4.3.2 June 2005 Groundwater Samples

The analytical results and statistical summaries of the detections in the groundwater samples collected during the RI are presented and summarized in Tables 4-7 through 4-14. The SCGs are included in the tables for comparison.

4.3.2.1 Overburden and Interface

Twelve overburden monitoring wells, including three overburden/bedrock interface (interface) wells, were sampled in June 2005. Overburden monitoring wells SMW-05, SMW-07, and SMW-08 could not be sampled during the RI due to insufficient water. The distribution of total BTEX, VOCs, cPAHs, non-cPAHs, PAHs, and SVOCs in the overburden and interface groundwater samples is presented on Figure 4-10. The distribution of individual compounds exceeding SCGs in the overburden and interface groundwater samples is presented on Figure 4-11. The analytical results for the overburden and interface groundwater samples collected during the RI are summarized in Table 4-7. A statistical summary of the detections in the overburden and interface groundwater samples is presented as Table 4-8.

Volatile Organic Compounds

VOCs detected at concentrations exceeding SCGs in the overburden consist primarily of BTEX, but also include styrene, isopropylbenzene, and MTBE. MTBE was detected at 62 µg/L in SMW-03D located upgradient from the site. The highest total BTEX concentration was detected in the interface well MW-10S, located north and downgradient of the site, on the north side of LaGrange Street. The second highest total BTEX concentration was detected at SMW-11 also located north and downgradient of the site, on the north side of LaGrange Street, west of MW-10S. Gas station related BTEX contamination (i.e., exhibiting a petroleum odor, not an MGP odor) was indicated in several soil samples collected on the Reid Petroleum property. An unknown component of the gas station related soil contamination may be impacting overburden groundwater in the area. BTEX was not detected in the upgradient and side gradient monitoring wells SMW-01S, SMW-01D, SMW-03S, SMW-03D, SMW-04S/D, or SMW-10, or the far downgradient interface well IW-01.

Semi-Volatile Organic Compounds

SVOCs detected in the overburden and interface monitoring wells consisted primarily of non-cPAHs. Naphthalene was detected at the highest concentrations. SMW-11, located north of the site, on the north side of LaGrange Street (see Figure 4-10), contained the highest concentration of total SVOCs at 17,102 µg/L, 16,000 of which was naphthalene. No SVOCs were detected at concentrations exceeding SCGs in the upgradient and side gradient monitoring wells SMW-01S, SMW-01D, SMW-03S, SMW-03D, SMW-04S/D, or SMW-10, or the far downgradient interface well IW-01.

Polychlorinated Biphenyls

No PCBs were detected in the overburden monitoring wells.

Metals

Arsenic, cadmium, chromium, iron, magnesium, manganese, nickel, and sodium were detected in one or more overburden or interface monitoring wells at concentrations exceeding SCGs. Arsenic was only detected at two locations and exceeded its SCG of 25 µg/L in both cases (at 29.7 µg/L in MW-10S and 27.8 µg/L in SMW-11). The other metals detected were widespread and do not appear to be associated with site-related contamination.

Cyanide

As shown in Tables 4-7 and 4-8, total cyanide was detected in 4 of the 12 wells sampled. Total cyanide was detected at concentrations ranging from 11.1 µg/L in well SMW-06D to 127 µg/L in well SMW-11. The SCG for cyanide in groundwater is 200 µg/L. All four wells in which total cyanide was detected are located downgradient from the site along the north side of LaGrange Street.

The groundwater samples in which cyanide was detected were not further analyzed to determine the cyanide speciation. This decision was made during the investigation based on the cyanide results exhibited by the soil samples. That is, the majority of the cyanide observed in the soils was determined to be bound in stable iron cyanide complexes and the same would be expected of cyanides observed in the site groundwater.

Total Recoverable Phenolics

Total recoverable phenolics were detected at concentrations above SCGs in 6 of the 12 overburden and overburden/bedrock interface wells; 5 of these locations were located downgradient. The other location was upgradient shallow overburden well SMW-01S. Detected concentrations ranged from 0.011 mg/L in IW-02 to 0.640 mg/L in MW-10S. Total recoverable phenolics were not detected in the upgradient and side gradient monitoring wells SMW-01D, SMW-03S, SMW-03D, SMW-04S/D, or SMW-10, or the downgradient interface well IW-01.

Summary

The major findings of the overburden groundwater sampling during the RI can be summarized as follows:

- VOCs detected in the overburden consisted primarily of BTEX. Concentrations were highest north of the site, on the north side of LaGrange Street. BTEX was not detected in the upgradient and side gradient monitoring wells. An unknown component of the overburden BTEX contamination may be related historical gas station operations.

- SVOCs detected in the overburden and interface monitoring wells consisted primarily of the non-carcinogenic PAH naphthalene. No SVOCs were detected at concentrations exceeding SCGs in the upgradient and side gradient monitoring wells.

- No PCBs were detected in the overburden monitoring wells.

- Arsenic, cadmium, chromium, iron, magnesium, manganese, nickel, and sodium were detected in one or more overburden or interface monitoring well at concentrations exceeding SCGs.

- Total cyanide was detected in 4 of the 12 overburden and interface wells sampled; however, it was not detected at concentrations exceeding its SCG.

- Total recoverable phenolics were detected at concentrations above SCGs in 6 of the 12 overburden and overburden/bedrock interface wells. Total recoverable phenolics were not detected in upgradient and side gradient monitoring wells SMW-01D, SMW-03S, SMW-03D, SMW-04S/D, or SMW-10, or the downgradient interface well IW-01.

4.3.2.2 Shallow Bedrock

Six shallow bedrock monitoring wells were sampled in June 2005. The distribution of total BTEX, VOCs, cPAHs, non-cPAHs, PAHs, and SVOCs in the shallow bedrock groundwater samples is presented on Figure 4-12. The distribution of individual compounds exceeding SCGs in the shallow bedrock groundwater samples is presented on Figure 4-13. The analytical results for the shallow bedrock groundwater samples collected during the RI are summarized in Table 4-9. A statistical summary of the detections in the shallow bedrock groundwater samples is presented as Table 4-10.

Volatile Organic Compounds

VOCs detected at concentrations exceeding SCGs in the shallow bedrock consist primarily of BTEX, but other VOCs exceeding SCGs include styrene and MTBE. MTBE was detected at 51 µg/L in MW-05, which is located upgradient from the site. The highest total BTEX concentration (20,000 µg/L) was detected in well MW-10, located approximately 35 feet north of the site, on the north side of LaGrange Street. BTEX concentrations were three orders of magnitude less at all other shallow bedrock monitoring well locations. BTEX was not detected in the upgradient shallow bedrock monitoring well MW-05.

Semi-Volatile Organic Compounds

SVOCs detected in the shallow bedrock monitoring wells consist primarily of non-cPAHs. Naphthalene was typically detected at the highest concentrations. MW-10, located north of the site, on the north side of LaGrange Street, contained the highest concentration of total SVOCs at 23,570 µg/L, 14,000 of which was naphthalene. Eleven SVOCs were detected at concentrations exceeding their respective SCGs at MW-10. No SVOCs were detected at concentrations exceeding SCGs in upgradient monitoring well MW-05 or downgradient well MW-11. However, low levels of SVOCs, including exceedances for naphthalene, and 2-methylnaphthalene were detected in upgradient well BMW-04-08, which is located in close proximity to the southern site boundary, south of the former oil tanks and the former plant powerstation.

Polychlorinated Biphenyls

No PCBs were detected in the shallow bedrock monitoring wells.

Metals

Cadmium, chromium, copper, iron, lead, magnesium, manganese, nickel, selenium, sodium, and zinc were detected in one or more shallow bedrock monitoring wells at concentrations exceeding SCGs. Metals exceeding SCGs were detected at the highest frequency and concentration at downgradient location MW-17. However, low recharge conditions at this monitoring well resulted in a very turbid sample, and results at this location may not be representative of actual groundwater conditions. Results for the metals, lead, magnesium, and sodium, exceeded their respective SCGs in all six samples.

Cyanide

As shown in Tables 4-9 and 4-10, total cyanide was detected in only one of the six shallow bedrock wells sampled at a concentration of 134 µg/L in well MW-17. The SCG for cyanide in groundwater is 200 µg/L.

The groundwater sample in which cyanide was detected was not further analyzed to determine the cyanide speciation. This decision was made during the investigation based on the cyanide results exhibited by the soil samples. That is, the majority of the cyanide observed in the soils was determined to be bound in stable iron cyanide complexes and the same would be expected of cyanides observed in the site groundwater.

Total Recoverable Phenolics

Total recoverable phenolics were detected at concentrations above SCGs in only one of the six shallow bedrock wells at a concentration of 0.560 mg/L in MW-10. MW-10 is located immediately downgradient and north the site, on the north side of LaGrange Street.

Miscellaneous Parameters

Chloride, sulfate, sulfide and TDS were each detected at concentrations exceeding their respective SCGs in all four shallow bedrock well samples submitted for analysis. Analysis of these parameters was performed on select wells to evaluate geochemical conditions in the subsurface that may affect or indicate the degree of natural attenuation processes occurring at the site. The natural attenuation assessment is presented in Section 5.0.

Summary

The major findings of the shallow bedrock groundwater sampling during the RI can be summarized as follows:

- VOCs in the shallow bedrock consisted primarily of BTEX. Concentrations were highest north of the site, on the north side of LaGrange Street, at monitoring well MW-10. BTEX was not detected in the upgradient shallow bedrock monitoring well MW-05.

- SVOCs detected in the shallow bedrock monitoring wells consisted primarily of the non-cPAH naphthalene. MW-10 contained the highest concentration of total SVOCs. No SVOCs were detected at concentrations exceeding SCGs in upgradient monitoring well MW-05 or downgradient well MW-11.

- No PCBs were detected in the shallow bedrock monitoring wells.

- Cadmium, chromium, copper, iron, lead, magnesium, manganese, nickel, selenium, sodium, and zinc were detected in one or more shallow bedrock monitoring wells at concentrations exceeding SCGs.

- Total cyanide was detected in only one of the six shallow bedrock wells sampled; however, the concentration did not exceed its SCG.

- Total recoverable phenolics were detected at concentrations above SCGs in only one of the six shallow bedrock wells at a concentration of 0.560 mg/L in MW-10.

4.3.2.3 Intermediate Bedrock

Twenty intermediate bedrock monitoring wells were sampled in June 2005. The distribution of total BTEX, VOCs, cPAHs, non-cPAHs, PAHs, and SVOCs in the intermediate bedrock groundwater samples is presented on Figure 4-14. The distribution of individual compounds exceeding SCGs in the intermediate bedrock groundwater samples is presented on Figure 4-15. The analytical results for the intermediate bedrock groundwater samples collected during the RI are summarized in Table 4-11. A statistical summary of the detections in the intermediate bedrock groundwater samples is presented as Table 4-12.

Volatile Organic Compounds

VOCs detected at concentrations exceeding SCGs in the intermediate bedrock consist primarily of BTEX, but other VOCs that exceeded SCGs include 1,2-dichloroethene(cis), isopropylbenzene, MTBE, styrene, tetrachloroethene, trichloroethene, and vinyl chloride. The chlorinated VOCs were all detected in well MW-15. MTBE was detected in three intermediate bedrock monitoring wells (MW-08, MW-16, and MW-18) at concentrations ranging from 0.75 µg/L in MW-18 to 17 µg/L in MW-16. The highest total BTEX concentrations (22,000 µg/L and 14,700 µg/L in wells MW-07 and MW-03, respectively) were detected onsite in the vicinity of the former coal tar sumps. BTEX was not detected in intermediate bedrock wells BMW-04-01, MW-13, MW-14, MW-18, and MW-19. BMW-04-01 is located on site, MW-14 is upgradient, and the other three are all down- or side gradient wells. The BTEX detected at MW-15 is likely not site-related, a moderate diesel odor has been noted at this well and forensic analytical results discussed later in Section 4.8 also indicate the contamination observed is possibly from a diesel source. The BTEX contamination plume in the intermediate bedrock extends from the site in the vicinity of the former coal tar sumps and retort building, primarily to the north and west, and spreads laterally as far east as MW-09 and south as MW-04.

The non-detect results for BMW-04-01 are not consistent with observations from the packer samples collected during well installation. It was initially suspected that this sample may have been swapped with the one from MW-04, but a second sample collection and analysis from September 19, 2005 proved otherwise. It is now believed that the groundwater from the more transmissive shallow bedrock at this location may be diluting the contamination observed during packer sampling, thereby resulting in the observed non-detects. During sampling, the well construction was an open rock hole from approximately 25 feet bgs (top of bedrock was at 20 feet bgs) to 70 feet bgs; therefore, it was open to both the shallow and intermediate bedrock zones. This well was retrofitted to a shorter screen interval.

Semi-Volatile Organic Compounds

SVOCs detected in the intermediate bedrock monitoring wells consist primarily of non-cPAHs. Naphthalene was typically detected at the highest concentrations. MW-07, located on site, contained the highest concentration of total SVOCs at 78,975 µg/L, 31,000 of which was naphthalene. Twenty-four SVOCs were detected at concentrations exceeding their respective SCG at MW-07. No SVOCs were detected at concentrations exceeding SCGs in onsite intermediate bedrock well BMW-04-01, upgradient well MW-14, or down/sidegradient wells MW-13, MW-15, MW-16, MW-18, and MW-19.

Polychlorinated Biphenyls

No PCBs were detected in the intermediate bedrock monitoring wells.

Metals

Iron, magnesium, manganese, and sodium were detected in one or more intermediate bedrock monitoring wells at concentrations exceeding SCGs. Sodium was detected at concentrations exceeding its SCG in all twenty intermediate bedrock wells. Iron and magnesium were detected at concentrations exceeding their SCGs in nearly all samples (17 and 18 of 20, respectively). Manganese was detected at a concentration exceeding its SCG at only one monitoring well, MW-18.

Cyanide

As shown in Tables 4-11 and 4-12, total cyanide was detected in 5 of the 20 intermediate bedrock wells sampled at concentrations ranging from 10.4 µg/L to 24.1 µg/L, which is well below the SCG for cyanide in groundwater of 200 µg/L.

The groundwater samples in which cyanide was detected were not further analyzed to determine the cyanide speciation. This decision was made during the investigation based on the cyanide results exhibited by the soil samples. That is, the majority of the cyanide observed in the soils was determined to be bound in stable iron cyanide complexes and the same would be expected of cyanides observed in the site groundwater.

Total Recoverable Phenolics

Total recoverable phenolics were above SCGs in 8 of the 20 intermediate bedrock wells at concentrations ranging from 0.011 mg/L in BMW-04-02 to .810 mg/L in MW-07. MW-07 is located on site in the vicinity of the former tar sumps.

Miscellaneous Parameters

Samples from ten of the intermediate bedrock wells were analyzed for additional miscellaneous parameters to evaluate geochemical conditions in the subsurface that may affect or indicate the degree of natural attenuation processes occurring at the site. Chloride and TDS were detected at concentrations exceeding their respective SCGs in all ten samples. Sulfate and sulfide were each detected at concentrations exceeding their respective SCGs in seven of the 10 intermediate bedrock well samples analyzed for these additional parameters. The parameter pH was detected above its SCG of 8.5 in 6 of the 20 intermediate bedrock groundwater samples. The effect of these parameters on natural attenuation processes was previously discussed in Section 1.4.2. The natural attenuation assessment is presented in Section 5.0.

Summary

The major findings of the intermediate bedrock groundwater sampling during the RI can be summarized as follows:

- VOCs detected at concentrations exceeding SCGs in the intermediate bedrock consist primarily of BTEX. The highest total BTEX concentrations were detected on site in MW-07 in the vicinity of the former coal tar sumps.

- SVOCs detected in the intermediate bedrock monitoring wells consist primarily of non-cPAHs. MW-07, located on site, contained the highest concentration of total SVOCs at 78,975 µg/L, 31,000 of which was naphthalene.

- No PCBs were detected in the intermediate bedrock monitoring wells.

- Iron, magnesium, manganese, and sodium were detected in one or more intermediate bedrock monitoring wells at concentrations exceeding SCGs.

- Total cyanide was detected in 5 of the 20 intermediate bedrock wells sampled, at concentrations below SCGs, ranging from 10.4 µg/L to 24.1 µg/L.

- Total recoverable phenolics were detected at concentrations above SCGs in 8 of the 20 intermediate bedrock wells. The highest concentration was in MW-07, which is located on site.

4.3.2.4 Deep Bedrock

Five deep bedrock monitoring wells were sampled in June 2005. The distribution of total BTEX, VOCs, cPAHs, non-cPAHs, PAHs, and SVOCs in the deep bedrock groundwater samples is presented on Figure 4-16. The distribution of individual compounds exceeding SCGs in the deep bedrock groundwater samples is presented on Figure 4-17. The analytical results for the deep bedrock groundwater samples collected during the RI are summarized in Table 4-13. A statistical summary of the detections in the deep bedrock groundwater samples is presented as Table 4-14.

Volatile Organic Compounds

VOCs detected at concentrations exceeding SCGs in the deep bedrock consist primarily of BTEX, but also include cyclohexane, isopropylbenzene, MTBE, styrene, and vinyl chloride. Vinyl chloride was detected in BMW-04-10. MTBE was detected in BMW-04-09 at 52 µg/L. The highest total BTEX concentrations (2,360 µg/L and 787 µg/L in wells BMW-04-09 and MW-02, respectively) were detected west of the site nearby the New York State Barge Canal. Low concentrations of BTEX in wells BMW-04-10 and BMW-04-13, both located on the other side of the canal, indicate the dissolved phase plume in the deep bedrock extends beneath the New York State Barge Canal. However, low levels of chlorinated VOCs detected at these locations indicate impacts by other unknown off-site sources as well.

Semi-Volatile Organic Compounds

SVOCs detected in the deep bedrock monitoring wells consist primarily of non-cPAHs. Naphthalene was typically detected at the highest concentrations, but SVOC concentrations in the deep bedrock are much lower than those detected in the shallow and intermediate bedrock.

BMW-04-09 contained the highest concentration of total SVOCs at 1,572 µg/L, 1,300 of which was naphthalene. Four of the five deep bedrock wells had SVOCs at concentrations exceeding SCGs. No SVOCs were detected in the deep bedrock monitoring well BMW-04-13 located west of the site on the other side of the New York State Barge Canal.

Polychlorinated Biphenyls

No PCBs were detected in the deep bedrock monitoring wells.

Metals

Chromium, iron, lead, magnesium, manganese, nickel, sodium, and zinc were detected in one or more deep bedrock monitoring wells at concentrations exceeding SCGs. Sodium was detected at concentrations exceeding its SCG in all five deep bedrock wells. Iron and magnesium were detected at concentrations exceeding their SCGs in nearly all samples (four and three of five, respectively). The other exceedances were isolated single occurrences. The metals concentrations are likely attributable to typical background in the area.

Cyanide

As shown in Tables 4-13 and 4-14, total cyanide was detected in two of the five deep bedrock wells sampled at concentrations ranging from 15.0 µg/L to 20.20 µg/L, which is well below the SCG for cyanide in groundwater of 200 µg/L.

The groundwater samples in which cyanide was detected were not further analyzed to determine the cyanide speciation. This decision was made during the investigation based on the cyanide results exhibited by the soil samples. That is, the majority of the cyanide observed in the soils was determined to be bound in stable iron cyanide complexes and the same would be expected of cyanides observed in the site groundwater.

Total Recoverable Phenolics

Total recoverable phenolics were detected at concentrations above SCGs in only one of the five deep bedrock wells at a concentration of 0.15 mg/L in BMW-04-09.

Miscellaneous Parameters

Samples from four of the deep bedrock wells were analyzed for additional miscellaneous parameters to evaluate geochemical conditions in the subsurface that may affect or indicate the degree of natural attenuation processes occurring at the site. Chloride, sulfide, and TDS were detected at concentrations exceeding their respective SCGs in all four samples. Sulfate was detected at concentrations exceeding its SCG in three of the four deep bedrock well samples analyzed for additional parameters. The parameter pH was detected above its SCG of 8.5 in two of the five deep bedrock groundwater samples. The natural attenuation assessment is presented in Section 5.2.4.

Summary

The major findings of the deep bedrock groundwater sampling during the RI can be summarized as follows:

- VOCs detected at concentrations exceeding SCGs in the deep bedrock consist primarily of BTEX. The highest total BTEX concentrations were detected in BMW-04-09 where DNAPL was observed while rock coring. Overall, concentrations in the deep bedrock are much lower than those detected in the shallow and intermediate bedrock. This is attributable to lower hydraulic conductivity measured in the deep bedrock. The lower hydraulic conductivity values reflect the different lithology in this part of the bedrock section, which corresponds to the lower Burleigh Hill Member and the upper Lewiston Member in that it is more argillaceous and less fractured than the units above.

- SVOCs detected in the deep bedrock monitoring wells consist primarily of non-cPAHs. Concentrations are much lower than those detected in the shallow and intermediate bedrock. BMW-04-09 contained the highest concentration of total SVOCs at 1,572 µg/L, 1,300 of which was naphthalene.

- No PCBs were detected in the intermediate bedrock monitoring wells.

- Chromium, iron, lead, magnesium, manganese, nickel, sodium, and zinc were detected in one or more deep bedrock monitoring wells at concentrations exceeding SCGs. The metals concentrations are likely attributable to the typical background in the area.

- Total cyanide was detected in two of the five deep bedrock wells sampled at concentrations below SCGs, ranging from 15.0 µg/L to 20.2 µg/L.

- Total recoverable phenolics were detected at concentrations above SCGs in only one of the five deep bedrock wells at a concentration of 0.15 mg/L in BMW-04-09.

4.4 DNAPL Observations

DNAPL observations during soil sampling and overburden/bedrock monitoring well installation, development, and sampling were recorded throughout the RI as well as during previous investigations. A summary of the qualitative observations of MGP products at site sampling points in the overburden and bedrock, from both historical investigations and the RI, is included on Tables 4-15 and 4-16 and presented on Figures 4-18 and 4-19, respectively.

Overburden

Additional soil boring descriptions and field observations were summarized on Table 3-1. Coal tar DNAPL in the form of staining or blebs was observed at 12 of the 31 borings advanced during the RI. Sheens attributable to coal tar DNAPL also were noted at two locations (GB-12 and GB-16). In the overburden soil, coal tar DNAPL blebs were primarily observed beneath the western portion of the Transit Street site extending northward beneath LaGrange Street, and beneath the Reid Petroleum property (Mobil Gas Station). DNAPL was not observed in the soil south or east of the site boundary, along the west side of Transit Street, or north of the New York State Barge Canal. Gasoline-like odors or sheens were observed in the soil at BMW-04-02, GB-17, GB-18, GB-22, and GB-24, which were advanced at the Reid Petroleum property.

Bedrock

Coal tar DNAPL was observed within the fractures of bedrock cores in several of the monitoring wells installed during the RI. No DNAPL was observed in the fractures of cores collected directly south of the site, at BMW-04-08 and BMW-04-14; however, sheens and/or odors were present.

DNAPL appears to have advanced within the bedrock primarily north and west of the site. DNAPL was observed in several fractures at monitoring well BMW-04-09 (west-southwest of the site), but the presence of DNAPL was not noted when MW-16 was installed in 1983.

To the west, some component of the coal tar DNAPL is migrating into the unlined Shaft #3 of the Main Interceptor Tunnel. Coal tar DNAPL was observed coating the eastern side of the shaft walls. Also, within the tunnel at approximately 75 feet below grade and north of the site, coal tar DNAPL seeps were observed on the north side of the tunnel, in the vicinity of where DNAPL stains were observed discharging into the New York State Barge Canal (see Figures 2-6 and 4-19).

Coal tar DNAPL was observed in all bedrock monitoring wells installed directly north of the site. DNAPL stains have been observed at the base of the New York State Barge Canal, which is also north of the site. The canal effectively stops the migration of DNAPL any further northward in the shallow and intermediate bedrock. In the deep bedrock, DNAPL was not observed when coring at BMW-04-10 located north of the canal; however, during well development tiny coal tar blebs entered the well, indicating coal tar DNAPL is present in the vicinity. The groundwater sample from BMW-04-10 reported only low concentrations of VOCs.

To the east and northeast, coal tar DNAPL was observed in trace amounts in a single fracture at MW-09 (approximately 47.5 feet bgs), and reportedly seen in the historical wells MW-13 and MW-15, when they were originally installed. Because the original MW-15 could not be located during the RI, it subsequently was replaced and coal tar DNAPL was not observed in the replacement well MW-15. Therefore, coal tar DNAPL in the bedrock appears to be present slightly northeast of MW-13, and extends slightly east in the vicinity of MW-09. The horizontal and vertical extent of DNAPL in the bedrock has been fully delineated as part of this investigation.

DNAPL Recovery

Several rounds of DNAPL measurements were performed during the RI using a weighted string. DNAPL was observed to accumulate in one well (BMW-04-11) at recoverable quantities. Traces of DNAPL (at unrecoverable quantities) were also observed in wells BMW-04-03, BMW-04-12, MW-01, MW-02, MW-03, MW-06, MW-08, and MW-10. However, some quantities of DNAPL were recovered from these wells when removing large amounts of water during well development activities. In addition, active DNAPL recovery has been conducted. To date, 13.59 liters of DNAPL have been recovered from well BMW-04-11. Table 4-17 summarizes DNAPL recovery efforts to date.

Samples of DNAPL were collected from bedrock monitoring wells at locations BMW-04-11 (on April 4, 2005 and June 14, 2005) and MW-02 (June 14, 2005) and sent to META for environmental forensic analyses, which included petroleum fingerprint and extended PAH analyses (i.e. the typical 8270 analysis plus additional derivative compounds). The April 2005 sample from BMW-04-11 also was analyzed for VOCs, TCLP VOCs, reactive cyanide and sulfide, ignitability, pH, percent sulfur, specific gravity, and viscosity. The June 2005 samples also were sent to STL for analysis of TCL SVOCs and PCBs. The results from these samples are presented on Tables 4-18 and 4-19. The DNAPL was observed to have a flash point of 130 degrees Fahrenheit, a specific conductivity of 1.1, and a kinematic viscosity of 9.9 centiStokes.

4.5 Surface Water Quality

The distribution of all analytes exceeding SCGs in surface water samples collected during the RI is shown on Figure 4-20. The analytical results for the nine surface water samples collected from the New York State Barge Canal during the RI are summarized in Table 4-20. A statistical summary of the detections in the surface water samples is presented in Table 4-21. The New York State Barge Canal is classified as a Class C water body by the NYSDEC.

Volatile Organic Compounds

Acetone, bromodichloromethane, chloroform, dibromochloromethane, trichloroethene, tetrachloroethene, cis-1,2-dichloroethene, and 1,1,1-trichloroethane were detected in one or more of the surface water samples collected from the New York State Barge Canal during the RI. All concentrations were below SCGs, and none of these compounds are associated with MGP residuals.

Semi-Volatile Organic Compounds

No SVOCs were detected in the surface water samples collected from the New York State Barge Canal during the RI.

Polychlorinated Biphenyls

No PCB compounds were detected in the surface water samples collected from the New York State Barge Canal during the RI.

Metals

Aluminum, barium, calcium, chromium, copper, iron, lead, magnesium, manganese, potassium, sodium, vanadium, and zinc were detected in one or more of the surface water samples collected from the New York State Barge Canal during the RI. As shown on Figure 4-20, the concentration of iron in five of the surface water samples exceeded the SCG for this parameter. All concentrations of vanadium were below the SCG for this parameter. There are no SCGs for total concentrations of the remaining metals detected in the samples.

Total Recoverable Phenolics

Total recoverable phenolics were detected in only one of the surface water samples collected from the New York State Barge Canal during the RI. As shown on Figure 4-20, the concentration at location SW-08 exceeded the SCG for this parameter. This location is a considerable distance upstream from both the Transit Street and State Road former MGP sites, and is not considered to be impacted by waste generated during former operations at these sites.

Summary

The major findings of the surface water sampling during the RI can be summarized as follows:

- No VOCs were detected at concentrations in exceedance of the SCGs. Reported concentrations of acetone and chlorinated hydrocarbons are below SCGs; however, the presence of these compounds are not MGP-related and indicate that these contributions are from other unknown source(s).

- SVOCs were not detected in any surface water samples at any concentration.

- PCBs were not detected in any surface water samples at any concentration.

- The concentrations of iron in five of the surface water samples exceeded the SCG for this parameter. All concentrations of vanadium were below the SCG for this parameter. There are no SCGs for total concentrations of the remaining metals detected in the samples.

- The concentration of total recoverable phenolics at location SW-08 exceeded the SCG for this parameter. However, this location is a considerable distance upstream from both the Transit Street and State Road former MGP sites, and is not impacted by waste by-products generated during former operations at these sites. Total recoverable phenolics were not detected in any of the remaining surface water samples collected from the New York State Barge Canal during the RI.

4.6 Sediment Quality

This section discusses the analytical results for the sediment samples collected during the RI.

4.6.1 Qualitative Findings

The various sediment conditions encountered across the study area are summarized below. Transects and sediment sampling locations are presented on Figures 2-3 and 2-4. Table 2-3 summarizes the sediment samples collected, sediment characteristics, and analyses. Transect profile summaries are included on Table 4-22. A summary of findings from the bucket auger sample locations, BA-01 through BA-12, is presented on Table 4-23.

In general, sediment thickness was relatively thin in the central portions of the transects, and tended to be significantly thicker (up to greater than 10.4 feet) at the base of the north and south New York State Barge Canal walls where talus material has accumulated. The sediments were generally characterized as light to dark brown, gray, black, and brownish-gray silts and clayey silts with varying amounts of organic material. Bedrock was exposed or was observed to be covered with less than 0.25 foot of sediments at approximately 20% of all sediment thickness sampling locations (see Table 4-22).

Numerous foreign objects and debris, including several shopping carts, a motorcycle, an automobile battery, a lawn mower, tires, a 55-gallon drum and general construction debris (bricks, rebar and lumber) were observed within the New York State Barge Canal.

The New York State Barge Canal is classified as a Class C surface water body by the NYSDEC. Class C surface water can be used for irrigation, food preparation, fishing, or primary and secondary contact recreation. Water is not withdrawn from the New York State Barge Canal for potable use. The Canal is open to discharge from multiple point and non-point sources. Over 25 non-permitted water discharge pipes ranging in diameter from 3 to 30 inches were observed in the survey area in addition to two State Pollutant Discharge Elimination System (SPDES) discharges. Observed flows in these outfall pipes ranged from non-existent to at least 5 gallons per minute. No stained or discolored discharges were noted emanating from the discharge pipes. Figure 2-3 presents the observed discharge pipe sizes and locations in the study area. White precipitate and MGP-related dark brown, viscous coal tar stains were observed on the rock face approximately 10 to 15 feet below the top of the Rochester Shale in the vicinity of transects TS-09, TS-10, and TS-11 on the south side of the New York State Barge Canal. Disturbance of the sediment in the vicinity of these transect locations along the south wall of the canal produced a sheen. In addition, tar was observed on some of the rock fragments at the base of the canal wall.

All PID readings of sediment cores and headspace samples were non-detect, with a few minor exceptions. A maximum value of 5.9 parts per million (ppm) above background was observed in TS-05 at a depth of 3 to 4 feet in sediments with a slight petroleum-like odor. Several other samples exhibited PID readings of 1 to 2 ppm above background, which is most likely attributable to the samples' high moisture content, since there was a total lack of staining and odor.

4.6.2 Quantitative Findings

Sediment criteria have been developed by the NYSDEC in accordance with their Technical Guidance for Screening Contaminated Sediments document (NYSDEC, 1999), which details the methodology for determining acceptable levels of non-polar organic contaminants and metals. Within this document NYSDEC identifies the following four categories of protection from which sediment criteria can be derived for non-polar organic compounds, and that can be used to evaluate the potential human health and environmental risk:

- Human health bioaccumulation

- Wildlife bioaccumulation
- Benthic aquatic life acute toxicity
- Benthic aquatic life chronic toxicity

Sediment criteria have been derived by the NYSDEC for 63 non-polar organic compounds or classes of compounds using the equilibrium partitioning methodology. A sediment is considered to be contaminated if the contaminant concentration exceeds the criteria for any of the categories of health and environmental risk. For non-polar organic contaminants, sediment to be considered (TBC) criteria can be calculated on a sample-specific basis using the applicable surface water quality standards and the chemical properties of the compound. TBCs can be calculated for parameters with known surface water criteria and octanol-water partition coefficients (K_{ow}). K_{ow} is defined as a measure of the degree to which an organic chemical will preferentially dissolve in water or an organic solvent. If the TOC of the sample is known, then a sample-specific guidance value can be calculated. Sample-specific SCGs were calculated for all sediment samples collected.

For metals contaminants, sediment screening criteria are based upon the chemical effects data. New York State-established screening criteria for sediments follow the Ministry of Ontario guidelines (Persaud et al., 1992) and chemical effects data developed by the National Oceanic and Atmospheric Agency (NOAA) (Long and Morgan, 1990). The Ministry of Ontario guidelines span background, lowest effect level (i.e., LEL-concentration in sediment that can be tolerated by the majority of benthic organisms, but still causes toxicity to a few species), and severe effect level (i.e., SEL-concentration at which pronounced disturbance of the sediment-dwelling community can be expected). Long and Morgan categorized chemical effects data in sediments according to low and median toxic effects (i.e., effects range-low [ER-L] and effects range-median [ER-M]). The lowest concentration in each of the two effects was selected as the NYSDEC sediment screening criterion (NYSDEC, January 1999). Using this methodology, the NYSDEC has established criteria for twelve metals: antimony, arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc. The criteria were used as a baseline comparison for evaluating metals concentrations in sediment samples collected from the New York State Barge Canal.

The analytical results for all 53 sediment samples are summarized and compared to SCGs in Tables 4-24 through 4-28. Statistical summaries of the detections in the sediment samples are presented in Table 4-29. The distribution of total BTEX, cPAHs, PAHs, SVOCs, PCBs, and cyanide in the sediment samples is depicted on Figures 4-21 through 4-24. The distribution of all compounds and analytes exceeding SCGs in the sediment samples collected during the RI is shown on Figures 4-25 through 4-48.

Because of the large area of the New York State Barge Canal that was investigated, the figures are divided into four areas corresponding to the area below the locks (Area 1), the area from the locks to the Transit Street bridge crossing (Area 2), the area from the Transit Street bridge crossing to just upstream of the High Street bridge crossing (Area 3), and the area from just upstream of the High Street bridge crossing to upstream of the Route 93 bridge (Area 4).

BTEX

As shown in Table 4-29, benzene was detected in one of the 53 sediment samples collected during the RI, at location SED-17 (0 – 1 foot). The concentration of benzene at this location was below the SCG for all categories of protection. Toluene, ethylbenzene, and xylene were not detected in any of the sediment samples.

Semi-Volatile Organic Compounds

As shown in Tables 4-24 through 4-27, one or more SVOCs were detected in 41 of the 53 sediment samples collected during the RI. Reported concentrations of benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene exceeded their respective SCGs for the Human Health Bioaccumulation Level of Protection at one or more locations. All reported SVOC concentrations were below the SCGs for the Wildlife Bioaccumulation Level of Protection. Reported concentrations of benzo(a)anthracene exceeded the SCG for the Benthic Aquatic Life Acute Toxicity Level of Protection at one or more locations. Reported concentrations of benzo(a)anthracene, bis(2-

ethylhexyl)phthalate, phenanthrene, and fluorene, exceeded their respective SCG for the Benthic Aquatic Life Chronic Toxicity Level of Protection at one or more locations.

Most of the SVOCs detected were PAHs. As shown on Tables 4-24 through 4-27, the detected concentrations of total PAHs ranged from 180 µg/kg at location SED-23 (1.5-2.5 feet) to 59,400 µg/kg at location SED-15 (0.5-1.5 feet). Total cPAH concentrations ranged from 420 µg/kg at location SED-01 (0-1 foot) to 30,100 µg/kg at location SED-15 (0.5-1.5 feet). Total non-cPAH concentrations ranged from 180 µg/kg at location SED-23 (1.5-2.5 feet) to 29,300 µg/kg at location SED-15 (0.5-1.5 feet). Total SVOCs ranged from 180 µg/kg at location SED-23 (1.5-2.5 feet) to 70,400 µg/kg at location SED-15 (0.5-1.5 feet). The distribution of SVOCs and PAHs exceeding SCGs in sediment samples collected during the RI is shown on Figures 4-25 through 4-40. As shown on Figures 4-25 through 4-40, the highest SVOC and PAH concentrations (including cPAHs and non-cPAHs) were detected in sediment samples collected within Areas 1 and 2, specifically, the sections of the New York State Barge Canal immediately downstream of the locks (locations SED-15, SED-22, SED-23, and SED-24) and along the south side of the canal in the vicinity of and downstream of the Transit Street bridge crossing (locations SED-06, SED-08, SED-16, SED-17, SED-18, and SED-25). The locations in the vicinity of the Transit Street Bridge are hydraulically downgradient from the Transit Street former MGP site, and have likely been impacted by contaminants from past operations at the site. During RI field activities, DNAPL stains were observed on the bedrock (canal wall) in this region of the canal. The locations immediately downstream of the locks are all in the general vicinity of the by-pass conduit through which water from the canal/locks flows as it bypasses the northern-most section of the locks. There is also a permitted SPDES outfall along the north side of the canal near the intake of the conduit (adjacent to sediment location SED-12). This outfall is situated on the north side of the canal and is a potential source of sediment contaminants in the vicinity.

While a portion of the elevated SVOC/PAH concentrations at locations SED-15, SED-22, SED-23, and SED-24 may have resulted from the downstream transport of contaminants from the Transit Street former MGP site via the canal or the by-pass conduit, the data suggest other potential major sources as well. The highest concentrations of SVOCs in sediment detected during the RI were at location SED-15 (0.5-1.5 feet), which is approximately 200 feet directly downstream of the conduit. The total SVOC/PAH concentrations at locations SED-15, SED-22, SED-23, and SED-24 are, on average, similar to or higher than those at locations SED-06, SED-08, SED-16, SED-17, SED-18, and SED-25, near which DNAPL stains, were observed on the bedrock face in the canal. The elevated concentrations at the latter locations can be, at least in part, attributed to former DNAPL discharges into the canal in this area. However, other urban and potentially former and current industrial sources that operate(ed) are or may have contributed to contamination along the study corridor and below the locks. This is further substantiated by the relatively low SVOC/PAH concentrations at locations SED-10, SED-19, SED-20, and SED-30, which are located between the two areas of higher SVOC/PAH concentrations (i.e., Areas 1 and 2).

Concentrations of PAHs and SVOCs in the sediments along the northern side of the canal in the vicinity of the DNAPL stains (i.e., locations SED-07, SED-09, SED-26, and SED-29) are consistent with those detected at upstream and locations. These sediments do not appear to have been impacted by waste generated during operations at the Transit Street former MGP site. Concentrations of SVOCs/PAHs in the sediments collected at locations adjacent to the State Road former MGP site are also relatively low, and consistent with those in sediments at upstream and downstream locations not expected to have been impacted by waste generated during operations at the Transit Street former MGP site.

Polychlorinated Biphenyls

As shown in Tables 4-24 through 4-27, PCBs (Aroclors 1242, 1248, 1254, and/or 1260) were detected in all 53 of the sediment samples collected during the RI. As depicted on Figures 4-25 through 4-48, reported concentrations of Aroclors 1242, 1248, 1254, and 1260 exceeded their respective SCGs for the Human Health Bioaccumulation, Wildlife Bioaccumulation, and Benthic Aquatic Life Chronic Toxicity Levels of Protection at one or more locations. Reported concentrations of Aroclor 1242 exceeded the SCG for the Benthic Aquatic Life Acute Toxicity Level of Protection.

Detected PCB concentrations ranged from 7 µg/kg at location SED-14 (1.5-2.5 feet) to 310,000 µg/kg at location SED-22 (2-3 feet). As shown on Figures 4-25 through 4-40, the highest total PCB concentrations were detected in the sediments collected in Area 1. As with the PAH/SVOC concentrations, the PCB concentrations in the sediment samples collected from Area 1 were, on average, greater than those in the other three study areas, including the section of Area 2 downgradient of the site at which DNAPL stains were observed on the bedrock wall in the canal. Again, this suggests that the elevated concentrations in the Area 1 sediments have been impacted by sources not associated with the Transit Street MGP site. This is further substantiated by the absence of PCBs in the NAPL samples and soil samples collected directly from the site source areas.

With the exception of locations SED-16 (0-1 foot) and SED-18 (0-1 foot), the PCB concentrations in the sediments collected from the section of Area 2 downgradient of the site are consistent with those at both upstream and downstream locations (other than those in Area 1), and along both sides of the canal. The moderately elevated concentrations at locations SED-16 (0-1 foot) and SED-18 (0-1 foot) are likely due to other unknown sources not associated with the Transit Street former MGP site, as PCBs were not detected in the NAPL samples collected directly from the site.

Metals

As shown in Table 4-28 and depicted on Figures 4-41, 4-43, 4-45, and 4-47, arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc were detected at concentrations that exceeded the LEL SCGs in one or more of the sediment samples collected during the RI. As shown in Table 4-28 and depicted on Figures 4-42, 4-44, 4-46, and 4-48, copper, lead, manganese, mercury, nickel, silver, and zinc were detected at concentrations that exceeded the SEL SCGs in one or more of the sediment samples.

On average, the number of metals exceeding criteria was greatest in samples collected in Area 2. However, both the number and concentrations of metals in the sediment samples collected at locations near which DNAPL stains were observed on the bedrock wall in the canal (i.e., SED-06, SED-08, SED-16, SED-17, SED-18, and SED-25) were consistent with those at other locations in Area 2 that are not expected to have been impacted by waste generated during operations at the former Transit Street MGP site. Instead, the elevated metals concentrations in Area 2 sediments relative to those in the other study areas can likely be attributed to the increased urbanization (i.e., potential for industrial discharges, stormwater runoff, etc.) in Area 2 as compared to the other areas investigated. The two locations exhibiting the highest number of metals exceeding LEL and/or SEL criteria are SED-13 (2-3 feet) with 10 metals exceeding LEL criteria and 4 exceeding SEL criteria, and SED-32 (4-4.8 feet) with 10 metals exceeding LEL criteria and 3 exceeding SEL criteria. Both of these locations are in the northern section of Area 1 downstream of the site, and both are located in the immediate vicinity of a SPDES outfall.

Total Cyanide

Figures 4-21 through 4-24 show the distribution of total cyanide in the 53 sediment samples collected during the RI. There are no established SCGs for total cyanide. As shown in Tables 4-24 through 4-27, total cyanide was detected only in 4 of the 53 sediment samples collected during the RI, all of which were located in the area of the canal adjacent to/downgradient of the Transit Street former MGP site. While the exact source of the cyanide in these sediments cannot be definitively determined from the available data, it is possible that their presence is due, at least in part, to waste generated during operations at the Transit Street former MGP site.

The four sediment samples in which total cyanide was detected by STL were sent to Clarkson University for further analysis to determine the amount of free cyanide and the various cyanide species present. The results are presented in the following table.

Location ID	**Total Cyanide (STL) (mg/kg)**	**Total Cyanide (Clarkson) (mg/kg)**	**Free Cyanide (mg/kg)**	**Ferric/Ferrous Iron Cyanide Complex (mg/kg)**	**Unknown Iron Cyanide Complex (mg/kg)**
SED-06 (0-1)	1.6	0.264	<0.030	0.203	Not Detected
SED-09 (0-1)	1.5	0.440	<0.050	0.267	Not Detected Not Detected
SED-16 (0-1)	1.4	0.368	<0.050	0.386	Not Detected
SED-17 (0-1)	2.6	0.200	<0.030	0.124	Not Detected

The differences in the total cyanide results between the STL and Clarkson analyses are likely due to the differences in the analytical methods used by the laboratories. The sample preparation procedures used by the Clarkson laboratory involve an alkaline digestion process that is generally not used by commercial environmental testing laboratories. Typically, this results in concentrations that are higher than those reported by the commercial laboratories (Ish Inc., May 2005). It is unclear why the total sediment concentrations reported by the Clarkson laboratory are lower than those reported by STL, although a similar pattern was observed in samples analyzed as part of another RI performed by URS (URS 2006). During that study, the Clarkson laboratory relative to those reported by STL, generally reported higher soil concentrations but lower sediment concentrations. The sediment matrix may be affecting the recovery of cyanide in the sediment samples.

Although there are differences between the total concentrations, the data from all of the analyses performed by the Clarkson laboratory indicate that there was no detectable free cyanide in the samples, and that most or all of the cyanide exists as iron-cyanide complexes. The remaining unclassified cyanide (i.e., species other than free, ferric/ferrous iron, or unknown iron cyanide) can be attributed to limitations in the accuracy of the analytical methods used and/or the possibility that the cyanide is bonded in other complexes that were not determined. Cyanides that are present in the sediment in the form of stable iron-cyanide complexes, and not as free cyanide, are not known to be a toxicological concern.

Total Recoverable Phenolics

Total recoverable phenolics were not detected in any of the 53 sediment samples collected during the RI.

Summary

The major findings of the sediment sampling can be summarized as follows:

- Benzene was detected in one of the sediment samples collected during the RI, at a concentration below the SCGs for all four levels of protection. No other BTEX compounds were detected in the sediment samples.

- Several SVOCs, primarily PAHs, were detected in sediment samples collected as part of the RI. Reported concentrations of benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene, exceeded their respective SCG for the Human Health Bioaccumulation Level of Protection at one or more locations. All reported SVOC/PAH concentrations were below the SCGs for the Wildlife Bioaccumulation Level of Protection. Reported concentrations of benzo(a)anthracene exceeded the SCG for the Benthic Aquatic Life Acute Toxicity Level of Protection at one or more locations. Reported concentrations of benzo(a)anthracene, bis(2-ethylhexyl)phthalate, phenanthrene, and fluorene exceeded their respective SCG for the Benthic Aquatic Life Chronic Toxicity Level of Protection at one or more locations. Sediments at locations SED-06, SED-08, SED-16, SED-17, SED-18, and SED-25 appear to have been impacted by former NAPL discharges into the canal in this area and the NAPL source appears to be coal tar residuals at the Transit Street former MGP site. The presence of SVOCs/PAHs at the remaining sediment locations are likely due to other urban and industrial sources not related to former site operations. The sediments in the canal at locations adjacent to the State Road former MGP site also do not appear to be impacted by MGP-related waste.

- PCB compounds (Aroclors 1242, 1248, 1254, and/or 1260) were detected in all of the sediment samples collected during the RI, at concentrations exceeding their respective SCGs for the Human Health Bioaccumulation, Wildlife Bioaccumulation, and Benthic Aquatic Life Chronic Toxicity Levels of Protection at one or more locations. Reported concentrations of Aroclor 1242 exceeded the SCG for the Benthic Aquatic Life Acute Toxicity Level of Protection. The presence of PCBs in the sediments is not attributable to operations at the Transit Street former MGP site.

- Arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc were detected at concentrations that exceeded the LEL SCGs in one or more of the sediment samples. Copper, lead, manganese, mercury, nickel, silver, and zinc were detected at concentrations that exceeded the SEL SCGs in one or more of the sediment samples. The presence of these metals in the sediments does not appear to be related to operations at the Transit Street former MGP site.

- Total cyanide was detected in 4 of the 53 sediment samples collected during the RI, all of which were from locations adjacent to/downgradient of the Transit Street site. Cyanide was not detected in the sediments collected upstream or downstream of the site. The majority of the cyanide detected was determined to exist as stable iron cyanide complexes. There are no established SCGs for cyanide.

- Total recoverable phenolics were not detected in any of the sediment samples collected during the RI.

4.6.3 Source Area Comparison

NAPL

Table 4-18 presents the chemical data for the dense non-aqueous phase liquid (DNAPL) sample collected from well BMW-04-11. No PCBs were detected in the DNAPL, which represents the worst-case example of contaminants related to the Transit Street Former MGP site. Given the absence of PCBs in the site DNAPL, the observed DNAPL stains on the bedrock wall in the canal cannot be contributing PCBs to the New York State Barge Canal.

Sediment samples collected in the section of the New York State Barge Canal at which the DNAPL stains were observed exhibited some of the highest PAH concentrations, indicating that the sediments in this region of the canal may have been impacted by waste from the Transit Street Former MGP site. However, the forensic evaluation of these sediments indicate that, as with sediments collected in other sections of the canal, the sediments collected in the vicinity of the stains have been impacted by other sources not related to the former MGP site. Therefore, the DNAPL stains are only one of potentially several contributing sources of contamination. A summary of the forensics evaluation is presented below.

Surface and Subsurface Soil

Tables 4-2 and 4-4 present statistical summaries of all of the surface soil and subsurface soil samples collected during the RI and indicate that:

- PCB compounds were only detected in 2 of the 50 soil samples collected at concentrations ranging from 14 to 58 μg/kg. This extent and quantity of PCB contamination is significantly less than that observed in the New York State Barge Canal, indicating that the NYSEG Transit Street and State Road sites are not the source of the PCBs in the New York State Barge Canal.

- While PAHs were detected in most of the surface and subsurface soil samples collected during the RI, the distribution and concentrations of PAHs in the sediments indicate that other sources of PAHs have impacted the sediments in all sections of the New York State Barge Canal. This is consistent with the findings of the forensics evaluation, which is summarized below. In addition, PAHs in soils are relatively immobile, and it is not expected that PAHs from the soil are a source of PAHs in the sediments.

- While metals exceeding SCGs were detected in the surface and subsurface soil samples collected during the RI, the distribution and concentrations of metals in the sediments indicate that other sources of metals have impacted the sediments in all sections of the New York State Barge Canal. As previously noted, the highest metals concentrations were observed in areas of relatively high urbanization and/or in the vicinity of outfalls into the canal.

Groundwater

The New York State Barge Canal acts as a regional sink for groundwater present in the overburden and shallow bedrock. Hence, groundwater in both the overburden and shallow bedrock flows towards the New York State Barge Canal. No PCBs were detected in any of the groundwater samples collected during the RI. While VOCs, SVOCs/PAHs, and metals were detected at concentrations exceeding SGCs at several groundwater locations, groundwater is not expected to be a major source of contaminants in the canal sediments.

Forensic Evaluation of Sediments

To assess the potential sources of PAH contamination in sediments from the New York State Barge Canal, sediment samples were sent to META Environmental, Inc. (META) for forensics analysis. Hydrocarbon fingerprints and extended PAH analyses/diagnostic PAH ratios, as well as site history and observations made during the RI, were evaluated during the forensics analysis. DNAPL and soil samples from suspected contaminant source areas were also sent to META for analysis so that PAHs in the sediments could be compared to those from the suspected source areas. META's complete forensics report is provided in Appendix I. Based on their evaluation of the forensics parameters, META has reported the following:

- All three DNAPL samples submitted for analysis contained PAH ratios consistent with CWG tar. These samples were collected from monitoring well locations BMW-04-11 and MW-02. BMW-04-11 is located along LaGrange Street just outside the northern perimeter of the Transit Street site. MW-02 is located northwest of the site along the eastern edge of the New York State Barge Canal. The CWG tar in the sample collected from location MW-02 appeared to be more weathered, and also contained severely weathered gasoline.

- Only two of the soil samples, GB-07 (5.0-5.2 feet) and GB-08 (12-14 feet), appeared to be impacted by CWG tar, as the forensics results were similar to those of the three DNAPL samples. However, some differences were noted that may have been due to weathering, mixing of PAH sources, and/or differences in tar composition. Both of these samples were located along LaGrange Street just outside the northern perimeter of the Transit Street site.

- The remaining soil samples submitted for forensics analysis had hydrocarbon fingerprints and diagnostic PAH ratios consistent with coal carbonization (CC) or coke oven (CO) derived materials and/or urban background. The soils from the State

Road site were more variable and different than those from the Transit Street site, and were likely impacted by multiple sources of contaminants.

- Based on a comparison of the sediment data to the data for the DNAPL and soil samples described above, META concluded that the sediment samples collected from the New York State Barge Canal do not appear to be impacted by CWG tar or related PAH sources. Rather, the sediments all contain varying mixtures of pyrogenic, petrogenic, and biogenic PAH sources, which is consistent with sediments in many urban waterways. META also concluded that sediment samples SED-06 (0-1 feet), SED-14 (0.5-1.5 feet), SED-15 (0.5-1.5 feet), and SED-24 (0-1 feet) appeared to contain PAHs from the same source as the soil samples collected from the State Road site.

4.7 Soil Vapor Quality

The results for the soil gas samples, sub-slab samples, indoor and outdoor ambient air samples are summarized on Table 4-28. Outdoor ambient air samples were collected at a rate of one per area sampled per day of sampling and were place immediately upwind of the sampling locations. The results for 1,1,1-trichloroethane, BTEX, and naphthalene are presented for all locations on Figure 4-49. 1,1,1-trichloroethane is included on the figure because it was elevated in the on-site subslab sample collected from beneath the warehouse building on the southeast corner of the site. The elevated result for naphthalene in sample H-03-IA-B was likely due to the presence of mothballs in this basement location.

5.0 CONTAMINANT FATE AND TRANSPORT

This section describes fate and transport processes that may influence the behavior of the contaminants detected at the site. The discussion emphasizes the processes that are essential in evaluating potential exposure of human and environmental receptors to the site contaminants detected at concentrations above the SCGs. The following items are presented in this section:

- General description of fate and transport processes occurring in soil, sediment, surface water, and groundwater systems.
- Identification and description of properties of contaminants detected at the site above the SCGs in the soil, sediment, surface water, and groundwater.
- Media-specific and contaminant-specific evaluation of potential fate and transport mechanisms occurring at the site.

No surface soil samples were collected during previous investigations. Contaminants identified in the surface soils collected as part of the RI above SCGs are PAHs and metals. All surface soils were collected at off-site locations. Contaminants in the on-site and off-site subsurface soils above SCGs during the RI and/or previous investigations are VOCs, SVOCs, and metals. In the on-site/off-site groundwater, contaminants above SCGs during the RI and/or previous investigations are VOCs, SVOCs, metals, and total recoverable phenolics. The water quality parameters of chloride, sulfate, sulfide, total dissolved solids, and pH also exceeded SCGs in the groundwater samples. Contaminants identified in the surface water samples above SCGs during the RI and/or previous investigations are VOCs, SVOCs, total iron, and total recoverable phenolics. In the sediment samples, contaminants detected above SCGs during the RI and/or previous investigations are VOCs, SVOCs, PCBs, and metals.

Total cyanide was detected in several surface soil, subsurface soil, and sediment samples collected. The majority of the cyanide detected was determined to exist as stable iron-cyanide complexes. There are no established SCGs for total cyanide.

VOCs were detected in soil vapor and indoor/ambient air samples collected during the RI. There are no established SCGs for VOCs in these matrices.

A detailed presentation of medium-specific contaminants detected during the RI and during previous investigations is provided in Section 4.0 of this report.

5.1 General Description of Fate and Transport Mechanisms

This section provides general descriptions of the fate and transport processes that can occur in the environment in which samples were collected as part of previous investigations or during the RI. In addition, the site characteristics that can affect these processes are discussed.

5.1.1 Transport Processes

Contaminant transport in the subsurface can occur as movement of discrete phase light non-aqueous phase liquid (LNAPL) or DNAPL in the vadose zone (i.e., above the water table), saturated zone (i.e., below the water table), and/or fractures in the underlying bedrock; migration of dissolved contaminants in groundwater; and/or as migration of volatilized contaminants in the soil vapor. The primary transport mechanisms are advection, dispersion, and partitioning of mass.

Advection occurs when the contaminant is carried along as part of the groundwater or soil vapor flow. Dispersion refers to the spreading of the migrating contaminants with or without actual groundwater movement due to diffusion and mechanical mixing created by non-uniformities in the flow field. Dispersion results in the widening of the affected area, as well as in the smearing of the plume boundaries.

Mass partitioning is a process in which contaminants move between different environmental media in response to concentration gradients. For example, contaminants dissolved in groundwater may sorb (i.e., attach) onto soil particles or volatilize into the soil vapor. The process may involve mass transfer in any direction between any of the environmental media.

The net result of mass partitioning is the distribution of the contaminant between all phases that remain in physical contact. Typically, mass partitioning acts to inhibit the migration of contaminants in groundwater or soil vapor by immobilizing a part of the mass in the soil matrix (retardation). However, the process may be reversed, resulting in the slow release of the sorbed contamination into the groundwater or soil vapor.

In the vadose zone, the total mass of a contaminant is partitioned between the dissolved phase (soil moisture), the gas phase (soil vapor), and the solid phase (soil matrix). In the saturated zone, the soil vapor phase is absent and the partitioning occurs only between the soil matrix and groundwater. Under equilibrium conditions, each phase contains a fraction of the total contaminant mass present in the system (i.e., total of both phases equals 100 percent of the contaminant mass present). The relative mass fractions are determined by the properties of each contaminant and by the nature of the soil matrix. Equilibrium conditions may be disturbed by phenomena such as migration of contaminated groundwater or soil vapor into an area, or removal of contaminant mass from one of the media through degradation processes or gravity flow. The changes in concentration gradients created by these circumstances result in the occurrence of mass transfer between the media until equilibrium is re-established.

The contaminant mass sorbed onto the soil matrix is essentially immobile, with the exception of contaminants in the topmost soil layer, which can be transported by processes (such as wind or surface runoff) capable of moving soil particles. Sorbed contaminants generally act as a source for the dissolved and vapor phases.

Transport of contaminants dissolved in the soil moisture in the unsaturated zone is generally limited as a result of very low flow rates in the absence of full saturation. The only significant mechanisms may be driven by water level fluctuations and gravity-driven downward flow during wet-weather periods. Such vertical transport of contaminants acts as a source for the saturated zone below.

The contaminant mass contained within the soil vapor and within groundwater in the saturated zone is more mobile. Soil vapor can migrate in both vertical and horizontal directions in response to pressure gradients. The migration can create a discharge of contaminants into the atmosphere or adjacent building basements, or act as a source of contamination for the groundwater in the saturated zone. The migrating soil gas may transfer mass into the soil matrix and soil moisture in previously uncontaminated areas, thus increasing the areal extent of soil contamination in the unsaturated zone.

The primary transport mechanisms for contaminants dissolved in groundwater are advection and dispersion. The magnitude of dispersion is site specific and is generally difficult to measure. Processes similar to those that occur for soil vapor can enable dissolved contaminants to reach a previously uncontaminated area and enter other environmental media.

Contaminants migrating with soil vapor or groundwater constantly interact with the soil matrix. The driving forces behind this process are created by concentration gradients between different phases, and the properties of the contaminants and the soil matrix. Contaminant mass may either sorb from the mobile soil vapor or groundwater onto the soil particles or it may undergo a reverse process of desorption.

In the case of sorption, contaminant mass is transferred from the mobile medium into the immobile soil medium. This phenomenon tends to retard contaminant migration, and is consequently referred to as retardation. The magnitude of the retardation depends on the properties of each contaminant and the soil matrix. The key indicator parameter for the retardation properties of the soil is the organic carbon content. Soils with high organic carbon content sorb dissolved contaminants more readily and create a more significant retardation effect than soils with limited, or no organic carbon content. Desorption is the process of transferring contaminants from the soil matrix into the groundwater or soil gas. As a result, soils containing contaminant mass may act as a source if exposed to the less-contaminated soil vapor or groundwater. Desorption from soil into the soil vapor or groundwater is increasingly inhibited by increasing content of organic carbon in the soil.

The primary transport mechanisms in surface water are advection, dispersion, and partitioning of mass. These processes are essentially the same as described for groundwater, although advection and dispersion of contaminants in many surface water systems is significantly enhanced due to the increased flow relative to most groundwater systems. In addition, partitioning of mass (volatilization) into the air is substantially greater in surface water systems. The transport of contaminants in surface water is also affected by flocculation and/or precipitation of contaminants. These processes may change the rate at which contaminants are transported or may cause them to settle out of the surface water into the sediment.

Partitioning of mass and erosion/particle entrainment are two primary transport mechanisms of contaminants in sediment. Contaminants sorbed to sediment particles are in equilibrium with the surface water immediately adjacent to the particles, based on the organic carbon content of the sediment and partitioning properties of each contaminant. Contaminants that desorb from the sediment into the surface water are then affected by surface water transport mechanisms. Particle entrainment is a process where sediment particles are moved from one location to another due to turbulent surface water flow. Contaminants in the sediment are thus transported along with the sediment particles.

5.1.2 Mass Destruction Processes

Most contaminant mass contained within the saturated formation and in sediments is not exposed to sunlight or the atmosphere. Therefore, abiotic mass destruction processes that rely on the presence of air or exposure to sunlight (such as hydrolysis and photolysis) have little impact within the subsurface and in sediments and will not be discussed. (The exception is contaminant mass exposed at the ground surface or at the sediment/surface water interface. However, this is typically only a small percentage of the total contaminant mass contained in the subsurface/sediment.)

The most significant mass destruction process that takes place in subsurface/sediment environments is microbial degradation. The microbial degradation processes for organic contaminants that operate in groundwater systems are biological oxidation, reductive dechlorination, and cometabolic degradation.

During degradation, organic compounds may be transformed into daughter forms, which may be recalcitrant or further degradable. Daughter compounds can be either more or less toxic than the parent compounds. If a contaminant degrades into a sequence of degradable daughter compounds, it is ultimately fully metabolized into such compounds as carbon dioxide, methane, water, and chloride (when chlorinated hydrocarbons are degraded).

5.2 Fate and Transport of Site Contaminants

In the past, the Transit Street site was used as a production facility for manufactured (coal) gas. Other kinds of wastes generated by the manufacturing process may have also been stored or processed at the site (coal slag, purifier wastes, coal tar, and tar decanter waste waters). Waste water generated at similar MGP sites have been shown to contain ammonia, cyanides, phenolic compounds, sulfides, oil and greases, acids and alkalis, and a variety of toxic organic pollutants.

This section discusses the possible fate and transport of the contaminants identified at the site. The properties of these contaminants that will impact their fate and transport are also discussed.

5.2.1 Contaminant Properties

As described in Section 4.0, several groups of compounds were detected at concentrations above SCGs: VOCs (BTEX, MTBE, cyclohexanes, acetone, chlorinated hydrocarbons, styrene, isopropylbenzene), SVOCs (PAHs, phenolics, phthalates, biphenyl, and furans), PCBs (Aroclors 1242, 1248, 1254, and 1260), metals, total recoverable phenolics, and miscellaneous water quality parameters. General properties of these groups, as well as other inorganics and NAPL, are discussed below.

5.2.1.1 VOCs

VOCs detected at levels above SCGs are BTEX, styrene, isopropylbenzene, cyclohexane, methylcyclohexane, MTBE, acetone, cis-1,2-dichloroethene, trichloroethene, tetrachloroethene, vinyl chloride, methylene chloride, 1,1-dichloroethane, and 1,4-dichlorobenzene. VOCs readily volatilize into the atmosphere or the soil gas. At the surface, these compounds may decay and/or volatilize upon exposure to sunlight and to the atmosphere. Dissolved contaminants are transported by advection and dispersion in groundwater and surface water. The same processes of advection and dispersion are responsible for the migration of these compounds in the atmosphere or the soil.

BTEX, styrene, isopropylbenzene, cyclohexane, and methylcyclohexane were detected in surface water, groundwater, and subsurface soil samples above SCGs. These compounds are volatile and moderately soluble in water. They are readily biodegraded under aerobic conditions and also degrade under anaerobic conditions, albeit at slower rates. They have low to moderate organic carbon-to-water partitioning coefficients and do not readily partition into the soil or sediment, making them relatively mobile in the environment.

Acetone was detected in subsurface soil samples above SCGs. Acetone is considered to be a common laboratory contaminant, and most of the reported concentrations in the samples are near the laboratory quantitation limits. Ketones (including acetone) are volatile and highly soluble in water. They are characterized by very low organic carbon-to-water partitioning coefficients. The degree to which they sorb into the soil matrix is insignificant and their mobility in the environment is very high. The biodegradability of ketones is generally relatively high and occurs under aerobic conditions.

MTBE was detected in groundwater samples above SCGs. MTBE has a low organic carbon-to-water partitioning coefficient and is relatively soluble in water. The degree to which it sorbs into the soil matrix is insignificant and its mobility in the environment is very high. MTBE biodegrades under aerobic conditions and, to a lesser extent, anaerobic conditions.

Tetrachloroethene, trichloroethene, cis-1,2-dichloroethene, 1,1-dichloroethane, methylene chloride, 1,4-dichlorobenzene, and vinyl chloride were detected in groundwater samples above SCGs. These compounds have low to moderate organic carbon-to-water partitioning coefficients and do not readily partition into the soil, making them relatively mobile in the environment. Chlorinated VOCs undergo reductive dechlorination under anaerobic conditions.

5.2.1.2 SVOCs

PAH concentrations above SCGs were detected in the surface soil, subsurface soil, groundwater, surface water, and sediment samples collected during the RI and/or previous investigations at the site. PAHs detected at levels above SCGs are acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, 2-methylnaphthalene, phenanthrene, and pyrene. Generally, PAHs are characterized by low volatility, low solubility in water, and a high organic carbon-to-water partitioning coefficient. As a result, they are relatively immobile, and typically sorb onto the soil/sediment matrix. Potential for leaching from the soil/sediment to ground or surface water decreases as the compound's molecular weight increases, and such leaching is unlikely even for low molecular weight compounds. As a result, the primary transport mechanism for PAHs is transport mechanically by wind and erosion/particle entrainment. PAHs are hydrocarbons containing two or more fused benzene rings. Their biodegradation rates are relatively low. PAHs with several rings degrade less readily than PAHs with fewer rings. cPAHs typically have four or more benzene rings and are resistant to biodegradation.

Phenolic compounds including phenol, 2-methylphenol, 4-methylphenol, 2,4-dimethylphenol, 4,6-dinitro-2-methylphenol, 4-chloro-3-methylphenol, and pentachlorophenol were detected at concentrations above SCGs in the groundwater and surface water samples collected during the RI and/or previous investigations at the site. Phenolic compounds are relatively non-volatile, and their solubility in water is high. They do not readily sorb into the soil/sediment matrix due to their low organic carbon-to-water partitioning coefficients. As a result, they are highly mobile in the environment. They are relatively biodegradable in anaerobic conditions.

Bis(2-ethylhexyl)phthalate was the only phthalate compound detected at a concentration above SCGs in the groundwater, surface water, and sediment samples collected during the RI and/or previous investigations at the site. Phthalates have a strong tendency to sorb onto soil/sediments and consequently are primarily transported mechanically by wind and erosion/particle entrainment. Bis(2-ethylhexyl)phthalate is considered to be biodegradable, though primarily under aerobic conditions.

Dibenzofuran concentrations above SCGs were detected in the subsurface soil and groundwater samples collected during the RI and/or previous investigations at the site. It is characterized by low volatility, low solubility in water, and a high organic carbon-to-water partitioning coefficient. As a result, it is relatively immobile, and typically associates with the soil matrix. Leaching is an unlikely pathway for dibenzofuran. It has a tendency to sorb to soil/sediment particles and consequently may be transported mechanically by wind and erosion/particle entrainment. Dibenzofuran is relatively non-biodegradable.

1,1-biphenyl concentrations above SCGs were detected in the groundwater samples collected during the RI and/or previous investigations at the site. 1,1-biphenyl is relatively non-volatile, and has a relatively high organic carbon-to-water partitioning coefficient. As a result, 1,1-biphenyl has limited mobility in the environment. 1,1-biphenyl is biodegradable.

5.2.1.3 PCBs

PCB (i.e., Aroclors 1242, 1248, 1254, and 1260) concentrations above SCGs were detected only in the sediment samples collected during the RI and/or previous investigations at the site. PCBs are relatively inert compounds, characterized by low solubility, low volatility, and high resistance to degradation. They readily sorb into soil or sediments due to a high organic carbon-to-water partitioning coefficient. As a result, PCBs are quite immobile in the environment, and are typically confined to soil or sediment matrices.

5.2.1.4 Metals

Metals concentrations above SCGs were detected in the subsurface soil, surface soil, groundwater, surface water, and sediment samples collected during the RI and/or previous investigations at the site. These metals include arsenic, barium, beryllium, calcium, cadmium, chromium, copper, iron, lead, magnesium, manganese, mercury, nickel, selenium, silver, sodium, and zinc. Metals are generally persistent and they may complex with other elements. They do not volatilize or degrade. However, in their soluble form, metals are mobile in aquatic environments. The ultimate preference of metals towards soil/sediment sorption or dissolution in water depends mostly on the acidity or alkalinity of the system.

5.2.1.5 Phenolics

In addition to the specific phenolic compounds previously discussed, total recoverable phenolic concentrations above SCGs were detected in the surface water and groundwater samples collected during the RI and/or previous investigations at the site. Phenols are relatively non-volatile, and their solubility in water is high. They do not readily sorb into the soil matrix due to their low organic carbon-to-water partitioning coefficients. As a result they are highly mobile in the environment. They are relatively biodegradable in anaerobic conditions.

5.2.1.6 Other Inorganics

The primary inorganic contaminants of concern found at the site are soluble cyanide salts and iron-cyanide complexes, though there are no SCGs for these parameters. Cyanide salts consist of a combination of the cyanide anion (CN^-) with a cation (such as sodium). The transport properties of the cyanide salt depend to a certain degree on the cation associated with the cyanide anion. Typically, the cyanide anion is relatively soluble and thus mobile in groundwater. Under acidic conditions (high hydrogen ion concentrations), the cation may be a hydrogen ion, which results in the formation of volatile hydrogen cyanide (HCN). HCN can migrate as a gas. Under varying pH conditions, cyanide complexes can become free cyanide. At the site, nearly all of the detected cyanide in soils was determined to be present as iron-cyanide complexes, and not free cyanide. The same is true for the sediment samples collected from the New York State barge Canal. Cyanide, as an anion, is readily and naturally degraded biologically by soil bacteria under aerobic conditions. In contrast, iron-cyanide complexes are relatively immobile and recalcitrant. In these compounds, cyanide does not exist as an anion, but is rather directly attached, via unusually strong coordinate bonds, to the iron atom. As relatively large, nonpolar inorganic compounds, they are not highly soluble. Therefore, iron-cyanide complexes tend to persist in soil/sediment; however, iron-cyanide complexes are not known to be a toxicological concern.

Sulfate, sulfide, chloride, and TDS were detected in groundwater samples above SCGs. The pH of some groundwater samples also exceeded SCGs (i.e., was outside of the 6.5-8.5 SU range). Sulfate, sulfide, chloride, and TDS are, by definition (i.e., ionic/dissolved species), highly soluble in water and therefore very mobile in groundwater and surface water systems. Sulfate and sulfide have been linked to MGP-related wastes. Sulfide may also be produced via reduction of sulfate in groundwater and surface water. However, all of the parameters listed above also occur naturally in the environment, as well as being introduced from anthropogenic sources. They are typically measured to evaluate overall water quality and the potential for natural attenuation of contaminants in groundwater systems, and not as a means to evaluate the transport of the primary (i.e., MGP-related) contaminants.

5.2.1.7 NAPL

Visible coal tar DNAPL was observed in soils at several locations at the Transit Street site, and it extends along the bedrock surface across LaGrange Street to the Reid Petroleum property in the overburden. Based upon these observations, it appears that the major source of DNAPL is beneath the former gasholders and the former tar sumps at variable depths up to the top of bedrock. The bedrock surface and slope induces migration of the DNAPL along this interface toward the north and west-northwest. There is a ridge in the bedrock surface that trends along the western edge of the substation. East of the ridge, the bedrock slopes north toward the canal; west of the ridge, the bedrock slopes steeply initially toward the west-northwest beneath Transit Street. Beyond Transit Street, the bedrock surface slopes gradually toward the west-northwest. For this reason, DNAPL is migrating laterally toward the north and west-northwest. As it migrates along the bedrock interface, DNAPL enters bedrock fractures where it then migrates throughout the fracture network. The fracture network in the bedrock is the result of regional and localized stresses acting upon the consolidated rock. These stresses have resulted in joint sets trending northeast/southwest and west-southwest/east-northeast. These joint sets are steep angle or vertical fractures. Horizontal fractures also exist along stratigraphic bedding planes. The strata in the region reportedly dip southerly at approximately 40 feet per mile. The slope of bedrock surface has induced DNAPL migration towards the north, west-northwest, and east-northeast from the site. It appears that the bulk of the DNAPL within the bedrock lies within the bedrock fractures at depths above approximately 60 to 65 feet. Below approximately 60 to 65 feet, the bedrock lithology becomes less fractured and more characteristic of shales, which have low hydraulic conductivities. For these reasons, NAPL has spread laterally above this bedrock zone.

Several rounds of DNAPL measurements were performed during the RI using a weighted string. DNAPL was observed to accumulate in one well (BMW-04-11) at recoverable quantities. Traces of DNAPL (at unrecoverable quantities) were also observed in wells BMW-04-03, BMW-04-12, MW-01, MW-02, MW-03, MW-06, MW-08, and MW-10. However, some quantities of DNAPL were recovered from these wells when removing large amounts of water during well development activities. In addition, active DNAPL recovery has been conducted. To date, 13.59 liters of DNAPL have been recovered from well BMW-04-11. Table 4-17 summarizes DNAPL recovery efforts to date.

Coal tar DNAPL is a mixture of many contaminants. Because of its form, it may display different characteristics than its constituents. DNAPL is generally not degradable in the subsurface. The high concentrations of hydrocarbons contained in DNAPL are lethal to microorganisms. However, its constituents may dissolve in water and volatilize, becoming mobile in the environment. Therefore, DNAPLs residing in the subsurface generally undergo gradual transformation, as volatile and soluble compounds are gradually removed. NAPL migration depends mostly on its physical properties. LNAPLs typically “float” on the surface of the groundwater table and migrate in response to hydraulic gradients. DNAPLs initially migrate downwards within the aquifer, until they encounter low permeability strata. At that point, they may migrate under the influence of the slope of the low permeability strata and/or hydraulic gradients.

The type of DNAPL observed at the site (i.e., coal tar) typically has a specific gravity above 1. It is also recalcitrant, resisting both dissolution and degradation by microorganisms. Its mobility is highly variable depending on its viscosity and the nature of the soil or strata in which is it found.

Samples of DNAPL collected from monitoring wells at locations BMW-04-11 and MW-02 were sent to META for environmental forensic analyses, which included hydrocarbon fingerprint and extended PAH analyses. The forensic analyses performed by META indicated that all DNAPL samples contain pyrogenic material from a CWG process. META also reported that the hydrocarbon fingerprint of the DNAPL from location MW-02 indicates the presence of weathered gasoline.

Only two soil samples, GB-07 (5.0-5.2 feet) and GB-08 (12-14 feet), had diagnostic PAH ratios consistent with the DNAPL samples (i.e., CWG tar). However, some differences were noted that may have been due to weathering, mixing of PAH sources, and/or differences in tar composition. Both of these samples were located along LaGrange Street just outside the northern perimeter of the Transit Street site.

META concluded that none of the sediment samples appeared to be clearly impacted by CWG tar or related PAH sources. While DNAPL, presumably CWG tar, was observed as stains on the bedrock wall in the New York State Barge Canal during the RI, the forensics data indicate that the PAHs in the sediments can be attributed to multiple pyrogenic, petrogenic, and biogenic sources. The dissimilarity between the DNAPL and sediment samples observed during the forensics evaluation indicates that the primary sources of PAHs in the sediments are not due to CWG tar or related products.

5.2.1.8 Summary

As described in Section 4.0, several contaminants were detected at the site above SCGs. VOCs are volatile and highly to moderately soluble in water. Some VOCs are readily biodegraded under aerobic conditions and also degrade under anaerobic conditions, albeit at much slower rates. They have low to moderate organic carbon-to-water partitioning coefficients and do not readily partition into the soil or sediment, making them relatively mobile in the environment. PAHs and furans are relatively immobile, and their biodegradation rates are relatively low. Phenols and phenolic compounds are relatively mobile, and relatively biodegradable in anaerobic conditions. Phthalates have a strong tendency to sorb onto soil/sediments and consequently are primarily transported mechanically by wind and erosion/particle entrainment. 1,1-biphenyl is relatively non-volatile, and its solubility in water is relatively low. Due to its relatively high organic carbon sorption coefficient, it readily sorbs into the soil/sediment matrix and therefore is not very mobile in the environment. 1,1-biphenyl is relatively biodegradable. PCBs are recalcitrant and readily sorb into soil or sediments due to a high organic carbon-to-water partitioning coefficient. As a result, PCBs are persistent and immobile in the environment, and are typically confined to soil or sediment matrices. Metals are recalcitrant, and their ultimate preference towards soil/sediment adsorption (immobile state) or dissolution in water (mobile state) depends mostly on the acidity/alkalinity of the system. Nearly all of the detected cyanide in soils/sediments was identified as iron-cyanide complexes and not free cyanide. Iron-cyanide complexes tend to persist in soil/sediment. Significant quantities of DNAPL are present in the overburden at the site and throughout the bedrock fractures beneath the site and site vicinity. MGP coal tar DNAPL is generally recalcitrant.

5.2.2 Fate and Transport in the Unsaturated Zone

5.2.2.1 Migration

Propagation of contaminants in the unsaturated zone is typically dominated by three processes: migration of dissolved phase contaminants with infiltrating precipitation; migration of volatilized contaminants in the soil vapor; and migration of the sorbed contamination with fugitive dust emissions or surface runoff. Contaminants present as separate-phase liquid within the soil or sorbed to the soil may dissolve as precipitation percolates through the unsaturated zone. This occurs during wet weather periods, when the water content exceeds the field capacity of the soil matrix. The flow is mostly gravity-driven and directed downward. Such downward migration through the unsaturated zone may constitute a source of contamination of the saturated zone below.

At the Transit Street site, the uppermost zone is the overburden, consisting of a mixture of fill (brown to red brown, silt, clayey silt, and silty clay with varying amounts of coal fragments, degraded concrete, and brick fragments) and reworked native soils (red brown silty fine sand with some coarse gravel). The overburden is approximately 10 to 20 feet thick at the site, and ranges from approximately 1.2 feet to 50 feet in nearby off-site locations. Depth to groundwater in the overburden in the vicinity of the Transit Street site is between six to nine feet below the ground surface, generally within the fill. Southeast and upgradient of the site where the overburden is significantly thicker, depth to groundwater is much deeper at approximately 21 to 25 feet bgs. North of the site, as the overburden thins out between the site and the New York State Barge Canal, some of the overburden wells have a very thin saturated zone or are seasonally dry (i.e., SMW-07 and SMW-08). However, the saturated thickness appears to increase slightly behind the retaining wall adjacent to the canal (i.e., in the vicinity of SMW-05 and SMW-09).

Infiltration-induced migration of contaminants downward through the unsaturated zone is expected to be a source of continuing contamination to the groundwater. Also, the intensity of infiltration-induced migration is expected to be low for PAHs and furans because of their low solubility in water. For contaminants of higher solubility, such as phenolics and VOCs, the extent of migration in the infiltrating water may be somewhat higher. For metals and cyanide complexes, the scale of migration will vary, as their solubility in water is determined primarily by the pH of the environment.

Contaminants of concern enter the soil vapor or the atmosphere through the process of volatilization. In some areas, the sources of contamination are in close contact with the atmosphere. Volatilization of VOCs to the soil gas in the unsaturated zone and to the atmosphere is expected to occur. The remaining MGP-related contaminants present in the unsaturated zone from approximately 0 to 8 feet bgs (PAHs, phenols, metals and cyanide complexes) are not readily volatile. As a result, the migration of contaminants through the gas phase, either in the soil vapor or in the atmosphere, is likely to be of little significance.

The surface of the Transit Street site is not paved. The majority of the site is covered with gravel, except where buildings or concrete pads of current/former structures still exist. Vegetation is sparse. It appears that there is little potential for fugitive dust emissions from the site in its current state. Because of the gravel covered surface, there appears to be limited potential for erosion and transport of surface soil by runoff. Therefore, contaminants that are sorbed to surface soil have limited ability to migrate off site via erosional processes.

5.2.2.2 Degradation

Generally, the occurrence and rates of unsaturated zone biodegradation have to be determined by means of field studies, such as respiration tests. However, vadose zone biodegradation is limited by the amount of moisture present in the soil and transport processes between bacteria and contaminants. Sufficient moisture for active biological growth may not be present at all locations where contamination is elevated. Also, without a continuous aqueous phase, mass transfer between the bacteria and contaminants will be low, especially for low mobility compounds such as PAHs. These conditions tend to limit the amount of natural biodegradation of some compounds that will occur in the vadose zone.

While some VOCs are subject to biodegradation, most MGP-related organic compounds detected at the site are generally relatively non-degradable (PAHs, furans). Metals do not degrade and cyanide complexes do not degrade readily. It is likely that degradation of the site contaminants will not be significant.

5.2.2.3 Summary

Infiltration-induced downward migration is likely to be a significant transport process at the site. A portion of the bulk mass of contamination in the overburden already lies in the saturated overburden and the bulk mass of contamination represents a continuing source to groundwater in the overburden where it exists, and groundwater in the bedrock. Downward migration of VOCs and phenolic compounds (highly soluble in water) will be much more significant than for PAHs and furans (low solubility in water). Migration of VOCs from the soil vapor to the surrounding atmosphere and nearby structures is expected to occur. For metals and iron-cyanide complexes, the solubility and the resulting extent of the migration will vary, as their solubility in water is determined primarily by the pH of the environment. While some migration of surface soil contaminants may occur via erosional processes, this process will be significantly limited by the gravel-covered surface.

Rates of contaminant degradation in the unsaturated zone are expected to be relatively low. While VOCs and, to a lesser extent, some other organic parameters (e.g., phenolics) may degrade, most organic compounds detected in the unsaturated zone at the site (i.e., PAHs/furans) are relatively non-degradable. Metals and iron-cyanide complexes are recalcitrant.

5.2.3 Fate and Transport in the Saturated Zone

5.2.3.1 Migration

Contaminant migration in the saturated zone takes place predominantly by means of the transport of the dissolved-phase contamination in groundwater. The controlling factors are the direction of the groundwater flow within the aquifer, the hydraulic gradient, the hydraulic conductivity of the aquifer material (both the average value and spatial distribution) and the chemical composition of the soil matrix. VOCs may also migrate from the groundwater/soil to the soil vapor of the unsaturated zone of the overburden. As shown on Figures 3-11 through 3-14, groundwater in the overburden generally flows north/northwest toward the canal. Bedrock topography influences contamination migration. As discussed in Section 3.6.2.2, bedrock surface elevation is higher beneath the southwest corner of the Transit Street former MGP site and just south of the site, which precludes DNAPL migration toward the south.

As shown in Figures 3-15 through 3-26, the general groundwater flow direction also appears to be toward the canal in all bedrock units that were monitored. The flow direction immediately adjacent to the canal may vary, depending on the water surface elevation in the canal, which is regulated. However, the elevation of the potentiometric surface away from the canal is significantly higher than the water level in the canal, and the long-term average flow is likely into the canal. As discussed in Section 3.6.3, the hydraulic gradients in the vicinity of the investigation area also vary based on location and on water elevation changes in the New York State Barge Canal. In the shallow and intermediate bedrock, the canal forms a boundary.

However, for the deep bedrock, which is located below the bottom elevation of the canal, the relationship between the groundwater flow and the canal is difficult to assess. The two systems may be connected to some degree, depending on the vertical conductivity of the strata that separate the deep bedrock from the canal. It is possible that some component of deep bedrock groundwater flow migrates beneath the canal and some component may migrate upwards and discharge into the canal.

Groundwater moves within bedrock via discrete fractures (secondary porosity). The cross sectional area of the fractures is not known; however, it is generally very low in fracture systems. Secondary porosities on the order of a fraction of a percent are not uncommon. Low cross sectional flow area and moderate gradients indicate that the migration velocity of groundwater at the site may be significant, although its actual magnitude would be difficult to determine without knowing the secondary porosity. The velocity could be on the order of several feet a day. Contaminant migration rates may also be comparable, because fractured rock aquifers are generally low in the organic carbon that may retard migration. The vertical joint sets discussed in Section 3.6.2.2 may also impact migration. Regionally significant joint sets trending N40E and N84E have been measured at the site; the latter set could be inducing contaminant migration towards the north and the New York State Barge Canal.

Other processes may retard the migration. In fractured aquifers, contaminants may adsorb onto the surface of the fractures, or may diffuse into the immobile water contained in the primary porosity. However, at the Transit Street site, the contamination is likely to have been present for over a century (see Site History, Section 1.2.1). This period of time could be sufficient to fill most of the adsorption sites and most of the primary porosity, resulting in little retardation at the site, although retardation may still be occurring at the leading edge of the migrating contaminants.

VOCs, SVOCs, metals, phenolics, and various water quality parameters were detected above SCGs in both the overburden and bedrock groundwater, at both on-site and off-site monitoring locations. While there are multiple potential sources for these contaminants in the groundwater, at least a portion of the contamination, particularly the VOCs (primarily BTEX) and SVOCs (primarily PAHs), is likely MGP-related. Contaminants within the overburden have migrated with the groundwater downward into fractures in the bedrock. The groundwater contamination in the overburden can be characterized as a relatively contained diffuse plume around the Transit Street site that extends into the Reid Petroleum property and co-mingles with another source of BTEX and fuel-related contamination associated with the Mobil Station. From there, contaminants may be discharged with groundwater directly into the canal, or transported through the fractured bedrock network to other off-site locations. The groundwater contamination in the bedrock regime is significantly more widespread. The horizontal and vertical extent of the dissolved groundwater plume in the bedrock has resulted from groundwater transport mechanisms and dissolution from MGP-related DNAPL within the bedrock regime.

The DNAPL in the bedrock represents a continuing source for dissolved-phase groundwater contamination. Coal tar DNAPL was observed within the fractures of bedrock cores in several of the monitoring wells installed during the RI. No DNAPL was observed in the fractures of cores collected directly south of the site (i.e., upgradient), at BMW-04-08 and BMW-04-14; however, sheens and/or odors were present. DNAPL appears to have advanced within the bedrock primarily north and west of the site. DNAPL was observed in several fractures at monitoring well BMW-04-09 (west-southwest of the site), but the presence of DNAPL was not noted when MW-16 was installed in 1983. To the west, some component of the coal tar DNAPL is migrating into the unlined Shaft #3 of the Main Interceptor Tunnel. Coal tar DNAPL was observed coating the eastern side of the shaft walls. Also, within the tunnel at approximately 75 feet below grade and north of the site, coal tar DNAPL seeps were observed on the north side of the tunnel, in the vicinity of where DNAPL stains were observed in the New York State Barge Canal (see Figures 2-6 and 4-19). Coal tar DNAPL was observed in all bedrock monitoring wells installed directly north of the site. The canal effectively stops the migration of DNAPL any further northward in the shallow and intermediate bedrock. In the deep bedrock, DNAPL was not observed when coring at BMW-04-10 located north of the canal; however, during well development tiny coal tar blebs entered the well, indicating coal tar DNAPL is present in the vicinity. The groundwater sample from BMW-04-10 reported only low concentrations of naphthalene and this location probably represents the northern extent of MGP-related groundwater contamination. To the east and northeast of the Transit Street site, coal tar DNAPL was observed in trace amounts in a single fracture at MW-09 (approximately 47.5 feet bgs), and reportedly seen in the historical wells MW-13 and MW-15, when they were originally installed.

Because the original MW-15 could not be located during the RI, it subsequently was replaced and coal tar DNAPL was not observed in the replacement well MW-15. Therefore, coal tar DNAPL in the bedrock appears to be present slightly northeast of MW-13, and extend slightly east in the vicinity of MW-09. The horizontal and vertical extent of DNAPL in the bedrock has been fully delineated as part of this investigation.

5.2.3.2 Degradation

As indicated previously, VOCs may degrade in both aerobic and anaerobic processes, and phenolic compounds may degrade in anaerobic environments. However, SVOCs (particularly PAHs) and metals are generally recalcitrant; therefore, degradation of these contaminants at the site is expected to be minimal or non-existent.

5.2.3.3 Summary

Migration in the saturated zone takes place predominantly by means of the transport of the dissolved-phase contamination in groundwater. At the site, the water-bearing unit is located in the lower portions of the overburden and in the underlying bedrock. Migration in the overburden and in all three bedrock units is evident based on the presence of MGP-related contaminants at both on-site and off-site locations. Groundwater flow is generally in a north/northwest direction toward the New York State Barge Canal, although flow patterns are somewhat influenced by seasonal changes in the canal water elevation.

The hydrologic regime in the bedrock indicates that the migration rates could be high. In the shallow and intermediate bedrock, contaminated groundwater discharges to the canal. In the deep bedrock, at least a portion of the groundwater from the site may migrate beneath the canal.

VOCs, SVOCs, metals, phenolics, and various water quality parameters were detected above SCGs in both the overburden and bedrock groundwater. VOCs may degrade in both aerobic and anaerobic processes, and phenolic compounds may degrade in anaerobic environments. SVOCs (particularly PAHs), and metals are generally recalcitrant; therefore, degradation of these contaminants is expected to be minimal or non-existent.

5.2.4 Natural Attenuation Processes

Natural attenuation in groundwater systems results from mechanisms that are classified either as destructive or nondestructive. Biodegradation is the most important destructive mechanism, although some abiotic destruction does occur. Nondestructive attenuation mechanisms include sorption, dispersion, dilution, and volatilization. Microbes generate energy for cell production by transforming available nutrients by transfer of electrons from donors to acceptors. In this process, the electron donor is oxidized and the electron acceptor is reduced. Typically, electron donors in the groundwater system include naturally occurring organic material and fuel hydrocarbons. Electron acceptors include DO, nitrate, iron (III), sulfate, and carbon dioxide. Biodegradation of fuel hydrocarbons occurs when they are used as the primary electron donor for microbial metabolism. DO is consumed first aerobically. After DO is consumed, anaerobic microorganisms use electron acceptors in the following order: nitrate, ferrous iron, sulfate, and carbon dioxide. Anaerobic biodegradation of BTEX compounds results in accumulation of fatty acids, methane, solubilization of iron, and nitrate/sulfate reduction in the groundwater system.

Chlorinated hydrocarbons will undergo reductive dechlorination in the subsurface via use as electron acceptors. After groundwater plumes contaminated with chlorinated solvents reach a steady state, sorption is no longer an important attenuation mechanism. Under these conditions, biotransformation, abiotic transformation, discharge through advective flow, and volatilization remain as important attenuation mechanisms. Removal, treatment or containment of DNAPL may be necessary for Monitored Natural Attenuation (MNA) to be a viable remedial option or to decrease the time needed for natural processes to attain remediation objectives.

5.2.4.1 Biological Processes in Groundwater

Biodegradation of non-halogenated hydrocarbons such as BTEX and certain halogenated compounds such as vinyl chloride (VC) occurs through their use as a primary substrate (electron donor) by subsurface microorganisms. The process is limited by electron-acceptor availability, with oxygen used first as the prime electron acceptor (aerobic respiration), followed by nitrate (nitrate reduction), ferric iron oxyhydroxide (iron reduction), sulfate (sulfate reduction), and carbon dioxide (methanogenesis). Each process is summarized below and Figure 5-1 shows the sequence of reactions based on ORP.

Aerobic Respiration

During aerobic respiration, microbes use oxygen as the terminal electron acceptor. Aerobic respiration typically occurs at DO concentrations of greater than about 0.5 mg/L. In this process, oxygen is reduced to water and DO concentrations decrease.

Nitrate Reduction

After DO has been depleted, nitrate may be used as an electron acceptor for anaerobic biodegradation, which results in the production of nitrite. In order for nitrate reduction to occur, nitrate concentrations in the contaminated portion of the aquifer must be less than 1.0 mg/L.

Iron Reduction

Ferric iron can be used as an electron acceptor in anaerobic degradation producing ferrous iron. The presence of ferrous iron in groundwater is as an indicator that microbiologic activity is within the range of ORP conditions that are most suitable for reductive dechlorination.

Sulfate Reduction

Sulfate may be used as an electron acceptor for anaerobic biodegradation that results in the production of sulfide. Concentrations of sulfate greater than 20 mg/L may cause competitive exclusion of dechlorination. A decrease in sulfate conditions relative to off-site locations is a sign of anaerobic microbiological activity.

Methanogenesis

During methanogenesis, acetate is split to form carbon dioxide and methane or carbon dioxide is used as an electron acceptor. Methanogenesis generally occurs after oxygen, nitrate, and sulfate have been depleted in the treatment zone and takes place when there is very low ORP. The presence of methane in groundwater contaminated with BTEX is indicative of microbial degradation.

Chlorinated hydrocarbons, including tetrachloroethene (PCE), trichloroethane (TCA), dichloroethane (DCA), chloroethane, trichloroethene (TCE), 1,1-dichloroethene (DCE), cis-1,2-DCE, and VC, may undergo biodegradation under three different circumstances:

1. Through intentional use as an electron acceptor;
2. Through intentional use as an electron donor; or
3. Through cometabolism where degradation of the compound is fortuitous and provides no benefit to the microorganism.

At a given site, one or all of these circumstances may pertain, although use of chlorinated hydrocarbons as electron acceptors is typically the most important process under natural conditions. Reductive dechlorination is a biological process that uses the chlorinated hydrocarbon as an electron acceptor. This process results in the removal of a chlorine atom (Cl^-)

and replacement by hydrogen (H^+). Reductive dechlorination requires an adequate supply of electron donors (e.g., BTEX or organic carbon) and suitable microbes. Based upon groundwater results as part of the RI and previous investigations, only low concentrations of chlorinated compounds were detected sporadically in a few overburden and bedrock groundwater wells and, hence, the chlorinated attenuation assessment is not presented.

5.2.4.2 Attenuation Assessment of BTEX

Dissolved Oxygen

Figures 5-2 and 5-3 depict the dissolved oxygen concentrations measured as part of the RI sampling program in the overburden and bedrock groundwater, respectively. In the overburden, DO detections were sporadic and concentrations were variable. The highest DO concentration was detected in upgradient well SMW-01S. At most locations, DO was not detected. In aerobic respiration, DO concentrations decrease. Results are inconclusive.

Figure 5-3 depicts the DO concentrations in the shallow, intermediate, and deep bedrock groundwater. DO concentrations were generally non-detect, with detectable concentrations found at only three locations. Aerobic respiration is not likely to occur to any significant extent.

Nitrate-Nitrogen

Figure 5-3 depicts the nitrate-nitrogen concentrations measured as part of the RI sampling program in the bedrock groundwater. Nitrate-nitrogen concentrations were reported to be non-detect in most bedrock wells, with detectable concentrations found at only four locations. These results are inconclusive. Overburden monitoring well groundwater samples were not analyzed for nitrate-nitrogen.

Ferrous Iron

Figure 5-3 depicts the ferrous iron concentrations measured as part of the RI sampling program in the bedrock groundwater. In the bedrock, ferrous iron concentrations were highest in upgradient wells BMW-04-08 and BMW-04-09. Detections in the remaining wells were sporadic and the concentrations were variable. Ferrous iron would be expected to increase if ferric iron was reduced to ferrous iron. Overburden monitoring well groundwater samples were not analyzed for ferrous iron. Results are inconclusive.

Sulfate

Figure 5-3 depicts the sulfate concentrations measured as part of the RI sampling program in the bedrock groundwater. The sulfate concentration at upgradient location MW-04 was by far the highest concentration detected in the groundwater samples, followed by downgradient location MW-17. Sulfate concentrations were fairly consistent at all other bedrock monitoring well locations. Sulfate concentrations would be expected to decrease in anaerobic biodegradation of fuels. Since there are no significant differences between the upgradient and downgradient sulfate concentrations, results are inconclusive. Overburden monitoring well groundwater samples were not analyzed for sulfate.

Summary

In the overburden, DO detections were sporadic and concentrations were variable. At most overburden and bedrock monitoring well locations, DO concentrations were below detectable levels. While the results are inconclusive, it is not expected that aerobic respiration will occur to any significant extent in the overburden or bedrock groundwater. The attenuation assessment based on nitrate, iron, and sulfate reduction in the bedrock groundwater is inconclusive. Nitrate-nitrogen, ferrous iron, and sulfate analyses were not performed on the overburden groundwater samples. Therefore, no attenuation assessment beyond the DO evaluation was made.

5.2.5 Fate and Transport in Surface Water

5.2.5.1 Migration

The site lies approximately 200 feet south/southeast from the New York State Barge Canal on a gently sloping parcel, bounded on the west by Transit Street, on the north by LaGrange Street, on the east by Saxton Street, and on the south by residential homes. Site topography today is likely similar to the way it was when the MGP was present. There are no other water courses in the immediate vicinity of the site. Surface water runoff at the site generally flows north/northwest toward the canal, but is limited by the gradual topography and previously-installed berms. Runoff that does occur from any portion of the site would be intercepted by the surrounding roads where it would enter storm drains and ultimately discharge into the canal. All surface water samples collected during the RI were from the canal.

Contaminants detected in the surface water during the RI and/or previous investigations include VOCs, SVOCs, metals, and total recoverable phenolics. The VOCs detected in samples collected during the RI (i.e., acetone and chlorinated hydrocarbons) were all below SCGs and are not associated with MGP waste. However, benzene and xylene were detected during previous investigations at concentrations above SCGs.

No SVOCs were detected in the surface water collected during the RI. MGP-related SVOCs detected in surface water above SCGs during previous investigations include PAHs and phenolics.

Metals detected in the surface water samples are generally naturally occurring and/or were likely introduced through contact with soils/sediments. All concentrations were below SCGs, except for iron in some of the samples.

Total recoverable phenolics were detected in surface water samples collected during both the RI and previous investigations at concentrations exceeding the SCG for this parameter.

The transport of contaminants in surface water may be affected by dilution and dispersion, flocculation and precipitation, and sorption to sediments. Dispersion and dilution substantially reduce the contamination entering surface water from any source. Both organic and inorganic contaminants sorb to small soil particles, which in turn would flocculate and precipitate into the sediments, removing the contaminants sorbed onto these particles. In addition, a significant portion of VOCs in surface water would be volatilized to the atmosphere.

5.2.5.2 **Degradation**

While the VOCs are biodegradable, the low concentrations detected may not support a microbial population adapted to metabolizing these compounds. SVOCs (particularly PAHs) generally do not biodegrade to any significant extent. Phenolics are biodegradable under anaerobic conditions. Metals are not degradable.

5.2.5.3 **Summary**

Benzene, xylene, SVOCs (primarily PAHs and phenols), iron, and total recoverable phenolics were detected in surface water at concentrations above SCGs. The presence of some of these contaminants (primarily PAHs) may be related to the former site operations, although other substantial sources are also likely, including past and current industrial facilities, urban sources, and SPDES outfalls The fate and transport of the contaminants in surface water may be affected by dilution and dispersion, flocculation and precipitation, and sorption to sediments. VOCs may also volatilize to the atmosphere.

5.2.6 Fate and Transport in Sediment

5.2.6.1 Migration

The primary contaminants found in sediments at levels above applicable criteria are metals, PAHs, and PCBs. VOCs (benzene and acetone) were detected at concentrations below their respective SCGs. Total cyanide was also detected in the sediments, though there are no SGCs for total cyanide. PAHs, PCBs, and metals are substantially immobile and recalcitrant. Contaminants sorbed to sediment particles are in equilibrium with the surface water immediately adjacent to the particles. The extent of partitioning between the sediment particle and the surface water depends upon the contaminant-specific organic carbon partitioning coefficient value, the organic carbon content of the sediments, and the solubility of the contaminant. Contaminants with high organic carbon partitioning coefficients tend also to have low solubilities and are likely to be sorbed to sediments. Contaminants with low organic carbon partitioning coefficients tend to be highly soluble in water and tend not to sorb to sediments. VOCs have low to moderate organic carbon partitioning coefficients and readily partition into the surface water, where they are transported and/or volatilized into the atmosphere. PAHs and PCBs have high organic carbon partitioning coefficients and are thus likely to stay sorbed to sediment particles. Metals cannot be destroyed and, while changes in oxidation state may increase or decrease mobility to a certain extent, most metals present in the sediment at concentrations exceeding SCGs are relatively insoluble and are not expected to partition into surface water at appreciable rates. Therefore, the metals would remain within the sediments. The cyanide detected in the sediments was determined to exist primarily as iron-cyanide complexes, which are largely immobile and recalcitrant.

Because the PAHs, PCBs, metals, and iron-cyanides in the sediment are unlikely to partition to the surface water, and because these contaminants are typically tightly bound to the sediment particles, transport of these contaminants is governed mainly through physical transport of the sediment particles by erosion.

5.2.6.2 Degradation

Benzene and xylenes are biodegradable under aerobic and, to a lesser extent, anaerobic conditions. While some PAHs are somewhat biodegradable under appropriate conditions, PAHs are typically recalcitrant in most sediments due to lack of oxygen and adequate mass transfer between the contaminants and bacteria that can degrade them. PCBs, metals, and iron-cyanide complexes are for the most part non-biodegradable. Therefore, these contaminants are expected to remain untransformed over time.

5.2.6.3 Summary

VOCs in the sediments may biodegrade and/or partition into the surface water, where they are transported and/or volatilize into the atmosphere. PAHs, PCBs, metals, cyanide (as iron-cyanide complexes) in the sediment are unlikely to degrade or otherwise be transformed and, because these contaminants are typically tightly bound to the sediment particles, contaminant transport is governed mainly through physical transport of the sediment particles by erosion.

5.3 Overall Assessment of Fate and Transport

The data suggest that past operations at the NYSEG’s Transit Street Former MGP site have resulted in impacts to soil (primarily subsurface) and groundwater (overburden and bedrock), and limited impacts to sediment in isolated sections of the New York State Barge Canal adjacent to the site.

VOCs above SCGs were detected in groundwater, surface water, and subsurface soil samples collected during the RI and/or previous investigations. VOCs in the subsurface may be transported via advection, dispersion, and partitioning of mass. In addition, they may volatilize to the atmosphere or undergo biodegradation. VOCs in surface water readily volatilize into the atmosphere. The data indicate that MGP-related VOCs (primarily BTEX) have migrated off site, predominantly north/northwest of the site via the overburden and bedrock groundwater. MGP-related DNAPL, potentially containing BTEX and other VOCs, was also observed seeping from bedrock fractures into the canal at locations north/northwest of the site.

SVOCs, primarily PAHs but also including, phenolics, and phthalates, above SCGs were detected in groundwater, surface water, surface soil, subsurface soil, and sediment samples collected during the RI and/or previous investigations. Phenolics are soluble in water and may be transported in via advection in groundwater/surface water. The remaining SVOCs are not highly soluble in water, but may be transported in groundwater/surface water where the medium is in contact with DNAPL, which was observed in the overburden soil and underlying bedrock, as well as seeping into the canal. Transport in surface soils is predominantly via erosional processes. The data indicate that MGP-related SVOCs (primarily PAHs) have migrated off site, predominantly north/northwest toward the canal. Biodegradation of SVOCs is expected to be minimal.

PCBs were detected above SCGs in the sediment samples collected during the RI and/or previous investigations. PCBs are recalcitrant and are not expected to desorb from the sediments into the surface water or biodegrade. Therefore they are relatively immobile. The distribution of PCB concentrations in the canal sediments suggests they have resulted from sources not related to operations at the Transit Street site. PCBs were not detected in any other matrix sampled.

Metals were detected above SCGs in the groundwater, surface water, surface soil, subsurface soil, and sediment samples collected during the RI and/or previous investigations. Metals are generally persistent and they may complex with other elements. They do not volatilize or degrade. However, in their soluble form, metals are mobile in aquatic environments. The ultimate preference of metals towards soil/sediment sorption or dissolution in water depends mostly on the acidity or alkalinity of the system. The distribution of metals concentrations in the various matrices suggests they have resulted from sources not related to operations at the Transit Street site.

Total recoverable phenolics (in addition to individual phenolic species as SVOCs) were detected above SCGs in groundwater and surface water samples collected during the RI and/or previous investigations. Phenolics are highly soluble in water and are primarily transported via advection in groundwater/surface water. Phenolics biodegrade under anaerobic conditions.

Cyanide, primarily in the form of iron-cyanide complexes, was also detected in surface soil, subsurface soil, and sediment samples collected during the RI. There are no SCGs for total cyanide/iron-cyanide complexes for soil or sediment. Iron-cyanide complexes are relatively immobile and recalcitrant, and do not readily biodegrade.

The groundwater contamination in the overburden is relatively contained and groundwater contamination in the bedrock aquifer appears is much more widespread vertically and laterally. Depth to groundwater in the overburden in the vicinity of the Transit Street site is generally within the fill between six to nine feet below the ground surface. Southeast and upgradient of the site where the overburden is significantly thicker, the depth to groundwater is much deeper at approximately 21 to 25 feet bgs. North of the site as the overburden thickness thins out between the site and the New York State Barge Canal, some of the overburden wells have a very thin saturated zone or are seasonally dry. However, the saturated thickness appears to increase slightly behind the retaining wall adjacent to the canal. As shown on Figures 3-11 through 3-26 groundwater generally flows north/northwest toward the canal.

Contaminants within the overburden have migrated with the groundwater downward into fractures in the shallow and intermediate bedrock, and have migrated through the fractures (secondary porosity). In the shallow and intermediate bedrock, the New York State Barge Canal appears to be the receptor of the groundwater passing through the site. In the deep bedrock, it is possible that some component of groundwater flow migrates beneath the canal and some component may migrate upwards and discharge into the canal. Trace quantities of MGP-related contaminants were detected in bedrock wells located on the north/west side of the canal and this area probably represents the northern extent of dissolved-phase groundwater contamination. The cross sectional area of the bedrock fractures is not known; however, it is generally very low in fracture systems. Secondary porosities on the order of a fraction of a percent are not uncommon. Low cross sectional flow area and moderate gradients indicate that the migration velocity of groundwater through fractures in the bedrock at the site may be significant, although its actual magnitude would be difficult to determine without knowing the secondary porosity. The velocity could be on the order of several feet a day. Contaminant migration rates may also be comparable, because fractured rock aquifers are generally low in organic carbon that may retard the migration.

It appears that the main source of residual MGP-related contamination at the site lies within the surface and subsurface soils of the overburden in the vicinity of the Transit Street site, and NAPLs within the fracture network of the bedrock. NAPL present in the overburden and bedrock will continue to act as a source in the saturated overburden and bedrock zones. Considering the properties of the contaminants of concern, dissolution and degradation are not likely to deplete source contaminants. The source formed by the NAPL in the overburden and fractures of the bedrock zone is expected to persist. Also, based on the period of time since the site was active, the plume of dissolved contamination produced by the source is unlikely to change. In the shallow and intermediate rock, the diffuse plume will continue to discharge to the canal.

Figure 5-4 depicts a planimetric view of soil samples reporting concentrations of total PAHs above 500 ppm, a common remedial action level at similar sites. The figure shows the maximum depth at which total PAHs were reported at concentrations above 500 ppm. Using an algorithm to generate the affected volume of soil with total PAHs above 500 ppm, the total volume impacted is approximately 5,447 cubic yards, of which 524 cubic yards are saturated. Figure 5-5 depicts the same information presented in Figure 5-4, except the data are presented as a three-dimensional model.

Figure 5-6 depicts a planimetric view of soil samples that were observed to be impacted with MGP-related tars (in any form including blebs, drops, saturated, etc.). In addition to the previously identified remedial goals for the Transit Street site, removal of pure-phase tars is a remedial goal commonly used at similar sites. The figure shows the maximum depth at which soils were impacted with tars. Using an algorithm to generate the affected volume of soils impacted with tars/DNAPLs, the total volume impacted is approximately 18,000 cubic yards, of which 1,182 cubic yards are saturated. Figure 5-7 depicts the same information presented in Figure 5-6, except the data are presented as a three-dimensional model. The difference between the affected volumes of the soils impacted with DNAPLs compared to the affected volume of soils reporting total PAHs above 500 ppm is largely attributable to analytical data constraint.

Figure 5-8 depicts a three-dimensional model/view of the DNAPLs observed in the bedrock fracture network during drilling and/or hydraulic packer testing. As shown in the figure, DNAPL has been observed in the fracture network within the shallow to intermediate bedrock at and north, west-northwest, and northeast of the site. These contaminants likely have migrated into this portion of the bedrock from the former gasholders and tar tanks. The shallow to intermediate portion of the bedrock was observed to be the most fractured and transmissive. DNAPL appears to be transported along the top of the bedrock at the site and through bedrock fractures off site. The fracture network in the bedrock is the result of regional and localized stresses acting upon the consolidated rock. These stresses have resulted in joint sets trending east-northeast/west-southwest and northeast/southwest. Horizontal fractures also exist along stratigraphic bedding planes. The slope of bedrock surface has induced DNAPL migration towards the north, west-northwest, and northeast from the site. It appears that the bulk of the DNAPL within the bedrock lies within the bedrock fractures at depths above approximately 60-65 feet. Below approximately 60-65 feet, the bedrock lithology becomes less fractured and more characteristic of argillaceous shales, which have low hydraulic conductivities. For these reasons, NAPL has spread laterally above this bedrock zone.

In the absence of remediation, the DNAPL in the vicinity of the former MGP structures is likely to persist in the foreseeable future. Likewise, the DNAPL located in the fractures of the saturated zone is expected to persist.

6.0 QUALITATIVE HUMAN HEALTH EXPOSURE ASSESSMENT

This section presents an exposure assessment for the Transit Street Former MGP site. This section includes both a Qualitative Human Health Exposure Assessment (HHEA) and a Fish and Wildlife Impact Analysis (FWIA). The qualitative HHEA presented in this section provides an evaluation of potential adverse health effects under current and potential future site conditions that may result from exposure to contaminants attributable to former activities at the Transit Street site. This qualitative HHEA uses data and information collected during URS's 2005-2006 field investigation, together with data collected as part of previous investigations, to assess human health exposure in the immediate and surrounding areas.

This qualitative HHEA follows the general format and procedures set forth in USEPA's Risk Assessment Guidance for Superfund (RAGS) (USEPA 1997a). As such, it includes three of the four required components (the fourth component, Risk Characterization, is not included because this assessment is qualitative):

- Identification of Contaminants of Potential Concern
- Exposure Assessment
- Toxicity Assessment

These components are presented in the following subsections.

6.1 Identification of Contaminants and Media of Potential Concern

Section 4.0 (Nature and Extent of Contamination) presented the analytical results for samples collected from different site media. For each medium, exceedances were noted when observed concentrations of detected contaminants were compared to applicable SCGs. For groundwater and surface water, the SCGs are the Class GA (groundwater) and Class C (surface water) standards and guidance values presented in NYSDEC TOGS 1.1.1, March 1998 (including subsequent revisions). For sub-surface and surface soils the SCGs are the RSCOs presented in NYSDEC TAGM #4046, January 1994. The Eastern USA Background Concentrations (metals only) are also included for comparison. For sediment samples, SCGs are the criteria presented in NYSDEC Technical Guidance for Screening Contaminated Sediments, January 1999, adjusted for organic carbon content. Sediment criteria are provided for benthic acute toxicity, benthic chronic toxicity, human health bioaccumulation, wildlife bioaccumulation, lowest effect levels, and severe effect levels. There are no SCGs for soil vapor or air, although these matrices are discussed in the following sections.

During this RI and/or during previous investigations, contaminants detected at one or more location for each medium include:

- Subsurface soil samples: VOCs/BTEX, SVOCs (including PAHs and phenols), PCBs, metals, total recoverable phenolics, total and free cyanide, and cyanide complexes.

- Surface soil samples: SVOCs (including PAHs), metals, total and free cyanide, and cyanide complexes.

- Sediment samples: VOCs/BTEX, SVOCs (including PAHs and phenols), PCBs, metals, total cyanide, and cyanide complexes.

- Surface water samples: VOCs, SVOCs (including PAHs and phenols), metals, and total recoverable phenolics.

- Groundwater samples: VOCs/BTEX, SVOCs (including PAHs and phenols), metals, chloride, nitrate, ferrous iron, sulfate, sulfide, total dissolved solids, total phenolics, and total cyanide.

- Soil vapor/air samples: VOCs/BTEX.

Many of the samples collected during previous investigations and the RI contained contaminants above SCGs. Within this report, a “medium of potential concern” is identified as a physical medium (such as soil or groundwater) in which one or more contaminants were detected at concentrations exceeding their SCGs. Table 6-1 presents a summary of contaminants of potential concern (CPCs) for all media. All contaminants detected above SCGs were considered CPCs. Additionally, iron cyanide complexes, for which there are no SCGs, were also included as CPCs because of their presence in surface soil, subsurface soil, and sediment. However, it should be noted that iron-cyanides are stable and not known to be a toxicological concern. Tables 1-2, 1-4, 1-6, 1-7, 4-2, 4-4, 4-6, 4-8, 4-10, 4-12, and 4-14 identify detected contaminants, identify SCG exceedances, and provide statistical summaries of detected contaminants in the sampled media.

6.2 Exposure Assessment

6.2.1 Identification of Potentially Exposed Receptors

The previous use of the Transit Street site was industrial/commercial, as described in Section 1.0. The Transit Street site is currently an electrical substation and contains a transformer area, switch house, and storage building. The entire property is enclosed by a locked 8-foot-high chainlink fence with access gates. There are two large gates for vehicular traffic, one at the southwest corner on Transit Street and the other at the northeast corner on LaGrange Street. There are also two small man gates adjacent to the large vehicle gate at the northeast corner, and the other at the northwest corner on the LaGrange Street side. During the RI fieldwork, no evidence of trespassing at the site was observed.

Several wells were identified within 3.11 miles of the site. The majority of these wells are part of an observation well network for the USGS Niagara Project (AES 1991). The remainders are water supply wells used for domestic or livestock purposes. There are no wells within a 1-mile radius of the site. The closest well to the site is located approximately 1.86 miles southeast and is used for domestic purposes. These wells are not known to be contaminated, and it is not expected that any of the wells are impacted by the groundwater at the Transit Street Site. The primary source of drinking water for the City of Lockport is the East Branch of the Niagara River, which is approximately 13 miles west. It is pumped from the river to the City of Lockport Water Treatment Plant where it is treated prior to distribution.

Under the current use scenario, potentially exposed receptors include industrial workers (i.e., those employed by or working for the current site owner), trespassers, and nearby residents. Additionally, recreational users of the New York State Barge Canal may be exposed to surface water and sediments.

It is not anticipated that the site will be developed for industrial, commercial, or residential use by the current property owner. In addition, transfer of ownership of any part or all of the property is not expected due to presence of major underground gas mains and high voltage overhead electrical lines at the site. Therefore, potentially exposed receptors for future use scenarios are the same as those for the current use scenario, and include industrial workers (i.e., those employed by or working for the current site owner), trespassers, nearby residents, and recreational users of the New York State Barge Canal.

6.2.2 Exposure Pathways

An exposure pathway is the manner by which an individual may come in contact with a contaminant. The elements of a completed exposure pathway include: the contaminated environmental media (i.e., surface soil, subsurface soil, soil vapor, air, groundwater, surface water, and sediment); the receptor (e.g., resident, trespasser, industrial worker) exposed to the contamination; and the routes of exposure or how the contaminant enters the body (i.e., inhalation, ingestion, and/or absorption through the skin [i.e., dermal contact]). Tables 6-2 and 6-3 present the exposure pathways assessed for the site under current and future land use scenarios, respectively. Direct contact exposure pathways (e.g., dermal exposure and ingestion) are considered to be complete or potentially complete for the surface water and sediment media under the current and future use scenarios. Inhalation exposure is considered to be complete or potentially complete for the soil vapor medium under the current and future use scenarios. All remaining pathways are considered to be incomplete for both current and future use scenarios. The following subsections discuss the rationale for identifying the exposure pathways as complete or incomplete.

6.2.2.1 Surface Soil

Currently, the site is primarily gravel covered, with some structures and concrete pads of former/existing structures present. Vegetation is sparse. Since the surface soil is not exposed and no intrusive activities that could lead to potential exposure are anticipated, the exposure pathway for surface soils is considered to be incomplete under both current use (Table 6-2) and future use (Table 6-3) scenarios.

6.2.2.2 Subsurface Soil

Under the current use scenario (Table 6-2), the exposure pathway for subsurface soils is considered to be incomplete because no intrusive activities that could lead to potential exposure are anticipated. Similarly, the exposure pathway for the future use scenario (Table 6-3) is considered to be incomplete. As discussed in Section 6.2.1, it is not anticipated that the current owner will develop the site, nor is it anticipated that there will be any transfer of property ownership. If any development occurs in the future to the extent that intrusive/excavation activities could result in potential exposure to subsurface soils, a Site Management Plan will need to be developed that will provide specific procedures for controlling and/or eliminating exposure to potentially contaminated subsurface soils.

6.2.2.3 Soil Vapor

Exposure via inhalation of soil vapor is considered a viable, potentially complete exposure pathway under both current use (Table 6-2) and future use (Table 6-3) scenarios. There are permanent structures located on the site in which potential receptors could be exposed, as well as nearby residents. CPCs were detected in the overburden groundwater in the vicinity of the site, and VOCs/BTEX were detected in the soil vapor at nearby residences and other nearby locations.

6.2.2.4 Air

Under the current use scenario (Table 6-2) and future use scenario (Table 6-3), the exposure pathway for air is considered to be incomplete because no intrusive/excavation activities that could lead to exposure are anticipated. If any development occurs in the future to the extent that the air exposure pathway would be complete, a Site Management Plan will need to be developed that will provide specific procedures for controlling and/or eliminating exposure to potentially contaminated air. The potential exposure hazard would be limited to air-borne particulates and dust.

6.2.2.5 Groundwater

Under the current use scenario (Table 6-2), groundwater near the site is not known to be used as a potable water supply (drinking water is supplied to local residents by the City of Lockport) and therefore the exposure pathway is considered incomplete. Because of the extensive public water supply systems in the area, it is not anticipated that the groundwater will be used as a source of potable water in the future. As previously discussed, it is also unlikely that there will be any intrusive activities in the future that would result in direct exposure to groundwater. Thus, the exposure pathway for the future use scenario (Table 6-3) is considered to be incomplete.

6.2.2.6 Surface Water and Sediment

Under the current and future use scenarios, the exposure pathway for sediment is considered to be potentially complete, since the canal is available for recreational use by the general public. Based on the concentrations and distribution of contaminants in the canal sediments, along with the forensic analyses performed by META, there appears to be some MGP-related impacts to the sediments along isolated sections of the canal where DNAPL stains were observed on the bedrock wall in the canal. Iron and total recoverable phenolics were the only CPCs identified in the surface water samples collected during the RI. Iron is a naturally occurring essential nutrient, and total recoverable phenolics was only detected at one location upstream of both the Transit Street and State Road sites. The presence of these analytes in the surface water does not appear to be attributable to the former MGP sites. Therefore, the exposure pathway for surface water is considered to be incomplete.

6.2.2.7 Summary

Under the current and future use scenarios, exposure via inhalation of soil vapor is considered a viable, potentially complete exposure pathway.

Under the current and future use scenarios, the exposure pathways for surface soil, subsurface soil, air, surface water, and groundwater are considered to be incomplete.

Under the current and future use scenarios, direct contact with and ingestion of sediment are considered viable, potentially complete exposure pathways.

6.3 Toxicity Assessment

The CPCs identified in Section 6.1 can be categorized by their toxicity and their relative effects on human health. Toxicological effects are divided into carcinogenic (cancer causing) and non-carcinogenic effects, with non-carcinogenic data further subdivided into chronic and long-term sub-chronic (less than seven years) critical effects.

6.3.1 Carcinogenic Effects

Twenty-two of the 75 CPCs identified on Table 6-1 are classified as carcinogenic in the SmartTOX database. The SmartTOX Toxicity Value Lookup Table incorporates the current information on USEPA's Integrated Risk Information System (IRIS) and the Health Effects Assessment Summary Tables (HEAST). The USEPA classifies chemicals for carcinogenicity based on the “weight-of-evidence” expressing the degree of confidence relating to the likelihood that exposure to a given chemical could cause cancer in humans (USEPA 1989). Table 6-4 identifies the toxicity values and potential carcinogenic effects for the 22 carcinogenic CPCs.

6.3.2 Non-carcinogenic Effects

Critical effects express the toxic endpoint(s) of an adverse response (such as liver damage) associated with the exposure to non-carcinogenic chemicals. Table 6-5 identifies the toxicity values and potential non-carcinogenic effects for all site CPCs.

6.3.3 Qualitative Human Health Risk Assessment Summary

This qualitative HHEA for the Transit Street site identified 75 CPCs (see Table 6-1) in the groundwater, surface water, sediment, surface soil, subsurface soil samples, and soil vapor/air, including the iron cyanide complexes for which no SCGs exist. Twenty-two of these CPCs are classified by USEPA as carcinogens. Table 6-4 identifies the toxicity values and potential carcinogenic effects for these 22 CPCs. Table 6-5 identifies the toxicity values and potential non-carcinogenic effects for all site CPCs.

Under both the current and future use scenarios, site workers and nearby residents may be exposed to soil vapor contamination. Site workers, trespassers, and recreational users of the canal may be exposed to sediment contamination. Under both scenarios, exposure pathways for all other potentially contaminated media are considered to be incomplete.

7.0 FISH AND WILDLIFE IMPACT ASSESSMENT (FWIA)

The FWIA for the site is presented in Appendix J. The FWIA uses information collected during URS's 2005 field investigation, together with data collected as part of previous investigations to assess impacts to fish and wildlife in the immediate and surrounding areas. The results of the FWIA Step I analysis indicate that the only ecological resources associated with the Transit Street Former MGP site are a few wetland areas located near the project area; however, there are no hydrologic connections between the site and these wetland areas. These resources are located within approximately two miles of the site and have the potential to provide recreational value. The FWIA Step IIA analysis indicates that there is potential for site-related contaminants to migrate to the adjacent canal. The FWIA Step IIB analysis indicates that some chemicals were reported at concentrations above sediment quality standards. It is likely that MGP-related constituents are mixed with contaminants attributable to urban sources. However, MGP-related DNAPL was observed in the canal east of the Transit Street bridge crossing, and a few sediment samples in this area appear to show greater MGP impacts. Based on the findings of this stepwise assessment, no additional ecological evaluation at the Transit Street Former MGP site is warranted. Because of its location in an urbanized area, the majority of the site does not provide suitable habitat for wildlife. Wildlife in the City of Lockport is limited primarily to urban dwelling birds and rodents. The highest value habitats within the 0.5-mile radius are the Barge Canal itself, the vegetated spoil areas along the strip of land along the top of banks adjacent to the Barge Canal and, in particular, the wooded banks along the Barge Canal. The wooded banks not only provide food and cover to many species, but also serve as a riparian corridor, facilitating the movement (especially nocturnal) of wildlife species seeking food, cover and prospective mates, and facilitating the dispersal of juveniles. Habitat resources on the immediate Transit Street site are very limited due to human disturbance.

In general, wildlife resources within the 0.5-mile radius of the site provide very limited value to humans. As indicated in the covertype map, the majority of the area is highly urbanized with residential, institutional, commercial, transportation and industrial land uses. Hunting opportunities are restricted because the radius is located within the City limits. Limited seasonal fishing occurs along portions of the Barge Canal. Walks along the Barge Canal may provide some opportunities for bird watching and general nature viewing as well as general recreation.

8.0 SUMMARY AND CONCLUSIONS

8.1 Summary

This RI was conducted to investigate contaminated media associated with past activities at the Transit Street Former MGP site. The site is approximately one acre in size, and is located in the City of Lockport, Niagara County, New York. The former MGP operated circa 1851 to 1927 as a manufacturing plant for gas generated from coal. The site included three gasholders, two tar tanks, a gas department, oil tanks, and a warehouse/storage building, which were demolished between 1928 and 1948. Currently, the site is a NYSEG electrical substation and contains a transformer area, switch house, and storage building. A locked 8-foot-high chain link fence encloses the entire property, with four locked gates allowing access to the property. Previous investigations of the site include a site screening conducted by WCC from 1982 through 1985; a supplemental investigation performed by AES from 1991 through 1995; and an air monitoring survey by Galson Corporation in 1992. The results of the previous investigations indicate that the soil and overburden/bedrock groundwater at the site, and possibly the surface water and sediment in the New York State Barge Canal, have been impacted by MGP-related contaminants. The previous investigations are summarized below.

8.1.1 Summary of Historical Analytical Data from Previous Investigations

Surface water, groundwater, soil, and sediment samples were collected during some of the previous investigations performed by WCC and AES, which is discussed in Section 1.2.3. A review of the analytical results from laboratory analyses of these samples indicates:

- A total of 33 soil samples, including three soil samples from two test pits, were collected from the Transit Street site. The highest total VOCs (553.2 mg/kg), total BTEX (444.3 mg/kg), total SVOCs (71,690 mg/kg), total PAHs (71,690 mg/kg), total cPAHs (6,890 mg/kg), and total non-cPAHs (64,800 mg/kg) results for subsurface soil were at test trench TT-02 at 5 feet bgs. Test trench TT-02 was located on the western side of the site. Three wooden sumps containing a coal tar-like substance were observed at test trench TT-02. VOCs exceeding SCGs consisted primarily of

BTEX compounds. PAHs were detected in several soil samples at concentrations that exceed SCGs. Total SVOC concentrations in excess of 500 mg/kg were detected in five subsurface soil samples (AB-04, TT-02, TT-05, SB-01, and SB-24) at the Transit Street site. These five soil samples were collected at locations near the former oil tanks, retorts, and coke storage area. PCBs were detected at three subsurface soil sample locations. However, all detections for PCBs were well below the SCG of 10 mg/kg. Several metals were detected in the soil samples collected from the Transit Street site. The metal concentrations were generally within one order of magnitude of their respective SCGs. The maximum detected concentration of cyanide was 79.2 mg/kg at SB-18 (2 to 4 feet), which is located along the northern property boundary, between the locations of the former offices and the gasholders. The maximum detected concentration of total recoverable phenolics was 2,440 mg/kg at TT-02 (5 feet). As previously discussed, three wooden sumps containing a coal tar-like substance were observed at test trench TT-02. Detected sulfide concentrations ranged from 7 mg/kg at samples SB-18 (2 to 4 feet) and SB-28 (6 to 8 feet) to 761 mg/kg at SB-24 (0 to 1.0 feet). There are no established SCGs for total cyanide, total recoverable phenolics, or sulfide in soil. The concentrations of compounds detected in the soil decrease with distance away from the former MGP structures. Detected concentrations of BTEX and PAHs were below SCGs or not detected at the soil sampling locations north, south, and east of the site. Detected concentrations of cyanide were highest near the north-central portion of the site and decreased to non-detect across LaGrange Street.

- 122 groundwater samples were collected during the previous investigations. VOCs detected in the groundwater at concentrations that exceed SCGs include BTEX, styrene, 1,4-dichlorobenzene, MTBE, and 1,1-dichloroethane. Elevated concentrations of BTEX were detected at the two on-site wells MW-03 and MW-07, which are near the western property boundary of the site. Elevated BTEX in groundwater has also been detected at several off-site wells north of the site (MW-01, MW-02, MW-06, MW-10, MW-11, MW-12, MW-13, MW-15, MW-17, SMW-06S, SMW-06D, and SMW-11). The highest total VOCs (54,100 μg/l) and total BTEX (50,200 μg/l) concentrations were at well MW-17, which is approximately 150 feet north of the Transit Street site. Well MW-17 reportedly had at least 30 inches of gasoline product present in it in 1984 and is downgradient from the gas station that is north of the site. The groundwater samples show that SVOCs, including PAHs, have been detected in all of the monitoring wells associated with the Transit Street site with the exception of well SMW-01D, which is approximately 200 feet southeast of the site. The maximum detected concentration of total SVOCs of 413,700 μg/l was observed in monitoring well MW-07 (May 1984). MW-07 is located in the vicinity of the former location of the retorts. In general, total SVOC concentrations decreases from west to east and groundwater impacts associated with the SVOCs are at the north end of the site. The maximum detected concentration (9.71 mg/L) of total recoverable phenolics was at monitoring well MW-10, which is north of the site. In 1992, the groundwater samples from the SMW wells were analyzed for metals. Several metals were detected in the groundwater samples from wells SMW-01D, SMW-01S, SMW-04D, SMW-10, and SMW-11 at concentrations that exceed their respective SCG. The detected concentration of antimony at 470 μg/L in well SMW-04D, iron at 3,910 μg/L in well SMW-11, and lead at 315 μg/L in well SMW-06S were the only concentrations that were greater than one order of magnitude above the SCG. These wells are located north (i.e., downgradient) of the site.

- Surface water samples were collected from six locations in the New York State Barge Canal in association with the previous site investigations. The highest detected concentrations of BTEX and SVOCs were detected at SEEP 1. VOCs and SVOCs were not detected in the surface water samples from location CSL-04, which is four miles upstream of the State Road site. The September 1984 surface water samples exhibited the highest total PAH concentrations detected at locations CSL-01 through CSL-03.

- Sediment samples were collected from the New York State Barge Canal at three locations (SE-01, SE-02, and SE-03) in association with the State Road site. BTEX and PAHs were not detected in the three sediment samples that were collected in November 1990. However, acetone and 4,6-dinitro-2-methylphenol and several metals were detected. Organic compounds were not compared to criteria because total organic carbon content, which would have been needed to calculate them, was not obtained. Metals detected in the sediment samples include arsenic, barium, beryllium, chromium, copper, iron, lead, magnesium, manganese, mercury, nickel, vanadium, and zinc. Metals have been compared to the LELs and SELs. Chromium, copper, iron, lead, manganese, mercury, nickel, and zinc were each detected at concentrations exceeding the LEL in one or more samples. Zinc was also detected at a concentration, 310 mg/kg, exceeding the SEL of 270 mg/kg in sample SE-03. Higher concentrations of the metals were detected in the sediment samples SE-02 and SE-03, which are adjacent and downgradient of the State Road site.

8.1.2 Additional Historical Information

Coal tar-impacted soils were encountered during construction activities in 1997 at the Reid Petroleum site. The site is a gas station property that Reid Petroleum owns, located directly north of the Transit Street former MGP, and bounded by LaGrange Street on the south, Transit Street on the west, Genesee Street on the north, and residential homes to the east. The zone of coal tar contamination was observed from six to eight feet below ground surface.

According to the NYSDEC Spill Records in the EDR report, there are two sites that are designated as open spill sites that are within ¼ mile of the NYSEG Transit Street Former MGP site. The open spill locations nearby the Transit Street site are possible contributing contaminant sources. The first open spill location, Spill #9975727, is at the former Dickies Donuts at 90 Walnut Street. On March 1, 2000, an unknown amount of gasoline was spilled affecting the soils in the vicinity. The second open spill location, Spill #8807842, is the Stamp’s Atlantic Gas Station located at 100 South Transit Street. On December 27, 1988, approximately 1,500 gallons of gasoline was spilled, affecting groundwater and soils in the area. Explosive levels of gasoline vapors affected sanitary sewers, private houses located one block north of the Transit Street former MGP site, and a restaurant located across the street from the Transit Street site. A soil gas survey implicated the Stamps Atlantic Station, stating that gasoline leaking from on-site tanks had contaminated groundwater and entered sanitary sewers in Lockport. Free gasoline product was observed in a test trench at the site during a subsequent investigation. In October 1990, an underground storage tank at the same site was hit during drilling and, in 1991, a delivery truck spilled about 100 gallons of petroleum. Various remedial activities have been completed at the Stamps Atlantic Gas Station. Total BTEX concentrations at monitoring wells at the Stamps

Atlantic Gas Station site remained relatively stable at concentrations above 10,000 μg/L during remedial efforts from February 2000 to February 2005. The extent of the original off-site gasoline product contamination plume was not entirely delineated during investigations, although product seemed contained to the overburden and not the bedrock on site. Average depth to bedrock at the station is 32.8 feet bgs, according to an August 1997 subsurface boring program by Matrix Environmental Technologies, Inc. Depth to groundwater varies from 10 to 20 feet below ground surface, and the historical groundwater flow direction is to the northwest.

8.2 Conclusions

8.2.1 Potential Source Areas and Site Conceptual Model

The migration of contaminants from the source areas to other portions of the site is controlled by the nature of the source areas, surface features, and hydrogeologic conditions at the site. The former MGP structures (particularly the former gasholders and the former tar sumps) appear to be the primary potential source areas of contamination at the site. Secondary potential sources of contamination in the overburden at the site include purifier wastes, which are known to contain high concentrations of cyanide. Former releases of MGP-related contaminants from the source areas could potentially have: remained in surface/subsurface soil and/or bedrock within and near the former MGP structures; migrated downward into groundwater contained in the overburden and/or shallow bedrock beneath the site; or migrated as DNAPL laterally via the bedrock fracture network and through the shallow bedrock groundwater in the dissolved phase before being discharged into the New York State Barge Canal.

The horizontal extent of the contamination in the overburden is relatively contained to the MGP-related structures themselves and extends across LaGrange Street to the Mobil Station to the north. DNAPL is likely pooled on the bedrock surface and has entered the bedrock through fractures. DNAPL may be transported along the top of bedrock and through bedrock fractures to the New York State Barge Canal. DNAPL stains were observed by URS personnel in the rock cut of the New York State Barge Canal north of the site. In addition, DNAPL was observed in the subsurface at the gas station (Reid Petroleum Site) immediately north of the Transit Street site when USTs were removed and replaced. Contaminants from the site also have the potential for downward migration into the interceptor tunnel and the Rochester Shale.

8.2.2 Geology

The site lies in the Erie-Ontario Lowlands physiographic province of New York State, which is characterized by low plains with little relief. Glacial deposition and shoreline deposits have modified the topography of the province. Regionally, the site lies on relatively flat, poorly drained lowland, termed the Tonawanda Plain. This area is located between two east-west trending, north cliff-facing escarpments, with the Niagara Escarpment to the north. The Niagara Escarpment, a major physiographic feature in Western New York, is underlain by the Lockport Dolomite, and is about 0.5 mile north of the site. Regionally, the rock dips to the south at approximately 40 feet per mile.

The site is underlain by fill materials and reworked native soils. Thickness of overburden at the site ranges from approximately 10 feet along Transit Street to 20 feet in the eastern portion of the site. Thickness of overburden for the entire investigation area ranges from approximately 1.2 to 51 feet. Fill materials typically were characterized as brown to red brown, silt, clayey silt, and silty clay with varying amounts of coal fragments, degraded concrete, and brick fragments and ranging from 3 to 11 feet thick. Native soils, consisting of red brown silty fine sand with some coarse gravel, only were encountered in approximately two-thirds of the soil borings advanced during the RI.

The underlying bedrock at the site is flat-lying dolomite and shale of Silurian age. The Gothic Hill Member of the Gasport Dolomite of the Lockport Group is the uppermost bedrock unit observed beneath the site. It consists of thick- to massive-bedded, coarse-grained, dark olive-gray to light-pink dolomitic limestone that weathers to a light olive-gray. The Gasport Dolomite ranges from not present (i.e., excavated away) to 17.3 feet thick at the site. A sharp contact separates the Gasport Member from the underlying DeCew Member of the Clinton Group. The DeCew Dolomite consists of variably bedded, dark-gray to olive-gray, argillaceous to sandy, fine-grained dolomite that is non-fossiliferous. It weathers to a distinctive light olive-gray. The DeCew Member ranges from not present to 6.35 feet thick nearby the site and grades into the Rochester Shale Member of the Clinton Group. The Rochester Shale is estimated to have a total thickness of approximately 60 feet to 90 feet in the site vicinity. The Rochester Shale is divided into two members, the upper Burleigh Hill Member and the Lewiston Member. The Burleigh Hill Member consists of rather uniform dark- to medium-gray, pale- and platy-weathering, highly calcareous shale to dolomitic mudstone. It is considered to be a transitional unit between the overlying dolomitic units above and the Lewiston Shale below. The Burleigh Hill was observed to be approximately 40 feet thick at the site. The Lewiston Member of the Rochester Shale consists of medium- to dark-gray, calcareous mudstone with interbedded fossiliferous lenses and beds. The Lewiston Member was never fully penetrated at the site, but is estimated to be up to 30 to 50 feet thick. There is a sharp contact between the Burleigh Hill and the Lewiston Members of the Rochester Shale, indicated by a thick bryozoan and brachiopod rich packstone (i.e., Unit E of the Lewiston Member). The upper portion of the bedrock sequence (the Gasport, DeCew, and Burleigh Hill Members) is exposed in the sidewalls of the nearby New York State Barge Canal. The floor of the canal adjacent to the site is excavated in the Burleigh Hill Member.

The Transit Street site lies on a relatively flat local bedrock surface. Bedrock appears to be slightly higher beneath the southwest corner of the property and just south of the site. The bedrock surface elevation slopes steeply to the west-northwest, and slightly towards the north and east. There is a bedrock ridge that forms the differing slopes. Locally, the bedrock bedding planes/units generally dip slightly to the south and west, although there appears to be a localized low elevation for the contact at the Gasport Formation and the Decew Formation in the vicinity of MW-10. Very few vertical fractures were observed during the RI field activities, but some are reported to be present in the area. Several vertical joint sets trending approximately west to east were observed in the rock face within the New York State Barge Canal. Previous investigations confirmed the presence of near-vertical joints beneath the site. In addition, regionally significant joint sets trending N40E and N84E have been measured at the site, and the latter set could be inducing contaminant migration towards the north and the New York State Barge Canal.

8.2.3 Hydrogeology

Overburden/Bedrock Interface

The top of the groundwater in the overburden in the vicinity of the Transit Street site is generally within the fill between six to nine feet below the ground surface. Southeast and upgradient of the site, where the overburden is significantly thicker, the groundwater is much deeper at approximately 21 to 25 feet bgs. North of the site as the overburden thins out between the site and the New York State Barge Canal, some of the overburden wells have a very thin saturated zone or are seasonally dry. However, the saturated thickness appears to increase slightly behind the retaining walls adjacent to the New York State Barge Canal. Groundwater elevation data indicate that groundwater in the overburden flows northwest toward the New York State Barge Canal, and tends to discharge into the Canal. The hydraulic conductivity in the overburden, based on slug tests, ranged from 1.83×10^{-5} to 1.25×10^{-4} cm/sec. Hydraulic conductivity in the overburden/bedrock interface ranges from 2.68×10^{-4} to 1.11×10^{-2} cm/sec.

Bedrock

Groundwater elevation data indicate that groundwater in the shallow, intermediate, and deep bedrock flows northwest toward the New York State Barge Canal, and tends to discharge into it. Changes in the hydraulic gradient near the canal appear to be reflective of seasonal changes in the canal water elevation. Hydraulic gradients in all three bedrock zones are highest during periods when the canal water elevation is at its seasonal low, indicating dewatering of the nearby bedrock units. Conversely, the hydraulic gradients are flatter when the canal water elevation is at its seasonal high. The effect is most apparent in monitoring wells situated near the canal walls. Lower hydraulic conductivities were typically measured in the deep bedrock as compared to the intermediate and shallow bedrock units.

8.2.4 Soil Quality

Surface Soil

The major findings of the surface soil sampling conducted as part of the RI indicate that several SVOCs (primarily PAHs), including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, and dibenz(a,h)anthracene, exceeded their respective SCGs in at least one sample location. PAH detections above SCGs are likely attributable to urban sources such as vehicle exhaust. No PCB compounds were detected in any surface soil sample collected during the RI. Beryllium, chromium, copper, iron, mercury, nickel, and zinc were detected at concentrations that exceeded SCGs in at least one of the RI surface soil samples. Total cyanide was detected in one of the surface soil samples collected as part of the RI. Very little of the cyanide detected is of the more toxic free cyanide. No surface soils were collected during previous investigations.

Subsurface Soil

The major findings of the subsurface soil sampling as part of previous investigations or during the RI indicate that VOCs, primarily BTEX compounds, were detected in the subsurface soil samples at concentrations above SCGs. Other VOCs exceeding SCGs at one or more locations include methylene chloride, acetone, and isopropylbenzene. The highest concentration for total BTEX detected during the RI, 181.4 mg/kg, was located at GB-09 (from 10-12 feet bgs) in the northwest corner of the Transit Street site. Reported concentrations of 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, dibenzofuran, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene exceeded their respective SCGs at one or more locations during the RI or previous investigations. Total SVOCs were detected above 500 mg/kg in six of the samples collected during the RI (GB-05, 6-8 feet, GB-09, 10-12 feet, GB-09, 12-13.8 feet, GB-15, 2-3 feet, GB-16, 0.5-1.5 feet, and GB-26, 9.5-10.75 feet). All of these samples, with the exception of GB-05 and GB-25, were from within the fenced in substation; GB-05 was located in the right-of-way on the north side of the Substation property, and GB-26 was located across LaGrange Street, north of GB-05. Most of the maximum exceedances during the RI were detected in boring GB-09 (12 to 13.8 feet bgs) and boring GB-16 (0.5 to 1.5 feet bgs). GB-09 was advanced in the northwest corner of the site, in the vicinity of the former purifier rooms. GB-16 was advanced at the southern edge of the concrete pad of the former 150,000 cubic foot gasholder. PCBs (Aroclors 1248, 1254, and/or 1260) were detected in four samples collected during the RI or previous investigations, but all concentrations were below SCGs. Barium, beryllium, cadmium, chromium, copper, iron, mercury, nickel, selenium, and zinc were detected at concentrations that exceeded SCGs in at least one of the subsurface soil samples collected during the RI or during previous investigations. Total cyanide was detected in several of the subsurface soil samples collected during the RI or during previous investigations, but there is no established SCG for cyanide in soil. The highest concentration detected during the RI was at boring GB-10 (from 6 to 6.2 feet bgs), which was advanced in the approximate vicinity of the former tar sumps. All soil samples in which total cyanide was detected were sent to Clarkson University for further analysis to determine the amount of free cyanide and the various cyanide species present. The majority of the cyanide was found to exist as stable iron cyanide complexes and not as free cyanide. Total recoverable phenolics were detected in six of the subsurface soil samples collected during the RI or during previous investigations. The highest concentration was detected at location TT-02 (previous investigation), which was a test trench near the former tar sumps. There is no established SCG for total recoverable phenolics. The affected volume of soil with total PAHs above 500 ppm was determined to be approximately 5,447 cubic yards, of which 524 cubic yards are saturated (i.e., below the water table). The affected volume of soils impacted with tars/DNAPLs is approximately 18,000 cubic yards, of which 1,182 cubic yards are saturated.

8.2.5 Groundwater Quality

Groundwater quality was assessed on two occasions during the RI. First, during bedrock monitoring well installation, packer test groundwater samples were collected from discrete intervals to assess the vertical extent of dissolved phase contamination. Second, at the conclusion of the drilling program in June 2005, groundwater samples were collected from wells monitoring the overburden and the shallow, intermediate, and deep bedrock.

8.2.5.1 Packer Samples

VOCs detected at concentrations exceeding SCGs in the packer test samples consist primarily of BTEX. Other VOCs that exceeded SCGs include 1,2-dichloroethene(cis), isopropylbenzene, MTBE, styrene, and vinyl chloride. Both VOC and SVOC concentrations appear to decrease with depth. SVOCs detected in the packer samples consisted primarily of non-cPAHs. Lead was detected in five of the 13 packer samples collected at concentrations well below the SCG of 25 µg/L.

8.2.5.2 Overburden/Bedrock Interface

VOCs detected at concentrations exceeding SCGs in the overburden/bedrock interface monitoring wells consist primarily of BTEX. Other VOCs that were detected at concentrations exceeding SCGs during the RI or previous investigations include 1,1-dichloroethane, 1,4-dichlorobenzene, styrene, isopropylbenzene, and MTBE. The highest total BTEX concentrations in samples collected during the RI were at locations MW-10S and SMW-11, both of which are located north (downgradient) of the site. BTEX was not detected in the upgradient and side gradient monitoring well samples collected during the RI. SVOCs detected above SCGs in the overburden/interface monitoring well samples collected during the RI consisted primarily of non-cPAHs. The highest SVOC concentrations were at location SMW-11, which is located north (downgradient) of the site. No SVOCs were detected at concentrations exceeding SCGs in the upgradient and side gradient monitoring well samples collected during the RI. No PCBs were detected in the overburden/interface monitoring well samples collected during the RI. Arsenic, cadmium, chromium, iron, lead, magnesium, manganese, nickel, and sodium were detected at concentrations exceeding SCGs in one or more overburden/interface monitoring well samples collected during the RI or previous investigations. Total cyanide was detected in four of the 12 overburden and interface monitoring well samples collected during the RI, but all concentrations were below the SCG for this parameter. All four wells in which total cyanide was detected are located downgradient from the site along the north side of the LaGrange Street. All concentrations of total cyanide detected in samples collected during previous investigations were also below the SCG. Total recoverable phenolics were detected at concentrations above SCGs in 6 of the 12 overburden/bedrock interface well samples collected during the RI. Total recoverable phenolics were not detected in the upgradient, side gradient, or far down gradient overburden/bedrock interface wells.

8.2.5.3 Shallow Bedrock

VOCs detected at concentrations exceeding SCGs in the shallow bedrock monitoring well samples collected during the RI or previous investigations consist primarily of BTEX, but also include styrene and MTBE. The highest total BTEX concentration (20,000 µg/L) in samples collected during the RI was at location MW-10, located north (downgradient) of the site. BTEX concentrations were three orders of magnitude less at all other shallow bedrock monitoring well locations. MTBE was detected at a concentration above the SCG at upgradient well MW-05, although BTEX was not detected at this location. SVOCs detected in the shallow bedrock monitoring well samples collected during the RI or during previous investigations consist primarily of non-cPAHs. During the RI, naphthalene was typically detected at the highest concentrations. MW-10, located north (downgradient) of the site, on the north side of LaGrange Street, contained the highest concentration of total SVOCs at 23,570 µg/L, 14,000 of which was naphthalene. Eleven SVOCs were detected at concentrations exceeding their respective SCG at MW-10. No SVOCs were detected at concentrations exceeding SCGs in upgradient monitoring well MW-05 or downgradient well MW-11. However, low levels of SVOCs, including exceedances for naphthalene and 2-methylnaphthalene, were detected in upgradient well BMW-04-08, which is located in close proximity to the southern site boundary. No PCBs were detected in the shallow bedrock monitoring well samples collected during the RI. The metals cadmium, chromium, copper, iron, lead, magnesium, manganese, nickel, selenium, sodium, and zinc were detected at concentrations exceeding SCGs in one or more shallow bedrock monitoring well samples collected during the RI. Total cyanide was detected in only one of the six shallow bedrock well samples collected during the RI; however, the concentration was below the SCG. Total recoverable phenolics were detected at concentrations above SCGs in only one of the six shallow bedrock well samples collected during the RI at location MW-10, which is located immediately downgradient and north of the site, on the north side of LaGrange Street. Total recoverable phenolics concentrations exceeded the SCG in several shallow bedrock samples collected during previous investigations.

8.2.5.4 Intermediate Bedrock

VOCs detected at concentrations exceeding SCGs in the intermediate bedrock monitoring well samples collected during the RI or during previous investigations consist primarily of BTEX. Other VOCs that were detected at concentrations exceeding SCGs include 1,2-dichloroethene(cis), isopropylbenzene, MTBE, styrene, tetrachloroethene, trichloroethene, and vinyl chloride. The highest total BTEX concentrations (22,000 µg/L and 14,700 µg/L in wells MW-07 and MW-03, respectively) were detected on site in the vicinity of the former coal tar sumps. The BTEX contamination plume in the intermediate bedrock appears to extend from the site primarily to the north and west, and spread laterally as far east as MW-09 and as far south as MW-04. The chlorinated VOCs were all detected in well MW-15, which is located northeast of the site and is likely impacted by non-MGP related sources of contaminants. MTBE was detected in three intermediate bedrock monitoring wells. MTBE is not associated with MGP waste; therefore, its presence at these locations is indicative of other non-MGP related sources of contaminants. SVOCs detected in the intermediate bedrock monitoring well samples collected during the RI and previous investigations consist primarily of non-cPAHs. During the RI, the highest concentration of total SVOCs (78,975 µg/L) was at location MW-07, 31,000 µg/L of which was naphthalene. MW-07 is located along the western boundary of the site. No PCBs were detected in the intermediate bedrock monitoring well samples collected during the RI. The metals iron, magnesium, manganese, and sodium were detected at concentrations exceeding SCGs in one or more intermediate bedrock monitoring well samples collected during the RI. Total cyanide was detected in five of the 20 intermediate bedrock well samples collected during the RI, but the concentrations were all below the SCG. Total recoverable phenolics were detected at concentrations above the SCG in 8 of the 20 intermediate bedrock well samples collected during the RI. The highest concentration was in MW-07. Total recoverable phenolics concentrations exceeded the SCG in several intermediate bedrock samples collected during previous investigations.

8.2.5.5 Deep Bedrock

VOCs detected at concentrations exceeding SCGs in the deep bedrock monitoring well samples collected during the RI or previous investigations consist primarily of BTEX. Other

VOCs that were detected at concentrations exceeding SCGs include cyclohexane, isopropylbenzene, MTBE, styrene, and vinyl chloride. The highest total BTEX concentrations during the RI (2,360 µg/L and 787 µg/L in wells BMW-04-09 and MW-02, respectively) were detected west of the site nearby the New York State Barge Canal. Low concentrations of BTEX in wells BMW-04-10 and BMW-04-13 indicate the dissolved phase plume in the deep bedrock extends beneath the New York State Barge Canal, although low levels of chlorinated VOCs at these locations indicate impacts by other sources as well. SVOCs detected in the deep bedrock monitoring well samples collected during the RI or previous investigations consist primarily of non-cPAHs. Naphthalene was typically detected at the highest concentrations during the RI. Overall, SVOC concentrations detected in deep bedrock are much lower than those detected in the shallow and intermediate bedrock groundwater, which is attributable to fewer fractures and lower hydraulic conductivities measured in the deep bedrock. No SVOCs were detected in the deep bedrock monitoring well BMW-04-13 located west of the site on the other side of the New York State Barge Canal. No PCBs were detected in the deep bedrock monitoring well samples collected during the RI. The metals chromium, iron, lead, magnesium, manganese, nickel, sodium, and zinc were detected at concentrations exceeding SCGs in one or more RI deep bedrock monitoring well samples. Total cyanide was detected in two of the five deep bedrock well samples collected during the RI, but the concentrations were all below the SCG. Total recoverable phenolics were detected at a concentration above the SCG in only one of the five deep bedrock well samples collected during the RI. Total recoverable phenolics concentrations exceeded the SCG in several deep bedrock samples collected during previous investigations.

8.2.5.6 <u>Groundwater Summary</u>

The groundwater contamination in the overburden is relatively contained around the site and extends into the Reid Petroleum Property where the dissolved phase plume co-mingles with another source associated with the gas station. Contaminants within the overburden have migrated with the groundwater downward into fractures in the shallow and intermediate bedrock, and have migrated through the fractures (secondary porosity). Groundwater contamination in the bedrock aquifer appears to be much more widespread vertically and laterally, and is also impacted with fuel-related contaminants in the vicinity of the gas station. In the shallow and intermediate bedrock, the New York State Barge Canal appears to be the receptor of the groundwater passing through the site. In the deep bedrock, it is possible that some component of groundwater flow migrates beneath the canal and some component may migrate upwards and discharge into the canal. Trace quantities of MGP-related contaminants were detected in bedrock wells located on the north/west side of the canal and this area probably represents the northern extent of dissolved-phase groundwater contamination.

8.2.6 Surface Water Quality

The major findings of the surface water sampling conducted as part of the RI indicate that no VOCs were detected at concentrations in exceedance of the SCGs. Concentrations of benzene and xylene exceeded SCGs in one surface water sample collected during previous investigations. During the RI, SVOCs were not detected in any surface water at any concentration. Concentrations of SVOCs, primarily cPAHs but also some phenolic compounds, exceeded SCGs in several samples collected during previous investigations. During the RI, PCBs were not detected in any surface water at any concentration. The concentrations of iron in five of the surface water samples collected during the RI exceeded the SCG. All metals concentrations were below SCGs in samples collected during previous investigations. The concentration of total recoverable phenolics at location SW-08 exceeded the SCG for this parameter. This location is a considerable distance upstream of both the Transit Street and State Road former MGP sites, and is likely not impacted by waste generated during former operations at these sites. Total recoverable phenolics were not detected in any of the remaining surface water samples collected during the RI. The concentrations of total recoverable phenolics exceeded the SCG in several surface water samples collected during previous investigations.

8.2.7 Sediment Quality

The major findings of the sediment sampling during the RI indicate that benzene was detected in one of the 53 sediment samples collected during the RI, at a concentration below the SCGs for all categories of protection. Toluene, ethylbenzene, and xylene were not detected in any of the sediment samples collected during the RI. Acetone was the only VOC detected in the three sediment samples collected during previous investigations. SCGs for VOCs were not derived for the historical sediment samples because they are dependent on the TOC content of each individual sample, and TOC data were not available. Several SVOCs, primarily PAHs, were detected in sediment samples collected during the RI. Reported concentrations of benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene exceeded their respective SCG for the Human Health Bioaccumulation Level of Protection at one or more locations. All reported SVOC/PAH concentrations were below the SCGs for the Wildlife Bioaccumulation Level of Protection. Reported concentrations of benzo(a)anthracene exceeded the SCG for the Benthic Aquatic Life Acute Toxicity Level of Protection at one or more locations. Reported concentrations of benzo(a)anthracene, bis(2-ethylhexyl)phthalate, phenanthrene, and fluorene exceeded their respective SCG for the Benthic Aquatic Life Chronic Toxicity Level of Protection at one or more locations. Sediments at locations SED-06, SED-08, SED-16, SED-17, SED-18, and SED-25, which are located downgradient of the site along the eastern portion of the canal, have likely been impacted by waste generated during operations at the Transit Street former MGP site. DNAPL stains were observed in the canal near these locations. The presence of SVOCs/PAHs at the remaining sediment locations are likely due, at least in part, to other sources not related to former site operations. The sediments in the canal at locations adjacent to the State Road former MGP site also do not appear to be impacted by MGP-related waste. 4,6-Dinitro-2-methylphenol was the only SVOC detected in the three sediment samples collected during previous investigations. SCGs for SVOCs were not derived for the historical sediment samples. PCB compounds (Aroclors 1242, 1248, 1254, and/or 1260) were detected in all of the sediment samples collected during the RI. Reported concentrations of Aroclors 1242, 1248, 1254, and 1260 exceeded their respective SCGs for the Human Health Bioaccumulation, Wildlife Bioaccumulation, and Benthic Aquatic Life Chronic Toxicity Levels of Protection at one or more locations. Reported concentrations of Aroclor 1242 exceeded the SCG for the Benthic Aquatic Life Acute Toxicity Level of Protection. The presence of PCBs in the sediments is not related to operations at the Transit Street or State Road former MGP sites.

Arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc were detected at concentrations that exceeded the LEL SCGs in one or more of the sediment samples collected during the RI or previous investigations. Copper, lead, manganese, mercury, nickel, silver, and zinc were detected at concentrations that exceeded the SEL SCGs in one or more of the sediment samples collected during the RI or previous investigations. The presence of these metals in the sediments does not appear to be related to operations at the Transit Street former MGP site. Total cyanide was detected in four of the 53 sediment samples collected during the RI, all of which were from locations adjacent to/downgradient of the Transit Street site. There are no established SCGs for cyanide. Cyanide was not detected in the sediments collected upstream or downstream of the site. The majority of the cyanide detected was determined to exist as stable iron cyanide complexes. Cyanide was not detected in any of the sediment samples collected during previous investigations. Total recoverable phenolics were not detected in any of the sediment samples collected during the RI.

To assess the potential sources of PAH contamination in sediments from the New York State Barge Canal, sediment samples were sent to META Environmental, Inc. (META) for forensics analysis. Hydrocarbon fingerprints and extended PAH analyses/diagnostic PAH ratios, as well as site history and observations made during the RI, were evaluated during the forensics analysis. DNAPL from monitoring wells and from stained soil samples collected from suspected contaminant source areas were also sent to META for analysis so that PAHs in the sediments could be compared to those from the suspected source areas.

The results from the forensics analysis indicate that DNAPL samples collected from monitoring well locations BMW-04-11 and MW-02 contained PAH ratios consistent with CWG tar, and the DNAPL collected at location MW-02 also appeared to contain weathered gasoline. Only two of the soil samples collected during the RI, GB-07 (5.0-5.2 feet) and GB-08 (12-14 feet), appeared to be impacted by CWG tar; the remaining soil samples submitted for forensics analysis had hydrocarbon fingerprints and diagnostic PAH ratios consistent with CC or CO derived materials and/or urban background. Based on a comparison of the sediment data to the data for the DNAPL and soil samples, META concluded that none of the sediment samples collected from the New York State Barge Canal appear to be impacted by CWG tar or related PAH sources. Rather, the sediments all contain varying mixtures of pyrogenic, petrogenic, and biogenic PAH sources, which is consistent with sediments in many urban waterways. META also concluded that sediment samples SED-06 (0-1 feet), SED-14 (0.5-1.5 feet), SED-15 (0.5-1.5 feet), and SED-24 (0-1 feet) appeared to contain PAHs from the same source as found in soil samples collected from the State Road site.

8.2.8 Contaminant Fate and Transport

The data suggest that past operations at the NYSEG's Transit Street Former MGP site have resulted in impacts to soil (primarily subsurface) and groundwater (overburden and bedrock), and limited impacts to sediment in isolated sections of the New York State Barge Canal adjacent to the site.

VOCs above SCGs were detected in groundwater, surface water, and subsurface soil samples collected during the RI and/or previous investigations. VOCs are volatile and highly to moderately soluble in water. Some VOCs are readily biodegraded under aerobic conditions and also degrade under anaerobic conditions, albeit at much slower rates. They have low to moderate organic carbon-to-water partitioning coefficients and do not readily partition into the soil or sediment, making them relatively mobile in the environment. VOCs in the subsurface may be transported via advection, dispersion, and partitioning of mass. In addition, they may volatilize to the atmosphere or undergo biodegradation. VOCs in surface water readily volatilize into the atmosphere. The data indicate that MGP-related VOCs (primarily BTEX) have migrated off site, predominantly north/northwest of the site, via the overburden and bedrock groundwater. MGP-related DNAPL, likely containing BTEX and other VOCs, was also observed seeping from bedrock fractures into the canal at locations north/northwest of the site.

SVOCs, primarily PAHs but also including furans, phenolics, and phthalates, above SCGs were detected in groundwater, surface water, surface soil, subsurface soil, and sediment samples collected during the RI and/or previous investigations. SVOCs, including PAHs and furans, are relatively immobile, and their biodegradation rates are relatively low. Phenolics are soluble in water, may be transported via advection in groundwater/surface water, and are relatively biodegradable in anaerobic conditions. Phthalates have a strong tendency to sorb onto soil/sediments and consequently are primarily transported mechanically by wind and erosion/particle entrainment. The remaining SVOCs are not highly soluble in water, but may be transported in groundwater/surface water where the medium is in contact with DNAPL, which was observed in the overburden soil and underlying bedrock, as well as seeping into the canal. Transport in surface soils is predominantly via erosional processes; however, all surface soils are covered at the site and, hence, there is no pathway. The data indicate that MGP-related SVOCs (primarily PAHs) have migrated off site via NAPL and groundwater transport, predominantly north/northwest toward the canal. Biodegradation of SVOCs is expected to be minimal.

PCBs were detected above SCGs in the sediment samples collected during the RI and/or previous investigations. PCBs are recalcitrant and readily sorb into soil or sediments due to a high organic carbon-to-water partitioning coefficient. As a result, PCBs are persistent and immobile in the environment, and are typically confined to soil or sediment matrices. The distribution of PCB concentrations in the canal sediments suggests they have resulted from sources not related to operations at the Transit Street site.

Metals were detected above SCGs in the groundwater, surface water, surface soil, subsurface soil, and sediment samples collected during the RI and/or previous investigations. Metals are generally persistent and they may complex with other elements. They do not volatilize or degrade. However, in their soluble form, metals are mobile in aquatic environments. The ultimate preference of metals towards soil/sediment sorption or dissolution in water depends mostly on the acidity or alkalinity of the system. The distribution of metals concentrations in the various matrices suggests they have resulted from sources not related to operations at the Transit Street site.

Total recoverable phenolics (in addition to individual phenolic species as SVOCs) were detected above SCGs in groundwater and surface water samples collected during the RI and/or previous investigations. Phenolics are highly soluble in water and are primarily transported via advection in groundwater/surface water. Phenolics biodegrade under anaerobic conditions.

Cyanide, primarily in the form of iron-cyanide complexes, was also detected in surface soil, subsurface soil, and sediment samples collected during the RI. There are no SCGs for total cyanide/iron-cyanide complexes for soil or sediment. Iron-cyanide complexes are relatively immobile and recalcitrant, and do not readily biodegrade.

The groundwater contamination in the overburden is relatively contained around the site and extends into the Reid Petroleum Property where the dissolved phase plume co-mingles with another source associated with the gas station. Contaminants within the overburden have migrated with the groundwater downward into fractures in the shallow and intermediate bedrock, and have migrated through the fractures (secondary porosity). Groundwater contamination in the bedrock aquifer appears to be much more widespread vertically and laterally, and is also impacted with fuel-related contaminants in the vicinity of the gas station. In the shallow and intermediate bedrock, the New York State Barge Canal appears to be the receptor of the groundwater passing through the site. In the deep bedrock, it is possible that some component of groundwater flow migrates beneath the canal and some component may migrate upwards and discharge into the canal. Trace quantities of MGP-related contaminants were detected in bedrock wells located on the north/west side of the canal and this area probably represents the northern extent of dissolved-phase groundwater contamination.

It appears that the main source of residual MGP-related contamination at the site lies within the surface and subsurface soils of the overburden in the vicinity of the Transit Street site, and NAPLs within the fracture network of the bedrock. NAPL present in the overburden and bedrock will continue to act as a source in the saturated overburden and bedrock zones. Due to the properties of the contaminants of concern, dissolution and degradation are not likely to deplete source contaminants. The source formed by the NAPL in the overburden and fractures of the bedrock zone is expected to persist. Considering the period of time since the site was active, the plume of dissolved contamination produced by the source is unlikely to change. In the shallow and intermediate rock, the diffuse plume will continue to discharge to the canal.

Figure 5-8 depicts a three-dimensional model/view of the DNAPLs observed in the bedrock fracture network during drilling and/or hydraulic packer testing. As shown in the figure, DNAPL has been observed in the fracture network within the shallow to intermediate bedrock at and north, west-northwest, and northeast of the site. These contaminants likely have migrated into this portion of the bedrock from the former gasholders and tar tanks. The shallow to intermediate portion of the bedrock was observed to be the most fractured and transmissive. DNAPL appears to be transported along the top of the bedrock at the site and through bedrock fractures off site. The fracture network in the bedrock is the result of regional and localized stresses acting upon the consolidated rock. These stresses have resulted in joint sets trending east-northeast/west-southwest and northeast/southwest. Horizontal fractures also exist along stratigraphic bedding planes. The slope of bedrock surface has induced DNAPL migration towards the north, west-northwest, and northeast from the site. It appears that the bulk of the DNAPL within the bedrock lies within the bedrock fractures at depths above approximately 60-65 feet. Below approximately 60-65 feet, the bedrock lithology becomes less fractured and more characteristic of argillaceous shales, which have low hydraulic conductivities. For these reasons, NAPL has spread laterally above this bedrock zone.

In the absence of remediation, the DNAPL in the vicinity of the former MGP structures is likely to persist in the foreseeable future. Likewise, the DNAPL located in the fractures of the saturated zone is expected to persist.

Using an algorithm to generate the affected volume of soil with total PAHs above 500 ppm, the total volume impacted is approximately 5,447 cubic yards, of which 524 cubic yards are saturated. Using an algorithm to generate the affected volume of soils impacted with tars/DNAPLs, the total volume impacted is approximately 18,000 cubic yards, of which 1,182 cubic yards are saturated.

8.2.9 Qualitative Human Health Exposure Assessment

Under the current and future use scenarios, direct contact with surface soil and/or direct contact with or ingestion of surface water, are not considered viable, potentially complete exposure pathways. Under these scenarios, exposure via inhalation of soil vapor is considered a viable, potentially complete exposure pathway. Under the current and future use scenarios, the exposure pathways for subsurface soil, air, and groundwater are considered to be incomplete. Under the current and future use scenarios, direct contact with sediment is considered a viable, potentially complete exposure pathway.

The qualitative HHEA for the Transit Street site identified 75 CPCs in the groundwater, surface water, sediment, surface soil, subsurface soil samples, and soil vapor/air, which includes the iron cyanide complexes for which no SCGs exist. Twenty-two of these CPCs are classified by USEPA as carcinogens.

8.2.10 Fish and Wildlife Impact Analysis

The fish and wildlife impact analysis (FWIA) used information collected during URS's 2005 field investigation, together with data collected as part of previous investigations, to assess impacts to fish and wildlife in the immediate and surrounding areas. The results of the FWIA Step I analysis indicate that the only potential ecological resources that may be impacted by contamination associated with the Transit Street Former MGP site are a few nearby wetlands; however, there are no direct connections between the site and these areas. The Pathway Analysis (FWIA Step II.A) indicated that site-related contaminants are potentially migrating to the adjacent canal. The Step II.B analysis indicates that some chemicals/analytes were reported at concentrations above sediment quality standards. It is likely that MGP-related constituents are mixed with contaminants attributable to urban sources. However, MGP-related DNAPL was observed in the canal east of the Transit Street bridge crossing, and a few sediment samples in this area appear to show greater MGP impacts. Based on the findings of this stepwise assessment, no additional ecological evaluation at the Transit Street Former MGP site is warranted.

8.3 Recommendations

Based upon the analytical results from the current and previous investigations, a Feasibility Study to evaluate site remedial alternatives should be conducted. In addition, NYSEG should develop a site management plan (SMP) to identify institutional controls and engineering controls (IC/ECs) for future use. The SMP would be developed to establish the controls and procedures necessary to manage contaminated soils and groundwater that may be encountered during maintenance or future activities, including the procedures for soil characterization and handling; health and safety of the workers and the community; disposal/reuse in accordance with applicable regulations and procedures; and maintenance of restrictions to "restricted-commercial use".

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