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LETTER OF TRANSMITTAL

To: *NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION*
Region 6, State Office Building
317 Washington Street
Watertown, New York 13601

Date:	09/02/05	Project No.:	2003118
Attention:	Mr. Peter Ouderkirk, P.E.		
RE:	Matt Petroleum Site		
	DEC Site No. B00192-6		
	Utica, New York		

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			SITE INVESTIGATION REPORT (VOLUMES 1-4)
1	Sep-05		SHEETS 1-12 (BOUND)

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SEP - 6 2005

CLEAN WATER/CLEAN AIR BOND ACT
ENVIRONMENTAL RESTORATION PROJECT

SITE INVESTIGATION REPORT
VOLUME I

for the

MATT PETROLEUM SITE
Leland Avenue, City of Utica
Oneida County, New York
DEC Site No. B00192-6

Prepared for:

CITY OF UTICA
1 Kennedy Plaza
Utica, New York 13502

Prepared by:

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Project No. 2003118

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TABLE OF CONTENTS

VOLUME I

TABLE OF CONTENTS
(Continued)

VOLUME I (Continued)

TABLE OF CONTENTS
(Continued)

VOLUME II

TABLES

TABLE OF CONTENTS
(Continued)

VOLUME II (Continued)

SHEETS

VOLUME III

APPENDICES

VOLUME IV

APPENDICES (Continued)

EXECUTIVE SUMMARY

A remedial site investigation and interim remedial measure (IRM) have been completed at the former Matt Petroleum site in Utica, Oneida County, New York. IRM activity included the removal of existing aboveground oil storage tanks, site buildings, underground piping, and removal and disposal of a limited quantity of impacted soils and liquids. After the above and underground infrastructure removal was completed, a soil and groundwater investigation commenced. Seventy-nine (79) soils borings, 54 test pits and 42 temporary and permanent groundwater monitoring wells were completed to assess both soil and groundwater conditions at the site. This investigation also included assessment of both on-site and off-site contaminant migration. Ninety-two (92) subsurface and surface soil samples were collected and analyzed each for volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs), 10 samples for metals and 11 samples for poly-chlorinated biphenyls (PCBs). Thirty-three (33) groundwater samples were collected for analysis of both VOCs and SVOCs, four of which were also analyzed for metals and PCBs.

The result of this investigation was a finding that substantial site soil and groundwater contamination exists. Either a zone of grossly contaminated soil or an area of concern (AOC) exists across approximately 65% of the site. The nature of site contamination within the area of concern is mainly one of residual contamination, while the zones of grossly contaminated soil contain free product and significant groundwater contaminant concentrations. Virtually the entire site contains groundwater with dissolved phase petroleum constituents, primarily VOCs with scant SVOC exceedances, at concentrations above the groundwater Standards, Criteria and Guidance (SCGs) for one or more compounds. Over half of the site soil samples, representing approximately two-thirds of the site, contain total VOCs at concentrations exceeding the soil SCGs. However, only 10 of 75 subsurface soil samples contained one or more SVOC at concentrations above the soil SCGs.

Off-site migration of site contaminants was found to have occurred along Leland Avenue, into the Mohawk River through groundwater discharge, and into a low-lying wet area. However, in three off-site groundwater sample locations only one VOC compound was detected at a concentration slightly above the groundwater SCGs and no SVOCs were detected above the SCG.

1.0 INTRODUCTION

1.1 Purpose of Report

The City of Utica was awarded a grant from the New York State Department of Environmental Conservation (DEC) under the Clean Water/Clean Air Bond Act for an Environmental Restoration Project at the former Matt Petroleum Corporation Storage and Distribution Terminal.

In the spring of 2004, an interim remedial measure was completed to demolish and remove remaining site infrastructure associated with the former bulk petroleum terminal. Following completion of the interim remedial measure, a site investigation was undertaken to characterize site environmental conditions and to identify the scope and extent of site contamination. This investigation identified potential contaminant migration pathways, both onto and off of the property, and assessed the risk to human and ecosystem receptors from site contamination. This report describes the site investigation results.

1.2 Site Description and Background

The property is located on Leland Avenue in the City of Utica, Oneida County, New York (refer to *Sheet 1 – General Site Plan and Site Location Map*). The property is approximately 4.5 acres in size, has one intact building, 16 monitoring wells and 26 temporary monitoring wells.

Prior to the spring of 2004, the property was the site of an abandoned bulk petroleum terminal. Since that time, a demolition project has removed all structures, including ten bulk petroleum tanks, three aboveground oil blending tanks, a slop tank, an oil/water separator, five loading racks, two pump houses, aboveground and buried piping, and four buildings (refer to *Sheet 2 – Site Infrastructure Removed (IRM)*). One garage was left standing. The site has been rough graded and a chain link fence around the entire perimeter controls site security.

A review of historical land use indicates the property had been the site of a bulk petroleum terminal since prior to 1950 to the early 1990's. Sanborn Fire Insurance Maps (refer to Appendix A of the 2004 Work Plan) indicate that during the first half of the 1900's, the property was the site of a brickyard having a number of kilns and storage sheds. Prior to construction of the Barge Canal in the early 1900's, the course of the Mohawk River was to the south of the site, but was relocated to the north as part of the Canal construction project.

1.3 Previous Investigations

Several phases of subsurface investigations have been performed on the site and ongoing groundwater monitoring has been performed over the last 10 years. Individual remediation projects have consisted of emptying and cleaning various aboveground storage tanks (ASTs) and closure and removal of several underground storage tanks (USTs).

Early Monitoring Wells

Four monitoring wells (MW-1 through MW-4) were installed on the site in the main bulk storage tank area, probably as part of the Major Oil Storage Facility monitoring program in the 1980's. No boring logs or well construction details are available.

Cut-Off (Slurry) Wall

Engineering plans for the Secondary Containment & Drainage Plan[1] show a cut-off wall (slurry wall) was installed around the main bulk storage tank area in approximately 1988, as part of an upgrade of the secondary spill containment system. Notes on construction details obtained from DEC files indicate the cut-off wall extends from the ground surface, across the water table, and 1 foot into the lower permeability silt soil (approximately 6 to 9 feet below ground surface [bgs]).

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[1]*Secondary Containment & Drainage Plan, Burgess Oil Corporation*, by Reed A. Trombe, P.E., dated September 18, 1989.

1993 Subsurface Investigation

In 1993, Atlantic Testing Laboratories, Inc. (ATL) installed five monitoring wells (MW-5 through MW-9) in the southwestern area of the site as part of a hydrogeologic investigation in response to DEC Spill No. 88-09026. The primary conclusions in ATL's report[2] were as follows:

- Subsurface soil conditions generally consist of a layer of silty sands and sandy silts, underlain by a low permeability clayey silt stratum. The clayey silt unit was encountered at depths ranging from 4.5 to 10.5 feet below grade.

(0.017 ft/ft)

- Groundwater data indicated a moderate hydraulic gradient (1.7%), with a flow direction generally to the southeast. The cut-off wall was cited as a potentially significant impact to groundwater elevations used in estimating this flow direction.

- Two discrete areas of subsurface contamination were identified:

    - The UST and loading rack area in the southwestern corner of the site, where soil and groundwater contaminated with fuel oil was identified.

    - The blending tank area, where monitoring well MW-1 had 7 inches of free-floating product [light non-aqueous phase liquid (LNAPL)] (i.e. fuel oil).

For additional information, refer to Appendix C – Boring Logs and Well Construction Details in the Work Plan for Site Investigation / Remedial Alternatives Report and Interim Remedial Measures at the Matt Petroleum Site dated January 2004 (2004 Work Plan).

Subsequent groundwater monitoring events by ATL in 1995 showed consistent levels of dissolved phase groundwater contamination in monitoring wells MW-5 through MW-9. Total volatile

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[2] *Subsurface Investigation and Preliminary Hydrogeologic Analysis*, by ATL, dated November 30, 1993.

organic compounds (VOCs) in these wells ranged from about 30 to 900 micrograms per liter (μg/L). Monitoring well MW-10 had non-detectable levels of contamination (MW-10 was damaged in 1995 and is no longer sampled). Anomalies in the groundwater elevations in MW-1 and MW-2 were also observed. In subsequent rounds of groundwater quality and elevation monitoring, MW-1 was consistently observed to have water levels approximately 4 feet lower than nearby MW-2. However, this well also consistently contained floating free product.

1998 Supplemental Investigation

In 1998, Eggan Excavating and Equipment Company performed additional investigation work[3] aimed at delineating the extent of the LNAPL plume in the blending tank area (MW-1). The investigation consisted of the performance of a test boring (TB-12) and installation of two monitoring wells (MW-11 and MW-13). The results and subsequent groundwater monitoring showed the following:

- LNAPL was present in groundwater in MW-11 at a thickness typically ranging from 0.01 to 0.09 feet. Semi-volatile organic compounds (SVOCs) were present at 1,200 micrograms per kilogram (μg/kg) in soil boring TB-12.

- No LNAPL and relatively low levels of dissolved VOCs were present in MW-13. SVOCs were below detection limits in groundwater samples from MW-11 and MW-13.

- The LNAPL in MW-1 was identified as biologically degraded or weathered #2 fuel oil.

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[3]*Quarterly Sampling Report*, by Eggan Excavating and Equipment Company, dated March 1999.

1998 EPA Removal Action

In 1998, the United States Environmental Protection Agency (EPA) completed an Emergency Removal Action at the site. The purpose of the action was to remove oil products from the ASTs, drums and containers, and any accumulations of oil on the ground. At the time of the work, the oil/water separator discharge valve was stuck closed and the separator was overflowing. The main activities completed included:

- Emptying and crushing of approximately 50 drums.

- Removal of approximately 188,000 gallons of oil-based products, including rinsate, from six ASTs.

- Removal of approximately 145,000 gallons of water from two ASTs.

- Emptying and cleaning out of AST-4. Seven thousand, five hundred (7,500) gallons of #6 oil was removed. Fifty thousand (50,000) gallons of water from AST-4 was processed through an oil/water separator and discharged to the Oneida County sanitary sewer system.

- Emptying and cleaning of horizontal tanks AST-11, AST-12 and AST-13.

- Emptying AST-2 of 27,000 gallons of #6 oil. Ninety-five thousand (95,000) gallons of water from AST-2 was processed through an oil/water separator and discharged to the Oneida County sanitary sewer system. Two hundred ten (210) tons of solidified sludge from AST-2 were landfilled.

- Removal of 9,500 gallons of heavy oil from AST-14. This tank was cleaned in place and the infrastructure left intact.

UST Closures

Five USTs have been removed from the site. UST-5, a 2,000-gallon diesel UST, was removed in about 1989. No information on the removal was found. Four USTs were closed and removed in 2002, and approximately 300 tons of contaminated soil was excavated. The tanks closed and removed were:

UST-1:	750-gallon waste oil
UST-2:	750-gallon waste oil
UST-3:	1,000-gallon #2 fuel oil
UST-4:	750-gallon #2 fuel oil

Precision Environmental Services, Inc. (PES) collected soil confirmation samples and summarized the tank closure work in a report.[4] Their findings are briefly summarized as follows:

- Excavations were completed to a depth of approximately 8 feet.
- Soil encountered was black or gray petroleum-stained silt and clay, with lesser amounts of medium-grained sand, ash, cinders and brick debris.
- Shallow groundwater was encountered and significant amounts of LNAPL were observed in the tank area prior to the excavation.
- Soil excavation was completed to about 5 to 10 feet laterally beyond the USTs and 2 to 4 feet below the USTs. Approximately 300 tons of contaminated soil was removed. The excavation was limited and not aimed at removing all contamination.

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[4] *Underground Storage Tank Closure/Interim Remedial Measures – Report of Findings*, by PES, September 2002.

- Significant LNAPL was present in the groundwater seepage in the UST-1, UST-2 and UST-3 excavations after completing the excavation. Minor amounts of LNAPL were observed in the UST-4 excavation.

- Confirmation soil sampling of the sidewalls and bottom of the excavations showed only two compounds were present at concentrations slightly above DEC soil cleanup values.[5] These compounds included 1,2,4-trimethylbenzene and 2-methyl naphthalene.

Groundwater Monitoring Data

Groundwater monitoring has occurred at this site since 1993. Groundwater elevation data has been collected using a common elevation datum since 1998. Sampling has been performed for VOCs using EPA Methods 503.1, 8021 and 8260, and for SVOCs using EPA Method 8270. Refer to Appendix D of the 2004 Work Plan for tables summarizing the historic groundwater elevation and contamination data, and groundwater contour maps representative of typical groundwater flow conditions.

Groundwater elevation data shows a general flow direction toward the southeast corner of the property. In the area of former MW-1 (located approximately 55 feet south of TW-5), the water table was found to be consistently lower than the surrounding area, the cause of which was not known.

Contamination data from a January 2002 PES groundwater monitoring report[6] showed the following.

[5]DEC, Technical and Administrative Guidance Memorandum (TAGM) 4046, *Determination of Soil Cleanup Objectives and Cleanup Levels*, January 24, 1994 and DEC memorandum dated April 10, 2001.

[6]*Quarterly Monitoring Report*, by PES, dated January 2002.

- LNAPL layers were reported in MW-1 and MW-11 in the blending tank area at 0.30 and 1.1 feet thick, respectively, which are the thickest recorded LNAPL measurements in these wells.

- Moderate levels of VOC contamination were reported in MW-5, MW-6, MW-7, MW-8 and MW-9 in the UST/loading rack area. Concentrations ranged from 22 to 338 µg/L. MW-13 in the blending tank area had a trace of VOC contamination (1.4 µg/L).

- Monitoring wells with a history of non-detected VOC concentrations include MW-2, MW-3 and MW-4 in the main bulk storage area and MW-10 in the UST area.

- Monitoring wells MW-5, MW-6 and MW-7 in the UST/loading rack area had low levels of SVOCs, ranging from 11 to 22 µg/L. All other wells have had a history of non-detected concentrations of SVOCs.

- Methyl-tertiary-butyl ether (MTBE) was detected in MW-7 and MW-8 in the UST area at 3 and 8 µg/L, respectively. Historically, all other wells had non-detectable MTBE levels.

Refer to Figure 3 – Contamination Data Plan and Appendix D – Historic Groundwater Data Tables in the 2004 Work Plan for additional information.

Past Remediation

Past remedial measures were limited to soil excavations as part of the UST closures in 2002 and the EPA removal action discussed above.

A pilot test of a high vacuum extraction system was performed by PES in 2002 and results summarized in the their report. A vacuum of 247 inches of water was applied to MW-1 and vacuum readings were monitored in wells MW-11 and MW-13, approximately 30 feet away. After 4 hours, no detectable vacuum was generated in either of the monitoring wells.

1.4 Standards, Criteria and Guidance (SCGs)

The following guidance or regulatory criteria have been used to evaluate the analytical results obtained from the investigation activities:

Soil	DEC Technical Administrative Guidance Memorandum (TAGM) No. 4046, *Determination of Soil Cleanup Objectives and Cleanup Levels*, dated January 1994 and revised April 10, 2001.
Sediment	DEC *Technical Guidance for Screening Contaminated Sediments*, dated January 25, 1999.
Groundwater and Surface Water	DEC Division of Water Technical and Operational Guidance Series (TOGS) 1.1.1, *Ambient Water Quality Standards and Guidance Values*, dated June 1998.

The specific SCGs for each of the chemicals of concern (COCs) have been provided on the appropriate analytical summary tables for the various media.

1.5 Report Organization

This report is presented in two segments. The first segment (Section 1.0) provides background information on the site. The second segment (Sections 2.0 through 7.0) describes the remedial investigation work that has been completed to characterize site contamination and assess the risks associated with this contamination.

It is to be noted that the monitoring wells referred to in the preceding subsections are no longer in existence, with the exception of MW-15. All other monitoring wells referred to in Sections 2 through 7 were installed under the direction of Plumley Engineering, P.C. during the course of this investigation.

2.0 INTERIM REMEDIAL MEASURES / SITE INVESTIGATION WORK SCOPE

At this site, true north makes an approximate forty-five degree angle to the left from a perpendicular line to the Mohawk River. For the purpose of simplifying discussion within this report, "site north" is defined as toward the River. Therefore, all directional references in this report refer to site north, not true north.

2.1 Interim Remedial Measures

Prior to initiating this investigation, previous interim remedial measures (IRMs) were implemented on this site (refer to Section 1.3). Those IRMs focused on the removal of discrete environmental contamination sources from the site. This investigation included an IRM to remove site infrastructure, including storage tanks and their liquid contents, loading racks, buildings (except one garage) and piping from the site. This effort facilitated the surface and subsurface site investigation by making areas of potential contamination, such as underneath tanks, readily accessible for drilling and other investigative measures.

When Matt Petroleum ceased operations, it left behind a bulk petroleum terminal consisting of ten bulk storage tanks, numerous aboveground tanks, three pump houses, two utility garages, a boiler house used for heating petroleum products and three loading racks. Aboveground and buried piping ran throughout the site to and from each of these facilities, as well as from a transfer facility located on the bank of the Mohawk River. This investigation determined that many of these tanks and much of the underground piping contained residual petroleum product.

In the fall of 2003, the City of Utica retained Paragon Environmental Construction, Inc. (Paragon) to complete the removal of petroleum products from tanks and piping and to undertake demolition operations of all aboveground tanks, piping and buried piping. Paragon also collected, inventoried and disposed of hazardous and other materials in the buildings. These materials included containers of oils, paints, cleaners, solvents and a number of unknown substances. Paragon performed this work from March through late June 2004. During site infrastructure demolition, petroleum products were found in many storage tanks and throughout the piping distribution network. Wherever possible, petroleum liquids were pumped into tanker trucks for appropriate disposal. This finding suggests the site petroleum release history may not have ended until June 2004.

At the same time Paragon was working on the site, the Utica Department of Public Works (DPW) completed the demolition of six buildings and three petroleum transfer racks. This work included asbestos abatement, building demolition and final disposal of all demolition debris. All site infrastructure removed in this IRM is highlighted on Sheet 2.

One utility garage was left on the site. It was initially thought that this building might house remediation equipment incorporated into the IRM work. It was later determined that groundwater and/or surface water collection would not be part of the IRM, and the building was cleaned out and left on-site.

2.2 Investigation and Field Characteristics

2.2.1 Site Survey of Surface Features

To identify the location of all natural and manmade features, a site topographic survey was completed. This survey includes the former locations of all tanks, buildings and the approximate location of all underground piping. The survey also includes the location of all test pits, borings wells and soil sampling locations completed as part of this investigation. Sufficient ground elevation data was collected to produce a 1-foot contour interval site map. This survey was utilized to develop site maps depicting the extent of soil and groundwater contamination.

2.2.2 Subsurface Soil and Vadose Zone

The following activities were completed to investigate the condition of the subsurface soils at the site:

- A total of 45 test pits (TP-1 through TP-45) were excavated in selected locations and logged during the period from May 14 to May 18, 2004. Soil lithology and observations regarding potential contamination were routinely recorded. Photo-ionization detection (PID) meter field screening of soil samples was also completed. The majority of the test pits were excavated to depths of 6 to 10 feet below grade. Plumley Engineering field personnel completed the field logging.

- A total of three test pits (TP-52 through TP-54) were completed to determine the absence or presence of the reported subsurface slurry cut-off wall installed around the former tank field. An additional three test pits (TP-46 through TP-48) were also completed against the retainer wall along the property line in the northwest sector of the site to obtain additional information on the vertical extent of soil contamination found in that area.

- Test pit soil descriptions and PID data are included in Appendix A and their locations on shown on Sheet 3.

- A total of 79 soil borings were completed (SB-1 through SB-79) across and adjacent to the site. These borings were completed using a *Geoprobe* percussion sampler. Samples were collected using 2-inch diameter by 4-foot long sleeved samplers. Standard boring log data were collected and recorded, including soil lithology, sample recovery, presence of potential contamination staining and PID field screening results for collected soil samples. The majority of the soil borings were completed to depths of 12 feet below grade. Plumley Engineering field personnel completed the field logging.

Soil samples were collected from the soil borings for laboratory analysis of site contaminants in accordance with the project work plan. Soil samples collected during the follow-up soil program also included analysis of target compound parameter list (TCL) and tentatively identified compounds (TICs). All soil analytical data are summarized in Tables 1 through 8. Data Usability Reports are presented in Appendix F. All boring locations are shown on Sheet 3 and boring logs are presented in Appendix B.

2.2.3 Groundwater Investigation

The investigation of the groundwater conditions at the site involved the following main activities:

- A total of 16 permanent monitoring wells were installed during field activities at various locations near but inside the property boundary. These wells are of 2-inch diameter construction and were installed using hollow stem drilling methods. The installation of 26 temporary wells (TW-1 through TW-26) was completed as part of a Geoprobe soil boring program. These were located in the site interior and constructed using 1-inch diameter well materials. TW-15 through TW-26 were installed to facilitate groundwater contour mapping and no water quality samples were collected from these wells. Appendix C contains construction diagrams for the monitoring and temporary monitoring wells and Appendix D contains the Groundwater Sampling Field Logs.

- Subsurface soil conditions were described and recorded during the installation of the wells and recorded on the drilling logs. PID field screening data of soil samples from most borings was also performed. Soil boring and well drilling logs are included in Appendices B and C and their locations are shown on Sheet 1.

- Groundwater samples from temporary (TW-1 through TW-14) and permanent (MW-1 through MW-16) monitoring wells were submitted to the project laboratory for analysis of site contaminants in accordance with the project work plan. The laboratory analytical data are summarized in Tables 9 through 13 and the Data Usability Reports are presented in Appendix F.

- Depth to groundwater measurements were obtained from accessible wells during the June 2004, February 2005, April 2005 and May 2005 field activities. The May 2005 data were used to construct the groundwater flow contours shown on Sheet 8.

2.2.4 Surface Soils

A total of 12 surface soil samples were collected during this investigation, including two samples along the Mohawk River bank. These samples were collected to assess the extent of surficial contamination and for use in the assessment of contaminant fate and transport and for the baseline risk assessment.

2.2.5 Perimeter Investigation

An important component of this investigation is to assess the occurrence of off-site migration of site contaminants. Three areas of focus were to assess whether a hydraulic connection existed between the storm drain in the southwestern site corner and an off-site low lying wet area, whether site contaminants have migrated off-site to the east toward Leland Avenue and whether there is contaminated groundwater discharge to the Mohawk River. To address these questions, a backhoe investigation of the storm drain was conducted. Off-site soil borings were installed along Leland Avenue. The borings were sampled, the data was evaluated, and a review was completed of soil and groundwater data for sample locations along the Mohawk River.

SW corner of site

Backhoe investigation of a hydraulic connection between a site storm water drain located adjacent to MW-4 and the off-site low lying area south of the site (parallel to the railroad tracks) was completed in April 2005. The corrugated metal piping extending from the storm drain to the site perimeter, toward an off-site low lying wet area, had previously been removed during the project IRM. The backhoe unearthed the pipe end near the site perimeter, but still on the site, to allow for collection of a sample of pipe sediment (sample P-1). This sediment was described as sandy and granular. A small amount of florescent dye was applied to the inside of the pipe and a DPW water truck supplied a portable water line and pumped water at an approximate pressure of 2,500 pounds per square inch (psi) for 3 minutes into the pipe. Water back-flushed into the small pit at the open pipe on-site with no indication of breakthrough. Adjacent catch basins on the two adjacent sites were checked for presence of the dyes, but none was observed. Subsequently, the backhoe was used to unearth soils outside the fence for collection of two off-site soil samples. These samples were collected along a straight line of orientation with the corrugated drainpipe. The backhoe action to collect the first sample unearthed the corrugated pipe, which then began to flow green dyed water from the pipe into the small excavation outside the site perimeter. The backhoe operator was then directed to crush the pipe to halt this flow. Two samples were collected along this line, one from approximately 5 to 7 feet beyond the site perimeter (sample HB-1) at a depth of approximately 1 foot below ground surface, and a second from approximately 12 to 14 feet beyond the perimeter (HB-2), also from an approximate depth of 1 foot below ground surface. Field notes indicate the soils collected for analysis exhibited strong hydrocarbon fuel odors. Additionally, one hand-augured soil sample and a water sample, both from PSB-64, were collected from the western edge of the low lying wet area from a depth of approximately 1 foot below ground surface.

To investigate off-site migration toward Leland Avenue, a total of five soil borings were installed: two across and east of Leland Avenue (PSB-62 and PSB-63) and three along Leland Avenue just outside the site property boundary but on the same side of Leland Avenue (PSB-77 through PSB-79). Soil samples were collected from the highest zone of observed impact in PSB-62, PSB-63, PSB-77 and PSB-78, and analyzed for TCL VOCs plus TICs per EPA Method 8260 and TCL SVOCs plus TICS per EPA Method 8270. Groundwater samples were collected from PSB-63 and PSB-79 (TW-26) for STARS[7] and

[7]DEC Spill Technology and Remediation Series (STARS) Memo #1 – *Petroleum-Contaminated Soil Guidance Policy*, dated August 1992.

TCL VOCs plus TICs per Method 8260 and for STARS and TCL VOCS plus TICs per Method 8270. In addition, a review was completed to assess whether off-site migration has occurred through soil leaching and affected groundwater discharge along the Mohawk River. This review considered soil and groundwater quality data for samples collected near and at the site boundary along the Mohawk River.

Section 4.5 Perimeter Investigation Results discusses analytical results from these samples. Soil boring logs and monitoring well construction details are presented in Appendices B and C. Soil and groundwater analytical results for these borings and samples are presented in Tables 1 through 13.

2.3 Summary of Field Activities Documentation

Field activities and the documentation recording these activities are summarized below:

Field Activity	Documentation
IRM Tasks	Construction Inspection Logs
Soil Borings	Boring Logs (Appendix B); Locations (Sheet 3)
Test Pits	Test Pit Summaries (Appendix A); Locations (Sheet 3)
Soil Samples	Chain of Custody Logs; Locations (Sheet 3)
Groundwater Sampling Field Logs	Field Sampling Logs (Appendix D)
Monitoring Wells	Well Construction Logs (Appendix C); Locations (Sheet 1)

3.0 PHYSICAL CHARACTERISTICS OF STUDY AREA

3.1 Surface Features

Current site surface features were surveyed and plotted on Sheet 1, including site topography, the existing building, fencing, surrounding streets, the Mohawk River and groundwater monitoring wells. Sheet 2 presents the location of all site infrastructure removed during the project IRMs.

3.2 Surface Water Hydrology

Surface water on the site is limited to precipitation runoff. Concrete curbing and concrete knee walls prevent runoff from the adjacent property to the west from entering the site. The Mohawk River borders the property to the north and flows to the southeast. The river elevation experiences periodic fluctuation associated with precipitation and dry periods, even though it is hydraulically connected to the Erie Canal, which is hydraulically controlled in Utica.

A river elevation monitoring point was established in late April 2005 to tie groundwater elevation data to the river surface elevation for comparative purposes. Suitable intact infrastructure on the former loading dock was designated as a benchmark for the collection of river elevation data. This benchmark is the center point of a steel grating on the former loading dock. The river elevation was measured during two rounds of site groundwater measurements in the spring of 2005.

A catch basin near the southeast corner of the site drains into a storm sewer that flows south along Leland Avenue.

3.3 Geologic Setting

The site is located within the Mohawk River valley, a major topographic feature in central New York that trends southeasterly through the Utica area. Highland areas merging with the Tug Hill and Appalachian Plateau physiographic regions to the north and south, respectively, define the main flanks of the valley. Typically in central New York, the top of the sedimentary bedrock formations rise in elevation out of the main eroded river valleys up into the adjacent highlands, and the overburden deposits are typically the thickest within the valleys, often dominated by glacial lake and stream deposits, as well as more recent river deposits associated with the occupying rivers.

The overburden geology map of New York (which maps surficial soil deposits) indicates the existence of river floodplain deposits associated with the Mohawk River and nearby areas of sandy lake (glacial) deposits. United States Geologic Survey (USGS) aquifer mapping of the Utica area shows cross section B-B' near the site, which indicates overburden consists of 20 to 30 feet of post glacial alluvium, underlain by 40 to 50 feet of lacustrine silts and clays, which in turn overlay 100 to 150 feet of unstratified glacial till. Below this till at the valley bottom lays a significant lens of outwash sand and gravel.

The bedrock geology map of New York State indicates the bedrock sedimentary rock formation underlying the area of the site is expected to be the Utica shale formation. This formation is part of a largely unaltered sequence of Paleozoic sedimentary rock formations with widespread occurrence in central New York.

3.3.1 Site Soils

Soil units identified through the subsurface investigation activities (test pit, and soil boring installation programs) indicate the presence of two main soil units across the site. These are referred to as the *fill unit*, encountered at the surface and the *clay-silt unit,* occurring beneath the fill.

Two geotechnical drilling borings conducted by Plumley Engineering on a site southwest of the Matt Petroleum site and at the same general distance from the river, logged 7 to 12 feet of surficial fill material (containing brick fragments and cinders) overlying lacustrine silts and clay deposits of 14 and 36 feet, respectively. Total geotechnical boring depths were 85 to 90 feet. These borings indicate the two soil units identified at this site extend beyond the site boundaries. Geologic characteristics of the soil units are described below.

***Surface Fill Unit*:**

The fill unit is most commonly a brown, dry to wet, compact, granular soil containing graded fine to coarse sands with considerable gravel, commonly including sand to gravel-size brick fragments, particularly in the eastern half of the site. Gravel to cobble-sized concrete rubble, pieces of wire, wood debris and steel piping were noted occasionally. However, in multiple locations randomly dispersed throughout the site the fill unit contains considerably more fines, including clay, silt and fine sand, lending some cohesiveness to the soil. Unified soil classifications of GW, GM and SM with gravel have been estimated based on field observations and are shown on the site cross sections (Sheets 4 through 7) reflecting these characteristics; the permeability of the fill varies considerably with the amount of fines present (higher permeability for the fills with less fines (GW)).

Fill was found present at all locations across the site. The thickness of the fill typically ranges between 4 to 7 feet. Generally, the surface fill is somewhat thinner in the western portion of the site. Maximum thickness of the surface fill unit is 10 feet.

This surficial material is consistent with descriptions from two geotechnical borings on a nearby site that encountered brick fragments and cinders in the surficial material overlying a clay-silt unit. A lack of a significant thickness of organic soil. indicative of former vegetated land and topsoil, also suggests the area was graded prior to surface fill placement. It is apparent, therefore, that in some areas the upper zone of the clay-silt unit has been disturbed by human activities.

***Clay-Silt Unit*:**

Beneath the surface fill unit, a brown to gray, moist, fine-grained, cohesive soil with variable proportions of silt and clay, with little or no gravel, was found present across the site. Relative density of the unit ranges from soft to stiff (based on manual/visual tests). Occasionally, thin seams of fine sand were noted, but otherwise the unit is weakly laminated or massive. Its permeability is expected to be very low, indicative of silt and clay-rich soils, as reported by the USGS Hydrogeology report. In places, the unit contains zones of very gray to black coloration and likely contains trace amounts of fine organics. The top of the unit is typically encountered at depths of 4 to 7 feet bgs and was typically investigated by soil borings to 12 feet. As the bottom of this unit was not encountered in the borings installed at this site, its thickness is uniformly known to be a minimum of 5 to 8 feet thick, but is likely to have considerably greater thickness, as evidenced by the previously described geotechnical borings.

This clay-silt unit is consistent with sediments reported by the US Geological Survey for the Utica Area[8] that mapped alluvium, lacustrine silts and clay sediments, till, and outwash sand and gravel below the Mohawk River. However, the upper zone of the lacustrine unit, in some locations, contains embedded extraneous material (e.g., concrete and brick fragments) indicating this unit has been disturbed by human activities. Sheets 4 through 7 contain subsurface cross sections through the site summarizing the soil conditions encountered.

3.3.2 Hydrogeology

Casey and Reynolds described regional hydrogeology for the Utica Area of Oneida and Herkimer counties. Glacial ice retreat at the end of the Wisconsin Glaciation resulted in the formation of two retreating ice lobes: one westward retreating and the other eastward retreating. Between these two lobes a glacial lake formed resulting in the deposition of fine lacustrine (silt and clay lake bottom) sediments. Although ice re-advances are known to have occurred to rework some of these sediments, lacustrine sediments remain in this valley today. Ultimately, ice retreat resulted in the deposition of lacustrine sand, silt and clay interbedded with till. The total thickness of unconsolidated sediments within the vicinity of this site is reported to be between 200 and 220 feet. The Mohawk River course in the vicinity of the site overlies the full thickness of these sediments. The vertical stratigraphy

[8]Casey, George D., Reynolds, Richard J., Hydrogeology of the Stratified-Drift Aquifers of the Utica Area, Oneida, Herkimer Counties, New York – Part 2 (East)

reported for a cross section located 0.4 miles northwest of the site is surficial alluvium overlying lacustrine silt and clay overlying 100 to 150 feet of glacial till. The valley bottom contains outwash sand and gravel. The reported groundwater flow direction for the Mohawk River Valley is cross-valley toward the River, with only a slight down-valley (down river) gradient.[9] This finding is consistent with observed conditions at this site. Although a portion of site groundwater does flow north toward, and discharges into, the Mohawk River, a portion of site groundwater also flows toward the south-southeast. That is, toward the original location of the Mohawk River before it was relocated from the south of the site when the New York canal system was built.

Additionally, it is known that a slurry cut-off wall was installed (circa 1988) around the main tank farm encompassing ASTs 1 through 8. During this investigation, an attempt was made to field locate this slurry wall. Its presence in one location was confirmed in the northeast site corner near the Mohawk River and Leland Avenue and may influence groundwater hydrology at that location. However, two additional trenches, dug 10 to 12 feet long transverse to the wall layout off the northeast corner of the remaining maintenance building, did not encounter an intact slurry wall. Additionally, excavated piping extending from loading racks into the tank farm for ASTs 1 through 8 crossed the known location of the slurry wall without encountering it. Based on these observations, the slurry wall is not intact around the full perimeter of the former tank farm.

The hydrogeology of the "critical stratigraphic section" pertinent to the extent of subsurface contamination is summarized as follows:

- Depth to groundwater is generally shallow at the site, commonly in the range of 1 to 4 feet bgs. In some areas in the eastern portion of the site, with thicker fill placed at higher elevations, the depth to groundwater is found at depths of 6 to 8 feet. Refer to Table 9 for detailed information.

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[9] Casey, George D., Reynolds, Richard J., Hydrogeology of the Stratified-Drift Aquifers of the Utica Area, Oneida, Herkimer Counties, New York – Part 2 (East).

- Throughout most of the site, the groundwater table occurs within the surface fill unit. In some localized areas in the northeastern site corner, the surface fill is not saturated and the water table is positioned near or below the top of the clay-silt unit underlying the surface fill unit.

- The general hydrogeologic condition of the site can be described as a "two layered system", comprised of a surface fill unit "aquifer," with variable, low-medium to high hydraulic conductivity values, underlain by "aquitard" (confining bed-type soils) of the clay-silt unit with very low hydraulic conductivity.

- ASTM D4044-96[10] methodology applied to all 16 permanent monitoring wells determined hydraulic conductivities in surficial soils. Conductivities ranged from 0.5 to 591 gallons per day per square foot. The three orders of magnitude range confirmed that the fill unit displays heterogeneous permeability. Table 14 presents a summary of individual slug test results. Additional slug test data is presented in Appendix E. The main soil unit description for MW-11 and the measured well conductivity magnitude are in apparent disagreement, however, this data was re-reviewed and accepted. These conductivities were field measured using a 3 and 6-foot length 1.7-inch diameter slugs and a data logger. In most wells, falling head data were used to determine conductivity values. It should be noted that slug tests performed in wells with little or no separation between the top of the screen and the water table, as was the case here, are not ideal conditions and increase the analysis difficulty. This situation, therefore, introduces somewhat more uncertainty to the results.

- Groundwater contours are constructed from water level elevation data from 16 monitoring wells and 26 temporary wells indicate a generalized, overall flow direction of west to east until a saddle point is reach where groundwater flow splits

[10]ASTM D4044-96 - (Field Procedure) for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifiers.

and either flows toward the river through a narrow passage centered between MW-2 and TW-13 or it turns toward the southeast toward MW-15. Flow gradients are in the range of 1 to 2%. However, the groundwater gradient exhibits notable site variation, with mounded areas along the southwestern and northeastern site corners and a steepened (~10%) gradient indicated along the river (Sheet 8). Possible explanations for this are:

- Variations of the hydraulic conductivity of the surface fill unit "aquifer" (depending on the amount of fines present) and the existence of confining bed type soils underlying the relatively thin "aquifer". Groundwater would tend to flow more preferentially through the more permeable zones in the fill unit and/or down elevation dip of the confining bed.

- The presence of subsurface utilities and former pipeline routes may locally influence groundwater flow.

- The slurry cut-off wall (refer to Sections 1.3 and 3.3.1) installed around the former main aboveground tank field may affect the natural groundwater flow pattern.

- Seven geologic cross sections are constructed for this site. Three (A-A', B-B', C-C') extend north-south, two (E-E', G-G') extend east-west and two follow the two groundwater flow paths across the site (D-D', F-F'). Section G-G' is along the River and shows the groundwater discharge point is centered near TW-13, and that a groundwater gradient of just under 11% exists between TW-12, located 30 feet away, and TW-13. It is interpreted that the presence of the slurry wall affects this gradient by raising the groundwater elevation at TW-12, located inside the slurry wall. Sections D-D' and F-F' clearly show the groundwater slope toward the two groundwater discharge points from the site. On both of these cross sections, the clay unit surface does not correlate with the groundwater flow paths.

- Four rounds of measurements displayed unusually low groundwater elevation readings in TW-8. This observation was investigated by installing TW-25 approximately 4 feet away and MW-16 approximately 20 feet to the south. An evaluation of TW-8, TW-9 (located along the river) and MW-16 was made. Each well has a 10-foot screened section approximately from elevation 395 to 405 feet, and TW-25 has a 5-foot screen approximately from elevation 400 to 405 feet. The groundwater elevations in TW-9, TW-25 and MW-16 on April 25, 2005 show that groundwater elevations in these three wells are within 0.6-foot of each other and TW-8 had an elevation that averaged 4.1 feet below the other three wells. Groundwater measurements made on May 18, 2005 show elevations in the three comparison wells to diverge by a maximum of 0.8 feet and TW-8, on average, was 6.2 feet lower than the other three wells. Three possibilities exist to explain this discrepancy:

    - A vertical downward gradient exists in the location of TW-8;

    - A preferential drainage pathway to the Mohawk River could exist along the bed of a former pipeline that ran from the River loading dock to the tank farm. This former pipeline bed lies several feet from TW-8 and the River elevation, measured on May 18, 2005 was approximately 1 foot below the TW-8 groundwater elevation on that date; or

    - Construction of TW-8 could be compromised.

4.0 NATURE AND EXTENT OF CONTAMINATION

Soil and groundwater associated with this site have been extensively investigated through the completion of 54 test pits, 79 soil borings, installation of 16 permanent groundwater monitoring wells and 26 temporary wells, and the collection of 12 surface soil samples. Soil and groundwater have been analyzed for VOCs, SVOCs, metals and PCBs. This intensive investigation revealed significant VOC and SVOC contamination of site soil and groundwater. A site summary of these results is presented on Sheet 9. The remainder of this section summarizes the site historical potential sources of contamination, conditions in the subsurface soils, groundwater quality, surface soil quality, perimeter investigation results, and a summary of the mapped area of concern and zones of grossly contaminated soils.

4.1 Sources of Contamination

This site was operated most recently as a bulk petroleum storage and dispensing site. The facility primarily stored and dispensed petroleum distillates and residuals and also gasoline. The presence of MTBE in eight monitoring wells demonstrates that release(s) of gasoline occurred at the site. During its operation as a bulk petroleum terminal, the facility maintained and operated the following components, each of which are considered potential sources of contamination to soil and groundwater at this site. These components include the following aboveground vertical storage tanks and their storage capacities in gallons:

- AST – 1 Kerosene (413,800)
- AST – 2 No. 6 Fuel Oil (720,300)
- AST – 3 Light Distillate (720,300)
- AST – 4 No. 6 Fuel Oil (1,551,200)
- AST – 5 Light Distillate (1,039,500)
- AST – 6 Light Distillate (1,220,800)
- AST – 7 No. 6 Fuel Oil (1,789,200)
- AST – 8 No. 2 Fuel Oil (1,789,200)
- AST – 9 No. 6 Fuel Oil (986,000)
- AST – 10 No. 2 Fuel Oil (2,260,500)

Additional facility infrastructure included:

- ASTs 11 through 13: Horizontal fuel blending tanks (~25,000 gallons each)
- AST – 14: Horizontal tank (~10,000 gallons)
- Underground storage tanks (1 through 5) stored waste oils, No. 2 fuel oil and gasoline (volume range 750 to 2,000 gallons)
- A boiler house used to heat residual petroleum products and an adjacent pump room
- An extensive network of aboveground and underground piping to move fuels to/from storage tanks or for loading/unloading
- A maintenance bay in the north end of the main building
- A garage located adjacent to the former AST-9
- An oil/water separator (~25,000 gallon)
- Fuel spills to the ground around the dispenser loading racks
- Five fuel loading racks and documentation of two additional loading racks previously removed

All of the above components of this site could have contributed to environmental petroleum releases. Additionally, on-site migration of contaminants from upgradient properties was also considered as a source of site contamination. Each of these potential contamination sources was investigated by through sampling and screening of test pits and soil borings, and sampling of groundwater and surface soils.

4.2 Subsurface Soils and Vadose Zone

A test pit program of 54 test pits was implemented to guide selection of locations for soil borings that provided soil samples for analysis of VOCs, SVOC, PCBs and metals. A total of 79 soil borings were installed across this 4.5-acre site. Soil intervals were typically screened with a PID meter and samples collected from the zones of highest PID readings for laboratory analysis. Twelve surface soil locations were sampled to assess the extent of contamination in the surficial soils. Sheet 3 shows the location of all surface and subsurface investigation points. The following conclusions are drawn from the soil analytical data:

- Fifty of 77 soil boring and six of six test pit samples (from SB-1 through SB-79, eight borings were not sampled, six of 54 test pits were sampled) showed the presence of VOCs in the subsurface soils and 21 of the 50 samples contained either individual VOCs or total VOCs at concentrations that were above the soil SCGs (Tables 1A/1B).

- Sixty-five of 77 soil boring samples detected SVOCs in the subsurface soils and 17 of the 65 samples contained one or more individual SVOCs at concentrations that were above the soil SCGs (Tables 2A/2B).

- Four soil boring samples were collected for metals analysis. One sample contained cyanide at 2.15 mg/kg; another sample contained mercury at 0.60, arsenic at 14.90 and zinc at 115 mg/kg, each above their respective SCGs (Table 3).

- Five subsurface soil boring samples were analyzed for PCBs. One sample detected Aroclor 1016 at a concentration well below the SCG (Table 4).

- Soil contamination is present in the zone of grossly contaminated soil from at or near ground surface down to 5 to 10 foot depths in many borings (ground surface down to the silty clay layer), and in the AOC frequently occurs from several feet below the ground surface down to the silty clay layer or into the top of this soil unit.

- No evidence of on-site migration of petroleum contaminants from the adjacent property located to the northwest or from any other direction was discovered.

4.3 Groundwater

Groundwater sampling results from the 16 monitoring and 14 temporary wells are summarized below. Groundwater quality contours are shown on Sheets 10 through 12.

- Eleven of 16 monitoring wells contained VOCs, and eight of these contained one or more VOC at a concentration that exceeds the groundwater SCGs. Thirteen of 15 temporary monitoring wells sampled contained VOCs, and 10 of these contained one or more VOCs at concentrations exceeding SCGs (Table 10).

- The distribution of VOCs at concentrations above the groundwater SCGs extended across the entire site and reached into the four site corners, as evidenced by exceedances in monitoring wells MW-1, MW-3, MW-4 and MW-6.

- Five of 16 monitoring wells contained SVOCs, and one of these contained one SVOC at a concentration exceeding the groundwater SCGs. Nine of 15 temporary monitoring wells sampled contained SVOCs, and two of these contained one or more SVOC compound at a concentration exceeding the groundwater SCGs (Table 11).

- Four monitoring wells sampled were analyzed for metals. All wells displayed elevated iron and manganese levels, and one well also had elevated magnesium and sodium concentrations. No other metals were present above groundwater SCGs (Table 12).

- Four monitoring wells sampled and analyzed for PCBs displayed results that were all below PCB detection limits (Table 13).

- No on-site migration of contaminated groundwater from the adjacent properties was documented to have occurred.

4.4 Surface Soils

A total of twelve surface soil samples were collected across the site, including two along the site perimeter with the Mohawk River. These samples were analyzed for VOCs by Method 8260, for SVOCs by Method 8270, and for PCBs and Target Analyte List metals plus mercury. Significant results are summarized below. A presentation of analytical results is contained in Tables 5 through 8, and surface soil samples locations are presented on Sheet 3.

- Four of 12 surface soil samples contained minor concentrations of VOCs that are all below the soil SCGs (Table 5).

- Eleven of 12 soil samples contained concentrations of SVOCs, seven of which contained one or more constituents at concentrations above the soil SCGs (Table 6).

- Six surface soil samples analyzed for metals showed zinc concentrations in all samples were above the typical background concentration. Arsenic, cadmium, copper and mercury were also present in some samples at concentrations above the soil SCGs (Table 7).

- Six surface soil samples analyzed for PCBs showed the presence of Aroclor 1260 at a concentration below the soil SCG (Table 8).

4.5 Perimeter Investigation Results

Perimeter investigation / evaluation of off-site contaminant migration was performed in three locations: at the low-lying wet area located at the southwest site corner; and along Leland Avenue; and along the Mohawk River.

Low Area

In the southwest corner, three soil samples (HB-1, HB-2, P-1) were collected during the storm drain investigation in the southwestern site corner. A backhoe investigation confirmed a hydraulic connection between this storm drain and the off-site low lying wet area when fluorescent dye was observed flowing from the pipe extending from the site out into the external low lying wet area. Soil sample results then confirmed that off-site discharge of petroleum had occurred from the site into this low-lying wet area. Hand boring samples, HB-1 and HB-2, each contained nine identified SVOCs. Two of these SVOCs, 2-Methylnaphthalene and Dibenzofuran at concentrations of 51 mg/kg and 7.2 mg/kg, respectively, are above the soil SCGs of 36.4 mg/kg and 6.2 mg/kg, respectively. In addition, these samples contained total SVOCs at concentrations of 721 mg/kg and 763 mg/kg, which are above the soil SCGs of 500 mg/kg total (Table 2B). The same two VOCs were found in these samples, cyclohexane and methylcyclohexane at concentrations of 0.19 to 0.46 mg/kg and 2.6 to 7.1 mg/kg, respectively, neither of which have specified SCGs. The total VOC concentrations in these samples were 300 and 205 mg/kg, respectively, exceeding the soil SCG of 10 mg/kg for total VOCs (Table 1B). A sediment sample (P-1) collected from inside this pipe on the site property was sandy and contained only a trace of acetone and no identified SVOCs. A hand boring sample PSB-64 collected from the low lying wet area contained one compound, 2-Methylnaphthalene, which at a concentration of 200 mg/kg was above the soil SCG of 37 mg/kg and the total SVOCs in this sample were 2,291 mg/kg, which was above the soil SCG of 500 mg/kg.

Review of the contaminants present in site soil borings in the vicinity of the low area at the southwestern site corner (SB-41, SB-43, SB-46, SB-47, SB-48) suggests that the suite of compounds present on-site correlates with the suite of compounds found in HB-1 and HB-2. Therefore, it is concluded that the proven hydraulic connection from a site storm drain to the low-lying wet area did act as a conduit for the release of hydrocarbons from the site.

Leland Avenue

Results of samples collected from off-site along Leland Avenue are summarized as follows. Soils samples from PSB-62, PSB-63, PSB-77 and PSB-78 all showed the presence of both VOCs and SVOCs, but none of these four soil samples contained individual or total concentrations above the soil SCGs. In addition, two groundwater samples were collected from TW-26 and PSB-63, both of which showed the presence of one or more VOC and one or more SVOC compound. In addition, TW-26 contained one compound, sec-Butylbenzene at a concentration of 7.7 μg/l, that is above the groundwater SCG of 5.0 μg/l.

Mohawk River

Along the Mohawk River, three borings (SB-65, SB-66, SB-67) and two surface soil (PSS-11 and PSS-12) samples were collected at the site perimeter. Additionally, monitoring wells MW-1, MW-2, MW-3, TW-9 and TW-13 are along the site perimeter near the River bank. SB-65 through SB-67 were non-detect for VOCs, but all three borings showed the presence of one or more SVOC. SB-67 had one SVOC compound, benzo(a)anthracene at 0.25 mg/kg that exceeded soil SCGs. PSS-11 and PSS-12 showed a trace of one VOC constituent in one sample but showed the presence of multiple SVOCs at concentrations below the soil SCGs. The five wells showed the presence of multiple VOCs in each well and each well contained one or more VOCs at concentrations exceeding the groundwater SCGs. SVOCs were present in MW-1 with one groundwater SCG exceedance, however, all five wells showed the presence of SVOC TICs.

Based on this data, it is concluded that discharge of VOC and SVOC compounds into the Mohawk River is occurring.

An examination of the Mohawk River flow in comparison to the estimated annual site groundwater discharge to the river provides perspective on the potential impact of this discharge. Based on hydraulic conductivity measurements obtained from the monitoring well slug tests and groundwater table contouring, an estimate of the groundwater discharge rate to the River was made. The three wells located along the riverbank, MW-1 through MW-3, were determined to have hydraulic conductivities ranging from 1 to 259 gallons per day per square foot. These conductivities, coupled with a hydraulic gradient of 8%, were applied to calculate a range of expected daily groundwater discharge volume to the River. This calculated volume ranged from 1,200 to 37,000 gallons per day (1 to 26 gallons per minute). This volume was then used to calculate a range of daily mass loading of organics (VOCs plus SVOCs) to the River. This calculation applied the highest total VOC plus SVOC concentration from MW-1 (1,776 μg/l) to the entire discharge length and also applied the average concentration from wells MW-1 through MW-3 (1,066 μg/l). Based on this approach, a daily organic mass loading (VOC plus SVOC) to the Mohawk River from ongoing groundwater discharge is on the order of 0.33 to 0.55 pounds per day (200 pounds per year). The daily Mohawk River flow rate for a one-year time period from October 2002 through September 2003 at Delta Dam near Rome, New York fluctuated from 176 to 1,850 cubic feet per second. These rates equate to daily flows of 113 million to 1.2 billion gallons per day. A waste load allocation on the order of 0.5 pounds per day is well within the assimilative capacity of this river.

In summary, off-site migration was found in three locations, along Leland Avenue, into the Mohawk River, and to the southwest into a low-lying wet area. The mass loading of organics to the Mohawk River from contaminated groundwater discharge is low and is expected to be well within the assimilative capacity of the River.

Analytical results from off-site sampling are contained in Tables 1A, 1B, 2A, 2B, 10 and 11 and the Data Usability Reports are presented in Appendix F. Location of borings and wells is shown on Sheet 3.

4.6 Area of Concern and Grossly Contaminated Zones

sheet 12 ?

Based on the site investigation completed, an Area of Concern (AOC) and ~~two~~ zones of grossly contaminated soils have been identified at the site (refer to Sheet 13). The major zone of gross contamination extends from the southwest site corner, along the western site boundary, and continues toward the Mohawk River. This is the area of former loading racks, USTs, fuel blending, and river dock unloading and underground piping to the tank farm. This major zone of gross contamination also extends eastward to include former ASTs 2 and 3. There is a small non-contiguous zone of gross contamination associated with SB-76 that reported free product in the boring log from a depth of 5 to 12 feet bgs. The AOC extends from the eastern border of the main zone of gross contamination eastward into the former tank farm for ASTs 1, 2, 3, 5, 7 and 8.

The distinction made between the zones of gross contamination and the AOC are based on the following. The zone of gross contamination shows the frequent presence of free product, field soil observations of high PID values, strong petroleum odors and visually heavy staining, and the zone also includes areas of high contaminant concentrations in groundwater. Free product was observed in April 2005 in the 12-inch recovery sump installed approximately 20 feet southeast of the location of surface soil sample 5 (PSS-5). This location is within the zone of gross contamination along the Mohawk River. The AOC was distinguished by frequent observations of residual petroleum soil staining and sheens, and moderate to high PID readings, but relatively few and small pockets of free product. The observation of staining and odor in the AOC were also more likely to have been observed to occur from several feet below the ground surface downward the silty clay layer.

5.0 CONTAMINANT FATE AND TRANSPORT

5.1 Potential Routes of Migration

This site is located in the center of the Mohawk River Valley. Groundwater discharges from this site into the Mohawk River and also from the southeast property corner. The contaminants at this site are predominantly VOCs and SVOCs derived from petroleum products and are present in both the soil and groundwater. The surficial fill material is heterogeneous and has been observed to vary significantly in its permeability due to the uneven distribution of coarse and fine fill materials across the site. Additionally, the slurry wall installed around the former large ASTs and coarse fill associated with former pipe trenches further impact the contaminant migration route.

The site groundwater flow pattern moves groundwater from west to east, where groundwater encounters a saddle point that divides flow either toward the Mohawk River or toward the southeast (Leland Avenue) and off-site. Affected groundwater following the southeast pathway migrates toward Leland Avenue. However, relatively low-level concentrations have been found in off-site soil and groundwater (refer to Section 4.5).

Compounds in the vadose zone soils can both volatilize and be released upward, or they can dissolve with infiltrating surface water and be carried downward into groundwater. Surficial contamination can be mobilized by site construction or wind erosion through aerosolization of soil particles containing one or more adhered contaminants. VOC contaminants in surface soils were generally either not detected or were detected at concentrations below the soil SCGs. SVOC contaminants were present in all 12 surface soil samples, seven of which contained one or more constituents at concentrations above the soil SCGs. Mercury was detected in 4 of 6 surface soil samples at concentrations above the soil SCGs. The site history documented does not indicate a prior use of organic mercuric compounds at this site. As a result, it is concluded that inorganic mercury is most likely the form present in the soil and is relatively stable in this form.

5.2 Contaminant Persistence

The octanol-carbon partitioning coefficient (Koc), which is a unit-less quantity, indicates the potential of a chemical to bind to organic carbon in the soil or sediment (soil sorption potential). Chemicals with values of Koc above 10,000 have a high affinity to adsorb to organic carbon, while values in the range of 1,000 to 10,000 may adsorb or desorb, dependent upon multiple factors. Values of Koc below 1,000 indicate the compound will show little adsorption to organic carbon (i.e. mobile through the soil column). The octanol-water partitioning coefficient (Kow), which is also a unit-less quantity, indicates the bioaccumulation or bioconcentration potential of a chemical in the fatty tissue of living organisms. Values of Kow below 500 indicate the compound has a low bioaccumulation potential and a high water solubility, thus making the compound available for biodegradation. Values of Kow above 1,000 indicate strong bioaccumulation potential, but low mobility in the soil column.

Compounds with high water solubility values, low Koc, and low Kow partitioning coefficients are most susceptible to biodegradation and least likely to be bioaccumulated. However, compounds with this profile also have the highest mobility potential through the subsurface.

Given suitable conditions, SVOC compounds will biodegrade in natural soil and groundwater environments. Many SVOC compounds, however, are susceptible to bioaccumulation. They are also susceptible to photodecomposition and oxidation in surface water and aquatic environments. Sorption of polycyclic aromatic hydrocarbons (PAHs), a subset of SVOCs, to soil and sediments increases with increasing soil (sorbent) particle surface area. For example, adsorption coefficients for sorption of pyrene to sediments for various particle sizes is: sand 9.4 to 68, silt 1,500 to 3,600 and clay 1,400 to 3,800, indicating a greater affinity for this compound to be adsorbed to silts and clays.[11] Microbial metabolism is the primary avenue of degradation for PAHs in soils. The rate and extent of microbial biodegradation is dependent upon several environmental factors: temperature; pH; oxygen concentration (>0.7 mg/l dissolved oxygen minimum necessary for biodegradation to occur); organic content; soil structure and particle size; characteristics of the microbial population; presence of compounds toxic to microorganisms (i.e. metals and cyanides); and physical and chemical properties of the PAHs. In general, two to three ring PAHs (i.e. naphthalene, acenaphthene, acenaphthylene, anthracene, fluorine, phenanthrene) can achieve biodegradation half-lives in soils on the order of a few weeks. However, four ring PAHs (fluoranthene, pyrene, chrysene, benz[a]anthracene) and five or more ring PAHs (benzo[a]pyrene, benzo[g,h,I]perylene) will have considerably longer half-lives, on the order of weeks to hundreds of days.[12] The PAH concentration in the soils can directly inhibit biological activity. For instance, inhibition to biological activity can begin to occur at petroleum hydrocarbon groundwater concentrations in the range of 200 to 500 mg/l, however, complete toxicity does not occur until petroleum presence approaches free phase product.[13]

SVOCs

Molecular weights of site SVOC compounds vary from relatively low (128 to 178) to high (202 to 390) values. In general, compounds within these molecular weight categories exhibit similar

[11]Toxicological Profile for Polycyclic Aromatic Hydrocarbons, US Dept. of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, August 1995, pp. 240, 252.

[12]Ibid. pp 237, 253.

[13]Vance, David B., What's Toxic, What's Not, 2 the 4 Technology Solutions, p.3.

environmental fates.[14] Table 15 groups the SVOCs into their respective molecular weight category. Seven of the compounds have low molecular weights and the remainders have high molecular weights. In general, higher molecular weight SVOCs are more persistent in soil environments.

- All of the SVOC compounds have very low to low-medium[15] solubility values in water. The solubility of several of the higher molecular weight SVOC contaminants is very low (0.0007 to 0.01 mg/L) when compared to the solubility of BTEX compounds (~100 to 500 mg/l). Some examples of high molecular weight SVOCs include benzo(g,h,i)perylene, benzo(a) anthracene and chrysene. The lower molecular weight compounds have the highest solubility values. For example, naphthalene, 2-methylnapthalene and dibenzofuran have the highest values (10 to 30 mg/L), while acenaphthylene, fluorene and phenanthrene form a secondary group with modest values (1 to 5 mg/L), however this class of compounds exhibits a very low solubility in comparison to VOCs.

- The Koc for the high molecular weight SVOC compounds are high, indicating their chemical tendency to sorb to organic bearing soils. The low molecular weight compounds have low to medium Koc values, indicating they are not likely to sorb to soil particles and are thus more likely to dissolve into either downward percolating water or flowing groundwater.

- SVOC compounds have very low vapor pressures, indicating they have low volatility. Their respective vapor pressures range considerably as a function of their molecular weights. The lower molecular weight compounds, such as naphthalene and acenaphthylene, have relatively higher vapor pressures (approximately 1×10^{-2} mm Hg), than do high molecular weight compounds, such as benzo(k)fluoranthene and chrysene, which have extremely low vapor pressures (1×10^{-7} to 1×10^{-11} mm Hg).

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[14] *Toxicological Profile for Polycyclic Aromatic Hydrocarbons*; Agency for Toxic Substances and Disease Registry; August 1995.

[15] Concentration terms refer to classification ranges presented in *Where did That Chemical Go?*; Nye, R.N.; Van Nostrand Reinhold, New York; 1990; see Table 11.

- SVOC compounds with high Kow values, those above approximately 1,000, have low soil mobility potential and a strong bioaccumulation potential. They can be expected to sorb to soil and occur at low concentrations in the groundwater due to their high soil sorption coefficients and low water solubility values. They will also undergo minimum volatilization. The SVOC compounds detected at this site all have Kow values above 1,000 and analytical results show low concentrations of most SVOCs in groundwater.

BTEX

- The BTEX compounds have solubility values in the medium to high range. Benzene has the highest solubility (about 1,800 mg/l), while the solubility of the other compounds range from 100 to 500 mg/l.

- All of the BTEX compounds have low log Koc values, indicating they are relatively mobile and will leach in the soil column.

- The vapor pressures of the BTEX compounds are relatively high, indicating that they are volatile.

BTEX compounds will degrade in suitable soil and groundwater environments and are not particularly susceptible to bioaccumulation. The fate and transport chemical data indicate the BTEX compounds are more mobile in the environment and will more readily partition into air and water than will SVOC compounds. BTEX will significantly volatilize from any source materials, leach in the soil column, and dissolve in groundwater at higher concentrations than will SVOCs.

MTBE

MTBE possesses chemical qualities (i.e., solubility, Koc, Kow, vapor pressure) similar to, but tending toward higher solubility and lower adsorption to soil particles than the BTEX compounds. These fate and transport chemical parameters for MTBE indicate it is more mobile in the environment and will more readily partition into air and water than will BTEX compounds. Therefore, MTBE will significantly volatilize from source materials, leach through the soil column and dissolve in groundwater at higher concentrations than will the BTEX compounds.

Table 15 contains chemical properties relevant to environmental fate of site contaminants. Optimum conditions to foster biodegradation of organic contaminants occur when the compounds have high water solubility, low soil sorption potential (i.e. high soil leaching potential), and a low Kow. Petroleum compounds in modest subsurface concentrations can degrade over time due to biodegration or chemical reactions. The reaction rate is compound specific, and for biodegradation to occur there must be suitable conditions to sustain the microbes including the absence of contaminant concentrations that are above the organism's toxicity threshold.

5.3 Contaminant Migration

A large zone of grossly contaminated soil lies along the entire western site boundary with extensions eastward along the Mohawk River and also eastward across the site center over the former ASTs 2 and 3. An area of concern exists east of the grossly contaminated soils covering much of the former tank farm for ASTs 1 through 8.

The principal groundwater flow path across this site is from west to east toward a groundwater divide. From this divide, groundwater either flows to the Mohawk River or toward the southeast. A small corner of the site in the southwestern corner has a groundwater flow path to the southwest toward an off-site low-lying wet area.

Based on site information gathered in the course of this investigation, it has been determined that migration of contaminants in groundwater is occurring from the site to the Mohawk River through groundwater discharge. Off-site migration of contaminated groundwater to the southeast along Leland Avenue also occurs, as evidenced by the presence of contaminated groundwater in TW-26. However, the contaminant concentrations are below the groundwater SCGs for all SVOCs and for all but one VOC (7.7 μg/l for sec-butylbenzene versus 5 μg/l SCG). Off-site testing of soils along

Leland Avenue showed the presence of low-level petroleum, but at concentrations one to two orders of magnitude below the soil SCGs. No evidence of on-site migration of contamination from adjacent sites was found in this investigation.

There is substantial petroleum contamination in vadose soils within identified zones of contamination that is an ongoing contributor to groundwater contamination. Within the "smear zone" (range of vertical fluctuation of the groundwater table), contamination is mobilized downward following seasonal high water table conditions. All impacted vadose soils contribute to a degree of volatilization and upward movement of vapors to the atmosphere.

6.0 QUALITATIVE EXPOSURE ASSESSMENT

6.1 Site Conceptual Model

The purpose of presenting a site conceptual model is to describe the key features of the site (including the nature/extent and the fate/transport characteristics of the contaminants) pertinent to evaluating the potential for exposures to the site contaminants. The site conceptual model also describes land use and human population characteristics at the site. The following narrative describes the site conceptual model used for the Qualitative Exposure Assessment.

- The site has a long history (50+ years) of use for the bulk storage of liquid petroleum products including petroleum distillates, residuals, fuels, and gasoline. Site infrastructure included an extensive network of above ground and underground piping, a river unloading dock, bulk storage tanks, trucker tank loading racks, fuel blending in aboveground storage tanks, and fleet fueling of delivery trucks.

- Known releases of petroleum products to the environment are many. This is evidenced by numerous past IRM actions to remove underground storage tanks, to resolve spills at the oil-water separator, to remove oil saturated soils in several areas, and historic documentation of free phase LNAPL in groundwater monitoring wells. Additionally, this investigation revealed evidence of widespread groundwater contamination above the groundwater SCGs across the entire site, of a significant percentage of the site acreage containing "gross soil contamination," and in several locations where soil contamination exceeds the soil SCGs. This site contamination occurred from separate petroleum releases across the site at differing times in the site history.

- This site and adjacent properties are all under industrial use. A similar bulk petroleum storage facility, from which all tanks have been removed, was located on the adjacent property to the west. The Mohawk River flows along the northern property boundary. To the east across Leland Avenue is a vacant parcel that was formerly a bulk petroleum storage facility (tanks have been removed) and later a bus garage. The Utica Transportation Authority bus garage and East Coast Olive Oil are located to the south. The nearest known residential property is an apartment complex located approximately 2,000 feet north on Leland Avenue, adjacent to I-90.

- No permanent streams, ponds or similar surface water bodies are located on the site. The nearest surface water body is the Mohawk River, which abuts the site to the north. A small area of standing surface water exists to the southwest of the site. Municipal water and sewer serve the surrounding area. The nearest known drinking water well is located approximately 1,400 feet west of the site.[16]

- A contiguous silty clay layer underlies the site at depths ranging from 8 to 12 feet below ground surface. Above this unit is fill material consisting of poorly sorted sand and silt, mixed with intermittent zones of building bricks. The fill material is extremely heterogeneous and displays widely varying hydraulic properties.

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[16]Hydrogeology of the Stratified Drift Aquifers in the Utica Area, Oneida and Herkimer Counties, New York – Part 2 (East), Casey, George D., Reynolds, Richard J., Sheet 1, 1988.

- Groundwater flows from the southwestern site corner toward the site center until it encounters a groundwater divide that splits flow either toward the Mohawk River or toward the southeast.

- Twelve surface soil samples revealed that VOCs, SVOCs and PCBs, where detected, were at concentrations below the soil SCGs. SVOCs in seven of twelve surface soil samples did contain one or more individual SVOCs at concentrations above the soil SCGs. Six of these samples are located within the mapped zone of grossly contaminated soils. Three samples located within either the primary area of concern or in the zone of grossly contaminated soils contained mercury at concentrations above the soil SCG.

6.2 Public Exposure Criteria

This section discusses the qualitative exposure assessment (EA) completed. An exposure assessment considers the following five elements:

1. Contaminant sources;
2. Contaminant source release and transport (migration) pathways;
3. A point of exposure (location or area where contacts can occur);
4. A route of exposure ("uptake" mechanism, for example, ingestion); and
5. A receptor population.

An exposure pathway is complete when all five elements are present and documented. An exposure pathway can be eliminated if any one of the five elements does not exist in the past, present or future condition. A potential exposure pathway exists if any one of the five elements comprising an exposure pathway is not documented.

The tables in the following section detail conditions considered and provide the rationale used in eliminating or retaining exposure pathways identified. This EA assessment generally conforms to guidance provided by the New York State Department of Health.[17]

6.3 Exposure Assessment Analysis

The section summarizes the five elements of the exposure assessment completed for this site and discusses the analyses made for each of the five elements. This investigation confirmed the presence of petroleum (VOC/SVOC) in soil and groundwater, a discrete presence of one PCB compound in a surface soil sample along the Mohawk River bank, and low level mercury in surface soil samples within the zone of grossly contaminated soil and AOC. A summary of EA elements evaluated for these contaminants is presented in Tables 6A through 6E below.

Table 6A - Release and Migration Pathways

Receiving Medium	Pathway	Release Sources
Air	• Vapor migration from contaminated subsurface soil and groundwater into buildings and to outdoor locations.	• Surface soils • Shallow groundwater plume • Subsurface soils
Surface Soil	• Contact with contaminated surface water runoff containing VOCs and possibly SVOCs	• Surface soils
Subsurface Soil	• Leaching	• Surface soils
Surface Water	• Mobilization of contaminants in surface soils by surface water runoff. • Contaminant mobilization in surface and subsurface soils by surface water as it percolates to groundwater.	• Surface soils
Groundwater	• Down gradient migration of contaminated groundwater to off-site areas. • Contamination from primary and grossly contaminated source areas	• Surface/subsurface soils

[17]Draft DER-10 Technical Guidance for Site Investigations and Remediation, December 2002, Appendix 3B NYSDOH Public Health Exposure Assessment Guidance

This EA considered direct contact with contaminants by potential receptors. Direct contact exposure may result from contacting contaminants at their source location.

Table 6B – Points of Exposure

Contaminated Medium	Points of Exposure
Surface soils	During Construction Activities: • Contact with site soils within contaminated soil zones.
Subsurface soil and ground-water in primary and grossly contaminated source areas.	During Construction Activities: • Site excavation or significant grading activities. • Vapor intrusion inside future commercial storage building.
Surface water	• Groundwater discharge along the riverbank.

Table 6C – Exposure Routes

Residual Contaminated Medium	Routes of Exposure
Surface Soil	Dermal absorption, inhalation, penetration
Subsurface Soil	Dermal absorption, inhalation, penetration during construction activity
Groundwater	Ingestion, Inhalation, Dermal absorption

Table 6D – Receptor Population

LAND USE AND POPULATION ANALYSIS		
Conditions	**Description**	**Activity Analysis**
Land Uses	• Site is zoned for light industrial use.	• Current and expected future conditions.
	• Land to the east, west, and south is zoned for industrial use.	• Current and expected future conditions.
Potential Receptor Populations Relative to Site	On-Site future use: • Indoor commercial /industrial workers.	• Current and expected future conditions. • Standard work day/ week schedules.
	• Outdoor grounds keeping personnel • Construction workers (indoors and outdoors). • Adult or adolescents walking along planned riverfront greenway.	• Occasional activities; current and expected future conditions.

Table 6E – Summary of Conceptual Exposure Analysis completes the EA. This table indicates the completed pathways for exposure to site contaminants and recommends action to mitigate these pathways. Potentially completed exposure pathways to site contaminants are limited to subsurface excavation activities. A Soil Management Plan and Engineering and Administrative controls are proposed to manage these pathways.

TABLE 6E - SUMMARY OF CONCEPTUAL EXPOSURE SCENARIO ANALYSES

Potentially Exposed Population	Exposure Route, Medium and Exposure Point	Pathway Complete?	Reason for Selection or Non-Selection	Exposure Risk	Action
On-Site Construction Worker	Ingestion of groundwater	No	Municipal water supply serves area.	NA	NA
	Inhalation of volatiles from subsurface soils	Yes	Incidental exposure during excavation activities.	Minimal	Soil Mgmt Plan
	Inhalation of volatiles from shallow groundwater	Yes	Incidental exposure during excavation activities.	Minimal	Soil Mgmt Plan
	Dermal contact with shallow groundwater	Yes	Exposure during excavation activities.	Minimal *	Soil Mgmt Plan
	Dermal contact with surficial soils	Yes	Incidental exposure during excavation activities.	Minimal **	Soil Mgmt Plan
	Dermal contact with subsurface soils	Yes	Exposure during excavation activities.	Minimal **	Soil Mgmt Plan
On-Site Future Worker	Ingestion of groundwater	No	Municipal water supply serves area.	NA	NA
	Inhalation of volatiles from subsurface soils	No	Inhalation of volatiles from subsurface soils	NA	NA
	Inhalation of volatiles from shallow groundwater	No	New and renovated buildings to have sub-slab soil vapor ventilation.	NA	NA
	Dermal contact / ingestion of shallow groundwater	No	Municipal water supply.	NA	NA
	Dermal contact with surficial soils	No	No exposure - majority of site is to be paved / landscaped.	NA	NA
	Dermal contact with subsurface soils	No	No exposure - majority of site is to be paved / landscaped.	NA	NA
Off-Site Construction Worker	Inhalation of volatiles from subsurface soils	Yes	Incidental exposure during excavation activities.	Minimal	Soil Mgmt Plan
	Inhalation of volatiles from shallow groundwater	Yes	Incidental exposure during excavation activities.	Minimal	Soil Mgmt Plan
	Dermal contact with shallow groundwater	Yes	Exposure during excavation activities.	Minimal *	Soil Mgmt Plan
	Dermal contact with surficial soils	No	Surficial soil contamination limited to site.	NA	NA
	Dermal contact with subsurface soils	Yes	Exposure during excavation activities.	Minimal **	Soil Mgmt Plan

Notes:

* Toxicity data review of the groundwater contaminant concentrations indicate minimal risk to human health from incidental dermal contact.

** Soil is impacted within designated Site zones. Remedial excavation / controlled management of soil disturbance during site redevelopment will minimize exposure.

NA Not Applicable

Unless otherwise noted, rationale applies to both current and future conditions.

6.4 Land Use Limitations

The Exposure Assessment results indicate that land use restrictions are warranted for this site and some of its immediately surrounding publicly accessible land. Substantial petroleum impact to subsurface soils and groundwater exists at this site. In limited areas, including the low-lying area to the southwest and also along a portion of Leland Avenue restriction to subsurface disturbance of soils should be implemented and administrative controls applied to restrict disturbance of subsurface soils and discharge of extracted groundwater unless governed by a soil and groundwater management plan.

7.0 SUMMARY AND CONCLUSIONS OF SITE INVESTIGATION

7.1 Investigation Overview

A comprehensive investigation of surface and subsurface soils and groundwater across the entire site has been completed. Its purpose was to characterize the nature and extent of site contamination and to develop sufficient information to support selection of a site remediation technology. The scope of this project included the emptying and removal of site infrastructure including bulk petroleum storage and blending tanks, above and underground piping, loading racks, and buildings. The subsequent site contamination investigation included the completion of 54 test pits, 79 soil borings, and installation of 15 permanent groundwater-monitoring wells and 26 temporary monitoring wells. It also included the collection and analysis of in excess of 144 soil samples and 62 groundwater samples for VOCs, SVOCs, metals and PCBs, as well as several rounds of groundwater table measurements.

Based on the breadth of data generated by this investigation, the nature and extent of site contamination is documented and presented within this report.

7.1.1 Nature and Extent of Contamination

Virtually all groundwater at this site is impacted at concentrations above the groundwater SCGs. Soil contamination is somewhat less widespread, but is mapped in two large zones; one area of grossly contaminated soils lies west and north of the maintenance building, extending north to the Mohawk River, with a spur reaching eastward over the location of former ASTs 2 and 3. The AOC extends further to the east to Leland Avenue and along the northeastern Mohawk River frontage.

Vertically, soils in the primary area of concern and in the zone of grossly contaminated soil are impacted above soil SCGs down to the silty clay layer at approximately 5 to 10 feet below ground surface.

7.1.2 Fate and Transport

Contaminants at this site are derived from distillate and residual petroleum fuels, and to a lesser extent gasoline, and are primarily found in subsurface soils and groundwater. In general, distillates contain an abundance of lower molecular weight compounds, have moderate to high water solubility, and are mobile in the subsurface environment. Residual fuel oils have an abundance of higher molecular weight compounds that have low water solubility and thus tend to remain close to their release point. The presence of organic carbon in the soil column can significantly influence subsurface migration patterns.

The environmental fate of individual compounds is primarily dependent upon biological metabolism, although chemical degradation, such as oxidation, also contributes to reduction of compound concentrations. The fate of individual compounds derived from fuel oils tends to mirror their mobility potential: compounds that are water soluble (mobile) are also more susceptible to biodegradation processes; and compounds that have low water solubility tend to remain in place, but have much slower biodegradation rates. The VOCs and lower molecular weight SVOCs are relatively mobile in the soil and groundwater while the higher weight SVOCs tend to remain close to their point of release. Although petroleum compounds are susceptible to biodegradation in the subsurface environment, each compound tends to degrade at its own rate as microorganisms selectively ingest and metabolize them. Molecular weight is an indicator of the rate of degradation as lower molecular weight compounds tend to be degraded faster than higher weight compounds. Outside factors, such as presence of compounds toxic to microorganisms or concentration of the target compound, also influence degradation rates. Individual compounds found at this site are susceptible to degradation processes, however, in at least portions of the primary area of concern and within portions of the gross contamination areas, the contaminant concentrations may act to slow biodegradation activity. Degradation rates can range from a few days to many years for individual compounds.

The existing soil contamination within the zone of gross contamination is an ongoing contributor to groundwater contamination. Groundwater contamination at concentrations above the State groundwater SCGs exists site-wide. An ongoing discharge of groundwater at concentrations exceeding groundwater SCGs into the Mohawk River exists, however the impact to the River is negligible due to the extreme disparity between the groundwater discharge rate and the river flow rate. Off-site migration of site contamination has also occurred along Leland Avenue and from the Southwest site corner into a low-lying wet area.

7.2 Conclusions

Groundwater flows across this site initially from west to east, until it encounters a groundwater divide that splits the flow either toward the Mohawk River or toward the southeast. Widespread groundwater contamination exceeding the groundwater SCGs extends across the entire site. This site also contains areas of significant vadose zone soil contamination that, while not as widespread as the groundwater contamination, affects a substantial portion of the site in zones that either exceed soil SCGs or are grossly contaminated. Within approximately half of the areas of soil contamination, the vertical extent generally reaches down from the ground surface to the surface of, or partially into, the underlying silty clay layer (depths to clay surface range from 7 to 12 feet below ground surface).

The zone of gross contamination contains soils that are ongoing contributors to groundwater contamination. Remaining portions of the impacted soil zone tend to display significant contamination beginning from 2 to 4 feet below ground surface downward to or partially into the clay layer.

Off-site migration contamination has occurred along Leland Avenue, in the low lying wet area southwest of the site, and through groundwater discharge into the Mohawk River. Along Leland Avenue, off-site contaminant migration is limited. VOCs and SVOCs detected in soils were at concentrations below their SCGs, however, one VOC constituent in one of two groundwater samples was slightly above the SCG. In the low lying wet area, three soil samples all exceeded one or more soil SCG for both VOCs and SVOCs, while one on-site sediment sample from a discharge pipe displayed results that were below the soil SCGs for VOCs/SVOCs. One groundwater sample from this area showed results that were below the SCGs for both VOCs and SVOCs. Along the Mohawk River, soil samples from three borings and two surface locations all showed that VOCs and SVOCs are below the soil SCGs. Groundwater sampled in five monitoring wells located along the bank of the Mohawk River showed that all five wells contained one or more VOCs at concentrations above the groundwater SCGs and one well contained one SVOC compound whose concentration was above the groundwater SCG.

Evidence of contaminant migration onto the site was not found in this investigation.

7.2.1 Data Limitations and Recommendations for Future Investigations

This investigation collected significant information related to site contamination. Although the total quantity of information collected is large, it must be compared to evidence suggesting a dozen or more individually discernable release events, and likely even more that cannot be separated from the background created from the known events. Caution is urged in applying theory to discern movement of contaminants at this site. The complexity in contaminant distribution created by the multiple release events is compounded by the fact that the natural site soils are overlain by 8 to 12 feet of heterogeneous fill material embedded with building bricks. In addition, although the site ceased operation in the 1990's, release of petroleum products was observed during the spring of 2004 IRM to remove the remaining oil storage and much of the piping infrastructure from the site. These three factors combine to obscure the identification of individual sources or even locations (i.e. underground piping leaks) of releases.

No further investigation of this site is recommended, as sufficient information now exists to define remedial alternatives for site soils and groundwater.

7.2.2 Recommended Remedial Action Objectives

The objectives of this site cleanup should be to protect human health and to render the site suitable for future light industrial use per its municipal zoning designation and suitable for a planned riverbank green space. Planned use for this site is to build a warehouse facility with an on-site parking area on the southern portion and to develop a green space along the riverbank as a public access bike path and walkway. A Soil Management Plan and administrative controls should be a part of the long-term management of this site.

Specific objectives for groundwater and soil include the following:

- Prevent the incidental ingestion and dermal contact with site groundwater that exceeds State drinking water concentration standards, and prevent inhalation of volatilized constituents from site groundwater.

- Prevent the ingestion and direct contact with contaminated soil.

- Prevent inhalation of contaminants volatilized from site soils.

- Prevent the discharge of significant contamination to surface water.

- To the extent practicable, restore groundwater to pre-release condition.