



**US Army Corps  
of Engineers®**  
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**Final  
Remedial Investigation Report  
For  
Phase IV Remedial Investigation/Feasibility Study  
At Formerly Used Defense Site  
The Former Lake Ontario Ordnance Works (LOOW)  
Niagara County, New York**

October 2011

*Prepared for:*

U.S. Army Corps of Engineers  
Baltimore District

Contract W912DR-06-D-0002  
Delivery Order 0009  
FUDS Project No. C02NY0025

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COMPLETION OF SENIOR TECHNICAL REVIEW

This document has been produced within the framework of the Earth Resources Technology, Inc. (ERT) and EA Engineering, Science, and Technology, Inc. (EA) quality management system. As such, a senior technical review, as defined in the Quality Control Plan for this project, has been conducted. This included review of the overall design addressed within the document, proposed or utilized technologies and alternatives and their applications with respect to project objectives and framework of USACE regulatory constraints under the current DERP-FUDS No. C02NY0025 project, within which this work has been completed.



3/31/11

Sandy Staigerwald (EA)  
Senior Technical Reviewer

Date

#### COMPLETION OF INDEPENDENT TECHNICAL REVIEW

This document has been produced within the framework of ERT's total quality management system. As such, an independent technical review, appropriate to the level of risk and complexity inherent in the project as defined in the Quality Control Plan for this project, has been conducted. This included review of assumptions (methods, procedures, and material used in analyses), alternatives evaluated; the appropriateness of data used and level of data obtained; and reasonableness of the results, including whether the product meets the project objectives. Comments and concerns resulting from review of the document have been addressed and corrected as necessary.



3/10/10

Wanfang Zhou  
Independent Technical Reviewer

Date

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## LIST OF ACRONYMS

ACM	asbestos containing material
AEC	Atomic Energy Commission
AFP	Air Force Plant
amsl	above mean sea level
AOC	area of concern
ARAR	applicable or relevant and appropriate requirements
ASTM	American Society for Testing and Materials
bgs	below grade surface
BNI	Bechtel National, Inc.
BTV	background threshold value
CDD	Central Drainage Ditch
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CL	silty clay
CLP	Contract Laboratory Program
cpm	counts per minute
COPC	constituent of potential concern
CWM	Chemical Waste Management LLC
DAF	dilution attenuation factor
DERP	Defense Environmental Restoration Program
DO	dissolved oxygen
DoD	Department of Defense
DOH	Department of Health
DOT	Department of Transportation
DQA	data quality assessment
DQI	data quality indicator
DQO	data quality objective
DUSR	Data Usability Summary Report
EA	EA Engineering, Science and Technology, Inc.
EDS	Environmental Data Services, Inc.
EPC	exposure point concentration
ERDA	Energy Research and Development Administration
ERT	Earth Resources Technology, Inc.
EU	Exposure Unit
ft	foot/feet
ft/yr	feet per year
FS	feasibility study
FSP	Field Sampling Plan
FUDS	Formerly Used Defense Site
FUSRAP	Formerly Utilized Sites Remedial Action Program
g/g	gram per gram
GLC	glaciolacustrine clay
GPL	GPL Laboratories, LLLP
HASP	Health and Safety Plan
HHRA	Human Health Risk Assessment
HPAH	high molecular weight polycyclic aromatic hydrocarbon

HQ	hazard quotient
HTRW	Hazardous, Toxic, and Radioactive Waste
IDW	investigative derived waste
IEUBK	Integrated Exposure Uptake Biokinetic
IPPP	Interim Production Pilot Plant
IRA	Interim Removal/Remedial Action
ITR	independent technical review
KOA	Kampgrounds of America, Inc.
L/kg	liters per kilogram
LOOW	Lake Ontario Ordnance Works
MEC	munitions and explosives of concern
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mL/min	milliliters per minute
mm Hg	millimeters of mercury
ML	clayey silt
MS	matrix spike
MSD	matrix spike duplicate
mS/cm	milliSiemens per centimeter
mV	millivolts
MW	monitoring well
NFSS	Niagara Falls Storage Site
NPL	National Priorities List
NTU	nephelometric turbidity units
NY	New York
NYCRR	New York Codes, Rules and Regulations
NYSATF	New York State Assembly Task Force on Toxic Substances
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSDOL	New York State Department of Labor
NYSTOG	New York State Technical and Operational Guidance Series
OE	Ordnance and Explosive
PAH	polycyclic aromatic hydrocarbon
PARCCS	precision, accuracy, representativeness, comparability, completeness and sensitivity
PCA	Preliminary Contaminant Assessment
PCB	polychlorinated biphenyls
pH	potential of hydrogen
PID	photoionization detector
PM	project manager
PPE	personal protective equipment
PPM	parts per million
PRG	Preliminary Remedial Goal
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan

QC	quality control
QCP	Quality Control Plan
QuEST	Quality Environmental Solutions and Technology, Inc.
R	rejected
RAGS	Risk Assessment Guidance for Superfund
RI	remedial investigation
ROE	rights of entry
RPD	relative percent difference
RSL	Regional Screening Level
RSP	Radiation Safety Plan
SAP	Sampling and Analysis Plan
SL	screening level
SLERA	Screening Level Ecological Risk Assessment
SM	sandy silt
SMDP	Scientific Management Decision Point
SOP	standard operating procedure
SOW	scope of work
SQL	sample quantitation limit
SSHP	Site-specific Safety and Health Plan
SSL	site-specific screening level
STR	senior technical review
SVOC	semi-volatile organic compound
TAL	Target Analyte List
TBC	To-Be-Considered
TCL	Target Compound List
TCLP	Toxic Characteristic Leaching Procedure
TDS	total dissolved solids
TNT	trinitrotoluene
TOC	total organic carbon
TOGS	Technical and Operational Guidance
U	non-detect
UCT	upper clay till
UPL	upper prediction limit
USACE	U.S. Army Corps of Engineers
USATEC	U.S. Army Topographic Engineering Center
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
UXO	unexploded ordnance
VOC	volatile organic compound
VP	Vicinity Properties
WDD	Western Drainage Ditch
WWTP	wastewater treatment plant
µg/L	micrograms per liter
µR/hr	microRoentgens per hour
µS/cm	microSiemens per centimeter
°F	degrees Fahrenheit

%R            percent recovery  
95UCLM       95<sup>th</sup> percentile upper confidence limit on the mean

## EXECUTIVE SUMMARY

Under contract number W912DR-06-D-0002, delivery order 0009 with the U.S. Army Corps of Engineers-Baltimore District (USACE-Baltimore), Earth Resources Technology, Inc. (ERT) has conducted a Remedial Investigation (RI) on Town of Lewiston property associated with former Wastewater Treatment Plant (WWTP) facilities (identified as Exposure Unit 7) on the former Lake Ontario Ordnance Works (LOOW) site, Formerly Used Defense Site Project Number C02NY0025, in Niagara County, New York.

The work was conducted under an ongoing authorized Defense Environmental Restoration Program—Formerly Used Defense Sites Hazardous, Toxic, and Radioactive Waste project and as outlined in a scope of work dated 13 May 2008. The Phase IV RI was performed between July and December 2009.

The Phase IV RI was limited to the Town of Lewiston property associated with the former WWTP facilities on the former LOOW, herein referred to as the site. The RI Report presents the acquired data and analysis of activities associated with the Phase IV RI. It was the intent of the Phase IV RI to utilize the same sampling and analytical protocols and methods as those utilized in previous RI phases in order to maintain consistency of method and reproducibility and representativeness of data.

The former WWTP is inactive and various structures have been partially and/or completely demolished. The former mixing house has been completely demolished and removed. The former pump house has been demolished and removed to the foundation. A slab and subsurface vault area remains in place. The former acid neutralization building has been partially demolished and the structural elements and underground vault remain in place. One of the former sludge beds has been demolished and removed during an interim removal/remedial action (IRA). Underground utilities associated with the former WWTP remain in place in unknown conditions. Other structures such as the venturi vault, Imhoff tank and one of the two sludge beds remain in place in various overgrown and decaying conditions. The former trinitrotoluene (TNT) waste lines, which terminated at the mixing house, were partially removed and the insides scoured during a remedial action conducted in 1999 (Radian International, 2000).

Investigation activities included two distinct mobilizations; the first mobilization focused on the characterization of soils and the second mobilization focused on the characterization of groundwater. During the first mobilization, soil sampling for field screening and off-site laboratory analyses was conducted. The intent of the first mobilization was to obtain analytical data that sufficiently characterized surface and subsurface soil constituents systematically across the former WWTP and in areas adjacent to former WWTP structures. In addition, the analytical data was intended to be used to confirm whether there were constituents in the vicinity of the TNT waste lines, or whether the IRA was sufficient with regard to potential subsurface soil impact. In total, 45 soil borings were advanced and 86 soil samples and two terrestrial sediment samples were collected and analyzed. The soil borings were distributed in both a systematic and biased fashion to investigate potential site-wide and structure-specific impacts to the environment. During the second mobilization three groundwater monitoring wells (MWs) were installed down gradient (based on regional groundwater flow) of the former acid neutralization

building, the Imhoff tank and the chlorination tank. Groundwater samples were collected and analyzed from each newly installed MW.

To evaluate the data collected during the two mobilizations, the constituents detected in the environmental samples were compared to health based screening criteria for surface soil, subsurface soil and groundwater from the U.S. Environmental Protection Agency (USEPA) Regional Screening Levels tables (USEPA, 2009a). Similarly, surface soil and terrestrial sediment concentrations were compared to published ecological benchmarks to identify constituents of potential concern to ecological receptors. In addition, the site-specific soil screening values for the protection of groundwater and a statistical comparison to background concentrations were considered to further evaluate detected constituent concentrations. Surface soil sample concentrations of metals exceeded risk-based screening values and/or ecological benchmarks and were subsequently evaluated in a Human Health Risk Assessment (HHRA) and Screening Level Ecological Risk Assessment (SLERA). Subsurface soil sample concentrations of metals exceeded risk-based screening values and were subsequently evaluated in the HHRA. Several groundwater sample concentrations of volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), and metals exceeded the risk-based screening values and were subsequently evaluated in the HHRA.

The SLERA and HHRA incorporate the results of samples collected and analyzed as part of the following efforts:

- USACE/EA. 2008. *Final Report of Results for the Phase III Remedial Investigation of Underground Utility Lines at the Former LOOW, Niagara County, NY*. April.
- USACE/ERT. 2009. *Final Field Sampling Plan Addendum for Phase IV Remedial Investigation and Feasibility Study for the Former, Niagara County, NY*. June.

Based on the results of the SLERA, there are no identified significant impacts to ecological receptors associated with the former WWTP and risks were identified as negligible.

The HHRA specifically evaluated risk associated with exposure two receptor groups: construction workers and potential future resident adults and children. Potential cancer risk and non-cancer hazards for residential receptors were evaluated in the HHRA for completeness; even though future residential land use is unlikely due to present land use restrictions (NYS Department of Health, 1974).

Based on the results of the HHRA, there are no identified impacts related to human receptors associated with the former TNT waste lines. Therefore, it is considered that the IRA completely addressed risk associated with soil in the vicinity of the former TNT lines.

The HHRA identified elevated risk for potential future resident adult and child exposure to PAHs in soil and sludge, and to polychlorinated biphenyls (PCBs) in sludge. Elevated risk for the future resident adult and child associated to exposure to PAHs in soil is due to the presence of a single sample location with elevated PAH concentrations above the project screening criteria. There is no evidence of widespread significant impacts related to PAHs in soil. However, as previously mentioned, due to the current land-use control prohibiting residential development on

the former WWTP property, the exposure pathway for residential receptors is not currently possible (NYSDEC, 1974).

Considering exposure to the whole Exposure Unit (EU) 7, the HHRA identified elevated risks for construction worker exposure to PAHs and PCBs in sludge contained within various former WWTP structures.

Elevated risk for construction worker exposures to PAHs and PCBs in sludge contained in various former WWTP structures should be further evaluated in a feasibility study (FS). It is recommended that the FS be prepared to evaluate remedial alternatives for PAHs and PCBs (Aroclor 1254) in the contaminated sludge in the underground utilities and pits associated with the former WWTP. The remedial alternative strategies should be developed in accordance with the USEPA Guidance for Conducting RIs and FSs under Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) (USEPA, 1988) and applicable regulatory requirements.

## 1.0 INTRODUCTION

Earth Resources Technology, Inc. (ERT) was contracted by the U.S. Army Corps of Engineers (USACE) to conduct an investigation of the Town of Lewiston property associated with former Department of Defense (DoD) Wastewater Treatment Plant (WWTP) facility on the former Lake Ontario Ordnance Works (LOOW) defense site in Niagara County, New York (NY) (Figures 1-1 and 1-2). The Phase IV Remedial Investigation (RI) work was performed under contract number W912DR-06-D-0002, delivery order number 0009, dated 25 June 2008. The Phase IV RI is the fourth phase of ongoing RI activities of former LOOW. Details of the Phase I, Phase II and Phase III RIs can be reviewed in their entirety in the following reports:

- Final Report of Results for the Phase I Remedial Investigation at the LOOW, Niagara County, New York [USACE/EA Engineering, Science and Technology, Inc. (EA), 1999],
- Final Report of Results for the Phase II Remedial Investigation at the LOOW, Niagara County, New York (USACE/EA, 2002), and
- Final Report of Results for the Phase III Remedial Investigation at the LOOW, Niagara County, New York (USACE/EA, 2008c).

Phase IV RI activities were conducted under an ongoing authorized Defense Environmental Restoration Program-Formerly Used Defense Sites (DERP-FUDS) Hazardous, Toxic, and Radioactive Waste (HTRW) project and as outlined in the Scope of Work (SOW) (USACE, 2008a). The WWTP is no longer functional and the land parcel is currently owned by the Town of Lewiston, New York.

Phase IV RI activities were conducted in accordance with previously approved project planning documents:

- Addendum to the Health and Safety Plan for the Phase I Remedial Investigation at the Former LOOW, Niagara County, New York, for the Phase IV Remedial Investigation (HASP) (USACE/ERT/EA, 2009a),
- Addendum to the Radiation Safety Plan (RSP) for TNT Site Walkover, LOOW, for the Phase IV Remedial Investigation at the Former LOOW, Niagara County, New York (RSP) (USACE/ERT/EA, 2009b),
- Addendum to the ISSI (ISSI Unexploded Ordnance, Inc.) Ordnance and Explosives Support Services Work Plan for Munitions and Explosives of Concern (MEC) Operations for the Phase IV Remedial Investigation at the Former LOOW, Niagara County, New York) (USACE/ERT/EA, 2009c),
- Addendum to the Work Plan Asbestos Containing Material (ACM) Removal for the Phase IV Remedial Investigation at the Former LOOW, Niagara County, New York (USACE/ERT/EA, 2009d),
- Final Field Sampling Plan Addendum for the Phase IV Remedial Investigation at the Former LOOW, Niagara County, New York (FSP) (USACE/ERT/EA, 2009e),
- Final Quality Assurance Project Plan (QAPP) for Phase IV Remedial Investigation at the Former LOOW, Niagara County, New York (USACE/ERT/EA, 2009f),

- Human Health Risk Assessment Work Plan for the Phase IV Remedial Investigation/Feasibility Studies at the Former LOOW, Niagara County, New York, Addendum to the Human Health Risk Assessment of Selected Exposure Units EU1-EU6, EU8, EU9, Work Plan (USACE/ERT/EA, 2009g), and
- Screening Level Ecological Risk Assessment Work Plan for the Phase IV Remedial Investigation/Feasibility Studies at the Former LOOW, Niagara County, New York, Addendum to the Screening Level Ecological Risk Assessment at Selected Exposure Units EU1-EU6, EU8, EU9, Work Plan (USACE/ERT/EA, 2009h).

This report details the activities associated with the Phase IV RI of the formerly used DoD WWTP located on the Town of Lewiston property, in Niagara County, New York (Figure 1-1). Sampling locations and analytical requirements were based on a detailed review of historic DoD operations and onsite structures, sampling results described in the Phase I, Phase II, and Phase III RI Reports, and other historical sources of information regarding potential impacts.

### **1.1 Project Scope and Objectives**

The objective of this report is to document activities that were conducted as part of the Phase IV RI for the former LOOW. The Phase IV RI was specific to the formerly used DoD WWTP on the Town of Lewiston property. Field activities for this RI were conducted in two mobilizations. The first mobilization focused on surface and subsurface soil characterization. Soil sample locations were determined based on a review of historical site information. The second mobilization focused on groundwater characterization. Groundwater sample locations were selected by reviewing historical site information and evaluating soil data collected during the first mobilization for the Phase IV RI.

The overall objective of this Phase IV RI is to comprehensively characterize both soil and groundwater media at the Town of Lewiston property, delineate the nature and extent of any identified constituents of potential concern (COPC), and to provide an evaluation of potential risk to human health and the environment posed by constituent concentrations in investigated media.

### **1.2 Site History**

In 1942, the War Department obtained a 7,500-acre parcel in northwestern Niagara County for the construction of a trinitrotoluene (TNT) production facility designated LOOW (Figure 1-1). TNT production, product support, and storage occupied 2,500 acres of the eastern portion of LOOW. The remaining 5,000 acres were left undeveloped, acting as a buffer zone and allowing for the possible expansion of production. Expansion never occurred, and in 1943, after 9 months of operation, LOOW was decommissioned due to excess TNT production at other facilities. The eastern 2,500 acres, which was the production area, was subsequently used by various other agencies of the DoD, including the Air Force and Navy. The Air Force and Navy later used the area for manufacturing plants, such as Air Force Plant 68 (AFP-68) and the Navy Interim Production Pilot Plant (IPPP), for manufacturing of high-efficiency borane fuels. The Army subsequently used the acreage for the construction of a Nike Missile Base.

In the mid 1940s, 1,500 acres of the southern portion of the former LOOW were transferred to the USACE, Manhattan Engineer District. The Manhattan Engineer District later gave rise to the U. S. Atomic Energy Commission (AEC). In 1974, the AEC was abolished and gave rise to the

Energy Research and Development Administration (ERDA) and the U.S. Nuclear Regulatory Commission (NRC). In 1977, ERDA became the U.S. Department of Energy. While under operation by the Manhattan Engineer District, radioactive materials were stored on portions of the 1,500 acres of the LOOW site. However, between the 1950s and 1980s, radioactive materials formerly housed on the acreage were consolidated, removed, and transferred to the current 191-acre Niagara Falls Storage Site (NFSS) area. During the investigations and consolidation, the acreage surrounding the NFSS that was formerly used by the AEC and its predecessor was designated as “Vicinity Properties” (VP) to facilitate the clean up and closure. The NFSS and remaining open VPs are currently being addressed under the Formerly Utilized Sites Remedial Action Program (FUSRAP). The acreage comprising the WWTP property is located north and adjacent to the northwestern corner of NFSS and was designated VP X. This site is not an open vicinity property as it was formally closed by DOE in 1992 [Bechtel National, Inc. (BNI), 1992], and USACE does not currently have the authority to re-evaluate the site under the FUSRAP program.

### **1.2.1 WWTP History**

The WWTP was constructed in 1942 to support the LOOW facility, and its purpose was to treat wastes from the LOOW sanitary sewer and acid lines and to dilute liquid waste from TNT waste lines. The WWTP was comprised of a sewage pump house, venturi vault, Imhoff settling tank, sludge beds, a chlorine contact tank, acid neutralization building, collection tank and final mixing houses, as well as underground utility lines used to convey wastes between these facilities. TNT process wastewater was diluted at the WWTP with treated sanitary and other industrial wastewaters prior to discharge. Wastes were discharged to a 30-inch diameter outfall line that exited the WWTP to the west and traversed from the WWTP to the Niagara River. After LOOW activities ceased, the WWTP was utilized by AFP-68, AFP-38, the Navy IPPP, the Nike Base, the Boron-10 Plant (a non-DoD facility), and for disposal of thiocyanate wastes [New York State Assembly Task Force on Toxic Substances (NYSATF), 1981]. AFP-38 operated from approximately 1950-1979 and was used for rocket, missile, and laser research and development. AFP-68 operated from approximately 1957-1959 and was a boron-based high energy fuels research and development project. The former LOOW WWTP was used for treatment of production wastes from both of these facilities. The Nike Missile Base was operated by the U.S. Army from 1954 to 1966, and the former LOOW WWTP received sanitary wastes from the facility. The Navy IPPP was built in 1956 for the production of high efficiency fuels. This facility utilized some of the existing TNT production lines and the former LOOW WWTP.

In addition to the WWTP, several support shops, referred to as the WWTP Vicinity Shops, were constructed in 1942, just west of the WWTP. The Vicinity Shops included a paint shop, fabrication shop, tool house, electrical shop, and portions of two unloading platforms.

The Town of Lewiston acquired the two parcels which comprised the former LOOW WWTP and Vicinity Shops in 1975. The Town WWTP property is bordered by Chemical Waste Management, LLC (CWM) property to the north and east, NFSS property to the south, and a National Grid power easement to the west (Figure 1-2). During the DOE investigation and remediation, the Town of Lewiston property, including the WWTP, was designated VP X. Remediation at VP X included soil removal to a depth of 1.2 feet (ft) below ground surface (bgs) around the structures of the WWTP and near the former railroad track on the southern boundary

of the parcel (at the NFSS boundary). VP X is currently designated a closed FUSRAP vicinity property (BNI, 1992).

Prior to the acquisition of the WWTP land by the Town of Lewiston, a letter was prepared by the State Commissioner of Health outlining the land-use restrictions that would be applied to the property in order for the state to approve the land transfer. The restrictions were imposed with the objective of protecting public health and safety and to “minimize danger to life and property from radiation hazards”. The restrictions indicate that the property cannot be used for residential purposes, schools, or hospitals but it can be used for industrial or commercial activities. These restrictions could be lifted if deemed appropriate by the Department of Health (DOH).

In addition to the above known DoD activities, an evaluation of historic aerial photographs identified two anomalies on the property. One of the anomalies was observed in a photograph from 1944. This anomaly was classified as “disturbed ground/scar” and was further described as a possible open storage area (USATEC, 2002). The anomaly was not noted in subsequent photos, suggesting that it was not maintained or did not present enough of a physical disturbance to be noted on later photos. The second anomaly was noted in a photo from 1958 and appeared during the timeframe from which the property was being used by the AEC (USATEC, 2002). The second anomaly is located primarily on CWM property to the north, but is immediately adjacent to the property boundary with the Town of Lewiston.

### **1.2.2 Historic WWTP Structures**

The function of any wastewater treatment system is to reduce or eliminate contaminants, by mechanical, chemical and/or biological processes, from wastewater prior to discharging the treated water. The original intent of the former LOOW WWTP was to treat wastewater generated solely by DoD operations. After the decommissioning of the former LOOW, the wastewater treatment plant was subsequently used to treat wastewater from both DoD and non-DoD operations conducted at the site.

Various structures were associated with the WWTP, including a venturi vault, an Imhoff tank, chlorine tank, acid neutralization building, a pumping station with an associated underground storage tank and mixing house.

#### *1.2.2.1 Venturi Vault*

A venturi vault system was used to promote aeration of the sanitary wastewater stream. Venturi pump systems supply large amounts of air, via mixing, to wastewater, providing oxygen to bacteria and other microorganisms that consume organic matter. The growth of helpful microorganisms is sped up by vigorous aeration with the concentrated microorganisms and wastewater. Based on the historical figures and process lines associated with the WWTP, aeration of the sanitary wastewater was conducted prior to entry into the Imhoff tank.

#### *1.2.2.2 Imhoff Tank and Sludge Beds*

Imhoff tanks are essentially a solids separation system. The Imhoff tank and associated sludge beds are a two-tiered system suitable for the collection and processing of sanitary sewage, and typically used for the clarification of sewage by simple settling, along with anaerobic digestion of extracted sludge. Settling takes place in the upper chamber of the Imhoff tank, from which solids settle (and are digested under anaerobic conditions) and conveyed to beds where sludge is

spread and dried. Water drained from the sludge was removed and transferred back to the Imhoff tank for processing. Typically after 6-9 months of drying, the sludge is removed from the sludge beds. Records of sludge removal from the beds at the WWTP and the ultimate disposal location are not available. The clarified water from the Imhoff tank was then chlorinated prior to discharge to the mixing house.

#### *1.2.2.3 Chlorine Tank*

A chlorine tank was used to provide chemical disinfection of the sanitary wastewater stream. Chlorine is used in the wastewater treatment process to remove biological contaminants. In addition, chlorine can be included as an odor control agent. Chlorine from the chlorine tank was introduced into the sanitary wastewater stream upon exiting the Imhoff tank. Periodically, chlorine may have been introduced as an odor suppressant to the sludge beds and Imhoff tank.

#### *1.2.2.4 Acid Neutralization Building*

The acid neutralization building was used to neutralize acid waste received by the WWTP. Typically, the neutralization medium was lump limestone or marble chips, with high calcium carbonate content. Acid wastes entering the system percolate through the limestone or marble and are chemically buffered to an acceptable pH level. In addition, at this point in the treatment process, further pH adjustments to the acid waste may have been performed with the addition of lime. The use of lime to adequately adjust pH is likely, due to properties of lime which also facilitates precipitation of metals into sludge which would settle on the bottom of the acid neutralization vaults and be easily removed upon dewatering of the vaults. In addition, a large wooden hopper labeled "lime" was encountered on site.

#### *1.2.2.5 Mixing House*

The mixing house was used to blend the treated sanitary and acid wastewaters, along with the TNT wastewater, and potentially to dechlorinate the mixed wastewater prior to discharge from the plant and into the Niagara River.

#### *1.2.2.6 Pump House*

Although gravity fed transport is ideal for wastewater treatment systems, the former pump house was utilized to subsidize flow through the operations of the treatment plant, transport of wastewater and process liquids.

### **1.2.3 Historic WWTP Operations**

The WWTP was used primarily to treat four types of wastewater: sanitary waste; acid waste; TNT production waste; and, following closing of LOOW, other process-related wastewater (i.e., boron production).

A single sanitary sewer line entered the WWTP from the east. Sanitary waste was first aerated in a venturi vault, located between the former pump station and the Imhoff tanks. After aeration, the sanitary waste was settled in the Imhoff tank. At this point, liquid waste was gravity fed from the Imhoff tank to a collection tank and solid waste was transferred to one of two sludge beds associated with the Imhoff tank. Upon entering the collection tank, the sewage wastewater was combined with treated acid waste and chemical waste. The resulting mixture was then gravity transferred to the former mixing house where it was combined with TNT production waste. Once adequately mixed, the treated wastewater was discharged through the 30-inch diameter outfall to the Niagara River.

Acid waste resulted from acid production and storage, laboratory processes and nitration process associated with TNT production. A single acid waste sewer entered the WWTP from the east and terminated at a manhole approximately 20 ft to the north of the acid neutralization building. At this point, the waste stream was gravity fed into the acid neutralization vaults. Volumes of acid waste which were above the capacity of the operating system were discharged from the manhole, via an overflow, to the Western Drainage Ditch.

From the acid neutralization building, treated acid waste was gravity transferred to the collection tank where it was combined with the treated sanitary waste stream and additional concentrated chlorine. As previously described, this mixture was then passed through the mixing house and ultimately discharged through the 30-inch diameter outfall to the Niagara River.

TNT waste was transferred to the WWTP through two TNT waste lines entering the WWTP from the north. The TNT waste lines received production waste from the TNT nitration areas and TNT washing facilities. TNT waste was directed to the mixing house where it was mixed with the treated waste streams. From this point, as previously described, the treated water was discharged through the 30-inch outfall to the Niagara River.

#### **1.2.4 Previous USACE Investigations**

An ongoing multi-phase RI is assessing the nature and extent of contamination associated with the former LOOW operations and subsequent DoD operations at areas of concern (AOCs) fully eligible for investigation within the approved and ongoing DERP-FUDS HTRW project. During these previous RI phases, formerly used DoD AOCs, including the WWTP, were assessed to determine the appropriateness of combining areas into exposure units (EUs) to facilitate the ongoing risk assessment at the former LOOW. An assessment of proximity, contaminant type and distribution, AOC history, similar terrain/vegetation, and industrial processes was performed to determine how to combine the AOCs into EUs. During this assessment, two EUs were identified on the Town of Lewiston WWTP parcels (Figure 1-2). EU 6 was identified as the WWTP Vicinity Shops and EU 7 was identified as the WWTP proper.

The WWTP Vicinity Shops (EU 6) were characterized during the Phase I and II RI and associated risk assessment (USACE/EA, 2008b). The Vicinity Shops are not included in the project boundaries for the Phase IV RI evaluation of the WWTP.

The WWTP was also included in previous investigations, including Phase I of the RI, but completion of the investigation was postponed, pending decisions on the eligibility of the site for additional evaluation under the ongoing HTRW and/or other FUDS projects. Previous sampling locations are presented in Figures 1-3 through 1-5. The investigation of the WWTP presented in this report represents Phase IV of the ongoing RI.

##### *1.2.4.1 Preliminary Contaminant Assessment*

A Preliminary Contamination Assessment (PCA) of the WWTP was conducted in 1992 (USACE/Acres, 1992), and involved the collection of samples from the pump house, chlorination tank, Imhoff tank, sludge beds, acid neutralization building, collection tank, mixing house, and the west drainage ditch. Samples were analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs),

pesticides, and metals. A subset of sludge, sewage, and soil samples were analyzed for explosives. A few VOCs were reported in an aqueous sample from the chlorination tank and in sediment samples from the west drainage ditch, while concentrations were below detection limits for the aqueous samples from the collection tank, acid neutralization building, pump house, and drainage ditch. Two phthalates were also detected in the sediment samples from the Western Drainage Ditch (WDD). Elevated concentrations of VOCs, SVOCs [primarily polycyclic aromatic hydrocarbons (PAHs)], PCBs, and metals were reported in the sludge samples. The highest reported concentration of VOCs (497.8 µg/kg) was in a sample collected from the pump house. The majority of the reported VOC constituents were benzene, toluene, ethyl benzene, and xylenes. A trace amount of 2,4-dinitrotoluene was reported in the sludge sample from the neutralization building. Trace concentrations of VOCs and SVOCs were also reported in the sewage and sludge samples from the mixing house (USACE/Acres, 1992). A detailed description of previous sample results is available for review in the *Preliminary Contamination Assessment Report, Operable Unit No. 2, Volume I of II* (USACE/Acres, 1992).

#### 1.2.4.2 Phase I RI

The WWTP and Vicinity Shops were investigated during the Phase I RI. The RI included collection of surface soil, subsurface soil, and groundwater samples from both areas. Soil samples were field screened for VOCs, PAHs, PCBs, and TNT. PAHs were detected in each of the field screening samples. Other compounds were detected in the screening samples, but not at concentrations of significance.

Three samples from each area were selected for re-screening and laboratory analysis of DoD marker compounds (explosives, boron, and lithium) based on the initial field screening results. Boron and lithium were detected in the six confirmation samples, but at concentrations below current screening criteria [2004 U.S. Environmental Protection Agency (USEPA) Region 9 Preliminary Remediation Goals (PRGs) (USEPA, 2004)]. Explosives were not detected in any of the confirmation samples.

One groundwater sample was collected from the WWTP area and one from the Vicinity Shops area. Boron and lithium were detected in each groundwater sample. In addition, metals were detected at elevated concentrations in the sample from the Vicinity Shops area. The explosive 1,3,5-trinitrobenzene was detected in this sample as well. A detailed description of previous sample results is available in the *Report for Phase I Remedial Investigation at the Former LOOW, Niagara County, NY* (USACE/EA, 1999).

The Phase I RI concluded that there may be impacts from DoD and non-DoD use at the WWTP, and therefore the site might not be eligible for further investigation under the DERP-FUDS HTRW project. It also concluded that the Vicinity Shops were not impacted by non-DoD use, and further evaluation of the elevated PAH concentrations and the boron in groundwater should be conducted.

#### 1.2.4.3 Phase II RI

Field Activities associated with the Phase II RI included 39 direct-push soil borings and three groundwater monitoring wells at the Vicinity Shops. Based on the results of the Phase I RI, the Vicinity Shops were investigated during the Phase II RI. However, the WWTP was not included for evaluation. Results of the Phase II RI indicated PAH concentrations exceeding health-based

criteria were detected in surface and shallow subsurface soil within the WWTP Vicinity Shops. PAH concentrations were widespread and appeared to be related to the road surfaces within the area. Results from groundwater samples collected from the WWTP Vicinity Shops indicated boron and manganese at concentrations exceeding the applicable screening criteria (USACE/EA, 2002).

#### *1.2.4.4 Phase III RI*

As recommended in the Phase II RI, the underground utilities present at the WWTP and Vicinity Shops were investigated as part of the Phase III RI for the former LOOW. The underground lines throughout LOOW, including those on the Town of Lewiston property, were designated EU 10. Six types of utilities are present within the WWTP (EU 7) area of the Town of Lewiston property: TNT waste lines; acid waste lines; drains, pits, and sumps; sanitary sewer lines; industrial wastewater lines; and a portion of the 30-inch outfall line. Sludge, wastewater, and subsurface soil samples were collected from each line type, with the exception of the TNT waste lines (which had undergone an IRA) and analyzed for VOCs, SVOCs, PAHs, PCBs, explosives, pesticides, and metals. The RI found that the sludge and wastewater in the WWTP Imhoff tank, chlorine tank, and the wooden discharge line from the acid neutralization building were some of the most impacted media at the LOOW facility.

Constituents exceeded USEPA Region 9 PRGs and were identified as COPCs. The following constituents within each of the chemical classes were identified as COPCs and were detected at elevated concentrations in the samples collected from the WWTP.

- Acid Waste Line: SVOCs, pesticides, PCBs, and metals in sludge, SVOCs and metals in wastewater; and metals in subsurface soil.
- Drains, Pits, and Sumps: VOCs, SVOCs, and metals in sludge; pesticides and metals in wastewater.
- Sanitary Sewer Line: metals in sludge, wastewater, and subsurface soil, and pesticides in wastewater.
- Industrial Wastewater Lines: metals in sludge and subsurface soil.
- 30-inch Outfall Line: SVOCs and metals in sludge and soil; pesticides and metals in wastewater.

In addition, a surface soil sample was collected from the southern sludge bed. Results did not exceed Region 9 PRGs with the exception of several metals. However, the metals concentrations were within background soil ranges with the exception of iron.

The Phase III RI recommended that a human health risk assessment (HHRA) be completed to evaluate the potential for risks from these COPCs associated with the underground lines and drains, pits and sumps. A detailed description of previous sample results is available in the *Report of Results for the Remedial Investigations of Underground Utility Lines, Formerly Used by the Department of Defense, LOOW, Niagara County, NY* (USACE/EA, 2008c).

#### *1.2.4.5 Human Health Risk Assessment*

The potential for risks from exposure to analytes in the underground utilities (EU-10) present at the WWTP were evaluated in the HHRA (USACE/EA, 2008b). Two exposure scenarios for

underground lines on the Town of Lewiston property were evaluated. The first involved potential exposure to all underground utilities located within the Town of Lewiston property and the second evaluated potential exposure to individual pipelines within the property. Receptors evaluated included the resident (child and adult), construction worker, commercial worker, maintenance worker, and trespasser (adolescent and adult). Within the Town of Lewiston property, there were four underground utilities evaluated in the HHRA: acid waste line, dry wells (including pits and sumps) (i.e., the collection tank), sanitary sewer line, and the wastewater line.

Results of the assessment for exposure to all lines on the property indicated that the non-carcinogenic hazard exceeded the USEPA's threshold of 1.0 for the construction worker and resident (child and adult) due to exposure to PCB in sludge. Total cumulative carcinogenic risk for the construction worker and resident was above the USEPA's threshold of  $1 \times 10^{-4}$  due primarily to PAHs in sludge.

When evaluated on a per line basis, hazards and/or risks above the USEPA carcinogenic risk range and/or hazard thresholds were indicated for the exposure of the construction worker and resident (child and adult) to PCB in sludge within the acid lines. PAHs also contributed to carcinogenic risk to the resident.

Hazards and/or risks above the USEPA thresholds were also indicated for the construction worker for exposure to PAHs in sludge within the drywells, pits, and sumps.

#### *1.2.4.6 Interim Removal Action for TNT Lines*

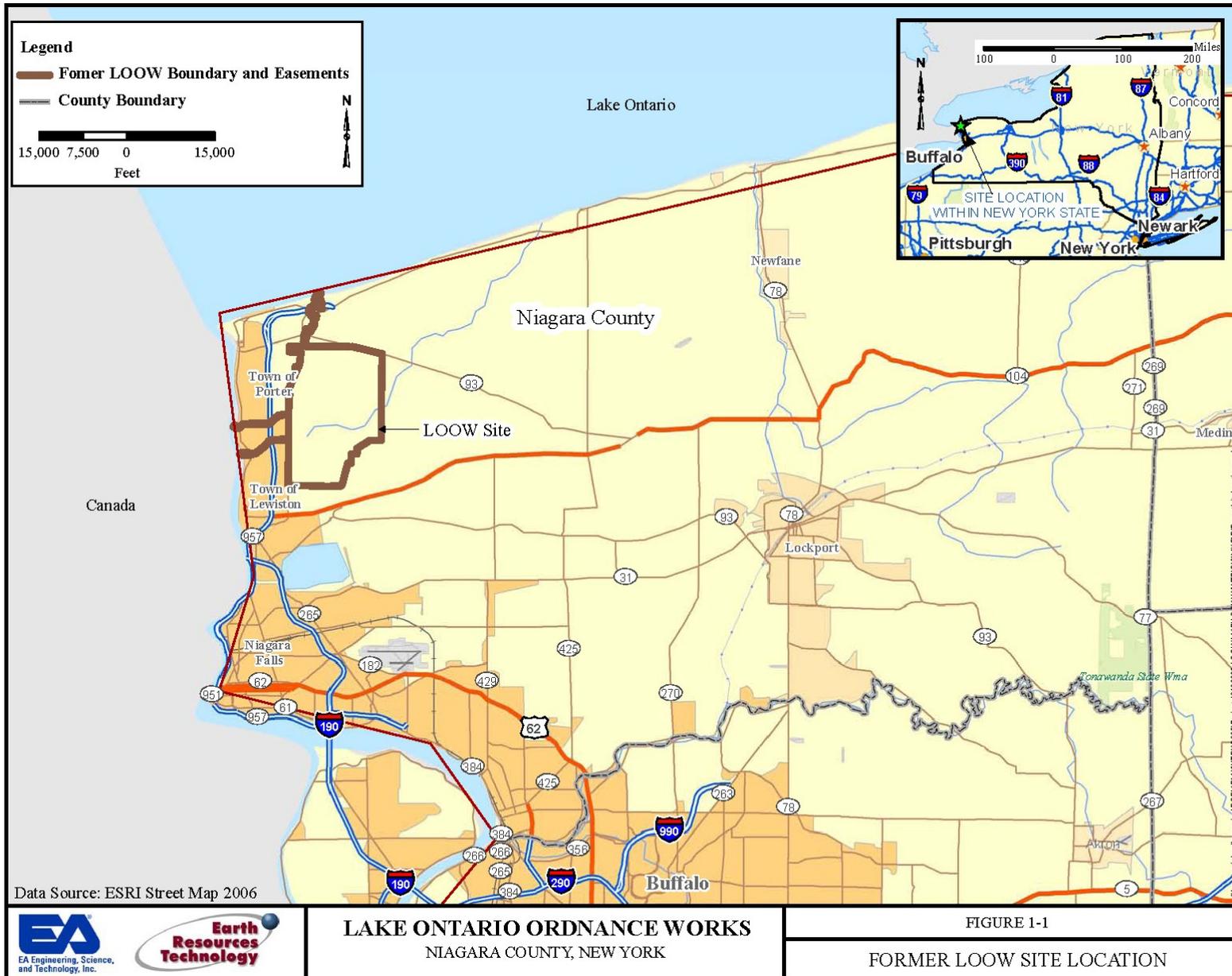
The USACE performed an Interim Removal/Remedial Action (IRA) on the TNT Lines in 1999 (Radian International, 2000). The IRA included removal of portions of the TNT line and cleaning and closing in place other portions of the lines. The portion of the TNT wastes lines on the Town of Lewiston property were cleaned and closed in place. Final administrative closure of the lines will take place as part of the FS once site-specific remedial goals are developed and the Department of Defense Explosives Safety Board agree that the remedial action adequately addressed the concern.

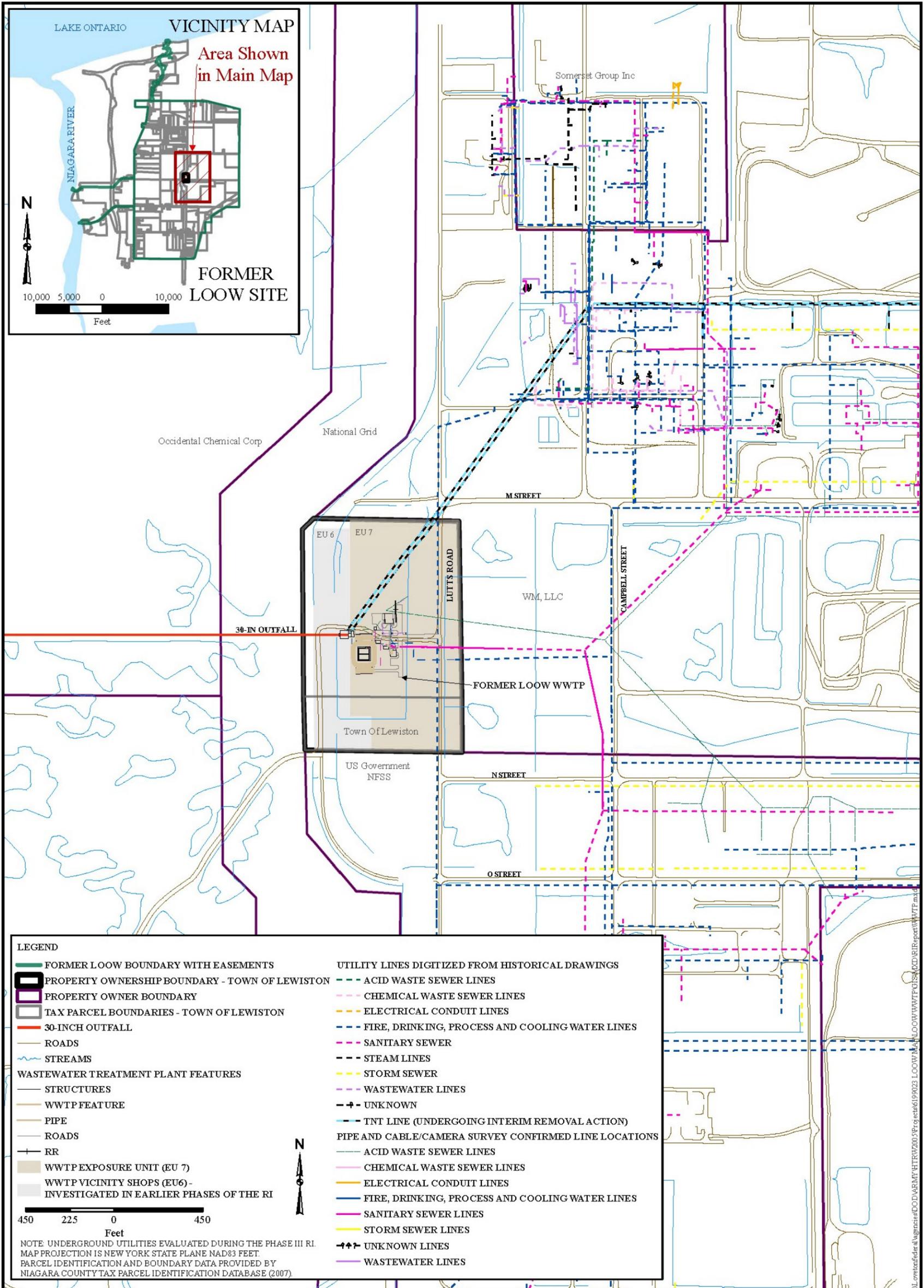
### **1.3 Report Organization**

This report documents appropriate background information and historical analytical data, Phase IV RI objectives, methodologies, field data and laboratory analytical data. Each report section, summarized below, provides information specific to the overall objective of the Phase IV RI.

- Section 1 provides historical information regarding the entire former LOOW and where appropriate, specific to the Town of Lewiston property, project objectives and the RI report organizational structure,
- Section 2 details the physical characteristics and environmental setting of the region and where applicable, specific to the former LOOW and Town of Lewiston property,
- Section 3 summarizes the activities and methodologies associated with the Phase IV RI,
- Section 4 details the investigation activities and methodologies,
- Section 5 details the data obtained as a result of the field efforts, emphasizing the results of laboratory analysis of soil and groundwater samples,

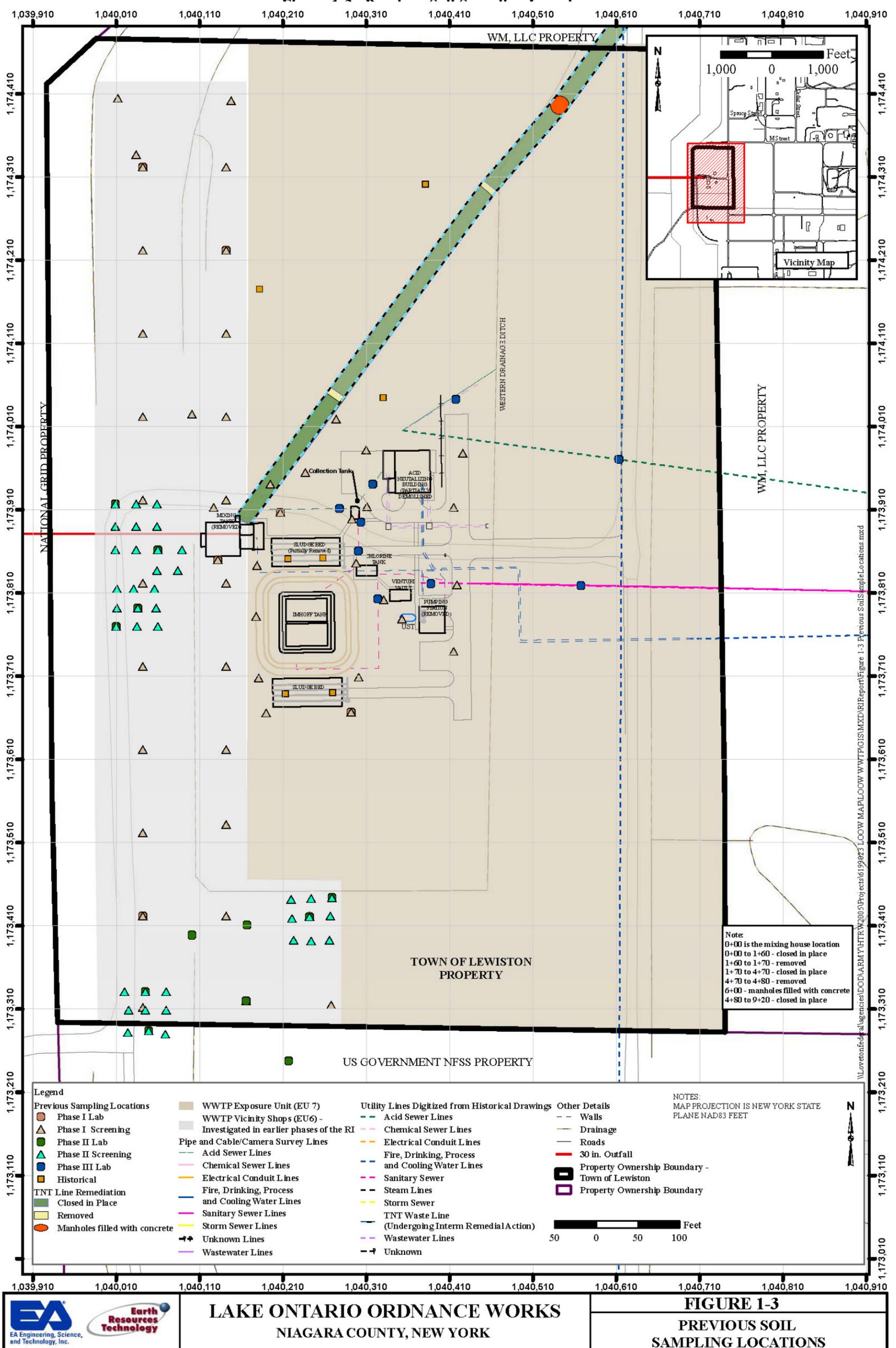
- Section 6 discusses the fate and transport of identified contaminants of potential concern at the site,
- Section 7 summarizes the nature and extent of contamination,
- Section 8 summarizes the HHRA associated with accumulated chemical data,
- Section 9 summarizes the screening level ecological risk assessment (SLERA) associated with accumulated chemical data, and
- Section 10 provides conclusions and recommendations based upon the data results, evaluations and assessments made in conjunction with the RI.





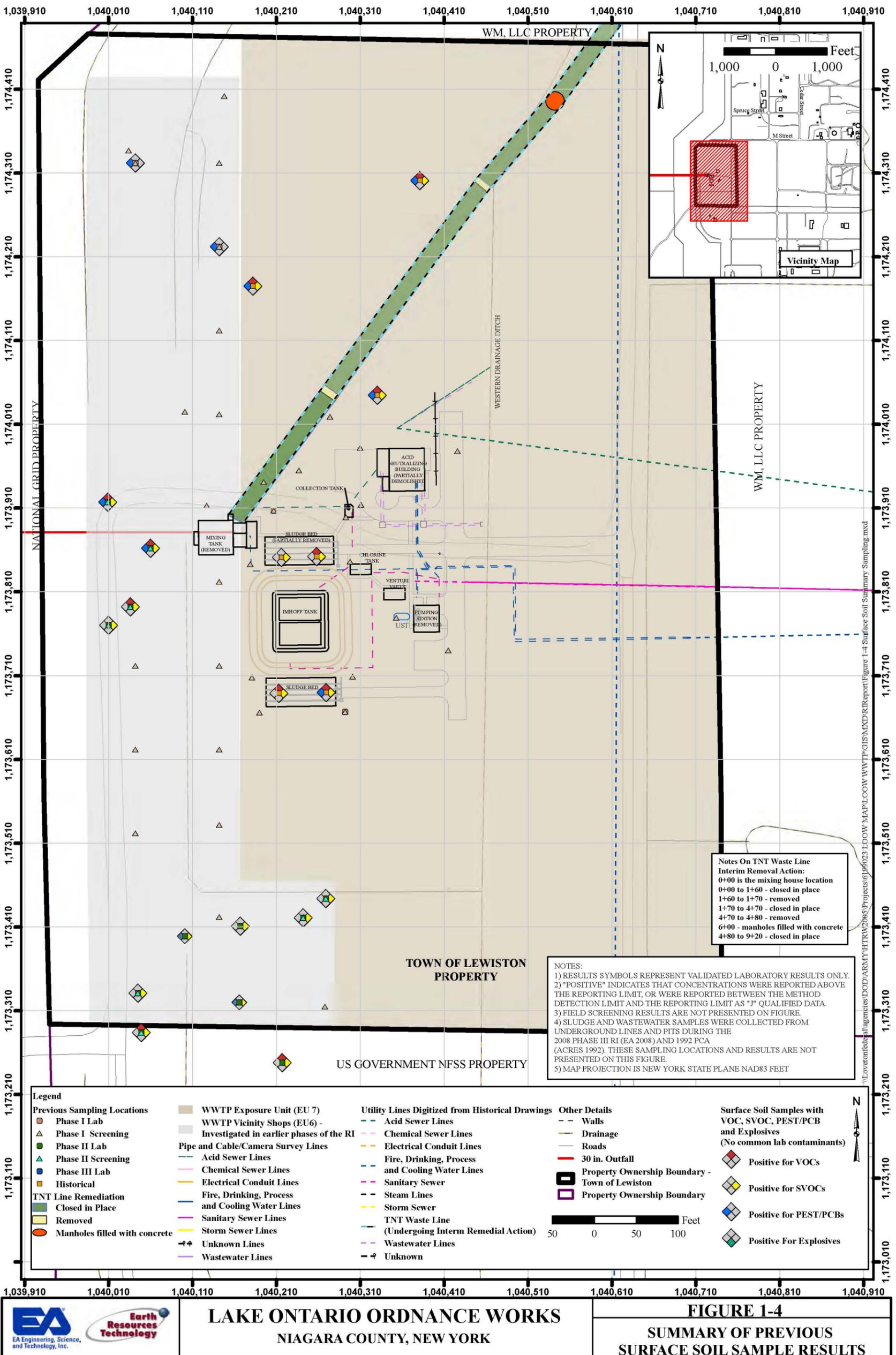
**LAKE ONTARIO ORDNANCE WORKS**  
 NIAGARA COUNTY, NEW YORK

**FIGURE 1-2**  
 LOCATION OF WWTP



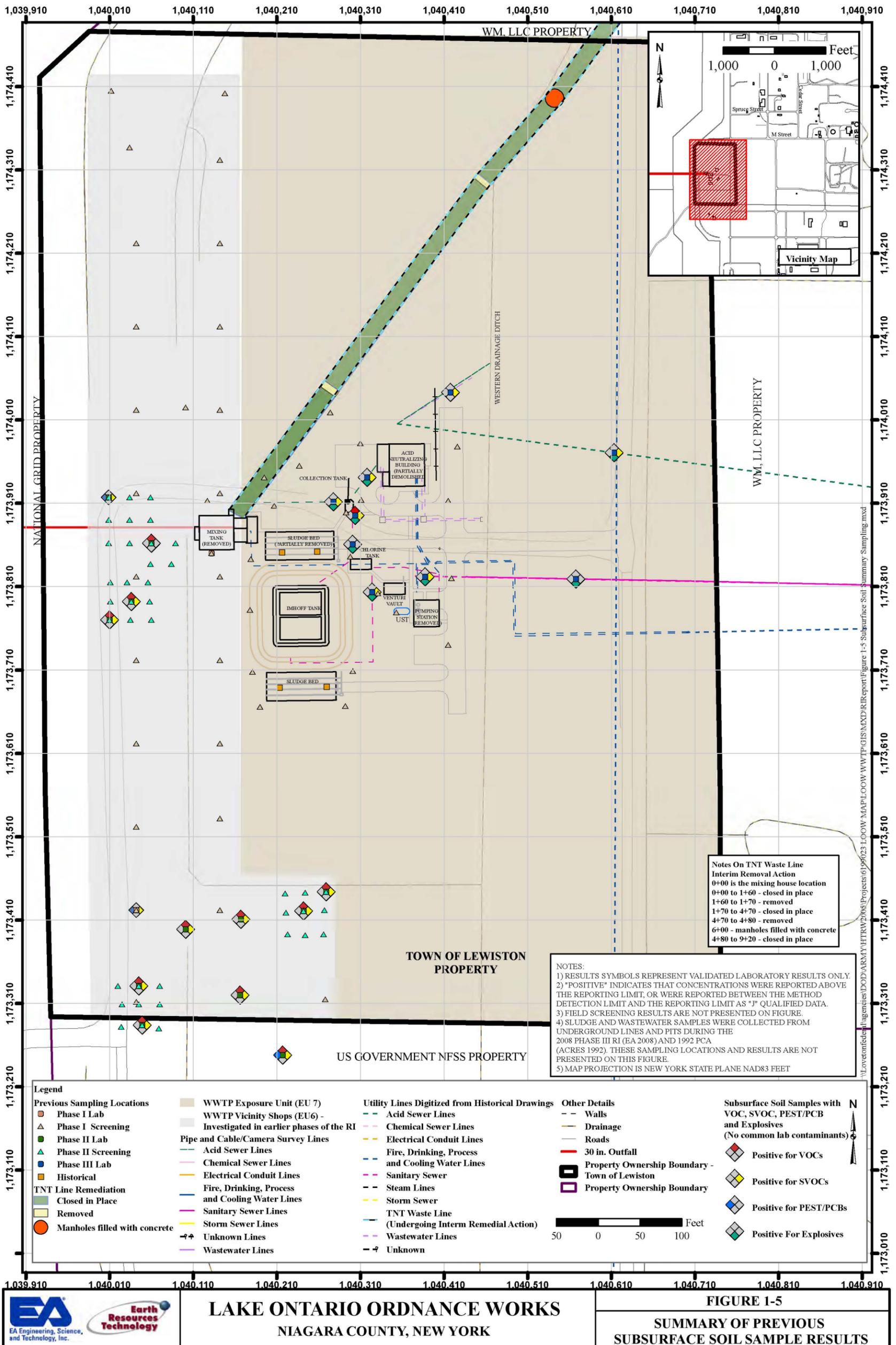
**LAKE ONTARIO ORDNANCE WORKS**  
 NIAGARA COUNTY, NEW YORK

**FIGURE 1-3**  
 PREVIOUS SOIL SAMPLING LOCATIONS



**LAKE ONTARIO ORDNANCE WORKS**  
 NIAGARA COUNTY, NEW YORK

**FIGURE 1-4**  
 SUMMARY OF PREVIOUS SURFACE SOIL SAMPLE RESULTS



**LAKE ONTARIO ORDNANCE WORKS**  
 NIAGARA COUNTY, NEW YORK

**FIGURE I-5**  
**SUMMARY OF PREVIOUS**  
**SUBSURFACE SOIL SAMPLE RESULTS**

## **2.0 PHYSICAL CHARACTERISTICS OF THE INVESTIGATION AREA**

### **2.1 Environmental Setting**

The site consists of approximately 14 acres of currently unused land owned by the Town of Lewiston. Of that acreage, approximately 4 acres were used as part of LOOW WWTP operations. Currently, there are no industrial or residential uses of the property. The site is located between the NFSS, on the southern border of the site, CWM, on the northern and eastern border of the site, and National Grid on the western border of the site.

### **2.2 Surrounding Land Use**

Approximately 380 private residences are located within the original 7,500-acre land parcel of the former LOOW. Most are located along Creek Road, the western section of Cain Road, Balmer Road, and Pletcher Road in the former 5,000-acre buffer zone. The largest residential area is located along Balmer Road and includes a mobile home park, Youngstown Mobile Park, consisting of approximately 92 units on Balmer Road, west of the former LOOW. A 13-acre Kampground of America (KOA), opened seasonally from April 1 through October 14, is located on the south side of Pletcher Road in the south-central portion of the former LOOW acreage. The KOA campground also includes a centrally located sewage disposal area. The Shrine of Fatima, attracting thousands of visitors each year, is located on the north side of Swann Road, within the former LOOW 5,000-acre buffer. There are also several small farms in the area.

### **2.3 Population**

According to 2008 U.S. Bureau of the Census data, the population of Niagara County was 214,464. The majority of the population in Niagara County surrounding the site is in the Towns of Lewiston (2,628), Niagara (8,404), Porter (6,699), and the City of Niagara Falls (52,326).

### **2.4 Meteorology**

Western New York, where the site is located, has a humid, continental climate characterized by warm summers and long, cold winters. The mean annual temperature is 48 degrees Fahrenheit (°F) with mean seasonal temperatures ranging between 25°F and 76°F. Mean annual precipitation is approximately 29 inches, distributed fairly evenly throughout the year. Snowfall, predominantly falling between November and March, averages approximately 51 inches per year. Wind data for the region indicated predominantly southwest winds with average monthly wind speeds ranging from 10 to 14 miles per hour.

### **2.5 Sensitive Ecosystems**

No sensitive ecosystems are recognized on the site. An inquiry of the U.S. Fish and Wildlife Service and New York State Department of Environmental Conservation (NYSDEC) was made during the SLERA conducted for EU 6 (adjacent to EU7) at the former LOOW with regard to threatened or endangered species. The agencies confirmed that there are no federally- or state-recognized endangered or threatened species that are known to inhabit or breed within the ecosystems at the site (USACE/EA, 2008d). Follow-up inquiries to both the U.S. Fish and Wildlife Service and NYSDEC were made in November 2010. The U.S. Fish and Wildlife Service confirmed that no federally-recognized endangered or threatened species are known to inhabit or breed within the ecosystems in all of Niagara County. NYSDEC was able to confirm

that no state-recognized endangered or threatened species are known to inhabit or breed within the ecosystems located on the property of the former LOOW (NYSDEC, 2011).

## 2.6 Local Vegetation

The site is generally overgrown with pasture-grass and northern shrub. Second growth wooded areas are dominated by maple, ash and oak trees. Within drainage swales, cattail-marsh grass dominates the vegetation. Species identified at EU 6 during 2004 are presented in Table 2-1.

## 2.7 Wildlife and Fish

An Ecological Assessment/Fish and Wildlife Impact Analysis was previously conducted as part of a Site-Wide Corrective Measures Study for specific exposure units at the former LOOW including EU 6, located adjacent to EU 7, in accordance with the NYSDEC Division of Fish Wildlife and USEPA guidance (Rust Environmental and Infrastructure, 1995). Species identified at EU 6 (adjacent to EU 7) during 2004 are presented in Table 2-1. Major findings of the report with respect to fish and wildlife are summarized below:

- According to the US Fish and Wildlife Service, NYSDEC Wildlife Resource Center, and NYSDEC Region 9 Office, there are no known occurrences of federally or state-listed endangered, threatened, or special concern wildlife species, rare plant, animals or natural communities on the former LOOW property.
- A variety of mammals, amphibians, reptiles, fish and bird species utilize the area within a one-half mile radius of the former LOOW. Species included the Black-capped Chickadee, Northern Cardinal, American Crow, Red-tailed Hawk, Great Blue Heron, Blue Jay, Canada Goose, Mallard, Red-winged Blackbird, Woodchuck, and White-tailed Deer (Rust Environmental and Infrastructure, 1995).
- Species, including those of a sensitive status, could potentially be found to inhabit areas within one-half mile of the site.

Subsequent inquiries and research conducted in accordance with this report has identified no threatened or endangered species potentially inhabiting the former LOOW (NYSDEC, 2011) and only one historically threatened species potentially inhabiting ecosystems within one-half mile of the former LOOW; the Eastern prairie fringed orchid (USFWS, 2011).

<b>Table 2-1. Species Observed Within EU 6 During 2004</b>		
<b>Herbs</b>		
Spikerush	Birdsfoot Trefoil	Teasel
Daisy fleabane	Indian	Hemp
Oxeye daisy	Cinquefoil	Sedge
Yellow hawkweed	Goldenrod	
<b>Shrubs and Vines</b>		
Gray-stemmed dogwood	Poison ivy	Virginia creeper
Tartarian honeysuckle	Canada honeysuckle	Winter grape
Hawthorn	Staghorn sumac	Highbush blueberry
<b>Trees</b>		
White ash	Eastern cottonwood	Quaking aspen
Black locust	Black willow	Slippery elm

<b>Table 2-1. Species Observed Within EU 6 During 2004</b>		
Pig nut	White Oak	Scarlet Oak
Basswood		
<b>Birds</b>		
Yellow warbler	Song sparrow	American crow
<b>Mammals</b>		
White-tailed deer	Squirrel (cf. Eastern gray)	
<b>Reptiles</b>		
American Toad	tadpoles	Snake (unidentified)
<i>Source: Screening Level Ecological Risk Assessment (SLERA) of Selected Exposure Units (EU1-EU-6, EU8, EU9, EU10) at the Former Lake Ontario Ordnance Works (LOOW), Niagara County, NY (USACE/EA, 2008d)</i>		

## 2.8 Surface Structures

Surface features remain that are associated with the former site use. The WDD, constructed during the 1940's to accommodate surface water run-off across the site, trends predominantly north across the eastern portion of the site. The WDD is approximately 25 ft wide and approximately 10 ft deep. In addition to receiving surface water run-off, the WDD received discharges from overflow conduits from acid sewer lines and the WWTP mixing tank.

Centrally located at the site are various structures related to the WWTP operations, in assorted physical conditions (Figure 2-1). A collection tank, chlorine tank, and Imhoff tank remain intact at the site. Two sludge beds, one north and one south of the Imhoff tank, have remained partially intact. The base of each sludge bed remains intact, but the above-grade, concrete foundation, walls and railings have been removed. The pump house slab and venturi vault slab remain intact. The venturi vault contains two vault openings and pump house slab contains six openings and two stairwells leading to the basement of the former structure. The acid neutralization building, the most northern of the structures associated with the WWTP, remains partially intact. Previous actions undertaken by the current owner to demolish the structure were suspended. What remains in place are the concrete slab, foundation, concrete ceiling support columns and concrete ceiling forms. Within the concrete slab are various pits and vaults housing connections to process support conduits including acid sewer lines, chemical sewer lines, sanitary sewer lines, and water lines.

## 2.9 Subsurface Structures

In addition to the surface structures, subsurface features remain from the previous site use, such as conduits, 30-inch outfall and the mixing tank, TNT lines, and pits, vaults, and sumps. A number of conduits are buried beneath the grade surface including water lines, acid sewer lines, TNT waste lines, wastewater lines, and sanitary sewer lines. After processing of liquids received by the WWTP, processed wastewater was discharged through the 30-inch diameter outfall to a point west of the site on the Niagara River. The 30-inch outfall was investigated during the Phase III RI of the former LOOW. The mixing tank was previously demolished and the foundation collapsed in place. Remnants of the foundation structure remain in the subsurface. There are two vitreous clay TNT waste lines. The northern line is 10 inches in diameter and the southern is 18 inches in diameter. However, both lines are encased in an approximately 3 ft square slab of concrete. The lines are approximately 12 ft apart from one another and traverse from the northern property line southwest to the location of the former mixing house. A

previous IRA was undertaken to scour the inside of the TNT lines and to close the lines in place. The TNT waste lines were exposed and opened at two locations during the IRA within the site boundary, north of the WWTP structures.

## **2.10 Geology**

Extensive geologic investigations have been conducted on the former LOOW, inclusive of more than 1,000 borings and test pits. Subsurface data obtained from these investigations indicates that the former LOOW is underlain by approximately 30 to 60 ft of unconsolidated glacial deposits overlaying the shale bedrock of the Queenston Formation. Eight distinct stratigraphic units have been previously identified at the former LOOW; fill, alluvium, upper glacial till, middle silt till, glaciolacustrine clay (GLC), glaciolacustrine silt and sand, lodgment till and bedrock. Five geologic units were anticipated to be encountered during the Phase IV RI activities and are described in descending order in the following sub sections.

### **2.10.1 Fill**

Due to various utilizations of the land associated with the former WWTP, natural topography of the surface and near surface soils, soils typically between surface grade and approximately 8 to 12 ft bgs, have been altered. Most areas where alterations have occurred are underlying or adjacent to roadways and associated with underground utilities and former WWTP structures. Areas were excavated, graded and filled during construction of the former WWTP. Much of the material used to fill and grade areas has been supplied from local suppliers and is therefore very similar in composition to the native deposits encountered at the site and may only be distinguished by signatures of disturbance or artifacts (USACE/EA, 1999). Generally, soil borings advanced during the Phase IV field activities confirmed these previous assumptions.

### **2.10.2 Alluvium**

Alluvium underlying the surface fill is discontinuous across the site and typically no greater than 5 ft in thickness. The alluvium layer varies in consistency and consists of fine sands, silt, and silty clay (USACE/EA, 1999).

### **2.10.3 Upper Glacial Till Sequence**

Glacial till underlies the alluvium, is typically between 15 ft to 20 ft in thickness, and consists of two distinct strata. The upper silt till overlies the upper clay till and is composed of compact to very dense, brown to purple-brown silt and fine sand with little fine gravel. This layer was observed at maximum thickness of 5 ft.

The upper clay till is commonly composed of stiff to hard, moderate brown to purple-brown silty clay with fine to coarse sand and fine gravel. Occasional deposits of cobbles, discontinuous wet sand, gravel and silt layers less than 6 inches in thickness can be observed and tend to be thicker near the base of the geologic unit. The upper glacial till is typically dry with wet sand or gravel lenses at the lower strata. Location C3-WWTP-SO-G400 presents an example where a wet, non-cohesive fine sand lens less than one inch thick was encountered at approximately 11 ft bgs.

Generally the target depth of subsurface soil collection during the Phase IV RI was either the base of various structures or the upper silt till, the unit of higher water content and potential contaminant accumulation.

#### **2.10.4 Middle Silt Till Unit**

Along the western and northwestern areas of the current CWM property, the approximate location of the focus of the Phase IV RI, a middle silt till layer has been identified which divides the GLC geologic unit. This unit is composed of a well graded, compact to very dense gray to gray brown silt and coarse to fine sand (USACE/EA, 1999).

#### **2.10.5 Glaciolacustrine Clay**

The GLC underlies the upper glacial till sequence and is typically composed of very soft to firm, gray to gray brown silty clay with traces of fine sand (USACE/EA, 1999). The unit is typically high in natural moisture content, averaging approximately 28 percent (USACE/EA, 1999). In the area of current RI activities, the middle silt till divides the GLC unit into two discontinuous clay layers; an upper unit averaging 10 ft in thickness and lower unit averaging 6 ft in thickness. The GLC unit is typically encountered at between 15 and 20 ft bgs at the site (C3-WWTP-BP09 and C3-WWTP-SO-BP08), and at the WWTP Vicinity Shop Area (Component 3), it was previously observed less than 2 ft in thickness (USACE/EA, 1999).

### **2.11 Surface Soil**

Surface soil is generally dry, clayey silt with some fine sand. In areas overgrown with vegetation and second growth wooded vegetation, typically the upper 1 ft contain high organic content. Due to past uses, the native surface soil is assumed to have been graded.

### **2.12 Hydrology**

#### **2.12.1 Surface Hydrology**

During operation of the former LOOW, a system of drainage ditches was constructed in order to drain surface water runoff across the site to the Central Drainage Ditch (CDD). Six Mile Creek, which originally flowed across the former LOOW was diverted to the CDD and ultimately discharges into Four Mile Creek. Six Mile Creek is described by the NYSDEC as a Class C fresh water source, indicating that it is suitable for fishing, primary and secondary recreational use. Four Mile Creek is described by NYSDEC as a Class B water body from its mouth at Lake Ontario to approximately 0.9 miles upstream (located 0.3 mile southeast of the intersection of Lake Road and Creek Road) (USACE/EA, 1999) and the remaining upstream portion is classified as a Class C water body. Classification as a Class B water body indicates the water body is suitable for primary and secondary recreational use. It is not considered suitable as a potable water source. The WDD, which flows south to north, enters the WWTP site from the NFSS site, which borders the WWTP to the south. The WDD traverses the eastern portion of the WWTP site predominantly in a northerly direction. Water flows through the WDD in a northerly direction and discharges to the CDD and ultimately into Four Mile Creek. The WDD is approximately 25 ft wide and 10 ft deep. Water contained within the WDD varies dramatically with the precipitation events and seasonal changes. At the time the Phase IV RI field activities were conducted, the water within the WDD was between 1 ft and 2 ft deep. Because the WDD remains dry for greater than 50 percent of the year, it is classified as terrestrial and not able to sustain aquatic habitat. Therefore, sediment only, and not surface water, was targeted during the RI field activities (USACE/ERT/EA, 2009e).

### **2.12.2 Regional Hydrogeology**

Groundwater within the unconsolidated overburden across the former LOOW is determined by glacial deposits and fluvial deposits. Previous investigations indicate glacial deposits vary between 30 ft and 60 ft in thickness, vary in permeability from low within glacial lake deposits to high within sand and gravel outwashes (USACE/EA, 1999). Groundwater flow within the unconsolidated deposits is in general influenced by local topography, trending north towards Lake Ontario and west towards the Niagara River. Previous investigations divided the subsurface hydrostratigraphy into three units or zones.

Zone 1 consists of unconfined water-bearing zones within the upper silt till, clay till, alluvium and fill units. The Upper Clay Till Unit comprises the Upper Water Bearing Zone and lacks a contiguous, dominant flow system. Where devoid of sand lenses, the hydraulic properties of the Upper Clay Till are representative of an aquitard and thus the term ‘aquifer’ is not used (USACE/HGL, 2007a). Flow in the Upper Water Bearing Zone generally proceeds toward the northwest with localized and seasonal variations. Vertical gradients in the Upper Water Bearing Zone are typically downward, but vary depending on the season and localized lithologic variations. Low permeability of near-surface materials, abate recharge to the Upper Water Bearing Zone and result in a swampy landscape with poor surficial drainage.

Zone 2 consists of moist, relatively impermeable material in the GLC unit. The Glacio-Lacustrine Clay/Middle Silt Till Units form an aquitard and confine the Lower Water Bearing Zone. This aquitard is continuous across the site, saturated and of a homogeneous nature.

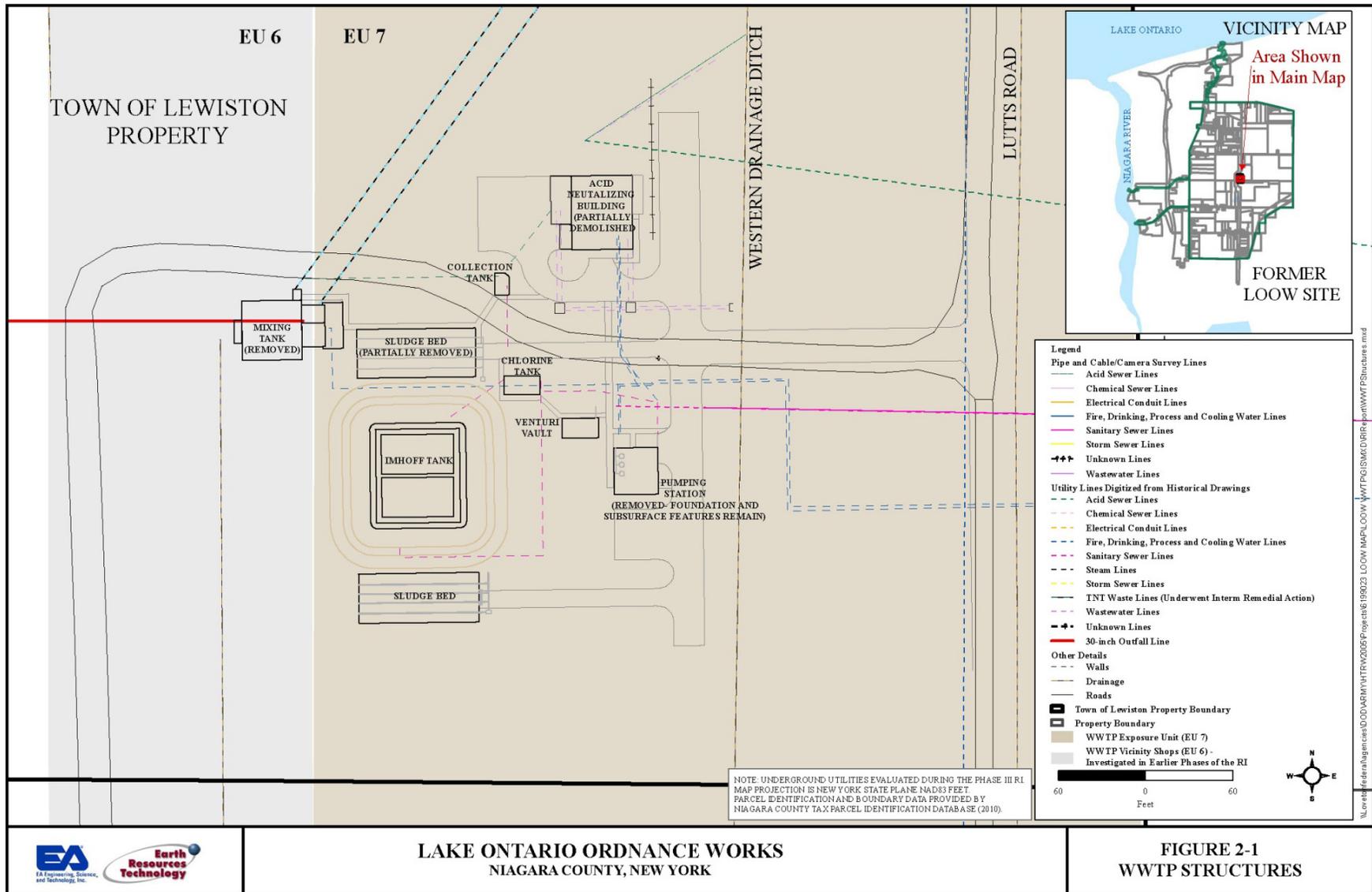
Zone 3 consists of a confined water-bearing zone predominantly within the glaciolacustrine silt and sand unit. The Lower Water Bearing Zone consists of alluvial sand and gravel and Upper Queenston Formation. The Basal Red Till serves as a secondary, discontinuous aquitard which further confines localized zones of the Upper Queenston Formation. Flow in the Lower Water Bearing Zone is to the northwest, with localized deviations due to lithologic heterogeneities (USACE/HGL, 2007a). Seasonal influences do not have the pronounced impact on flow directions as is typical of flow in the Upper Water Bearing Zone (USACE/HGL, 2007a). The Lower Water Bearing Zone has a greater transmissivity than the Upper Water Bearing Zone. The Lower Water Bearing Zone is recharged by a combination of connate water from the Queenston Formation, recharge from regional sources and to a lesser degree, recharge through the overlying Zone 2 Glaciolacustrine Clay. The hydraulic conductivities of each formation vary considerably with Zone 3 being the most permeable. Table 2-2 summarizes the hydraulic conductivities of each zone.

**Table 2-2. Regional Hydraulic Conductivity**

Zone	Stratigraphic Unit	Hydraulic Conductivity (ft/day)	
		Vertical	Horizontal
1	Upper Clay Till	$2 \times 10^{-3}$	$6 \times 10^{-3}$
	Upper Silt Till	$2 \times 10^{-3}$	$6 \times 10^{-3}$
	Middle Silt Till	$3 \times 10^{-4}$	$9 \times 10^{-3}$
2	Glaciolacustrine Clay	$6 \times 10^{-5}$	$1 \times 10^{-4}$
3	Glaciolacustrine Silt and Sand	$8.5 \times 10^{-5}$	
	• Stratified Coarse Sand		$6 \times 10^{-1}$
	• Non-Stratified Silt and Fine Sand		$9 \times 10^{-2}$
	• Stratified Silt and Fine Sand		$3 \times 10^{-2}$
	• Interlayered Silt, Sand and Clay		$9 \times 10^{-3}$

*Legend:*  
 Ft/day: ft per day  
 Source: Hydrogeologic Characterization, Chemical Waste Management, Inc. (Golder, 1985)  
 Note: Values presented in the table were derived from rising head tests following the bail-down of piezometers

Groundwater within the Queenston Formation is moderate to highly mineralized, with total dissolved solids (TDS) concentrations averaging 2,600 milligrams per liter (mg/L). High TDS concentrations are generally attributed to elevated levels of sodium, calcium and chloride in the connate water within the formation (Johnston, 1964). Connate water refers to water that was deposited simultaneously with the bedrock and became trapped in rock pore space. Essentially connate waters exhibit zero flow.



### 3.0 DATA COMPARISON METHODS

#### 3.1 Regulatory Criteria

This investigation has been performed under the USACE DERP-FUDS program and is intended to identify potential environmental impacts associated with historic DoD operations at the site. The NYSDEC is providing regulatory oversight of this and other projects at the former LOOW.

##### 3.1.1 Soil

The USEPA Regional Screening Levels (RSLs) were used to evaluate soil analytical data and identify COPCs. Similar to previous remedial investigations performed at the site, in order to account for circumstances where multiple constituents were reported and to reduce the likelihood that a constituent that should have been retained for further consideration is dropped, data for non-carcinogenic analytes were compared to  $1/10^{\text{th}}$  of the applicable USEPA criteria (with the exception of lead).

Site-specific screening levels (SSLs) for the protection of groundwater were established for this project based on the *Guidance for Developing Soil Screening Levels for Superfund Sites* (USEPA, 1996) and the *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (USEPA, 2002b), and compared to subsurface soil constituent concentrations.

The chemical-specific soil-water partition derivation for the migration from soil to groundwater pathway for inorganic analytes is established based on the equation (USEPA, 2002b):

$$C_t = C_w [(K_d) + \theta_w + \theta_a H' / \rho_b]$$

Where:

- $C_t$  = screening level in soil (mg/kg)
- $C_w$  = target leachate concentration (mg/L)
- $K_d$  = soil-water partition coefficient (L/kg)
- $\theta_w$  = water-filled soil porosity ( $L_{\text{water}}/L_{\text{soil}}$ )
- $\theta_a$  = air-filled soil porosity ( $L_{\text{air}}/L_{\text{soil}}$ )
- $H'$  = dimensionless Henry's law constant
- $\rho_b$  = soil bulk density (kg/L)

The soil partition coefficient ( $K_d$ ) is established based on the equation:

$$K_d = (K_{oc} * f_{oc})$$

Where:

- $K_{oc}$  = soil organic carbon-water partition coefficient (L/kg)
- $f_{oc}$  = organic carbon content of soil (g/g)

The fraction of organic carbon was estimated based on the average total organic carbon for subsurface soil samples collected from within EU 7 during this Phase IV RI. Samples collected from the vicinity of the WWTP during previous phases of the RI did not include total organic carbon analysis, and were therefore not utilized in calculating the average fraction of organic

carbon. A dilution attenuation factor (DAF) is typically utilized to account for natural attenuation and constituent mass reduction. In order to be as conservative as possible and evaluate the potential worst-case scenario, a DAF of one (negligible) was used for the calculation of SSLs. This is consistent with methodology utilized through RI Phase I, II, and III. Additionally, chemical specific parameters utilized in the equations were obtained from the USEPA soil screening guidance (USEPA, 2002b).

For the target leachate concentration,  $C_w$ , the New York State Technical and Operational Guidance Series (TOGS) 1.1.1 Ambient Water Quality Standards and Guidance Values (which includes the Part 703.5 standards) value was used. The TOGS are discussed in Section 3.1.2 below. SSLs were developed in accordance with methodology and target leachate concentrations used during previous phases of the RI for consistency of reporting.

Soil parameters used for the calculation of site-specific SSLs are presented in Table 3-1.

Parameter	Value	Units	Reference
Dilution Attenuation Factor	DAF = 1	Unitless	Conservative Assumption (USEPA, 1996)
Fraction of Organic Content in Soil	$f_{oc} = 0.005$	mg/mg	Site-specific
Water-filled porosity	$\theta_w = 0.15$	$L_{water}/L_{soil}$	Golder, 1993
Air-filled porosity	$\theta_a = 0.25$	$L_{air}/L_{soil}$	Calculated (total minus water-filled)
Total soil porosity	$\theta = 0.4$	$L_{pore}/L_{soil}$	Linsley, 1982
Dry soil bulk density	$\rho_b = 1.4$	kg/L	Dragum, 1998

Chemical-specific parameters and site-specific SSLs are presented in Table 3-2.

Analyte	$C_w$	H'	$k_{oc}$	$k_d$	SSL
	$\mu\text{g/L}$		$L/\text{kg}$	$L/\text{kg}$	$\text{mg/kg}$
1,2-Dichlorobenzene	33	0.0785	443.1	2.19	6.9
1,3-Dichlorobenzene	33	0.108	434	2.15	6.8
1,4-Dichlorobenzene	33	0.0985	434	2.15	6.8
4-Nitrotoluene	55	0.00023	309	1.53	8.2
1,2,4-Trichlorobenzene	55	0.0581	717.6	3.55	18.3
1,1,1-Trichloroethane	55	07.1	140	0.693	4.63
1,1,2,2-Tetrachloroethane	55	0.014	79	0.39	2.5
1,1,2-Trichloroethane	11	0.037	75	0.37	0.485
1,1-Dichloroethane	55	0.23	53	0.26	2.05
1,1-Dichloroethene	5	1.1	65	0.32	3.13
1,2-Dichloroethane	0.6	0.04	38	0.19	0.18
1-Methylnaphthalene	2.3	0	0	0	0.246
2,4,6-Trinitrotoluene	5	18,700	1,800	9.1	45.9
2,4-Dinitrotoluene	5	0.000022	363.8	1.8	9.5
2-Amino-4,6-dinitrotoluene	73	0.000000066	100.5	0.5	44
2-Butanone	50	0.0011	4.5	0.022	6.48

**Table 3-2. Phase IV RI Site-specific Soil Screening Levels**

Analyte	C <sub>w</sub>	H'	k <sub>oc</sub>	k <sub>d</sub>	SSL
	µg/L		L/kg	L/kg	mg/kg
2-Chlorophenol	180	0.00046	443.1	2.2	414
2-Methylnaphthalene	10	0.021	2976	14.7	148
2-Methylphenol	1,800	0.000049	443.1	2.2	4,140
2,4-Dimethylphenol	730	0.000039	717.6	3.55	2,671
4,4'-DDD	0.3	0.00016	4,470,000	22,100	6,600
4,4'-DDE	0.2	0.00086	2,630,000	13,000	2,600
4,4'-DDT	0.2	0.00033	65	0.32	0.086
4-Amino-2,6-dinitrotoluene	73	0.00098	65	0.64	31.3
4-Chloro-3-methylphenol	None	0.0001	718	0.4	NA
4-Methyl-2-pentanone	2,000	0.0053	130	0.64	1,500
4-Methylphenol	180	0.000029	81	0.4	91
Acenaphthene	20	0.0064	0.004.9	24	487
Acenaphthylene	20	0.0047	2000	9.9	200
Acetone	50	0.0016	0.58	0.0029	5.51
Aldrin	0.004	0.007	2,450,000	12,000	48.5
Alpha-BHC	0.01	0.0048	1,230	6.1	0.062
Alpha-chlordane	0.05	0.002	120,000	594	29.7
Aluminum	37,000	0	0	1,500	55,500,000
Anthracene	50	0.0027	24,000	118.8	5,945
Antimony	3	0	0	45	135
Aroclor 1232	0.9	0.00932	10,300	51	46
Aroclor 1242	0.9	0.014	44,800	222	200
Aroclor 1248	0.9	0.018	43,900	217	196
Aroclor 1254	0.9	0.0116	75,600	370	337
Aroclor 1260	0.9	0.0137	207,000	1,025	922
Arsenic	25	0	0	200	5,000
Barium	1,000	0	0	41	41,100
Benz[a]anthracene	0.002	0.00014	398,000	1970	3.94
Benzene	1	0.23	62	0.31	0.46
Benzo[a]pyrene	None	0.000046	1,020,000	5,049	NA
Benzo[b]fluoranthene	0.002	0.00455	1,230,000	6090	12.2
Benzo[g,h,i]perylene	None	0.0000058	3860000	19107	NA
Benzo[k]fluoranthene	0.002	0.000034	1,230,000	6090	12.2
Benzyl Butyl Phthalate	50	0.000052	57,500	285	14,200
Beryllium	3	0	0	790	2,370
Beta-BHC	0.04	0.0048	1,260	6.2	0.25
Bis(2-Ethylhexyl) Phthalate	55	0.0000042	15,100,000	74,750	375,000
Boron	1,000	0	0	3	3,100
Cadmium	5	0	0	75	376
Calcium	None	0	3,390	0	NA
Carbazole	None	0.00000063	46	0.23	NA
Carbon Disulfide	60	1.2	46	0.23	33
Carbon Tetrachloride	5	1.2	150	0.74	5.3
Carbon, Total Organic	None	0	0	0	NA
Chlorobenzene	5	0.127	268	0	7.28
Chloroform	7	0.15	53	0.26	2.8
Chloromethane	5	0.98	35	0.17	2.3
Chromium	50	0	0	1,800,000	90,000,000
Chrysene	0.002	0.0039	400,000	1980	3.96
Cis-1,2-Dichloroethene	5	0.17	36	0.18	1.58

**Table 3-2. Phase IV RI Site-specific Soil Screening Levels**

Analyte	C <sub>w</sub>	H'	k <sub>oc</sub>	k <sub>d</sub>	SSL
	µg/L		L/kg	L/kg	mg/kg
Cobalt	11	0	0	45	496
Copper	200	0	0	428	85,600
Cyanide, Total	200	0	0	9.9	2,000
Cyclohexane	13,000	6.13	146	NA	25,000
Delta-BHC	0.04	0.0048	11,700	58	2.33
Dibenz[a,h]anthracene	0.0029	0.0000006	3,800,000	18,800	55
Dibenzofuran	37	0.00053	7,800	39	1,400
Dieldrin	0.004	0.00062	21,400	106	0.42
Diethyl Phthalate	29,000	0.000025	105	NA	18,200
Di-N-butyl Phthalate	50	0.0000019	33,900	168	8,400
Di-N-octyl Phthalate	50	0.0000019	2,400	11.8	596
Endosulfan I	220	0.00046	2,140	10.6	2,350
Endosulfan II	220	0.00046	2,140	10.6	2,350
Endosulfan Sulfate	220	0.00046	2,140	10.6	2,350
Endrin	11	0.00031	12,300	61	671
Endrin Aldehyde	5	0.00031	12,300	61	305
Endrin Ketone	5	0.00031	12,300	61	305
Ethylbenzene	5	0.32	200	0.99	5.8
Fluoranthene	50	0.00066	107,000	530	26,500
Fluorene	50	0.0032	7,900	39	1,960
Gamma-BHC	0.05	0.0048	1,070	5.3	0.27
Gamma-chlordane	0.05	0.002	120,000	594	29.7
Heptachlor	0.04	0.045	1,410,000	7,000	279
Heptachlor Epoxide	0.03	0.00039	83,200	411	12.4
Hexachlorobenzene	0.04	0.054	55,000	270	11
Hexachlorobutadiene	0.5	0.33	54,000	266	133
Hexachlorocyclopentadiene	5	1.1	1,670	8.3	42.8
Hexachloroethane	5	0.16	1,780	8.8	45
HMX (Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetra)	1,800	0.000000036	1,850	9.2	16,700
Indeno[1,2,3-Cd]pyrene	0.002	0.0000066	3,470,000	17,200	34
Iron	300	0	0	25	7,500
Isophorone	71	0.00027	58	0.29	28
Isopropylbenzene	5	0.47	820	4.0	21
Lead	25	0	0	900	22,500
Lithium	73	0	0	300	NA
Magnesium	35,000	0	0	4.5	NA
Manganese	300	0	0	65	19,500
Mercury	0.7	0.47	0	52	36.5
Methyl Acetate	37,000	0.0047	3.1	NA	4,560
Methoxychlor	35	0.00065	97,700	484	16,900
Methcyclohexane	None	0	0	NA	NA
Methylene Chloride	5	0.09	10	0.05	0.87
Molybdenum	180	0	0	20	3,620
Naphthalene	10	0.02	1,200	5.9	61
Nickel	100	0	1,200	5.9	605
Percent Solids	None	0	0	65	NA
Nitrobenzene	0.4	0.00098	190	0.94	0.42
Phenanthrene	50	0.00096	4,800	24	1,200
Phenol	1	0.000016	29	0.14	0.25

**Table 3-2. Phase IV RI Site-specific Soil Screening Levels**

Analyte	C <sub>w</sub>	H'	k <sub>oc</sub>	k <sub>d</sub>	SSL
	µg/L		L/kg	L/kg	mg/kg
Potassium	None	0	0	0	NA
Pyrene	50	0.00045	68,000	340	16,800
RDX	0.61	0	0	0.04	NA
Sec-Butylbenzene	5	0.72	1,330	NA	34
Selenium	10	0	0	300	3,000
Silver	50	0	0	8.3	420
Sodium	20,000	0	0	100	NA
Styrene	5	0.11	520	2.6	13
Tetrachloroethene	5	0.75	270	1.3	7.9
Tetryl	150	0	0	0	NA
Thallium	0.5	0	0	1,500	750
Toluene	5	0.27	140	0.7	4.2
Trans-1,2-Dichloroethene	5	0.38	38	0.19	1.8
Trichloroethene	5	0.42	94	0.47	3.2
1,2,4-Trimethylbenzene	5	0.252	614	NA	16
Vanadium	180	0	0	1,000	180,000
Vinyl Chloride	2	1.1	19	0.094	0.795
Xylenes (Total)	5	0.3	200	0.99	5.75
Zinc	2000	0	0	62	124,000
Tert-Butylbenzene	55	0.54	3.39	NA	1.1

*Legend:*

NA = no criterion for protection of groundwater, or no physical constants available

"None" = no criterion for ground water

C<sub>w</sub> values are H(W<sub>S</sub>) GA values (meaning source of drinking water - ground water, in µg/L) from the TOGS 1.1.1 dated June 1998, with the exception of carbon disulfide, which was from an addendum dated April 2000. Tap water values are listed if there were no value in TOGS, and these come from the EPA Regional Screening Levels (EPA 2009a); "none" means that there is no criterion listed in TOGS or tap water RSL table.

\* = essential human nutrient

H' = Henry's Law Constant (Dimensionless)

K<sub>oc</sub> = Soil organic carbon - water partition coefficient

K<sub>d</sub> = Soil - water partition coefficient

Source of chemical parameters: the chemical parameters utilized during initial development of the SSLs during the Phase II RI were utilized for this RI (USACE/ EA 2002). The original 2001 source was the ORNL toxicity database: <http://rais.ornl.gov/index.shtml> published on line in June 2001, which utilized data from multiple sources including Table C out of the US EPA SSL guidance (USEPA 2002b) and USEPA program WATER8. For chemicals for which SSLs were not previously developed (s-butylbenzene, t-butylbenzene, cyclohexane, diethylphthalate, and 1,2,4-trimethylbenzene) parameters currently (as of 27 September 2010) listed on the <http://rais.ornl.gov/website> (as of 27 September 2010) were utilized.

### 3.1.2 Groundwater

Groundwater at the site was evaluated against the USEPA RSLs for tapwater for identifying COPCs. The New York State Technical and Operational Guidance Series (TOGS) 1.1.1 Ambient Water Quality Standards and Guidance Values (which includes the Part 703.5 standards) were also considered and were used for identification of COPCs in the absence of a RSL for tapwater. Analysis for chloride and total dissolved solids was not performed on groundwater samples from monitoring wells installed at the WWTP. Accordingly, the groundwater cannot be classified as Class GA (potable water) or GSA / GSB (saline water). However, the groundwater analytical data was compared to the Class GA water quality standards

to provide a conservative screening approach. The groundwater values used for evaluation are presented in Table 3-3.

<b>Table 3-3. Phase IV RI Groundwater Screening Levels (SL)<sup>1</sup></b>		
<b>Analyte/Compound</b>	<b>USEPA RSL Drinking Water</b>	<b>Background Threshold Value<sup>4</sup></b>
<b>Volatile Organic Compounds (VOCs) (µg/L) – TCL</b>		
1,1,1-Trichloroethane	910 <sup>2</sup>	0.44
1,1,2,2-Tetrachloroethane	0.067	NA
1,1,2-Trichloroethane	0.24	NA
1,1-Dichloroethane	2.4	NA
1,1-Dichloroethene	5 <sup>3</sup>	NA
1,2-Dibromo-3-chloropropane	0.00032 <sup>2</sup>	NA
1,2-Dichlorobenzene	370	NA
1,2-Dichloropropane	0.39	NA
1,3-Dichlorobenzene	3.0 <sup>3</sup>	NA
1,3-Dichloropropane	730	NA
1,4-Dichlorobenzene	0.43	NA
2-Butanone	710 <sup>2</sup>	4.49
4-Methyl-2-pentanone	200 <sup>2</sup>	NA
Acetone	2,200 <sup>2</sup>	30.5
Benzene	0.41	0.37
Bromodichloromethane	0.12	NA
Bromoform	8.5	NA
Bromomethane	0.87 <sup>2</sup>	NA
Carbon disulfide	100 <sup>2</sup>	NA
Carbon tetrachloride	0.2	NA
Chlorobenzene	9.1 <sup>2</sup>	0.39
Chloroethane	21,000	NA
Chloroform	0.019	NA
Chloromethane	190	NA
Dibromochloromethane	0.15	NA
Ethylbenzene	1.5	0.3
Isopropylbenzene	66 <sup>2</sup>	NA
Methylene chloride	4.8	NA
Methyl tert butyl Ether	12	NA
Styrene	160 <sup>2</sup>	NA
Tetrachloroethylene	0.11	NA
Toluene	230 <sup>2</sup>	4.45
Total 1,2-dichloroethane	2.4	NA
Trichloroethylene	2.0	NA
Trichlorofluoromethane	130 <sup>2</sup>	NA
Vinyl chloride	0.016	<b>1.48</b>
Xylenes, total	20 <sup>2</sup>	0.96
cis-1,2-Dichloroethylene	37 <sup>2</sup>	NA
cis-1,3-Dichloropropene	0.43	NA
m,p-Xylene	120 <sup>2</sup>	NA
o-Xylene	120 <sup>2</sup>	NA
tran-1,2-Dichloroethene	11 <sup>2</sup>	NA
tran-1,3-Dichloropropene	0.4 <sup>3</sup>	0.5
<b>Semivolatile Organic Compounds (SVOCs) (µg/L) – TCL</b>		

<b>Table 3-3. Phase IV RI Groundwater Screening Levels (SL)<sup>1</sup></b>		
<b>Analyte/Compound</b>	<b>USEPA RSL Drinking Water</b>	<b>Background Threshold Value<sup>4</sup></b>
1,2,4-Trichlorobenzene	2.3	NA
2,4,5-Trichlorophenol	370 <sup>2</sup>	NA
2,4,6-Trichlorophenol	6.1	NA
2,4-Dichlorophenol	11 <sup>2</sup>	NA
2,4-Dimethylphenol	73 <sup>2</sup>	NA
2,4-Dinitrophenol	7.3 <sup>2</sup>	NA
2-Chloronaphthalene	290 <sup>2</sup>	NA
2-Chlorophenol	18 <sup>2</sup>	NA
2-Methylnaphthalene	15 <sup>2</sup>	NA
2-Nitroaniline	37 <sup>2</sup>	NA
2-Nitrophenol	0.049	NA
2-Methylphenol	15 <sup>2</sup>	NA
3-Nitroaniline	1.1 <sup>2</sup>	NA
3,3-Dichlorobenzidine	0.15	NA
4,6-Dinitro-2-methyl phenol	0.37 <sup>2</sup>	NA
4-Bromophenyl-phenylether	0.27	NA
4-Chloroaniline	0.034 <sup>2</sup>	NA
4-Chlorophenyl phenyl ether	0.23	NA
4-Nitroaniline	3.4	NA
4-Nitrophenol	0.049	NA
4-Methylphenol	18 <sup>2</sup>	NA
Acenaphthene	220 <sup>2</sup>	NA
Acenaphthylene	37 <sup>2</sup>	NA
Anthracene	1,100 <sup>2</sup>	NA
Benzo(a)anthracene	0.029	NA
Benzo(a)pyrene	0.0029	NA
Benzo(g,h,i)perylene	18 <sup>2</sup>	NA
Benzo(b)fluoranthene	0.029	NA
Benzo(k)fluoranthene	0.029	<b>0.033</b>
Benzyl butyl phthalate	730 <sup>2</sup>	NA
Carbazole	3.4	NA
Chrysene	2.9	NA
Dibenz(a,h)anthracene	0.0029	NA
Dibenzofuran	12 <sup>2</sup>	NA
Diethyl phthalate	2,400 <sup>2</sup>	NA
Dimethyl phthalate	3,700 <sup>2</sup>	NA
Fluoranthene	150 <sup>2</sup>	NA
Fluorene	150 <sup>2</sup>	NA
Hexachlorobenzene	0.042	NA
Hexachlorobutadiene	0.86	NA
Hexachlorocyclopentadiene	22 <sup>2</sup>	NA
Hexachloroethane	4.8	NA
Indeno(1,2,3-c,d)pyrene	0.029	NA
Isophorone	71	NA
Naphthalene	0.14	NA
Pentachlorophenol	0.56	NA
Phenanthrene	0.62 <sup>2</sup>	NA
Phenol	1,100 <sup>2</sup>	NA
Pyrene	110 <sup>2</sup>	NA

<b>Table 3-3. Phase IV RI Groundwater Screening Levels (SL)<sup>1</sup></b>		
<b>Analyte/Compound</b>	<b>USEPA RSL Drinking Water</b>	<b>Background Threshold Value<sup>4</sup></b>
Bis(2-chloroethoxy) methane	11 <sup>2</sup>	NA
Bis(2-chloroethyl) ether	0.012	NA
Bis(2-chloroisopropyl) ether	0.32	NA
Bis(2-ethylhexyl) phthalate	4.8	NA
di-n-butyl phthalate	370 <sup>2</sup>	NA
di-n-octyl phthalate	150 <sup>2</sup>	NA
n-nitroso-di-n-propylamine	0.0096	NA
n-nitrosodiphenylamine	91 <sup>2</sup>	NA
Total PAHs	10,000	NA
<b>Metals (µg/L) – TAL</b>		
Aluminum	3,700 <sup>2</sup>	0.98
Antimony	1.5 <sup>2</sup>	0.0023
Arsenic	0.045	0.031
Barium	730 <sup>2</sup>	0.047
Beryllium	7.3 <sup>2</sup>	NA
Boron	730 <sup>2</sup>	3.82
Cadmium	1.8 <sup>2</sup>	0.0025
Calcium	None	620
Chromium (insoluble)	5,500 <sup>2</sup>	0.0032
Cobalt	None	0.0028
Copper	150 <sup>2</sup>	0.2
Iron	2,600 <sup>2</sup>	8.81
Lead	0.00037 <sup>2</sup>	0.006
Lithium	7.3 <sup>2</sup>	1.13
Magnesium	35,000 <sup>3</sup>	580
Manganese	88 <sup>2</sup>	0.72
Mercury	0.057 <sup>2</sup>	0.00017
Molybdenum	18 <sup>2</sup>	NA
Nickel	73 <sup>2</sup>	0.0065
Potassium	NS	62.1
Selenium	18 <sup>2</sup>	0.0042
Silver	18 <sup>2</sup>	0.000018
Sodium	20,000 <sup>3</sup>	1,200
Thallium	0.5 <sup>3</sup>	0017
Vanadium	1.8 <sup>2</sup>	0.0028
Zinc	1,100 <sup>2</sup>	0.13
<b>Polychlorinated Biphenyls (µg/L)</b>		
Aroclor 1016	0.96	NA
Aroclor 1221	0.0068	NA
Aroclor 1232	0.0068	NA
Aroclor 1242	0.034	NA
Aroclor 1248	0.034	NA
Aroclor 1254	0.034	NA
Aroclor 1260	0.034	NA
<b>Pesticides (µg/L)</b>		
alpha-BHC	0.012	NA
beta-BHC	0.037	NA
delta-BHC	0.037	NA
gamma-BHC (Lindane)	0.061	NA

<b>Table 3-3. Phase IV RI Groundwater Screening Levels (SL)<sup>1</sup></b>		
<b>Analyte/Compound</b>	<b>USEPA RSL Drinking Water</b>	<b>Background Threshold Value<sup>4</sup></b>
4,4-DDD	0.28	NA
4,4-DDE	0.20	0.015
4,4-DDT	0.20	<b>0.041</b>
Aldrin	0.004	NA
alpha-Chlordane	0.19	NA
gamma-Chlordane	0.19	NA
Chlordane	0.19	NA
Dieldrin	0.0042	NA
Endosulfan I	22 <sup>2</sup>	NA
Endosulfan II	22 <sup>2</sup>	NA
Endosulfan sulfate	22 <sup>2</sup>	NA
Endrin	1.1 <sup>2</sup>	NA
Endrin aldehyde	1.1 <sup>2</sup>	NA
Endrin ketone	1.1 <sup>2</sup>	NA
Heptachlor	0.015	NA
Heptachlor epoxide	0.0074	NA
Methoxychlor	18 <sup>2</sup>	NA
Toxaphene	0.061	NA
<b>Explosives (µg/L)</b>		
HMX	180 <sup>2</sup>	NA
RDX	0.61	NA
1,3,5-Trinitrobenzene	110 <sup>2</sup>	NA
1,3-Dinitrobenzene	0.37 <sup>2</sup>	NA
2,4,6-Trinitrotoluene (TNT)	2.2	NA
2-Amino-4,6-dinitrotoluene	7.3 <sup>2</sup>	NA
2,6-Dinitrotoluene	3.7 <sup>2</sup>	NA
2,4-Dinitrotoluene	7.3 <sup>2</sup>	NA
2-Nitrotoluene	3.7 <sup>2</sup>	NA
3-Nitrotoluene	0.31	NA
4-Amino-2,6-Dinitrotoluene	7.3 <sup>2</sup>	NA
4-Nitrotoluene	4.2	NA
Nitrobenzene	0.12	NA
<i>Legend:</i>		
<i>NA = No background threshold value for constituent</i>		
<i>TCL = Target Compound List</i>		
<sup>1</sup> <i>USEPA Regional Screening Levels for Tapwater (USEPA 2009a). In the absence of a USEPA RSL, the NYSDEC Groundwater TOGS value was used.</i>		
<sup>2</sup> <i>SL based on 1/10<sup>th</sup> non-carcinogenic value from USEPA for RSL for Tapwater (USEPA 2009a)</i>		
<sup>3</sup> <i>SL based on NYSDEC Groundwater TOGS value</i>		
<sup>4</sup> <i>Background threshold value based on data set presented in the NFSS RI (USACE/SAIC, 2007b)</i>		
<i>Gray shading indicates constituent reporting limits which exceed the screening criteria</i>		
<i>Bold Text indicates background threshold values which exceed the screening criteria</i>		

### 3.2 Background Data

#### 3.2.1 Data Source

A site-specific background evaluation was performed to compare EU 7 data with background soil sample data collected during the previous Phase I and Phase II RIs at the Former LOOW (USACE/EA, 1999; 2002). The background soil samples were obtained from various locations

(several properties) within the undeveloped portion of the 7,500-acre former LOOW, as indicated on Figure 4.1 of the Phase II RI Report (USACE, 2002). Additional background groundwater samples were collected during the investigation of the NFSS and were also utilized during the background evaluation (USACE, 2007b). The results of the background evaluation are presented in Appendix I.

### **3.2.2 Comparison of Data to Background Concentrations**

Inorganic constituents detected in soil at EU 7 underwent a background screening using hypothesis testing. Hypothesis testing consisted of the quantile test in conjunction with the Wilcoxon Rank Sum test. Both tests were conducted with the null hypothesis that site concentrations are less than or equal to background. If the null hypothesis was rejected for either the quantile test or Wilcoxon Rank Sum tests at the 95% significance level, then it was concluded that the site data exceeded background. All statistical computations were conducted using ProUCL version 4.00.04 (USEPA, 2009b).

Inorganic constituents detected in groundwater at EU7 underwent a background screening using a point-to-point comparison to background threshold values (BTV) calculated as part of the NFSS RI (USACE/SAIC, 2007b). All statistical computations were conducted using ProUCL version 4.00.04 (USEPA, 2009b).

### **3.3 Laboratory Data Evaluation**

Laboratory qualifiers, laboratory reports and Quality Assurance/Quality Control (QA/QC) data were qualitatively evaluated in conjunction with the data reduction and reporting process. This data was used to evaluate whether the data objectives for precision, accuracy, representativeness, comparability, completeness and sensitivity (PARCCS) were achieved as defined in the approved QAPP (USACE/ERT, 2009f).

## **4.0 REMEDIAL INVESTIGATION ACTIVITIES**

### **4.1 Pre-Investigation Activities**

Prior to investigation activities, various pre-investigation activities were performed in order to ensure the safety of field personnel and in order to obtain access to all proposed investigation areas. The pre-investigation activities included ensuring valid rights-of-entry (ROEs) existed for the former LOOW WWTP property which is currently owned by the Town of Lewiston, New York; coordinating field activities, as appropriate, with property owners and other stakeholders; performance of municipal and private utility checks; cleanup and removal of potential ACM from the acid neutralization building structure; focused brush clearance, and any other site preparations.

#### **4.1.1 Rights of Entry**

Valid ROEs are required for conducting activities on any land not owned by those parties trespassing or conducting RI field activities. ROEs were established for the Town of Lewiston property and all requirements of the agreement were adhered to during the performance of RI field activities. All site activities were coordinated with the USACE and the property owner to ensure cooperation among parties during the completion RI field activities and to communicate potential land-use restrictions resulting from site work.

#### **4.1.2 Utility Clearance**

The current site owner indicated that no private utilities have been installed on the property to their knowledge. Regardless of this, and in accordance with the approved Phase IV RI Field Sampling Plan (FSP) (USACE/ERT/EA, 2009e), New York One Call was contacted to perform utility location and mark outs for the property. Field personnel confirmed that a site-wide utility clearance had been conducted prior to commencing intrusive activities.

#### **4.1.3 Radiation Screening**

Radiation surveys were conducted on vegetation that was removed, soil and groundwater samples collected, and equipment that was used during the RI field activities prior to demobilizing the equipment from the site. Radiation screening was performed as a prudent health and safety measure due to the historical use of the LOOW site to store materials with elevated radioactivity. Prior to commencing with RI field activities, a background dose rate level of 7.7 MicroRoentgens per hour ( $\mu\text{R/hr}$ ) was established with the Ludlum Model 19, at the selected background location (Figure 4-1), presumed to be free of potential radiological impacts, and in accordance with the approved RSP Addendum (USACE/ERT/EA, 2009b). A record of the radiation screening survey data is provided in Appendix B.

Prior to brush clearance activities, representative reference samples of vegetation to be cleared were scanned using a dose rate-meter and values recorded. In addition, each area to be cleared of vegetation was surveyed and continuous readings were collected. After surveying an area, an average dose-rate was established from the observed readings. None of the cleared vegetation exhibited radiological impacts.

In addition, during Geoprobe<sup>®</sup> activities, drilling activities, groundwater monitoring well installation and sampling, dose rates were monitored. Soil cores, soil cuttings and equipment, both disposable and reusable, were screened for radioactive constituents. Equipment used for the installation of groundwater monitoring wells and collection of groundwater samples was routinely screened after all liquids evaporate from the equipment surface. Radiological survey data collected in association with these activities is presented in Appendix B and discussed further in Section 4.2.1.2, Section 4.3.1.2, and Section 5.1.2. Figure 4-1 shows the survey locations and graphically provides general dose rate measurements.

#### **4.1.4 Vegetation Clearance and Debris Removal**

Brush clearance was required to access certain sample locations throughout the WWTP area on the Town of Lewiston property. Vegetation to be cleared was first field screened for radiological impacts that exceeded the site-specific background dose rate. None of the cleared vegetation exhibited radioactivity greater than the established background dose rate of 7.7  $\mu\text{R/hr}$ . Cleared brush and vegetation that was removed in order to gain access to proposed sampling locations was mulched and spread in place.

Large debris and saplings (less than 6 inches in diameter) that were encountered during site preparation activities were mulched in place. Fallen trees greater than 6 inches in diameter were removed and piled in front of a breach in the chain-link fence bounding the western property line where the subsurface 30-inch diameter WWTP outfall line leaves the site, as directed by the USACE. Large debris that was deliberately removed and piled in front of the chain link fence opening included large timber beams; various scrap metals; an approximate 17-ft section of chain-link fence; and other miscellaneous items.

#### **4.1.5 Closure of Exposed Pits and Vaults**

Various open manholes, vaults and other pits associated with the former WWTP operations presented potential health and safety hazards to field personnel performing activities at the site. Prior to performing field activities in areas that presented health and safety hazards, associated fall hazards were mitigated by closure of some of the open fall hazards. Fall hazards which were equal to or less than 4 ft x 8 ft in size were covered with fiberglass mesh grating capable of bearing foot-traffic from an average sized adult and semi-permanently sealed with steel saddle slips and concrete anchor bolts. In addition, an open stairwell located on the former pump house slab which descends into the basement of the structure was covered with chain-link fencing and structural tubing support, and similarly secured to the structure. In total, two manholes adjacent to the former acid neutralization building, five utility openings, vaults and/or stairwells on the former pump house slab, and eight utility openings and/or vaults on the former acid neutralization building slab were covered and sealed prior to completing additional field activities in those areas.

#### **4.1.6 Asbestos Debris Consolidation and Removal**

In order to provide a safe work environment for field personnel conducting RI field activities, unconsolidated debris piles containing suspected ACM which prohibited safe access to sample locations adjacent to the acid neutralization building were removed and disposed of as ACM. In addition, utility insulation wrap, consistent with utility wrap containing ACM, was observed on various conduits and pipes within the acid neutralization building. This potential ACM material

was also removed and disposed of as ACM to reduce RI worker exposure. Project closeout reports, developed by the licensed asbestos project monitor and licensed asbestos removal contractor, are provided in their entirety as Appendix C.

All ACM removal activities were conducted in accordance with Article 30, Section 904 of the New York State Labor Law and Section 56-3.4 of the New York State Code Rule 56. All ACM removal work was conducted by a New York State licensed asbestos contractor (Metro Contracting and Environmental, Inc.) and licensed ACM handlers. The contractor asbestos license and employees' asbestos certification are provided in Appendix C.

In addition, and as required by New York State law, asbestos cleanup work was supervised by a licensed project monitor. Personal air, work space air and ambient air was monitored (QuES&T, Inc) on a daily basis to ensure a safe working environment by collecting samples and submitting the samples to an analytical laboratory. After completing the ACM cleanup activities, clearance samples were collected and submitted to an analytical laboratory for confirmation of a clean environment prior to breaking down the containment structure. No air samples exceeded personal safety requirements and the complete ACM sample results are provided in Appendix C.

In total, 4.76 tons of suspected ACM containing material was removed and disposed of at Niagara Falls Landfill, Niagara Falls, New York. A copy of the waste disposal manifest is presented in Appendix C.

## **4.2 Soil Sampling Activities**

Soil sampling activities, including terrestrial sediment sampling from within the WDD (C3-WWTP-SO- BP03-0.5 and C3-WWTP-SO- BP04-0.5), were completed in accordance with the previously approved FSP Addendum (USACE/ERT/EA, 2009e) developed in order to successfully complete the project objectives established for the Phase IV RI. The purpose of the soil sampling activities was to fully characterize the nature and extent of potential impacts inherent to the site due to historic DoD activities. Both field screening and laboratory analytical soil samples were collected during field activities. At most locations where soil samples were collected for laboratory analysis, collocated surface and subsurface analytical samples were collected.

In addition to completing a full characterization of the site, field soil screening and laboratory analytical soil samples were collected along the TNT lines in order to verify that soil associated with the TNT line IRA that remains in place does not pose unacceptable risk to human health.

### **4.2.1 Field Soil Screening**

Three field screening techniques were utilized during Phase IV RI activities and are described in the following subsections.

#### *4.2.1.1 Soil Total VOC Screening*

Each soil core that was collected via direct push technologies was screened using a photoionization detector (PID) for total VOC impacts according to the approved FSP (USACE/ERT/EA, 2009e). Soil screens were conducted prior to removing the acetate sleeve from the soil core, by slicing a hole in the acetate sleeve of which each soil core was collected, and inserting the PID probe. PID readings were observed for a minimum of 5 seconds to allow

for stabilization, and then the highest VOC reading was recorded on a sample location-specific field boring log, by the field geologist. Results of soil total VOC screening are discussed in Section 5.1.1.

#### *4.2.1.2 Soil Radiation Screening*

During direct push sampling activities, drilling activities, groundwater monitoring well installation and sampling, dose rates were monitored using a Bicon MicroRem dose rate meter. Radiation screening results were recorded and submitted as part of a daily activity and health and safety log. If dose rates exceeded criteria established in the RSP Addendum, appropriate health and safety actions as described in the RSP Addendum (USACE/ERT/EA, 2009b) were to be conducted. In addition, each set of soil samples that were delivered to the analytical laboratory were screened a second time after packaging and prior to the shipping of the sample coolers by a third party independent courier. Results of soil radiation screening are discussed in Section 5.1.2.

#### *4.2.1.3 Soil Explosives Screening*

In order to confirm that soil remaining in place after the IRA in the vicinity of the TNT lines was not impacted with explosives, field screening analysis utilizing DropEx<sup>®</sup> and Expray<sup>®</sup> sample kits. DropEx<sup>®</sup> and Expray<sup>®</sup> field screen sample kits are capable of detecting a wide range of explosive constituents, including TNT which was the focus of the field screening effort. DropEx<sup>®</sup> and Expray<sup>®</sup> field screen sample kits are capable of positively detecting explosive constituents as low as 20 nanograms. The positive detection of explosives constituents at this level was sufficient to identify locations for analytical sample collection. Field Screening included 226 surface soil and 8 subsurface soil samples. In addition, 8 DropEx<sup>®</sup> samples were collected from the acid neutralization building slab and field screen analyzed in order to identify any inherent potential explosive impacts. To ensure sample preparation and field analysis techniques were consistent with the established standard operating procedure, a total of 11 duplicate field screen samples were collected and analyzed using a combination of DropEx<sup>®</sup> and Expray<sup>®</sup> field screen kits. All samples were collected and field analyzed in accordance with the approved FSP Addendum (USACE/ERT/EA, 2009e). Results of soil explosive screening are discussed in Section 5.1.3.

### **4.2.2 Analytical Soil Sampling**

Two analytical soil sampling strategies were utilized to maximize the statistical validity of the former LOOW WWTP investigation; systematic and biased analytical soil sampling. Systematic sampling is statistically and functionally similar to simple systematic sampling. The intent of the sampling approach is to provide every component within the sample population a known and equal probability of selection and assumes that the sample population is categorically homogenous. Biased sampling is statistically significant when used in conjunction with a systematic sampling approach. A biased sample is one that is selected based upon professional judgment and which may not be representative of a randomly or systematically sampled population.

A total of 86 soil samples, 44 surface soil samples and 42 subsurface soil samples, were collected using direct push (i.e. Geoprobe<sup>®</sup>) technology and acetate macrocore liners (Figure 4-2). All samples were collected in accordance with the approved FSP Addendum (USACE/ERT/EA, 2009e) and delivered to GPL Laboratories for analysis.

A total of 84 soil samples were analyzed for Target Compound List (TCL) VOCs, TCL SVOCs, explosives, TCL pesticides, PCBs, and Target Analyte List (TAL) metals plus lithium and boron in accordance with the approved project QAPP (USACE/ERT/EA, 2009f). Two surface soil samples were collected based upon historic information indicating the presence of two transformers potentially containing PCB-laden fluid, which had previously been removed from the site. The two surface samples collected were analyzed for PCBs only, due to intention of identifying potential impacts of PCB-laden fluid.

### **4.3 Groundwater Sampling Activities**

Groundwater sampling activities were conducted in accordance with the previously approved FSP Addendum (USACE/ERT/EA, 2009e). Groundwater monitoring wells were installed to evaluate the potential for leakage and possible contaminant migration from WWTP structures that contained water and sediment. Groundwater samples were collected from three newly installed groundwater monitoring wells (MWs) and analyzed for TCL VOCs and SVOCs, explosives, TCL PCBs and pesticides, and TAL metals, including lithium and boron. In addition, field groundwater quality parameters were recorded during the purging event for each of the MW locations.

#### **4.3.1 Groundwater Monitoring Well Installation**

Three groundwater MWs were installed and sampled during Phase IV RI activities. The three MWs were installed hydraulically down-gradient to former WWTP structures of concern (Figure 4-2). The intent of the MW locations was to detect potential groundwater impacts resulting from degradation of the former WWTP structures. The new MWs were installed to approximate depths of 22.5 ft bgs and constructed using approximately 15 ft (12 ft below grade and approximately 3 ft of stick-up above grade) of 2-inch diameter of schedule 40 polyvinyl chloride (PVC) riser and approximately 10 ft of 2-inch schedule 40 PVC – 0.01 inch slotted screen. A filter pack, comprised of #01 Morie sand, was placed around the well screen from an approximate depth of 23 ft bgs to 10 ft bgs, followed by an annular space seal consisting of betonite pellets from approximately 10 ft bgs to 8 ft bgs and cement-betonite grout from 8 ft bgs to the surface grade. After allowing the newly constructed MWs to sit over a 24-hour period, the annular space seal settled to approximately 1 ft bgs at each location. Concrete was used to fill the depression and to construct a pad at the base of each MW.

MW-BP-14 was installed approximately 20 ft to the northwest of the former acid neutralization building. C3-WWTP-MW-BP-15 was installed approximately 25 ft due north of the former chlorine tanks and 25 due east of the northern sludge bed. MW-BP-16 was installed approximately 50 ft to the northwest of the former Imhoff tank and approximately 10 ft to the southeast of the former mixing tank. The borelogs and construction details for the newly installed MWs are provided in Appendix D.

The newly installed MWs were allowed to equilibrate for more than 48 hours prior to developing. Development of the MWs consisted of removing a minimum of three static well volumes from each MW, making visual observations of groundwater turbidity. Static groundwater elevations were measured after development, and varied from 299.19 ft above mean sea level (amsl) (C3-WWTP-B15), 299.24 ft amsl (C3-WWTP-BP16) and 305.65 ft amsl (C3-

WWTP-BP14). Based on the data, the inferred groundwater gradient at the site is from north-northeast to south-southwest.

#### *4.3.1.1 Soil VOC Screening*

MW installation soil cuttings, development water and purge water was screened with a PID for potential VOC impacts. There were no elevated PID readings associated with the soil cuttings, development water and purge water.

#### *4.3.1.2 Soil Radiation Screening*

MW installation soil cuttings were screened for elevated radioactivity. Radiological screening data did not indicate elevated readings at any of the installed groundwater monitoring well locations. Complete radiological screening data is included in Appendix B.

### **4.3.2 Field Groundwater Quality Screening**

Groundwater quality parameters were monitored and the data recorded during purging of each MW prior to collecting groundwater samples. The intent of monitoring these variables served a variety of purposes, including ensuring the health and safety of field personnel, establishing inferences regarding the site groundwater quality and to ensure connection with the underlying aquifer prior to collecting the samples for laboratory analysis.

#### *4.3.2.1 VOC Groundwater Screening*

Upon arriving at each MW and opening the well cap, the well head space was screened using a PID for VOC impacts according to the approved FSP (USACE/ERT/EA, 2009e). Well head screens were performed in a manner that minimized potential dissipation of any accumulated organic vapors. PID readings were observed for a minimum of 5 seconds, to allow for stabilization, and then the highest VOC reading was recorded on a sample location -specific field boring log, by the field geologist (see Appendix D for screening results).

#### *4.3.2.2 Groundwater Quality Parameter Screening*

In order to ensure connectivity with the underlying aquifer and in order to obtain field screen groundwater quality data, groundwater quality parameters were screened in accordance with the approved FSP (USACE/ERT/EA, 2009e) during the purge event prior to collecting a sample aliquot for laboratory analysis at each MW location. Groundwater quality parameters that were recorded include pH, specific conductivity, turbidity, dissolved oxygen, temperature, and oxygen reduction potential (see Appendix D for screening results).

### **4.3.3 Analytical Groundwater Sampling**

A total of three groundwater samples were collected for laboratory analysis of TCL VOCs and SVOCs, explosives, TCL pesticides and PCBs, and total TAL metals, plus lithium and boron in accordance with the approved project QAPP (USACE/ERT/EA, 2009f). All groundwater samples were collected in accordance with the approved FSP Addendum (USACE/ERT/EA, 2009e) and delivered to GPL Laboratories for analysis.

### **4.3.4 Characterization and Disposition of IDW**

During the completion of field activities, all generated investigative derived waste (IDW) that was impacted, was containerized in U.S. Department of Transportation (USDOT) approved 55-gallon drums, analytically characterized and disposed of at an offsite permitted disposal facility.

Representative samples were collected for both groundwater and soil IDW, and laboratory analyzed for RCRA characteristics, Toxicity Characteristic Leaching Procedure (TCLP) VOCs, TCLP metals, TCLP SVOCs, TCLP Pesticides, TCL VOCs, TCL SVOCs, explosives, TCL pesticides, TAL metals plus lithium and boron, Gross Alpha/Beta, Gamma Spectroscopy, Isotopic Uranium, Isotopic Thorium and Isotopic Plutonium.

In total, one 55-gallon drum filled with groundwater IDW and six 55-gallon drums filled with soil IDW were characterized as non-hazardous waste and disposed of at the Modern Disposal Services, Model City, New York. Applicable bills of lading for the disposed IDW are provided in Appendix E.

#### **4.4 Borehole Geology**

A total of 45 direct-push borings were completed during the Phase IV RI. Based on field assessments of the completed borings, site lithology was characterized. Representative cross-sections of the investigation area are presented in Figure 4-3 and Figure 4-4.

Surface soil at the site generally consisted of dry, sandy silt (ML) and silty sand (SM). Occasionally, surface soils were classified as tight, silty clay (CL). Typically, this classification is consistent to the southeast portion of the site, an area of little historic intrusive activities; and the aerial anomalies in the northwest portion of the site. Tight, silty upper clay till (UCT) was generally encountered between 2 ft bgs and 5 ft bgs, directly underlying the sand and silt. In addition, surface samples collected exhibited high organic content from grade surface to 1 ft bgs.

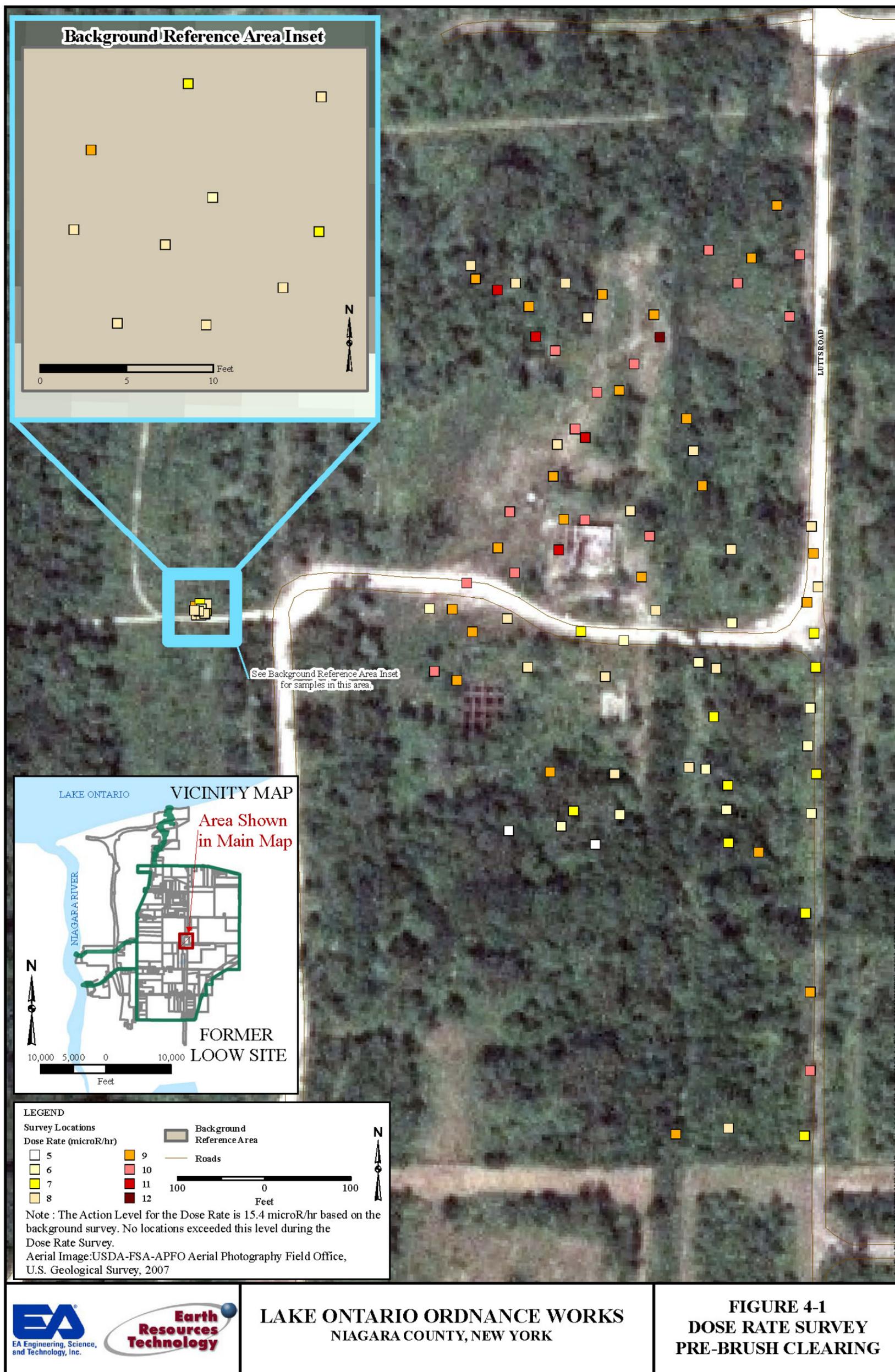
The typical site surface soil characterization was not consistent with the surface soils along the TNT waste lines transecting the site to the former Mixing Tank. Along this transect, ML was encountered to depths of between 4 ft bgs and 10 ft bgs. This change in lithology is likely due to the intrusive activities involved with the installation and remediation of the TNT waste lines,

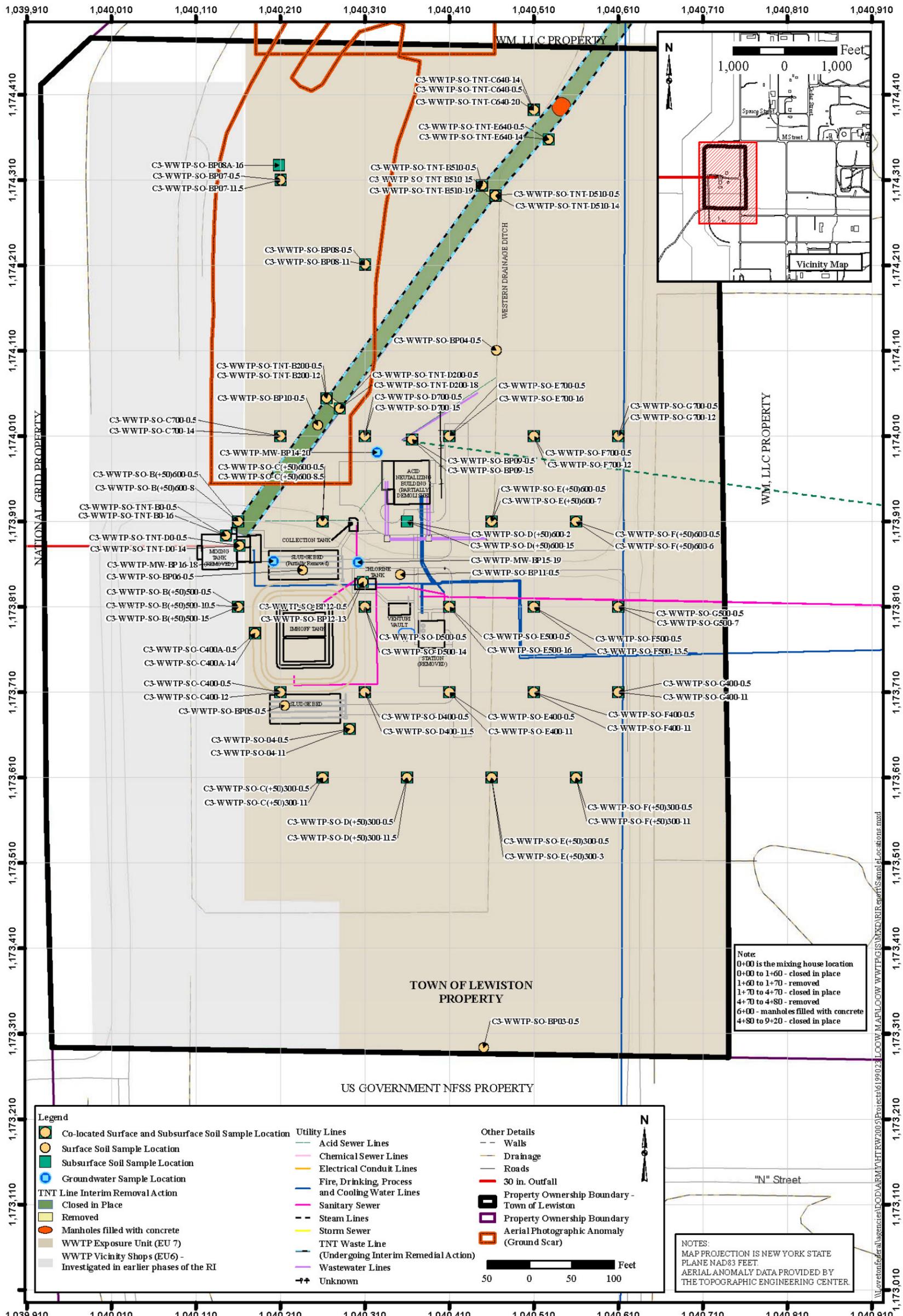
Borings were typically terminated at the interface between the UCT and the GLC, repeated refusal or encountered groundwater. Subsurface soil was generally characterized as UCT, with the exception of occasional thin lenses of silt, fine sand and gravel. The GLC was typically encountered between 11 ft bgs [C3-WWTP-B(+50)500] and 18 ft bgs (C3-WWTP-E700).

In particular, significant sand and silt lenses were identified associated with C3-TNT-B200 from 11.75 ft bgs to 12.25 ft bgs, C3-WWTP-F(+50)300 from 10.75 ft bgs to 11 ft bgs, C3-WWTP-G400 from 11 ft bgs to 11.5 ft bgs, C3-WWTP-G500 from 8 ft bgs to 8.25 ft bgs, C3-WWTP-G700 from 11 ft bgs to 11.25 ft bgs, and C3-WWTP-D(+50)300 from 9.5 ft bgs to 10 ft bgs. The presence of the sand and silt layer associated with C3-TNT-B200 is assumed to be the result of previous intrusive activities and associated mixing of the surface and subsurface soils. Contrary to historic intrusive activity associated with C3-TNT-B200, the presence of sand and silt lenses in subsurface soil associated with C3-WWTP-G500 and C3-WWTP-D(+50)300 are likely not the result of previous intrusive activities and may indicate the presence of a discontinuous glacial outwash deposit, typically characterized by thin channels gouged into native GLC units. This allowed a pathway for water to flow during glacial retreat.

A confirmed groundwater interface was not encountered at each boring location. In addition, very few water bearing units were encountered while completing the borings. Generally, the

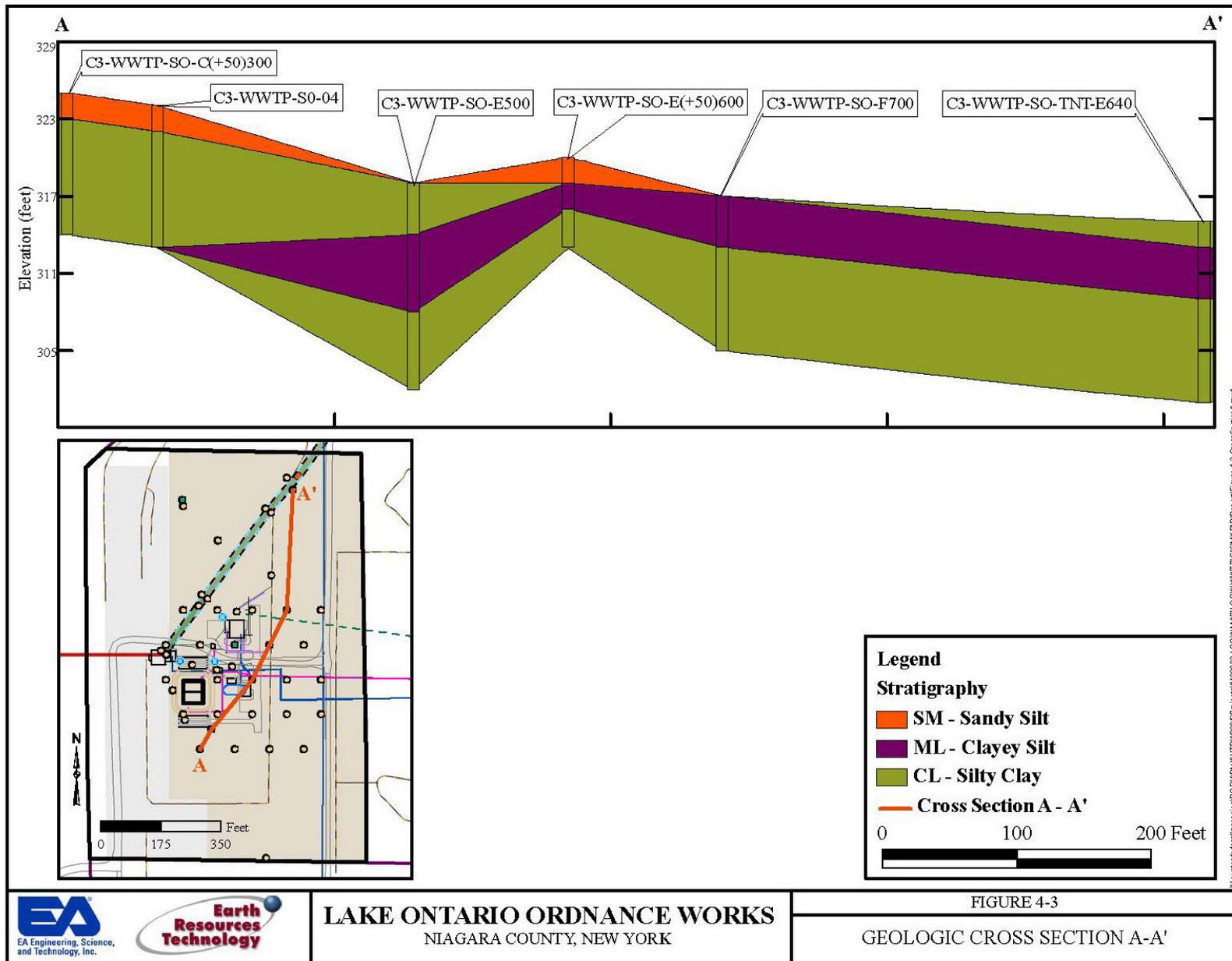
occurrence of subsurface water-bearing units in the UCT increased in frequency adjacent to the former WWTP structures. In particular, borings located adjacent to the acid neutralization building and mixing tank had a higher occurrence of water-bearing units within the UCT.

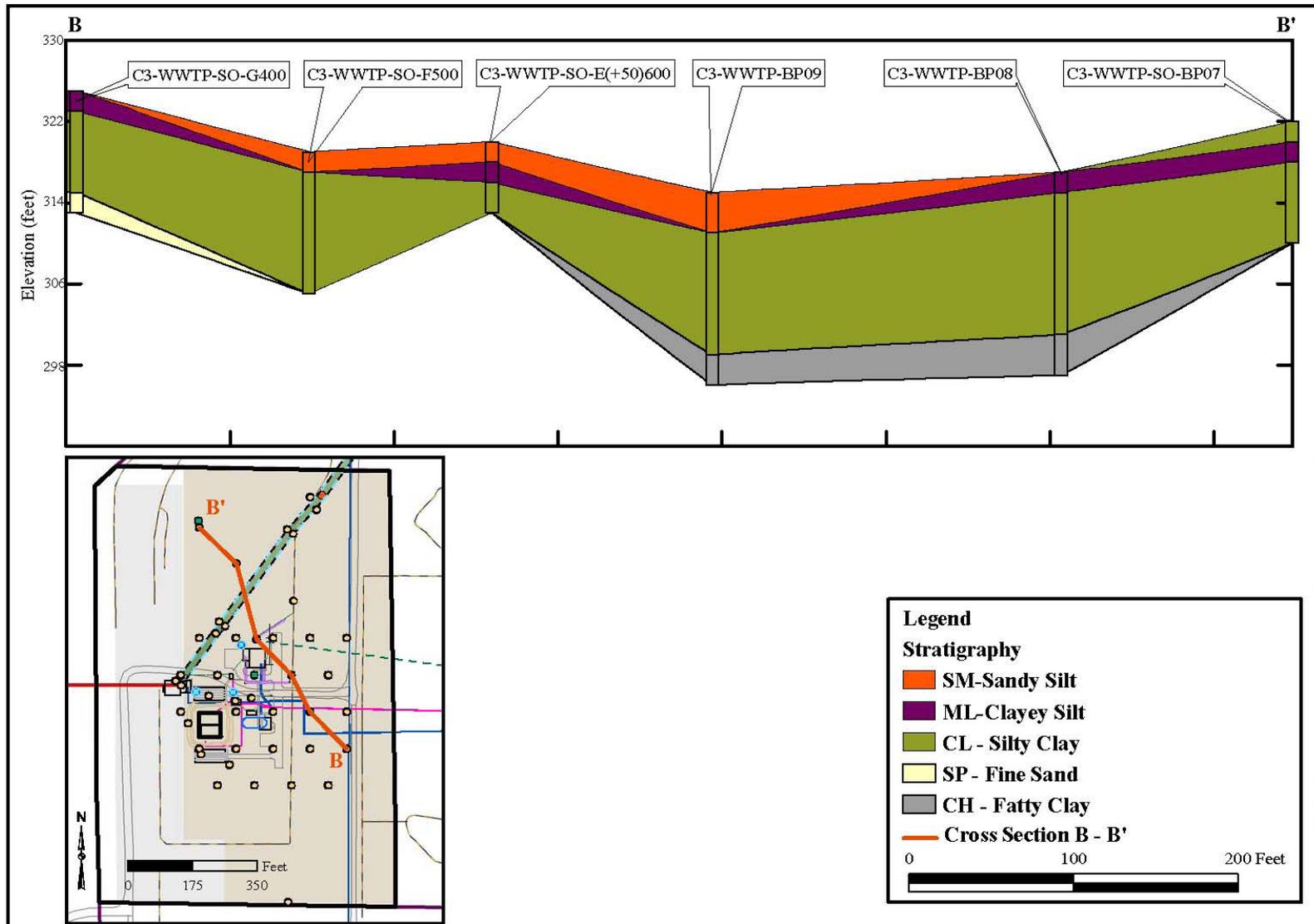




**LAKE ONTARIO ORDNANCE WORKS**  
 NIAGARA COUNTY, NEW YORK

**FIGURE 4-2**  
 WWTP RI  
 SAMPLE LOCATIONS





M:\enviro\lago\lago\100\04\PM\1\1\TR\2005\09\proj\458\1990\23\_100\MAP\LOD\W\W\F\G\I\SM\DR\Report\Figure\_4-4\_Cross\_Section\_B.mxd

**EA** EA Engineering, Science, and Technology, Inc. **Earth Resources Technology**

**LAKE ONTARIO ORDNANCE WORKS**  
 NIAGARA COUNTY, NEW YORK

FIGURE 4-4  
 GEOLOGIC CROSS SECTION B-B'

## **5.0 SITE CHARACTERIZATION RESULTS**

The following subsections detail the analytical results, specifically those exceeding screening criteria that warranted additional evaluation within a risk assessment. The subsections detail field screening results and laboratory analytical results for surface soil samples, subsurface soil samples and groundwater samples. The investigation of this site typically included surface soil and vadose zone sampling and analysis. In addition, sample locations were established using both systematic and biased sampling approaches. Systematic sample locations were arranged using a 100 ft by 100 ft grid system. Biased sample locations were selected based on historical site data and site reconnaissance.

### **5.1 Field Soil Screening Results**

#### **5.1.1 Total VOC Screening Results**

Most total VOC screening results were non-detect for the majority of surface soil (0 – 2 ft bgs) core samples. Fifteen (15) of 45 soil boring locations had reportable VOC concentrations and 14 of the 15 reportable concentrations ranged from approximately 0.1 part per million (ppm) to 23.0 ppm. One VOC screen associated with surface soil from boring C3-WWTP-C700 (refer to Figure 4-2 for boring location) indicated VOC concentrations of 268 ppm at a depth of between 1 ft bgs and 2 ft bgs. The anomalous VOC concentration is likely the result of slag that was identified during inspection of the soil core at approximately 1 ft bgs.

Likewise, VOC screening results were non-detect for the majority of subsurface soil core samples. Eight (8) of 45 soil boring locations had reportable VOC concentrations and 7 of the 8 reportable concentrations ranged from approximately 0.1 ppm to 12.0 ppm. VOC screen concentrations associated with subsurface soil from boring C3-WWTP-B(+50)600 (refer to Figure 4-2 for boring location) ranged from 44 ppm to 285 ppm at a depth of between 5 ft bgs and 12 ft bgs. Weathered petroleum odors were identified by the field geologist associated with the soils at approximately 6 ft bgs. In order to further characterize this anomaly, a soil sample was collected from 8 ft bgs on soil boring C3-WWTP-B(+50)600 and submitted for the full suite of laboratory analyses.

#### **5.1.2 Radiation Screening Results**

Radiation screening was conducted as specified in the RSP Addendum (USACE/ERT/EA, 2009b). Initial radiation dose rate screening was conducted prior to brush clearing activities and ranged from 5  $\mu$ R/hr to 12  $\mu$ R/hr with an average of approximately 9  $\mu$ R/hr. The average background radiation determined for this investigation was 7.7 $\mu$ R/hr.

All pre-brush clearing radiation dose rates were within the radiation safety parameters established for the investigation. Figure 4-1 presents the locations of each of the pre-brush clearing dose rate screenings. During post-clearance debris consolidation, radiation activity was detected at a single location adjacent to the northwest corner of the acid neutralization building. The dose rate at this location, 16  $\mu$ R/hr, was greater than 2 times the established background concentration of 7.7  $\mu$ R/hr. In addition, the counts per minute (cpm) measured at the location, 13,000 cpm, were approximately 2.5 times the established background. The radiation detection was communicated to the USACE on-site representative and further delineated by USACE and

ERT personnel. Surface soil (0-2 ft bgs) at the location was surveyed and it was determined that elevated readings extend horizontally in an approximate 3 ft by 3 ft square area. Subsurface investigation of the elevated radiation detection was beyond the scope of work for these RI activities and was therefore not performed. Per instruction from a USACE health physicist, the location of the anomalous hit was georeferenced (1173983.25N, 1040333.79E) and then covered with cobble and concrete/brick debris.

Radiation screening was conducted at each of the 240 TNT line surface soil field sample locations and on each of the 44 intrusive soil borings. The average dose rate detected across the 240 TNT sample points was 9.4  $\mu\text{R/hr}$  with a maximum detected level of 15  $\mu\text{R/hr}$ , below the established health and safety criteria of two times the average dose rate background reading. The minimum detected dose rate along the TNT surface soil field sample locations was 7  $\mu\text{R/hr}$ .

Each collected Geoprobe<sup>®</sup> soil core was screened for average dose rate and average direct count. The average dose rate for the soil cores was 7.4  $\mu\text{R/hr}$ . None of the soil core individual radiation screening results exceeded the health and safety criteria established in the RSP Addendum (USACE/ERT, 2009b). Table 5-1 presents the dose rate and direct count rates detected for each soil boring.

#### **5.1.1 Explosives Screening Results**

Surface and sub-surface explosives field screening was conducted along the TNT waste lines that traverse the former WWTP. DropEx<sup>®</sup>, a non-aerosol explosives detection kit, was used for the field screening analysis of 240 surface sample locations established in a grid pattern across the TNT waste lines and along 8 Geoprobe<sup>®</sup> soil borings located along the TNT waste lines. None of the 240 individual surface samples screened along the TNT waste lines reacted positively, which would have indicated the presence of TNT. Eight soil borings were advanced within four identified areas along the TNT waste lines that had previously been excavated in order to gain access to the TNT waste lines for scouring during the IRA. Each of the eight soil borings were advanced to depths of between 14 ft and 20 ft bgs. Each 4-ft macrocore section that was collected was screened along the entire length using the DropEx<sup>®</sup> detection kits. None of the eight soil core screens returned positives screening results for potential explosives. Complete results of the DropEx<sup>®</sup> TNT field screen results are provided in Appendix B.

**Table 5-1. Soil Boring Dose Rate and Direct Count Rates**

Date	7/10/09	7/10/09	7/10/09	7/10/09	7/20/09	7/8/09	7/8/09	7/21/09	7/8/09	7/9/09	7/20/09	7/10/09	7/10/09	7/10/09	7/8/09	7/9/09
Borehole Location ID	SS04	BP3	BP4	BP5	BP6	BP7	BP8	BP9	BP10	BP11	BP12	C(+50)300	D(+50)300	E(+50)300	F(+50)300	C400
Dose Rate Observed at Borehole/Location (µR/hr)	3	7	8	3	9	9	9	9	9	8	7	7	6	10	7	4
Direct Count Observed at Borehole/Location (cpm)	2254	4265	BKGD	3315	BKGD	4864	4844	BKGD	5394	BKGD	BKGD	4247	3848	4780	3758	5084
Depth (ft)	0-4	Sediment Surface	Sediment Surface	0-1.2	NA	0-4	0-4	0-4	0-0.5	0-0.5	0-4	0-4	0-4	Sediment Surface	0-4	0-4
Average Dose Rate Observed over Core (µR/hr)	3	6	8	2	NA	9	10	8	8	8	6	7	8	7	8	3
Average Direct Count Observed over Core (cpm)	2466	3141	BKGD	2276	NA	4878	4917	BKGD	5062	BKGD	BKGD	3586	3599	3212	3455	2405
Depth (ft)	4-8	0-4				4-8	4-8	4-8			4-8	4-8	4-8	0-3.5	4-8	4-8
Average Dose Rate Observed over Core (µR/hr)	3	7	NA	NA	NA	10	10	8	NA	NA	6	7	8	7	8	2
Average Direct Count Observed over Core (cpm)	2466	3309	NA	NA	NA	4644	4961	BKGD	NA	NA	BKGD	3656	3596	3153	3634	2391
Depth (ft)	8-11.5	4-7				8-11	8-11.5	8-12			12-16	8-113.5	8-11.5		8-12	8-12
Average Dose Rate Observed over Core (µR/hr)	3	7	NA	NA	NA	10	9	8	NA	NA	5	6	7	NA	7	3
Average Direct Count Observed over Core (cpm)	2540	3229	NA	NA	NA	4547	4818	BKGD	NA	NA	BKGD	3695	3671	NA	3570	2557
Depth (ft)						11-11.8		12-16								
Average Dose Rate Observed over Core (µR/hr)	NA	NA	NA	NA	NA	8	NA	8	NA	NA	NA	NA	NA	NA	NA	NA
Average Direct Count Observed over Core (cpm)	NA	NA	NA	NA	NA	4849	NA	BKGD	NA	NA	NA	NA	NA	NA	NA	NA
Depth (ft)								16-20								
Average Dose Rate Observed over Core (µR/hr)	NA	NA	NA	NA	NA	NA	NA	7	NA	NA	NA	NA	NA	NA	NA	NA
Average Direct Count Observed over Core (cpm)	NA	NA	NA	NA	NA	NA	NA	BKGD	NA	NA	NA	NA	NA	NA	NA	NA

**Legend:**  
 cpm = Counts per minute  
 µR/hr = microRoentgens per hour  
 Blank cell = data not collected because the borehole was terminated at the depth interval of the last reported values  
 BKGD = Indicates that the screening was conducted by a different instrument due to a malfunction encountered with the original equipment. Since the new equipment was calibrated differently, only comparisons could be made to the calibrated background as opposed to comparing readings to values previously obtained. See Instrument Malfunction Report included in Appendix B  
 NA = Not applicable  
 Direct count, calculated as cpm, is an aggregate measurement of all radioactive decay events at a given point (e.g. alpha, beta, mixed gamma/beta, mixed gamma alpha, and/or mixed alpha/beta). Typically, direct count instrumentation is used to detect point sources.  
 Exposure rate, calculated as µR/hr, is the quantity of radiation delivered to a point at a set distance over a specified period of time. Typically, an exposure rate meter is used to determine what radiation exposure is to the body at whatever point the operator happens to be located from any sources that may be in the general vicinity of wherever the instrument operator may be standing.  
 Direct count and exposure rate are individual measurements determined with two different types of detectors, but direct count typically will correlate with exposure rate as long as the energy of radiation is constant and the instruments are calibrated for a particular fixed energy. Therefore, for a given gamma/beta energy, the direct count rate will respond linearly with the intensity of the radiation exposure rate. In this case, readings on both instruments will elevate linearly as they get closer to a radioactive source.

**Table 5-1. Soil Boring Dose Rate and Direct Count Rates (Cont.)**

Date	7/20/09	7/10/09	7/9/09	7/8/09	7/8/09	7/10/09	7/20/09	7/9/09	7/9/09	7/8/09	7/8/09	7/8/09	7/8/09	7/21/09	7/10/09	7/9/09	7/8/09	7/21/09	7/21/09	7/9/09
Borehole Location ID	C400A	D400	E400	F400	G400	B(+50)500	D500	E500	F500	G500	B(+50)600	C(+50)600	D(+50)600	E(+50)600	F(+50)600	C700	D700	E700	F700	
Dose Rate Observed at Borehole/Location (µR/hr)	7	4	5	8	6	9	7	8/	9	8	6	8	8	7	8	9	8	9	9	
Direct Count Observed at Borehole/Location (cpm)	BKGD	4983	2602	4173	4064	4954	BKGD	3818	4238	3871	3440	3618	BKGD	4265	4334	4406	BKGD	BKGD	4818	
Depth (ft)	0-4	0-4	0-4	0-4	0-4	0-4	0-4	0-4	0-4	0-4	0-4	0-4	0-4	Sediment Surface	0-4	0-3	0-4	0-4	0-4	
Average Dose Rate Observed over Core (µR/hr)	7	3	9	7	7	9	6	7	7	6	7	9	8	6	7	8	8	7	6	
Average Direct Count Observed over Core (cpm)	BKGD	2469	4476	3412	3414	4442	BKGD	4149	3492	3344	4739	4848	BKGD	3141	3705	4884	BKGD	BKGD	3663	
Depth (ft)	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	0-4	4-8	3-7	4-8	4-8	4-8	
Average Dose Rate Observed over Core (µR/hr)	8	2	8	7	7	9	6	7	7	7	9	9	9	7	8	9	8	7	8	
Average Direct Count Observed over Core (cpm)	BKGD	2571	4248	3503	3559	4585	BKGD	4017	3591	3509	4759	4707	BKGD	3309	3919	4777	BKGD	BKGD	3943	
Depth (ft)	8-12	8-11.8	8-11	8-12	8-12	8-10.5	8-12	8-12	8-12	8-12	8-12	8-12	8-12	4-7	8-11.5	7-11	8-12	8-12	8-12	
Average Dose Rate Observed over Core (µR/hr)	7	5	9	8	8	9	5	7	7	8	10	9	9	7	6	9	8	7	8	
Average Direct Count Observed over Core (cpm)	BKGD	2384	4218	3480	3515	4638	BKGD	4076	3596	3347	4710	4749	BKGD	3229	3754	4720	BKGD	BKGD	3798	
Depth (ft)	12-16					8-12		12-16	12-13.5	12-14.5	12-15.8	12-15	12-16			11-14.5	12-16	12-16		
Average Dose Rate Observed over Core (µR/hr)	7	NA	NA	NA	NA	8	NA	9	8	6	8	10	9	NA	NA	10	9	7	NA	
Average Direct Count Observed over Core (cpm)	BKGD	NA	NA	NA	NA	BKGD	NA	4061	3705	3382	4576	4748	BKGD	NA	NA	4692	BKGD	BKGD	NA	
Depth (ft)						12-16											16-20	16-20		
Average Dose Rate Observed over Core (µR/hr)	NA	NA	NA	NA	NA	7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	9	6	NA	
Average Direct Count Observed over Core (cpm)	NA	NA	NA	NA	NA	BKGD	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	BKGD	NA	

**Legend:**  
 cpm = Counts per minute  
 µR/hr = microRoentgens per hour  
 Blank cell = data not collected because the borehole was terminated at the depth interval of the last reported values  
 BKGD = Indicates that the screening was conducted by a different instrument due to a malfunction encountered with the original equipment. Since the new equipment was calibrated differently, only comparisons could be made to the calibrated background could be made as opposed to comparing readings to values previously obtained. See Instrument Malfunction Report included in Appendix B  
 NA = Not applicable  
 Direct count, calculated as cpm, is an aggregate measurement of all radioactive decay events at a given point (e.g. alpha, beta, mixed gamma/beta, mixed gamma alpha, and/or mixed alpha/beta). Typically, direct count instrumentation is used to detect point sources.  
 Exposure rate, calculated as µR/hr, is the quantity of radiation delivered to a point at a set distance over a specified period of time. Typically, an exposure rate meter is used to determine what radiation exposure is to the body at whatever point the operator happens to be located from any sources that may be in the general vicinity of wherever the instrument operator may be standing.  
 Direct count and exposure rate are individual measurements determined with two different types of detectors, but direct count typically will correlate with exposure rate as long as the energy of radiation is constant and the instruments are calibrated for a particular fixed energy. Therefore, for a given gamma/beta energy, the direct count rate will respond linearly with the intensity of the radiation exposure rate. In this case, readings on both instruments will elevate linearly as they get closer to a radioactive source.

**Table 5-1. Soil Boring Dose Rate and Direct Count Rates (Cont.)**

Date	7/9/09	7/20/09	7/20/09	7/20/09	7/20/09	7/9/09	7/9/09	7/9/09	7/9/09
Borehole Location ID	G700	TNT-B0	TNT-D0	TNT-B200	TNT-D200	TNT-B510	TNT-D510	TNT-C640	TNT-E640
Dose Rate Observed at Borehole/Location ( $\mu\text{R/hr}$ )	7	8	8	8	8	10	10	8	12
Direct Count Observed at Borehole/Location (cpm)	4533	5152	5381	BKGD	BKGD	4580	4920	4675	4568
Depth (ft)	0-4	0-4	0-4	0-4	0-4	0-4	0-4	0-4	0-4
Average Dose Rate Observed over Core ( $\mu\text{R/hr}$ )	8	8	7	8	8	10	10	9	9
Average Direct Count Observed over Core (cpm)	4061	3941	3887	BKGD	BKGD	5043	5119	3750	3844
Depth (ft)	4-8	4-7	4-6	4-8	4-8	4-8	4-8	4-8	4-8
Average Dose Rate Observed over Core ( $\mu\text{R/hr}$ )	8	7	7	8	7	10	11	8	8
Average Direct Count Observed over Core (cpm)	4028	3762	3971	BKGD	BKGD	4948	5121	3870	3807
Depth (ft)	8-12	7-12	4-8	8-12	8-12	8-12	8-12	8-12	8-12
Average Dose Rate Observed over Core ( $\mu\text{R/hr}$ )	9	6	7	8	7	10	10	8	9
Average Direct Count Observed over Core (cpm)	3974	BKGD	BKGD	BKGD	BKGD	5113	5051	3761	3754
Depth (ft)		12-16	8-12	12-16	12-16	12-15	12-14	12-16	12-14.5
Average Dose Rate Observed over Core ( $\mu\text{R/hr}$ )	NA	6	7	8	8	10	10	8	8
Average Direct Count Observed over Core (cpm)	NA	BKGD	BKGD	BKGD	BKGD	5336	5193	3794	3846
Depth (ft)			12-16	16-20	16-18				12-16
Average Dose Rate Observed over Core ( $\mu\text{R/hr}$ )	NA	NA	7	8	8	NA	NA	NA	7
Average Direct Count Observed over Core (cpm)	NA	NA	BKGD	BKGD	BKGD	NA	NA	NA	BKGD
Depth (ft)									16-20
Average Dose Rate Observed over Core ( $\mu\text{R/hr}$ )	NA	NA	NA	NA	NA	NA	NA	NA	8
Average Direct Count Observed over Core (cpm)	NA	NA	NA	NA	NA	NA	NA	NA	BKGD

**Legend:**  
 cpm = Counts per minute  
 $\mu\text{R/hr}$  = microRoentgens per hour  
 Blank cell = data not collected because the borehole was terminated at the depth interval of the last reported values  
 BKGD = Indicates that the screening was conducted by a different instrument due to a malfunction encountered with the original equipment. Since the new equipment was calibrated differently, only comparisons could be made to the calibrated background could be made as opposed to comparing readings to values previously obtained. See Instrument Malfunction Report included in Appendix B  
 NA = Not applicable  
 Direct count, calculated as cpm, is an aggregate measurement of all radioactive decay events at a given point (e.g. alpha, beta, mixed gamma/beta, mixed gamma alpha, and/or mixed alpha/beta). Typically, direct count instrumentation is used to detect point sources.  
 Exposure rate, calculated as  $\mu\text{R/hr}$ , is the quantity of radiation delivered to a point at a set distance over a specified period of time. Typically, an exposure rate meter is used to determine what radiation exposure is to the body at whatever point the operator happens to be located from any sources that may be in the general vicinity of wherever the instrument operator may be standing.  
 Direct count and exposure rate are individual measurements determined with two different types of detectors, but direct count typically will correlate with exposure rate as long as the energy of radiation is constant and the instruments are calibrated for a particular fixed energy. Therefore, for a given gamma/beta energy, the direct count rate will respond linearly with the intensity of the radiation exposure rate. In this case, readings on both instruments will elevate linearly as they get closer to a radioactive source.

## 5.2 Data Quality Assessment

### 5.2.1 Laboratory Data Evaluation

This data quality assessment (DQA) describes the evaluation of data quality indicators (DQIs) that were used to assess the overall quality of the analytical data collected for the former LOOW Phase IV RI. The DQIs (accuracy, precision, completeness, representativeness, and comparability) are assessed with respect to the data quality objectives (DQOs). Project DQOs establish the data end uses and end users and provide objective criteria by which the data quality can be measured. More importantly, the DQO process identifies the up-front protocols, processes, procedures, and methods by which the DQOs can be met. With the appropriate planning for project DQOs, their achievement provides the basis for concluding that the acquired investigation data is scientifically sound, legally defensible, and adequate for their intended use.

The specific DQOs for accuracy, precision, completeness, representativeness, and comparability were established in the project-planning phase. DQOs may be qualitative statements, while others set quantitative criteria or goals. Both are evaluated in this DQA.

The LOOW Phase IV RI sampling and analysis was conducted using the QC requirements and QA objectives as outlined in the QAPP for the Phase IV RI at the former LOOW (USACE, 2009f).

Samples were analyzed for TCL VOCs, TCL SVOCs plus PAHs, TCL explosives, TCL pesticides, TCL PCBs, TAL metals, lithium and boron.

#### 5.2.1.1 *Environmental Analytical Laboratories*

Environmental and field QC soil samples were analyzed by GPL Laboratories. Environmental and field QC groundwater samples were analyzed by CT Laboratories. The laboratories analyzed all environmental samples (i.e., soil and water) and field QC samples (i.e., trip blanks, equipment rinsate blanks, field duplicates) using accepted laboratory standard operating procedures (SOPs) based on the *SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (USEPA, 2008).

#### 5.2.1.2 *Analytical Data Validation*

Analytical data were independently validated for adherence to method QA/QC criteria by Environmental Data Services (EDS) using specifications established in the LOOW Phase IV QAPP and the guidelines described in the USEPA Contract Laboratory Program (CLP) National Functional Guidelines for Organic Data Review (USEPA, 1999b) and the USEPA CLP National Functional Guidelines for Inorganic Data Review (USEPA, 2002a), modified to accommodate the criteria in the analytical methods used in this program, and Region II SOPs for data validation, including:

- VOA - *USEPA Region II SOP HW-24, Revision 1, June 1999: Validating Volatile Organic Compounds by SW-846 Method 8260B* (USEPA, 1999a)
- Metals and Cyanide - *USEPA Region II SOP No. HW-2, Revision 11, January 1992, for Evaluation of Metals Data for the Contract Laboratory Program* (USEPA, 1992b)

- SVOA and PAH - *USEPA Region II SOP No. HW-22, Revision 2, June 2001: Validating Semivolatile Organic Compounds by SW846 Method 8270C* (USEPA, 2001)
- Explosives - *USEPA Region II SOP, Revision 1.3, September 1994: Validating Explosive Residues by HPLC and the USEPA Region II SOP No. HW-22, Revision 2, June 2001: Validating Semivolatile Organic Compounds by SW846 Method 8270C* (USEPA, 1994)
- Pesticide - *USEPA Region II SOP No. HW-23, Revision 0, April 1995: Validating Pesticide/PCB Compounds by SW-846 Method 8080A* (USEPA, 1995)

All data received from the laboratories were subjected to an initial review to ensure that all Level IV CLP elements were submitted. Data verification checklists were produced in this effort, and are provided in Appendix F. These items were reviewed in accordance with the above referenced data validation procedures.

#### 5.2.1.3 *Quality Data Management*

The LOOW Phase IV database was populated with analytical results from samples collected during the LOOW Phase IV RI. In certain cases, data were selected for incorporation into or exclusion from the database (i.e., two results from the same sampling point). The selection processes are described below.

- Data points qualified with "R" (rejected) were marked to prevent incorporation into the usable data population.
- All laboratory and field QC results were marked to prevent incorporation into the usable data population.
- All duplicate values (same sample location) were identified with a unique sample ID to identify them for appropriate incorporation into the usable data population.
- All dilutions results were evaluated for best value and detection limit using the following procedure:
  - The diluted sample results were selected for all compounds that exceeded the analytical calibration range in the original data set,
  - The non-diluted sample results were selected for all target compounds reported within the calibration range, and
  - The most sensitive detection limit (the non-diluted or original sample) was selected for undetected compounds.
- All reanalysis results were evaluated for best value, based on QC results, established criteria, detection limit, and professional judgment.

#### 5.2.1.4 *Data Quality Objectives*

The project DQOs for the LOOW Phase IV RI were developed using the USEPA DQO process (USEPA, 2006). The USEPA DQO process focuses on the need/decision/action evaluation for a site. Quality assurance objectives were developed to support the project DQOs. The primary goal of the quality assurance objectives is to ensure the collected data supporting the conclusions of the RI are defensible.

There were several objectives of this RI, and each concerned the collection of sufficient data. The DQOs included;

- collecting data of sufficient quality and quantity to locate potential health risks posed by the formerly used DoD WWTP at the former LOOW,
- determining if COPCs are present,
- determining if COPCs represent a risk to human health or the environment, and
- delineating the extent of the COPCs.

The required inputs for making informed decisions included analytical results from surface and subsurface soil and groundwater. Additional required inputs were chemical specific applicable or relevant and appropriate requirements (ARARs) and risk-based “to be considered” (TBC) criteria; and sample location, type, and depth.

The DQOs also specified that the Phase IV RI would be confined to the vicinity of the former WWTP, Town of Lewiston Property, exclusive of underground sanitary, acid waste, and industrial wastewater lines and pits, vaults, and sumps; and if analytical data results exceeded chemical specific ARARs and risk-based TBC criteria (USEPA RSLs or in the absence of RSLs, New York State TOGS Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations [inclusive of 6NYCRR Part 703] [NYSDEC, 1998, 2004]) then additional evaluations of potential human health and environmental risks may be warranted.

Performance and acceptance criteria were developed in order to minimize the potential for study error rates. Quantitative project specific objectives for the DQIs of precision, accuracy, completeness and sensitivity were developed in order to define acceptable measurement error and to assess the overall quality of the analytical data collected for the LOOW Phase IV RI.

Numerical DQOs for accuracy, precision, and completeness were calculated for the LOOW Phase IV RI. This provides the main point of reference for an assessment of the LOOW Phase IV RI environmental data as a whole.

A summary of the project DQIs is provided below. A more defined assessment of the data quality results, including statistical evaluations, is presented in Section 5.2.3..

**Accuracy:**

Accuracy is defined as the extent of agreement between a measured or calculated value and the true value. Accuracy was determined for the LOOW Phase IV RI using spike percent recovery data from matrix spike/matrix spike duplicate (MS/MSD) samples. Data validation indicated that, although not all specific recoveries for specific compounds met the DQO for recovery, the number and magnitude of failures were within acceptable validation guidelines such that all data was usable, but some was qualified, as appropriate. The overall project accuracy for all matrices and all parameters as presented by the average MS/MSD percent recovery was 98 percent, indicating that the Phase IV RI DQOs for accuracy were met.

**Precision:**

Precision is defined as the reproducibility, or degree of agreement, among replicate measurements of the same compound or element analyzed under identical conditions. Precision is expressed as relative percent difference (RPD) between the two results. The overall RPD for all matrices and all parameters was 95.6% of the RPDs for field duplicate analyses, and 94.9% of the RPDs of the MS/MSD analyses were within the Phase IV RI DQOs for precision. A data quality control summary for precision is presented in Section 5.2.3.2..

**Completeness:**

Completeness for the LOOW Phase IV RI refers to the fraction of valid data obtained (i.e. not rejected) compared to that which was planned, calculated as follows:

$$\text{Completeness (\%)} = \frac{\text{Number of Valid Measurements Made}}{\text{Number of Measurements Planned}}$$

Completeness determinations were made separately for samples obtained from the field collection effort and data obtained from the analytical measurement system. The completeness goal for the LOOW Phase IV RI was 95%. Field completeness was 97%, indicating that the LOOW Phase IV RI DQO for field completeness was met. Analytical completeness for each matrix and analytical group were as follows:

Analytical Group	Matrix		
	Surface Soil and Terrestrial Sediment	Subsurface Soil	Groundwater
	% Analytical Completeness		
VOCs	91	86	98
SVOCs	100	100	100
Pesticides	100	96	100
PCBs	100	100	100
Explosives	100	100	100
Metals	100	100	100

Percent completeness was dependent upon the number of data that were rejected within each matrix and analyte group; VOCs had the highest number of rejections per matrix, with subsurface soil being the matrix with the most rejected results. The higher number of rejects associated with VOCs is due to the higher number of failed laboratory QC measures with this method. Failed QC measures included, but are not limited to, low initial calibration values, high LCS recoveries, low internal standard values, grossly exceeded holding times, low surrogate recoveries, low MS/MSD recoveries, and high continuing calibration values.

**Representativeness:**

Representativeness, in part, was accomplished by the consistent use of approved drilling techniques, sample collection methods, equipment, and sample containers for the field work. Representativeness was also assessed by evaluating the RPD values calculated from the field duplicate samples, duplicate concentration values reported from redundant analyses, and the concentrations of contaminants detected in the field and laboratory QC blanks. The

reproducibility of a representative set of samples reflects the degree of homogeneity of the sampled medium.

### **Comparability:**

Comparability refers to the confidence with which one data set can be compared to another. To improve data comparability, the data set used for the LOOW Phase IV RI was generated by employing standardized analytical methods and standardized data validation procedures. The project planning, including lab selection, incorporated various appropriate USEPA and USACE guidance documents, as well as direct input from USACE on field and laboratory issues, to ensure the comparability of the data.

### **Sensitivity:**

Sensitivity for the LOOW Phase IV RI was evaluated as a function of the laboratory reporting limits with respect to potential chemical specific ARARs risk-based TBC criteria, and the screening level benchmarks. Typically, reporting limits should be less than the screening levels, but this does not always occur (e.g., because of dilutions). The analytical methods and the resultant reporting limits during the LOOW Phase IV RI resulted in many reporting limits being greater than current USEPA RSLs.

Additionally, the laboratories participated in the analysis of Performance Evaluation (PE) samples for organics and inorganics. The laboratory performance throughout the duration of the LOOW Phase IV RI analytical testing indicates their ability to generate accurate results over time. Based on the overall quality of the PE sample results and the stringent QC requirements set by the standardized methods, the data generated is considered comparable to other data generated through similar processes.

## **5.2.2 Data Quality Assessment**

Environmental samples were collected and analytical data were evaluated during the LOOW Phase IV RI to support technical conclusions and recommendations. These data (i.e. concentration values and laboratory qualifiers) were incorporated into one database. Following an initial review to ensure that all Level IV CLP elements were received from the laboratory, hard copy data packages were submitted to the data validator for validation. The qualifiers applied to estimated or rejected data points were incorporated into the database once the Data Usability Summary Reports (DUSRs) were received and reviewed. The usable data population was then determined using the preparation and selection process described in the Quality Data Management section, described above.

### *5.2.2.1 Data Validation Process*

Analytical data were validated according to the guidelines and procedures described in the documents listed in Section 5.2.1.2. The validators were responsible for the following:

1. reviewing laboratory data packages and applying required control limits (obtained from references listed in Section 5.2.1.2),
2. using professional judgment where specific limits were not specified,
3. qualifying affected data points on the applicable result forms, and
4. preparing a DUSR for actions taken.

### 5.2.2.2 *Data Bias Assessment*

The DQA was conducted using the LOOW Phase IV RI QC data (by matrix and by parameter) and the data validation results. The QC data were evaluated for the number of results observed within the set acceptance criteria. When the data are observed as being lower or higher than the criteria, a bias existed. However, for the purpose of this project and based on the Data Validation Guidelines used, bias has been considered as estimated, indicated by a “J” data qualifier.

## 5.2.3 **Quality Control Summary**

### 5.2.3.1 *Analytical Data Evaluation*

This project utilized both field and analytical laboratory QC measures to meet the data quality objectives presented in the QAPP. The sampling program consisted of 86 field soil samples and 3 field groundwater samples collected during the Phase IV RI field activities. For the combined analyses and matrices for this site, the laboratories were provided with all field samples, which included the following field QC samples; 6 rinsate blanks, 6 trip blanks, 10 field duplicates, 10 MS/MSD pairs. The evaluation of results for accuracy, precision, representativeness, sensitivity, and completeness are discussed below.

### 5.2.3.2 *Accuracy and Precision*

Laboratory accuracy and precision assessment and sample matrix effect evaluation were conducted using MS/MSDs. Accuracy and precision were expressed as the percent recovery (%R) and RPD of the spike compounds or elements, respectively. For samples collected and analyzed as field duplicates, precision was expressed as the percent difference of the concentration of elements detected in the sample and associated duplicate. As with MS/MSDs, the field duplicate data served as indications of the matrix sampled and precision in the analytical system. Rinsate blanks and trip blanks were collected to also serve to identify contamination effects. An MS/MSD or a spike and analytical duplicate analysis was required for every 20 samples of a similar matrix. Field duplicates were collected at a 10% frequency by matrix. Rinsate blanks were collected once per sampling day.

#### **Rinsate Blanks:**

Equipment rinsate blanks were collected to evaluate the decontamination technique used for non-dedicated sampling equipment. Equipment blanks were collected by pouring American Society for Testing and Materials (ASTM) Type II reagent water through a recently decontaminated piece of equipment into a prepared sample container appropriate for the required analysis.

In total, six rinsate blank quality control samples were collected during the LOOW Phase IV RI field activities; one rinsate blank was collected each day that environmental samples were collected, and was submitted for laboratory analysis of the full suite of project target compounds and analytes. Constituent concentrations detected associated with the collected rinsate blanks are presented in Table 5-2.

Rinsate blank detections were used to qualify the results of the associated environmental samples according to USEPA CLP National Functional Guidelines for Organic Data Review (USEPA, 1999b) and the USEPA CLP National Functional Guidelines for Inorganic Data Review (USEPA, 2002a).

Sample Name	C3-WWTP-RB01	C3-WWTP-WW-RINSATE-01	C3-WWTP-WW-RINSATE-2	C3-WWTP-WW-RINSATE-3	C3-WWTP-WW-RINSATE-4	C3-WWTP-WW-RINSATE 5
Sample Date	11/12/09	07/08/09	07/09/09	07/10/09	07/20/09	07/21/09
Sample Type	RB	RB	RB	RB	RB	RB
Analyte	USEPA RSL Tapwater					
<b>Pesticides (8081) (µg/L)</b>						
Dieldrin	0.0042	<b>0.027 J</b>				
<i>Legend:</i> USEPA RSL = USEPA Regional Screening Level for tap water (December 2009). One-tenth of the RSL for non-carcinogenic chemicals (except for lead) is used for comparison. Yellow shading and bold text = Analyte concentration exceeds RSL Blank cell = Analyte not detected above screening criteria RB = Rinsate Blank J = Estimated value data qualifier µg/L = micrograms per liter						

**Trip Blanks:**

Trip blanks monitor for VOC contamination during sample transport and storage. Trip blanks were prepared by the laboratory with ASTM Type II water, stored with the unused sample bottles, and returned to the laboratory with each cooler containing VOC samples. Constituent concentrations detected associated with trip blanks are presented in Table 5-3.

Sample Name	Trip Blank
Sample Date	7/20/09
Sample Type	TB
Analyte	USEPA RSL Tapwater
<b>Volatile Organic Compounds (8260C) (µg/L)</b>	
Chloromethane	190
Trichloroethene	2.0
	5.5 J
	1.9 J
<i>Legend:</i> USEPA RSL = USEPA Regional Screening Level for tap water (December 2009). One-tenth of the RSL for non-carcinogenic chemicals (except for lead) is used for comparison. J = Estimated value data qualifier µg/L = micrograms per liter	

**Matrix Spikes:**

The LOOW Phase IV RI MS/MSD samples were analyzed at the correct frequency, and the accuracy control limits used to evaluate the data were taken from the QAPP. Overall, 17% of the MS/MSD %R results and 5% of the MS/MSD RPD results were outside of established control limits. MS/MSD results for each matrix and analytical group were as follows:

**Table 5-4. Matrix Spike/Matrix Spike Duplicate Relative Percent Difference Comparison**

Analytical Group	Matrix			
	Soil		Groundwater	
	MS %R	MS/MSD RPD	MS %R	MS/MSD RPD
VOCs	72	90	99	100
SVOCs	81	99	92	94
Pesticides/PCBs	92	88	100	100
Explosives	100	100	100	100
Metals	91	96	96	96

**Field Duplicates:**

Duplicate environmental field samples were collected at selected locations to evaluate the precision of the sampling techniques. The RPD value of each detected compound or element was reviewed to assess the sample collection reproducibility and matrix variability. Where good field techniques are consistently implemented and matrix effects are minimum, the RPDs are expected to be low. Sixty-eight percent of the field duplicate RPDs for surface soil results were within acceptance criteria. This percentage is low, and mostly attributed to exceeded acceptance criteria for duplicate metals results. There were 96.4% of the field duplicate RPDs for subsurface soil results within acceptance criteria. There were 90.4% of the field duplicate RPDs for groundwater results within acceptance criteria. Higher RPDs were exhibited in the PAH results in some groundwater field duplicates, which is not uncommon. Tables 5-4 thru 5-6 summarize the RPD values that were outside the acceptance criteria. The RPD values outside of the acceptance criteria were typically the result of poor instrument sensitivity during particular analysis runs.

*5.2.3.3 Representativeness*

Representativeness was evaluated by comparing preservation and analytical procedures to those described in the QAPP, by evaluating holding times, and by examining blanks for possible contamination of samples during collection and analysis.

All samples were preserved, prepared, and analyzed following methods specified in the QAPP. Several samples were not prepared and analyzed within the holding time required for the respective analyses. Analytical results for samples having holding times that were grossly exceeded were rejected during data validation. This included most samples for re-analysis of VOCs. Equipment rinsate blanks, method blanks, and trip blanks were found to be mostly free of target analytes. Table 5-2 presents analytes in equipment rinsate blanks having concentrations greater than project screening criteria, and Table 5-3 presents all analytes detected in trip blanks.

Representativeness, in part, was also accomplished by the consistent use of approved sampling techniques, environmental sample collection methods, equipment, decontamination methods, and sample containers for the field work according to the guidelines and specifications described in the LOOW Phase IV RI QAPP. The data are considered representative of site conditions for the purpose of the LOOW Phase IV RI.

#### 5.2.3.4 Sensitivity

In general, quantitation limits should be lower than the screening level benchmarks. The analytical methods and the resultant quantitation limits during the LOOW Phase IV RI resulted in some sample quantitation limits (SQL) being greater than current USEPA RSLs. Sample quantitation limits above the respective screening levels are identified in Table 5-7 (surface soil), Table 5-8 (subsurface soil), and Table 5-9 (groundwater).

#### 5.2.3.5 Completeness

The field and analytical completeness goals were 95%. Completeness was calculated according to the equation presented in Section 5.2.1.4. Several analytical results were rejected. Despite the few analytical discrepancies, the project completeness goals were achieved. Greater than 97% of planned samples were collected and greater than 95% of the analytical results per analytical group and method were valid, except for VOCs in surface soil (91%) and VOCs in subsurface soil (86%).

#### **Rejected Data:**

As a result of data quality being outside objectives limits, some data were rejected according to project-specific guidelines and USEPA CLP National Functional Guidelines for Organic Data Review (USEPA, 1999b). Tables 5-10 thru 5-12 summarize the rejected data. QC criteria did not affect detected samples to the extent that data validation by USEPA CLP NFGs warranted rejecting those data. Several non-detects were rejected due to issues including, but not limited to:

- Grossly exceeded holding times in re-analyses
- Severely low LCS recoveries
- Low initial calibration RRF values
- Severely low internal standard recoveries
- Severely low surrogate recoveries

DUSRs in Appendix F provide a complete explanation for all rejected data.

**Table 5-5. Surface Soil Field Duplicates Above 20% RPD**

Sample Name	C3-WWTP-SO-BP03-0.5	C3-WWTP-SO-DUP-6	RPD	C3-WWTP-SO-C400A-0.5	C3-WWTP-SO-DUP-7	RPD	C3-WWTP-SO-D(+50)300-0.5	C3-WWTP-SO-DUP-5	RPD	C3-WWTP-SO-E400-0.5	C3-WWTP-SO-DUP-4	RPD	C3-WWTP-SO-G500-0.5	C3-WWTP-SO-DUP-01	RPD	C3-WWTP-SO-TNT-D510-0.5	C3-WWTP-SO-DUP-3	RPD	C3-WWTP-SO-TNT-E640-0.5	C3-WWTP-SO-DUP-02	RPD	
Sample Depth (ft bgs)	0.5			0.5			0.5			0.5			0.5			0.5			0.5			
Sample Date	7/21/09			7/21/09			7/21/09			7/21/09			7/21/09			7/21/09			7/21/09			
Sample Type	N	FD		N	FD		N	FD		N	FD		N	FD		N	FD		N	FD		
Analyte	USEPA RSL																					
<b>Volatile Organic Compounds (8260C) (µg/kg)</b>																						
2-Butanone	2,800,000	220 J	52 J	123.5%	7.8 R	6.6 UJ		9.6 R	5.7 J		6.6 J	5 J	27.6%	7.3 UJ	6.7 U		10 J	8.4	17.4%	8.6 UJ	7.7 UJ	
4-Isopropyltoluene		9.3 UJ	3.3 UJ		3.9 R	3.3 UJ		4.8 U	4.1 U		4 U	5.1 U		3.7 U	3.3 U		3.8 U	4.2 UJ		4.3 UJ	3.8 UJ	56.2%
Acetone	6,100,000	1,200 J	220 J	138%	12 J	13 J	8%	130 J	120 J	8%	84 J	100 J	17.4%	22 J	23 J	4.4%	43 J	100	79.7%	41 J	23 J	
Benzene	1,100	9.3 UJ	3.3 UJ		3.9 R	3.3 UJ		4.8 U	4.1 U		4 U	5.1 U		3.7 U	2.1 J	55.2%	2.8 J	4.2 U	40%	4.3 UJ	3.8 UJ	
Carbon disulfide	82,000	44 J	18 J	83.9%	3.9 R	3.3 UJ		4.8 U	4.1 U		4 U	5.1 U		3.7 U	3.3 U		3.8 U	4.2 U		4.3 UJ	3.8 UJ	
Methyl acetate	7,800,000	310 J	36 J	158.4%	3.9 R	3.3 UJ		4.8 UJ	4.1 UJ		79 J	5.1 U	175.7%	3.7 U	3.4 U		3.8 U	4.2 U		4.3 UJ	3.8 UJ	
Methylcyclohexane		9.3 UJ	3.3 UJ		3.9 R	3.3 UJ		4.8 U	4.1 U		4 U	5.1 U		3.7 U	3.4 U		2.3 J	4.2 U	58.5%	2.9 J	3.8 UJ	26.9%
Methylene chloride	11,000	15 J	3.4 J	126.1%	7.8 R	6.6 UJ		9.6 U	8.1 U		8 U	10 U		7.3 U	6.7 U		7.6 U	8.3 U		8.6 UJ	7.7 UJ	
<b>Semi-Volatile Organic Compounds (8270C) (µg/kg)</b>																						
Bis(2-ethylhexyl) phthalate	35,000	68 U	70 U		380 U	380 U		420 U	380 U		57 U	56 U		60 J	400 U	147.8%	380 U	54 U		370 U	380 U	
Diethyl phthalate	4,900,000	100 U	310 J	102.4%	380 U	380 U		420 U	380 U		85 U	83 U		400 U	400 U		380 U	80 U		370 U	380 U	
<b>Metals (6020, 7470A, 7471A) (mg/kg)</b>																						
Aluminum	7,700	11,700	13,100	11.3%	14,900	12,900	14.4%	18,500	18,100	2.2%	18,800	17,800	5.5%	11,700	12,300	5%	15,800	15,300	3.2%	21,000	16,100	26.4%
Antimony	3.1	0.13 J	0.13 J		0.1 J	0.092 J	8.3%	0.1 J	0.1 J		0.094 J	0.081 J	14.9%	0.084 J	0.079 J	6.1%	0.15 J	0.11 J	30.8%	0.19 J	0.12 J	45.2%
Arsenic	0.39	3.6 J	4.4 J	20%	4 J	3.3 J	19.2%	4.4 J	3.9 J	12%	2.7 J	3.2 J	16.9%	3 J	3.2 J	6.5%	3 J	3.6 J	18.2%	3.6 J	3 J	18.2%
Cadmium	7.0	0.21 J	0.24 J	13.3%	0.21 J	0.2 J	4.9%	0.27 J	0.25 J	7.7%	0.3 J	0.28 J	6.9%	0.36 J	0.34 J	5.7%	0.37 J	0.21 J	55.2%	0.42	0.34 J	21.1%
Calcium		35,700	34,500	3.4%	28,800	17,100	51%	3,090	2,530	19.9%	3,050	3,950	25.7%	13,400	12,400	7.8%	34,400 J	29,300	16%	44,000 J	34,900 J	23.1%
Chromium	12,000	17.3 J	18.3 J	5.6%	18.7	14.6	24.6%	24.6	22.9	7.2%	25 J	23.6 J	5.8%	18.1	18.5	2.2%	19.6	20 J	2%	27	19.7	31.3%
Cobalt	2.3	9.1 J	9.6 J	5.3%	9 J	6.8 J	27.8%	10.4	10	3.9%	10.9 J	10.1 J	7.6%	7.2	7.5	4.1%	9.9	9.1 J	8.4%	11.1	10.2	8.5%
Copper	310	27.6	24.7	11.1%	25.3	19.5	25.9%	25.6	31.2	19.7%	25	23.7	5.3%	24.8 J	28.9 J	15.3%	29.8 J	25.3	16.3%	26.7 J	24.7 J	7.8%
Iron	5,500	24,700	27,800	11.8%	27,000	20,400	27.8%	33,700	31,900	5.5%	31,400	29,700	5.6%	20,000	21,500	7.2%	25,400	25,200	0.8%	34,800	24,500	34.7%
Lithium	16	20.4 J	22 J	7.5%	22.9	18.9	19.1%	28	26.4	5.9%	32 J	28.7 J	10.9%	19.6	22	11.5%	25.2	25.4 J	0.8%	34.7	27.1	24.6%
Magnesium		7,570	8,660	13.4%	7,450	4,660	46.1%	6,220 J	6,220 J		5,660	5,150	9.4%	4,550	4,830	6%	8,900	7,440	17.9%	11,100	8,660	24.7%
Manganese	180	839	924	9.6%	627	615	1.9%	816 J	759 J	7.2%	686	910	28.1%	750 J	535 J	33.5%	676 J	659	2.5%	567 J	653 J	14.1%
Mercury	0.56	0.02 J	0.026 J	26.1%	0.022	0.028	24%	0.039	0.022 J	55.7%	0.035 J	0.023 J	41.4%	0.028 U	0.016 U		0.029 J	0.021 J	32%	0.018 J	0.016 J	11.8%
Nickel	150	19.2	21.3	10.4%	20.5	13.7	39.8%	24.3	22	9.9%	22.5	22	2.2%	16.1	16.5	2.5%	21.8	21.1	3.3%	30.3	22.8	28.2%
Potassium		2,080	2,240	7.4%	1,880 J	1,040 J	57.5%	2,020	1,760	13.8%	2,010 J	1,890 J	6.2%	1,170 J	1,370 J	15.7%	2,250	2,040 J	9.8%	3,650	2,210	49.1%
Selenium	39	5.1 U	1.5 U		4 U	1.2 U		4.5 U	1.2 U		1.2 J	1.2 U		4.2 U	1.5 J	94.7%	4 U	1.1 U		1.9 J	1.1 U	53.3%
Silver	39	0.044 J	0.051 J	14.7%	0.046 J	0.043 J	6.7%	0.07 J	0.054 J	25.8%	0.062 J	0.056 J	10.2%	0.047 J	0.052 J	10.1%	0.078 J	0.054 J	36.4%	0.086 J	0.054 J	45.7%
Sodium		135 J	216 J	46.2%	91 J	83.5 J	8.6%	81 J	63 J	25%	74.6 J	63.3 J	16.4%	75 J	80.6 J	7.2%	116 J	99.5 J	15.3%	146 J	114 J	24.6%
Thallium		2 U	0.1 U		0.12 J	0.16 J	28.6%	0.14 J	0.11 J	24%	0.2 J	0.14 J	35.3%	0.17 J	0.1 U	51.9%	0.14 J	0.21 J	40%	0.24 J	0.15 J	46.2%
Vanadium	39	26.6	30.2	12.7%	33.8 J	27.9 J	19.1%	43	41.9	2.6%	37.6	35.4	6%	27.6	30.3	9.3%	36.5	34.4	5.9%	52.3	36.5	35.6%
Zinc	2,300	70.4	86.6	20.6%	48.4	41.1	16.3%	57.6	55.2	4.3%	68.9	65.8	4.6%	44.7	46.3	3.5%	50.8	50.4	0.8%	64.7	49.8	26%

*Legend*  
 USEPA RSL = USEPA Regional Screening Level for residential site use. One-tenth of the RSL for non-carcinogenic chemicals (except for lead) is used for comparison. For chromium, one-tenth the RSL for trivalent chromium is presented.  
 Yellow shading = Exceeds 20% RPD  
 RPD Blank Cell = Not analyzed, both results were non-detect, or result was rejected  
 N = Normal Sample  
 FD = Field Duplicate  
 RPD = Relative Percent Difference  
 J = Estimated value data qualifier  
 U = The sample was analyzed for but not detected above the sample reporting limit. Reporting limit values are associated with non-detects.  
 mg/kg = milligrams per kilogram  
 µg/kg = micrograms per kilogram  
 ft bgs = feet below ground surface

<b>Table 5-6. Subsurface Soil Field Duplicates Above 20% RPD</b>								
<b>Sample Name</b>			C3-WWTP-SO-D(+50)600-15	C3-WWTP-SO-DUP-9	RPD	C3-WWTP-SO-TNT-C640-20	C3-WWTP-SO-DUP-8	RPD
<b>Sample Depth (ft bgs)</b>			15			20		
<b>Sample Date</b>			7/21/09			7/21/09		
<b>Sample Type</b>			N	FD		N	FD	
<b>Analyte</b>	<b>USEPA RSL</b>	<b>SSL</b>						
<b>Metals (6020, 7470A, 7471A) (mg/kg)</b>								
Arsenic	0.39	5,000	3.8 J	2.8 J	30.3%	2.7 J	2.9 J	7.1%
Calcium			48,100 J	46,600 J	3.2%	42,100 J	54,300 J	25.3%
Manganese	180	19,500	872	766	12.9%	743	953	24.8%
Mercury	0.56	36.5	0.014	0.0081	53.4%	0.013	0.0043	100.6%
Thallium		750	0.13 J	0.22 J	51.4%	0.15 J	0.11 J	30.8%
<p><i>Legend</i>                      USEPA RSL = USEPA Regional Screening Level for residential site use. One-tenth of the RSL for non-carcinogenic chemicals (except for lead) is used for comparison.                      SSL = Site-specific Soil Screening Values                      Yellow shading = Exceeds 20% RPD                      N = Normal Sample                      FD = Field Duplicate                      RPD = Relative Percent Difference                      J = Estimated value data qualifier                      mg/kg = milligrams per kilogram                      ft bgs = feet below ground surface</p>								

<b>Table 5-7. Groundwater Field Duplicates Above 20% RPD</b>				
<b>Sample Name</b>		<b>C3-WWTP-MW- BP15-19</b>	<b>C3-WWTP-MW- DUP01</b>	<b>RPD</b>
<b>Sample Date</b>		11/12/09	11/12/09	
<b>Sample Type</b>		N	FD	
<b>Analyte</b>	<b>USEPA RSL Tapwater</b>			
<b>Volatile Organic Compounds (8260C) (µg/L)</b>				
Carbon disulfide	1,000	0.6 J	2 U	107.7%
<b>Semi-Volatile Organic Compounds (8260C) (µg/L)</b>				
Benzo[a]anthracene	0.029	0.01 J	0.24 U	71%
Benzo[a]pyrene	0.0029	0.012 J	0.023 U	62.9%
Benzo[b]fluoranthene	0.029	0.012 J	0.022 U	58.8%
Benzo[g,h,i]perylene	1,100	0.01 J	0.023 U	78.8%
Chrysene	2.9	0.012 J	0.021 U	54.5%
Dibenz[a,h]anthracene	0.0029	0.011 J	0.021 U	62.5%
Fluoranthene	1,500	0.0093 J	0.021 U	77.2%
Indeno[1,2,3-c,d]pyrene	0.029	0.012 J	0.022 U	58.8%
Pyrene	1,100	0.012 J	0.021 U	54.5%
<b>Metals (6010) (mg/L)</b>				
Beryllium	0.073	0.41 U	0.14 J	98.2%
Cobalt	0.011	0.74 J	0.5 J	38.7%
Lead		2.6 J	4.7 J	57.5%
Selenium	0.18	4.5 J	2.4 J	60.9%
Silver	0.18	1 J	3.2 U	104.8%
Vanadium	0.18	2.4 J	1.8 J	28.6%
<p><i>Legend</i>                      USEPA RSL = USEPA Regional Screening Level for tap water (December 2009). One-tenth of the RSL for non-carcinogenic chemicals (except for lead) is used for comparison.                      Yellow shading = Exceeds 20% RPD                      N = Normal Sample                      FD = Field Duplicate                      RPD = Relative Percent Difference                      J = Estimated value data qualifier                      U = The sample was analyzed for but not detected above the sample reporting limit. Reporting limit values are associated with non-detects.                      mg/L = milligrams per liter                      µg/L = micrograms per liter</p>				

**Table 5-8. Surface Soil Analytical Results Above Project Sensitivity Objectives**

Sample Name	C3-WWTP-SO-04-0.5	C3-WWTP-SO-B(+50)500-0.5	C3-WWTP-SO-B(+50)600-0.5	C3-WWTP-SO-BP03-0.5	C3-WWTP-SO-BP04-0.5	C3-WWTP-SO-BP05-0.5	C3-WWTP-SO-BP06-0.5	C3-WWTP-SO-BP07-0.5	C3-WWTP-SO-BP08-0.5	C3-WWTP-SO-BP09-0.5	C3-WWTP-SO-BP12-0.5	C3-WWTP-SO-C(+50)300-0.5	C3-WWTP-SO-C(+50)600-0.5	C3-WWTP-SO-C400-0.5	C3-WWTP-SO-C400A-0.5	C3-WWTP-SO-C700-0.5	
Sample Depth (ft bgs)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
Sample Date	2009-07-10	07/10/09	07/08/09	07/10/09	07/10/09	07/10/09	07/20/09	07/08/09	07/08/09	07/21/09	07/20/09	07/10/09	07/08/09	07/10/09	07/20/09	07/08/09	
Parent	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Analyte	USEPA RSL																
<b>Volatile Organic Compounds (8260C) (µg/kg)</b>																	
1,2,3-Trichloropropane	5.0	< 5.1J	< 7.6J		< 9.3J	< 15J	< 11J										
1,2-Dibromo-3-chloropropane	5.4		< 7.6J		< 9.3J	< 15J	< 11J										
<b>Semi-Volatile Organic Compounds (8270C) (µg/kg)</b>																	
1,2-Diphenylhydrazine	610					< 1,100	< 850							< 720			
3,3-Dichlorobenzidine	1,100					< 2,200	< 1,700							< 1,400			
4,6-Dinitro-2-methyl phenol	610	< 890	< 920	< 750		< 2,200	< 1,700	< 780	< 800	< 820		< 760	< 940	< 1,400	< 790	< 770	< 790
Bis(2-chloroethyl) ether	210	< 440	< 460	< 380		< 1,100	< 850	< 390	< 400	< 410		< 380	< 470	< 720	< 400	< 380	< 390
Hexachlorobenzene	300	< 440	< 460	< 380		< 1,100	< 850	< 390	< 400	< 410		< 380	< 470	< 720	< 400	< 380	< 390
n-Nitrosodimethylamine	2.3	< 440	< 460	< 380	< 200	< 1,100	< 850	< 390	< 400	< 410	< 160	< 380	< 470	< 720	< 400	< 380	< 390
n-Nitrosodi-n-propylamine	69	< 440	< 460	< 380	< 95	< 1,100	< 850	< 390	< 400	< 410	< 75	< 380	< 470	< 720	< 400	< 380	< 390
Pentachlorophenol	3,000	< 890															
<b>PAH (8270C) (µg/kg)</b>																	
Benzo[a]anthracene	150	< 440	< 460	< 380	< 460	< 1,100	< 850	< 390	< 400	< 410	< 370	< 380	< 470		< 400	< 380	< 390
Benzo[a]pyrene	15	< 440	< 460	< 380	< 400	< 1,100	< 850	< 390	< 400	< 410	< 320	< 380	< 470		< 400	< 380	< 390
Benzo[b]fluoranthene	150	< 440	< 460	< 380		< 1,100	< 850	< 390	< 400	< 410		< 380	< 470		< 400	< 380	< 390
Dibenz[a,h]anthracene	15	< 440	< 460	< 380	< 65	< 1,100	< 850	< 390	< 400	< 410	< 51	< 380	< 470		< 400	< 380	< 390
Indeno[1,2,3-c,d]pyrene	150	< 440	< 460	< 380		< 1,100	< 850	< 390	< 400	< 410		< 380	< 470		< 400	< 380	< 390

*Legend*  
 USEPA RSL = USEPA Regional Screening Level for residential site use. One-tenth of the RSL for non-carcinogenic chemicals (except for lead) is used for comparison.  
 Yellow shading and bold text = Analyte concentration exceeds USEPA RSL  
 Blank cell = Analyte not detected above screening criteria  
 N = Normal Sample  
 FD = Field Duplicate  
 J = Estimated value data qualifier  
 µg/kg = micrograms per kilogram  
 ft bgs = feet below ground surface  
 < - the sample was analyzed for but not detected above the sample reporting limit. Reporting limit values are associated with non-detects.

**Table 5-8. Surface Soil Analytical Results Above Project Sensitivity Objectives (Cont.)**

Sample Name	C3-WWTP-SO-D(+50)300-0.5	C3-WWTP-SO-D400-0.5	C3-WWTP-SO-D500-0.5	C3-WWTP-SO-D700-0.5	C3-WWTP-SO-DUP-01	C3-WWTP-SO-DUP-02	C3-WWTP-SO-DUP-03	C3-WWTP-SO-DUP-04	C3-WWTP-SO-DUP-05	C3-WWTP-SO-DUP-06	C3-WWTP-SO-DUP-07	C3-WWTP-SO-E(+50)300-0.5	C3-WWTP-SO-E(+50)600-0.5	C3-WWTP-SO-E400-0.5	C3-WWTP-SO-E500-0.5	C3-WWTP-SO-E700-0.5
Sample Depth (ft bgs)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Sample Date	07/10/09	07/10/09	07/20/09	07/21/09	07/08/09	07/09/09	07/09/09	07/09/09	07/10/09	07/10/09	07/20/09	07/10/09	07/10/09	07/09/09	07/09/09	07/21/09
Parent	N	N	N	N	FD	N	N	N	N	N						
Analyte	USEPA RSL															
<b>Volatile Organic Compounds (8260C) (µg/kg)</b>																
1,2,3-Trichloropropane	5.0								<b>&lt; 5.1J</b>				<b>&lt; 9.7J</b>	<b>&lt; 16J</b>		
1,2-Dibromo-3-chloropropane	5.4												<b>&lt; 9.7J</b>	<b>&lt; 16J</b>		
<b>Semi-Volatile Organic Compounds (8270C) (µg/kg)</b>																
1,2-Diphenylhydrazine	610												<b>&lt; 770</b>	<b>&lt; 1,400</b>		
3,3-Dichlorobenzidine	1,100												<b>&lt; 1,500</b>	<b>&lt; 2,700</b>		
4,6-Dinitro-2-methyl phenol	610	<b>&lt; 840</b>	<b>&lt; 800</b>	<b>&lt; 780</b>		<b>&lt; 810</b>	<b>&lt; 750</b>			<b>&lt; 770</b>		<b>&lt; 760</b>	<b>&lt; 1,500</b>	<b>&lt; 2,700</b>		
Bis(2-chloroethyl) ether	210	<b>&lt; 420</b>	<b>&lt; 400</b>	<b>&lt; 390</b>		<b>&lt; 400</b>	<b>&lt; 380</b>			<b>&lt; 380</b>		<b>&lt; 380</b>	<b>&lt; 770</b>	<b>&lt; 1,400</b>		
Hexachlorobenzene	300	<b>&lt; 420</b>	<b>&lt; 400</b>	<b>&lt; 390</b>		<b>&lt; 400</b>	<b>&lt; 380</b>			<b>&lt; 380</b>		<b>&lt; 380</b>	<b>&lt; 770</b>	<b>&lt; 1,400</b>		
n-Nitrosodimethylamine	2.3	<b>&lt; 420</b>	<b>&lt; 400</b>	<b>&lt; 390</b>	<b>&lt; 160</b>	<b>&lt; 400</b>	<b>&lt; 380</b>	<b>&lt; 160</b>	<b>&lt; 170</b>	<b>&lt; 380</b>	<b>&lt; 210</b>	<b>&lt; 380</b>	<b>&lt; 770</b>	<b>&lt; 1,400</b>	<b>&lt; 170</b>	<b>&lt; 160</b>
n-Nitrosodi-n-propylamine	69	<b>&lt; 420</b>	<b>&lt; 400</b>	<b>&lt; 390</b>	<b>&lt; 75</b>	<b>&lt; 400</b>	<b>&lt; 380</b>	<b>&lt; 76</b>	<b>&lt; 78</b>	<b>&lt; 380</b>	<b>&lt; 99</b>	<b>&lt; 380</b>	<b>&lt; 770</b>	<b>&lt; 1,400</b>	<b>&lt; 80</b>	<b>&lt; 76</b>
Pentachlorophenol	3,000													<b>&lt; 2,700</b>		
<b>PAH (8270C) (µg/kg)</b>																
Benzo[a]anthracene	150	<b>&lt; 420</b>	<b>&lt; 400</b>	<b>&lt; 390</b>	<b>&lt; 360</b>	<b>&lt; 400</b>	<b>&lt; 380</b>	<b>&lt; 370</b>	<b>&lt; 380</b>	<b>&lt; 380</b>	<b>&lt; 480</b>	<b>&lt; 380</b>	<b>&lt; 770</b>	<b>&lt; 1,400</b>	<b>&lt; 390</b>	<b>&lt; 370</b>
Benzo[a]pyrene	15	<b>&lt; 420</b>	<b>&lt; 400</b>	<b>&lt; 390</b>	<b>&lt; 320</b>	<b>&lt; 400</b>	<b>&lt; 380</b>	<b>&lt; 320</b>	<b>&lt; 330</b>	<b>&lt; 380</b>	<b>&lt; 420</b>	<b>&lt; 380</b>	<b>&lt; 770</b>	<b>&lt; 1,400</b>	<b>&lt; 340</b>	<b>&lt; 320</b>
Benzo[b]fluoranthene	150	<b>&lt; 420</b>	<b>&lt; 400</b>	<b>&lt; 390</b>		<b>&lt; 400</b>	<b>&lt; 380</b>			<b>&lt; 380</b>		<b>&lt; 380</b>	<b>&lt; 770</b>	<b>&lt; 1,400</b>		
Dibenz[a,h]anthracene	15	<b>&lt; 420</b>	<b>&lt; 400</b>	<b>&lt; 390</b>	<b>&lt; 51</b>	<b>&lt; 400</b>	<b>&lt; 380</b>	<b>&lt; 52</b>	<b>&lt; 54</b>	<b>&lt; 380</b>	<b>&lt; 68</b>	<b>&lt; 380</b>	<b>&lt; 770</b>	<b>&lt; 1,400</b>	<b>&lt; 54</b>	<b>&lt; 52</b>
Indeno[1,2,3-c,d]pyrene	150	<b>&lt; 420</b>	<b>&lt; 400</b>	<b>&lt; 390</b>		<b>&lt; 400</b>	<b>&lt; 380</b>			<b>&lt; 380</b>		<b>&lt; 380</b>	<b>&lt; 770</b>	<b>&lt; 1,400</b>		

*Legend*  
 USEPA RSL = USEPA Regional Screening Level for residential site use. One-tenth of the RSL for non-carcinogenic chemicals (except for lead) is used for comparison.  
 Yellow shading and bold text = Analyte concentration exceeds USEPA RSL  
 Blank cell = Analyte not detected above screening criteria  
 N = Normal Sample  
 FD = Field Duplicate  
 J = Estimated value data qualifier  
 µg/kg = micrograms per kilogram  
 ft bgs = feet below ground surface  
 < - the sample was analyzed for but not detected above the sample reporting limit. Reporting limit values are associated with non-detects.

**Table 5-8. Surface Soil Analytical Results Above Project Sensitivity Objectives (Cont.)**

Sample Name	C3-WWTP-SO-F(+50)300-0.5	C3-WWTP-SO-F(+50)600-0.5	C3-WWTP-SO-F400-0.5	C3-WWTP-SO-F500-0.5	C3-WWTP-SO-F700-0.5	C3-WWTP-SO-G400-0.5	C3-WWTP-SO-G500-0.5	C3-WWTP-SO-G700-0.5	C3-WWTP-SO-TNT-B0-0.5	C3-WWTP-SO-TNT-B200-0.5	C3-WWTP-SO-TNT-B510-0.5	C3-WWTP-SO-TNT-C640-0.5	C3-WWTP-SO-TNT-D0-0.5	C3-WWTP-SO-TNT-D200-0.5	C3-WWTP-SO-TNT-D510-0.5	C3-WWTP-SO-TNT-E640-0.5
Sample Depth (ft bgs)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Sample Date	07/08/09	07/09/09	07/09/09	07/09/09	07/09/09	07/08/09	07/08/09	07/09/09	07/20/09	07/20/09	07/09/09	07/09/09	07/20/09	07/20/09	07/09/09	07/09/09
Parent	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Analyte	USEPA RSL															
<b>Volatile Organic Compounds (8260C) (µg/kg)</b>																
1,2,3-Trichloropropane	5.0				<b>&lt; 5.4 R</b>					<b>&lt; 7.6 R</b>						
1,2-Dibromo-3-chloropropane	5.4				<b>&lt; 5.4 R</b>					<b>&lt; 7.6 R</b>						
<b>Semi-Volatile Organic Compounds (8270C) (µg/kg)</b>																
1,2-Diphenylhydrazine	610															
3,3-Dichlorobenzidine	1,100															
4,6-Dinitro-2-methyl phenol	610	<b>&lt; 810</b>	<b>&lt; 800</b>	<b>&lt; 870</b>	<b>&lt; 800</b>	<b>&lt; 760</b>	<b>&lt; 810</b>	<b>&lt; 800</b>	<b>&lt; 780</b>	<b>&lt; 770</b>	<b>&lt; 770</b>	<b>&lt; 770</b>	<b>&lt; 770</b>	<b>&lt; 780</b>	<b>&lt; 760</b>	<b>&lt; 760</b>
Bis(2-chloroethyl) ether	210	<b>&lt; 410</b>	<b>&lt; 400</b>	<b>&lt; 440</b>	<b>&lt; 400</b>	<b>&lt; 380</b>	<b>&lt; 400</b>	<b>&lt; 400</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 380</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 380</b>	<b>&lt; 370</b>
Hexachlorobenzene	300	<b>&lt; 410</b>	<b>&lt; 400</b>	<b>&lt; 440</b>	<b>&lt; 400</b>	<b>&lt; 380</b>	<b>&lt; 400</b>	<b>&lt; 400</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 380</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 380</b>	<b>&lt; 370</b>
n-Nitrosodimethylamine	2.3	<b>&lt; 410</b>	<b>&lt; 400</b>	<b>&lt; 440</b>	<b>&lt; 400</b>	<b>&lt; 380</b>	<b>&lt; 400</b>	<b>&lt; 400</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 380</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 380</b>	<b>&lt; 370</b>
n-Nitrosodi-n-propylamine	69	<b>&lt; 410</b>	<b>&lt; 400</b>	<b>&lt; 440</b>	<b>&lt; 400</b>	<b>&lt; 380</b>	<b>&lt; 400</b>	<b>&lt; 400</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 380</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 380</b>	<b>&lt; 370</b>
Pentachlorophenol	3,000															
<b>PAH (8270C) (µg/kg)</b>																
Benzo[a]anthracene	150	<b>&lt; 410</b>	<b>&lt; 400</b>	<b>&lt; 440</b>	<b>&lt; 400</b>	<b>&lt; 380</b>	<b>&lt; 400</b>	<b>&lt; 400</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 380</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 380</b>	<b>&lt; 380</b>
Benzo[a]pyrene	15	<b>&lt; 410</b>	<b>&lt; 400</b>	<b>&lt; 440</b>	<b>&lt; 400</b>	<b>&lt; 380</b>	<b>&lt; 400</b>	<b>&lt; 400</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 380</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 380</b>	<b>&lt; 370</b>
Benzo[b]fluoranthene	150	<b>&lt; 410</b>	<b>&lt; 400</b>	<b>&lt; 440</b>	<b>&lt; 400</b>	<b>&lt; 380</b>	<b>&lt; 400</b>	<b>&lt; 400</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 380</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 380</b>	<b>&lt; 370</b>
Dibenz[a,h]anthracene	15	<b>&lt; 410</b>	<b>&lt; 400</b>	<b>&lt; 440</b>	<b>&lt; 400</b>	<b>&lt; 380</b>	<b>&lt; 400</b>	<b>&lt; 400</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 380</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 380</b>	<b>&lt; 370</b>
Indeno[1,2,3-c,d]pyrene	150	<b>&lt; 410</b>	<b>&lt; 400</b>	<b>&lt; 440</b>	<b>&lt; 400</b>	<b>&lt; 380</b>	<b>&lt; 400</b>	<b>&lt; 400</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 380</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 380</b>	<b>&lt; 370</b>
<p><i>Legend</i>                      USEPA RSL = USEPA Regional Screening Level for residential site use. One-tenth of the RSL for non-carcinogenic chemicals (except for lead) is used for comparison.                      Yellow shading and bold text = Analyte concentration exceeds USEPA RSL                      Blank cell = Analyte not detected above screening criteria                      N = Normal Sample                      FD = Field Duplicate                      J = Estimated value data qualifier                      µg/kg = micrograms per kilogram                      ft bgs = feet below ground surface                      &lt; - the sample was analyzed for but not detected above the sample reporting limit. Reporting limit values are associated with non-detects.</p>																

**Table 5-9. Subsurface Soil Analytical Results Above Project Sensitivity Objectives**

Sample Name			C3-WWTP-SO-04-11	C3-WWTP-SO-B(+50)500-10.5	C3-WWTP-SO-B(+50)500-15	C3-WWTP-SO-B(+50)600-8	C3-WWTP-SO-BP07-11.5	C3-WWTP-SO-BP08-11	C3-WWTP-SO-BP08A-16	C3-WWTP-SO-BP09-15	C3-WWTP-SO-BP12-13	C3-WWTP-SO-C(+50)300-11	C3-WWTP-SO-C(+50)600-8.5
Sample Depth (ft bgs)			11	10.5	15	8	11.5	11	16	15	13	11	8.5
Sample Date			07/10/09	07/10/09	07/20/09	07/08/09	07/08/09	07/08/09	07/20/09	07/21/09	07/20/09	07/10/09	07/08/09
Parent			N	N	N	N	N	N	N	N	N	N	N
Analyte	USEPA RSL	SSL											
<b>Volatile Organic Compounds (8260C) (µg/kg)</b>													
1,2,3-Trichloropropane	5.0		<b>&lt; 5.1J</b>									<b>&lt; 5.3</b>	<b>&lt; 7.2</b>
1,2-Dibromo-3-chloropropane	5.4												<b>&lt; 7.2J</b>
<b>Semi-Volatile Organic Compounds (8270C) (µg/kg)</b>													
4,6-Dinitro-2-methyl phenol	610		<b>&lt; 830</b>	<b>&lt; 800</b>	<b>&lt; 800</b>	<b>&lt; 790</b>	<b>&lt; 780</b>	<b>&lt; 770</b>	<b>&lt; 800</b>		<b>&lt; 820</b>	<b>&lt; 780</b>	<b>&lt; 740</b>
Bis(2-chloroethyl) ether	210		<b>&lt; 410</b>	<b>&lt; 400</b>	<b>&lt; 400</b>	<b>&lt; 400</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 400</b>		<b>&lt; 410</b>	<b>&lt; 390</b>	<b>&lt; 370</b>
Hexachlorobenzene	300	10,900	<b>&lt; 410</b>	<b>&lt; 400</b>	<b>&lt; 400</b>	<b>&lt; 400</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 400</b>		<b>&lt; 410</b>	<b>&lt; 390</b>	<b>&lt; 370</b>
n-Nitrosodimethylamine	2.3		<b>&lt; 410</b>	<b>&lt; 400</b>	<b>&lt; 400</b>	<b>&lt; 400</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 400</b>	<b>&lt; 170</b>	<b>&lt; 410</b>	<b>&lt; 390</b>	<b>&lt; 370</b>
n-Nitrosodi-n-propylamine	69		<b>&lt; 410</b>	<b>&lt; 400</b>	<b>&lt; 400</b>	<b>&lt; 400</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 400</b>	<b>&lt; 80</b>	<b>&lt; 410</b>	<b>&lt; 390</b>	<b>&lt; 370</b>
Phenol	1,800,000	251	<b>&lt; 410</b>	<b>&lt; 400</b>	<b>&lt; 400</b>	<b>&lt; 400</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 400</b>		<b>&lt; 410</b>	<b>&lt; 390</b>	<b>&lt; 370</b>
<b>PAH (8270C) (µg/kg)</b>													
Benzo[a]anthracene	150	3,940	<b>&lt; 410</b>	<b>&lt; 400</b>	<b>&lt; 400</b>	<b>&lt; 400</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 400</b>	<b>&lt; 390</b>	<b>&lt; 410</b>	<b>&lt; 390</b>	<b>&lt; 370</b>
Benzo[a]pyrene	15		<b>&lt; 410</b>	<b>&lt; 400</b>	<b>&lt; 400</b>	<b>&lt; 400</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 400</b>	<b>&lt; 340</b>	<b>&lt; 410</b>	<b>&lt; 390</b>	<b>&lt; 370</b>
Benzo[b]fluoranthene	150	12,200	<b>&lt; 410</b>	<b>&lt; 400</b>	<b>&lt; 400</b>	<b>&lt; 400</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 400</b>		<b>&lt; 410</b>	<b>&lt; 390</b>	<b>&lt; 370</b>
Dibenz[a,h]anthracene	15	54,600	<b>&lt; 410</b>										
Indeno[1,2,3-c,d]pyrene	150	34,400	<b>&lt; 410</b>	<b>&lt; 400</b>	<b>&lt; 400</b>	<b>&lt; 400</b>	<b>&lt; 390</b>	<b>&lt; 390</b>	<b>&lt; 400</b>		<b>&lt; 410</b>	<b>&lt; 390</b>	<b>&lt; 370</b>
<b>Explosives (8330) (µg/kg)</b>													
2,4,6-Trinitrotoluene	190	0.0459	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.099</b>
2,4-Dinitrotoluene	1.6	0.00954	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.099</b>
2-Amino-4,6-dinitrotoluene	15	0.0441	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.099</b>
Nitrobenzene	4.8	0.000421	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.10</b>	<b>&lt; 0.099</b>
p-Nitrotoluene	30	0.00818	<b>&lt; 0.20</b>	<b>&lt; 0.20</b>	<b>&lt; 0.20</b>	<b>&lt; 0.20</b>	<b>&lt; 0.20</b>	<b>&lt; 0.20</b>	<b>&lt; 0.20</b>	<b>&lt; 0.20</b>	<b>&lt; 0.20</b>	<b>&lt; 0.20</b>	<b>&lt; 0.20</b>

*Legend*  
 USEPA RSL = USEPA Regional Screening Level for residential site use. One-tenth of the RSL for non-carcinogenic chemicals (except for lead) is used for comparison.  
 SSL = Site-Specific Screening Levels  
 Yellow shading and bold text = Analyte concentration exceeds USEPA RSL  
 Green shading and bold text = Reporting limit exceeds SSL  
 Blank cell = Analyte not detected above screening criteria  
 N = Normal Sample  
 FD = Field Duplicate  
 J = Estimated value data qualifier  
 µg/kg = micrograms per kilogram  
 ft bgs = feet below ground surface  
 < - the sample was analyzed for but not detected above the sample reporting limit. Reporting limit values are associated with non-detects.

**Table 5-9. Subsurface Soil Analytical Results Above Project Sensitivity Objectives (cont.)**

Sample Name		C3-WWTP-SO-C400-12	C3-WWTP-SO-C400A-14	C3-WWTP-SO-C700-14	C3-WWTP-SO-D(+50)300-11.5	C3-WWTP-SO-D(+50)600-15	C3-WWTP-SO-D(+50)600-2	C3-WWTP-SO-D400-11.5	C3-WWTP-SO-D500-14	C3-WWTP-SO-D700-15	C3-WWTP-SO-DUP-8	C3-WWTP-SO-DUP-9
Sample Depth (ft bgs)		12	14	14	11.5	15	2	11.5	14	15	20	15
Sample Date		07/10/09	07/20/09	07/08/09	07/10/09	07/21/09	07/21/09	07/10/09	07/20/09	07/21/09	07/21/09	07/21/09
Parent		N	N	N	N	N	N	N	N	N	FD	FD
Analyte	USEPA RSL	SSL										
<b>Volatile Organic Compounds (8260C) (µg/kg)</b>												
1,2,3-Trichloropropane	5		< 5.1J								< 5.7J	
1,2-Dibromo-3-chloropropane	5.4										< 5.7J	
<b>Semi-Volatile Organic Compounds (8270C) (µg/kg)</b>												
4,6-Dinitro-2-methyl phenol	610		< 810	< 820	< 780	< 790			< 800	< 820		
Bis(2-chloroethyl) ether	210		< 410	< 410	< 390	< 400			< 400	< 410		
Hexachlorobenzene	300	10,900	< 410	< 410	< 390	< 400			< 400	< 410		
n-Nitrosodimethylamine	2.3		< 410	< 410	< 390	< 400	< 160	< 160	< 400	< 410	< 170	< 170
n-Nitrosodi-n-propylamine	69		< 410	< 410	< 390	< 400	< 78	< 75	< 400	< 410	< 79	< 74
Phenol	1,800,000	251	< 410	< 410	< 390	< 400			< 400	< 410		
<b>PAH (8270C) (µg/kg)</b>												
Benzo[a]anthracene	150	3,940	< 410	< 410	< 390	< 400	< 380	< 360	< 400	< 410	< 380	< 360
Benzo[a]pyrene	15		< 410	< 410	< 390	< 400	< 330	< 320	< 400	< 410	< 340	< 310
Benzo[b]fluoranthene	150	12,200	< 410	< 410	< 390	< 400			< 400	< 410		
Dibenz[a,h]anthracene	15	54,600										
Indeno[1,2,3-c,d]pyrene	150	34,400	< 410	< 410	< 390	< 400			< 400	< 410		
<b>Explosives (8330) (µg/kg)</b>												
2,4,6-Trinitrotoluene	190	0.0459	< 0.099	< 0.099	< 0.10	< 0.10	< 0.099	< 0.099	< 0.10	< 0.10	< 0.10	< 0.10
2,4-Dinitrotoluene	1.6	0.00954	< 0.099	< 0.099	< 0.10	< 0.10	< 0.099	< 0.099	< 0.10	< 0.10	< 0.10	< 0.10
2-Amino-4,6-dinitrotoluene	15	0.0441	< 0.099	< 0.099	< 0.10	< 0.10	< 0.099	< 0.099	< 0.10	< 0.10	< 0.10	< 0.10
Nitrobenzene	4.8	0.000421	< 0.099	< 0.099	< 0.10	< 0.10	< 0.099	< 0.099	< 0.10	< 0.10	< 0.10	< 0.10
p-Nitrotoluene	30	0.00818	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20

*Legend*  
 USEPA RSL = USEPA Regional Screening Level for residential site use. One-tenth of the RSL for non-carcinogenic chemicals (except for lead) is used for comparison.  
 SSL = Site-Specific Screening Levels  
 Yellow shading and bold text = Analyte concentration exceeds USEPA RSL  
 Green shading and bold text = Reporting limit exceeds SSL  
 Blank cell = Analyte not detected above screening criteria  
 N = Normal Sample  
 FD = Field Duplicate  
 J = Estimated value data qualifier  
 µg/kg = micrograms per kilogram  
 ft bgs = feet below ground surface  
 < - the sample was analyzed for but not detected above the sample reporting limit. Reporting limit values are associated with non-detects.

**Table 5-9. Subsurface Soil Analytical Results Above Project Sensitivity Objectives (cont.)**

Sample Name			C3-WWTP-SO-E(+50)300-3	C3-WWTP-SO-E(+50)600-7	C3-WWTP-SO-E400-11	C3-WWTP-SO-E500-16	C3-WWTP-SO-E700-16	C3-WWTP-SO-F(+50)300-11	C3-WWTP-SO-F(+50)600-6	C3-WWTP-SO-F400-11	C3-WWTP-SO-F500-13.5	C3-WWTP-SO-F700-12	C3-WWTP-SO-G400-11
Sample Depth (ft bgs)			3	7	11	16	16	11	6	11	13.5	12	11
Sample Date			07/10/09	07/10/09	07/09/09	07/09/09	07/21/09	07/08/09	07/09/09	07/09/09	07/09/09	07/09/09	07/08/09
Parent			N	N	N	N	N	N	N	N	N	N	N
Analyte	USEPA RSL	SSL											
<b>Volatile Organic Compounds (8260C) (µg/kg)</b>													
1,2,3-Trichloropropane	5.0			< 6.0J									
1,2-Dibromo-3-chloropropane	5.4			< 6.0J									
<b>Semi-Volatile Organic Compounds (8270C) (µg/kg)</b>													
4,6-Dinitro-2-methyl phenol	610			< 810				< 810	< 770	< 830	< 670	< 790	< 800
Bis(2-chloroethyl) ether	210			< 400				< 410	< 390	< 420	< 330	< 390	< 400
Hexachlorobenzene	300	10,900		< 400				< 410	< 390	< 420	< 330	< 390	< 400
n-Nitrosodimethylamine	2.3		< 170	< 400	< 160	< 170	< 150	< 410	< 390	< 420	< 330	< 390	< 400
n-Nitrosodi-n-propylamine	69		< 79	< 400	< 78	< 82	< 69	< 410	< 390	< 420	< 330	< 390	< 400
Phenol	1,800,000	251		< 400				< 410	< 390	< 420	< 330	< 390	< 400
<b>PAH (8270C) (µg/kg)</b>													
Benzo[a]anthracene	150	3,940		< 380	< 400	< 380	< 400	< 340	< 410	< 390	< 420	< 330	< 390
Benzo[a]pyrene	15			< 330	< 400	< 330	< 350	< 290	< 410	< 390	< 420	< 330	< 390
Benzo[b]fluoranthene	150	12,200		< 400				< 410	< 390	< 420	< 330	< 390	< 400
Dibenz[a,h]anthracene	15	54,600											
Indeno[1,2,3-c,d]pyrene	150	34,400		< 400				< 410	< 390	< 420	< 330	< 390	< 400
<b>Explosives (8330) (µg/kg)</b>													
2,4,6-Trinitrotoluene	190	0.0459	< 0.10	< 0.098	< 0.10	< 0.10	< 0.099	< 0.10	< 0.098	< 0.099	< 0.10	< 0.10	< 0.10
2,4-Dinitrotoluene	1.6	0.00954	< 0.10	< 0.098	< 0.10	< 0.10	< 0.099	< 0.10	< 0.098	< 0.099	< 0.10	< 0.10	< 0.10
2-Amino-4,6-dinitrotoluene	15	0.0441	< 0.10	< 0.098	< 0.10	< 0.10	< 0.099	< 0.10	< 0.098	< 0.099	< 0.10	< 0.10	< 0.10
Nitrobenzene	4.8	0.000421	< 0.10	< 0.098	< 0.10	< 0.10	< 0.099	< 0.10	< 0.098	< 0.099	< 0.10	< 0.10	< 0.10
p-Nitrotoluene	30	0.00818	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20

*Legend*  
 USEPA RSL = USEPA Regional Screening Level for residential site use. One-tenth of the RSL for non-carcinogenic chemicals (except for lead) is used for comparison.  
 SSL = Site-Specific Screening Levels  
 Yellow shading and bold text = Analyte concentration exceeds USEPA RSL  
 Green shading and bold text = Reporting limit exceeds SSL  
 Blank cell = Analyte not detected above screening criteria  
 N = Normal Sample  
 FD = Field Duplicate  
 J = Estimated value data qualifier  
 µg/kg = micrograms per kilogram  
 ft bgs = feet below ground surface  
 < - the sample was analyzed for but not detected above the sample reporting limit. Reporting limit values are associated with non-detects.

**Table 5-9. Subsurface Soil Analytical Results Above Project Sensitivity Objectives (cont.)**

Sample Name			C3-WWTP-SO-G500-7	C3-WWTP-SO-G700-12	C3-WWTP-SO-TNT-B0-16	C3-WWTP-SO-TNT-B200-12	C3-WWTP-SO-TNT-B510-15	C3-WWTP-SO-TNT-B510-19	C3-WWTP-SO-TNT-C640-14	C3-WWTP-SO-TNT-C640-20	C3-WWTP-SO-TNT-D0-14	C3-WWTP-SO-TNT-D200-18	C3-WWTP-SO-TNT-D510-14	C3-WWTP-SO-TNT-E640-14
Sample Depth (ft bgs)			7	12	16	12	15	19	14	20	14	18	14	14
Sample Date			07/08/09	07/09/09	07/20/09	07/20/09	07/09/09	07/20/09	07/09/09	07/21/09	07/20/09	07/20/09	07/09/09	07/09/09
Parent			N	N	N	N	N	N	N	N	N	N	N	N
Analyte	USEPA RSL	SSL												
<b>Volatile Organic Compounds (8260C) (µg/kg)</b>														
1,2,3-Trichloropropane	5.0		< 6.3							< 4.5 R			< 5.4	
1,2-Dibromo-3-chloropropane	5.4		< 6.3J										< 5.4J	
<b>Semi-Volatile Organic Compounds (8270C) (µg/kg)</b>														
4,6-Dinitro-2-methyl phenol	610		< 820	< 930	< 810	< 770	< 780	< 800	< 780		< 820	< 790	< 780	< 780
Bis(2-chloroethyl) ether	210		< 410	< 470	< 410	< 380	< 390	< 400	< 390		< 410	< 400	< 390	< 390
Hexachlorobenzene	300	10,900	< 410	< 470	< 410	< 380	< 390	< 400	< 390		< 410	< 400	< 390	< 390
n-Nitrosodimethylamine	2.3		< 410	< 470	< 410	< 380	< 390	< 400	< 390	< 150	< 410	< 400	< 390	< 390
n-Nitrosodi-n-propylamine	69		< 410	< 470	< 410	< 380	< 390	< 400	< 390	< 73	< 410	< 400	< 390	< 390
Phenol	1,800,000	251	< 410	< 470	< 410	< 380	< 390	< 400	< 390		< 410	< 400	< 390	< 390
<b>PAH (8270C) (µg/kg)</b>														
Benzo[a]anthracene	150	3,940	< 410	< 470	< 410	< 380	< 390	< 400	< 390	< 350	< 410	< 400	< 390	< 390
Benzo[a]pyrene	15		< 410	< 470	< 410	< 380	< 390	< 400	< 390	< 310	< 410	< 400	< 390	< 390
Benzo[b]fluoranthene	150	12,200	< 410	< 470	< 410	< 380	< 390	< 400	< 390		< 410	< 400	< 390	< 390
Dibenz[a,h]anthracene	15	54,600												
Indeno[1,2,3-c,d]pyrene	150	34,400	< 410	< 470	< 410	< 380	< 390	< 400	< 390		< 410	< 400	< 390	< 390
<b>Explosives (8330) (µg/kg)</b>														
2,4,6-Trinitrotoluene	190	0.0459	< 0.10	< 0.10	< 0.099	< 0.10	< 0.098	< 0.099	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
2,4-Dinitrotoluene	1.6	0.00954	< 0.10	< 0.10	< 0.099	< 0.10	< 0.098	< 0.099	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
2-Amino-4,6-dinitrotoluene	15	0.0441	< 0.10	< 0.10	< 0.099	< 0.10	< 0.098	< 0.099	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Nitrobenzene	4.8	0.000421	< 0.10	< 0.10	< 0.099	< 0.10	< 0.098	< 0.099	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
p-Nitrotoluene	30	0.00818	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20

*Legend*  
 USEPA RSL = USEPA Regional Screening Level for residential site use. One-tenth of the RSL for non-carcinogenic chemicals (except for lead) is used for comparison.  
 SSL = Site-Specific Screening Levels  
 Yellow shading and bold text = Analyte concentration exceeds USEPA RSL  
 Green shading and bold text = Reporting limit exceeds SSL  
 Blank cell = Analyte not detected above screening criteria  
 N = Normal Sample  
 FD = Field Duplicate  
 J = Estimated value data qualifier  
 µg/kg = micrograms per kilogram  
 ft bgs = feet below ground surface  
 < - the sample was analyzed for but not detected above the sample reporting limit. Reporting limit values are associated with non-detects.

<b>Table 5-10. Groundwater Analytical Results Above Project Sensitivity Objectives</b>						
Sample Name			C3-WWTP-MW- BP14-20	C3-WWTP-MW- BP15-19	C3-WWTP-MW- BP16-18	C3-WWTP-MW- DUP01
Sample Depth (ft bgs)			14	15	16	15
Sample Date			11/12/09	11/12/09	11/12/09	11/12/09
Sample type			N	N	N	FD
Analyte	USEPA RSL Tapwater	NYSTOGS				
<b>Volatile Organic Compounds (8260C) (µg/L)</b>						
1,1,2,2-Tetrachloroethane	0.067		< 1	< 1	< 1	< 1
1,1,2-Trichloroethane	0.24		< 1.6	< 1.6	< 1.6	< 1.6
1,2-Dibromo-3-chloropropane	0.00032		< 1.5	< 1.5	< 1.5	< 1.5
1,2-Dichloroethane	0.15		< 1.1	< 1.1	< 1.1	< 1.1
1,2-Dichloropropane	0.39		< 1	< 1	< 1	< 1
1,4-Dichlorobenzene	0.43		< 1.6	< 1.6	< 1.6	< 1.6
Benzene	0.41		< 1	< 1	< 1	< 1
Bromodichloromethane	0.12			< 1	< 1	< 1
Carbon tetrachloride	0.20		< 1.3	< 1.3	< 1.3	< 1.3
Chloroform	0.19			< 1		< 1
cis-1,3-Dichloropropene	0.43		< 1	< 1	< 1	< 1
Dibromochloromethane	0.15		< 1	< 1	< 1	< 1
Tetrachloroethylene	0.11		< 1.3	< 1.3	< 1.3	< 1.3
trans-1,3-Dichloropropene	0.43		< 1	< 1	< 1	< 1
Vinyl chloride	0.016		< 1	< 1	< 1	< 1
<b>Semi-Volatile Organic Compounds (8260C) (µg/L)</b>						
2,2-Oxybis(1-chloropropane)	0.32		< 1	< 1	< 1	< 1
2-Nitrophenol	0.31		< 2	< 2.1	< 2	< 2.1
3,3-Dichlorobenzidine	0.15		< 9.9 J	< 10 J	< 10 J	< 10 J
4-Bromophenyl phenyl ether	0.32		< 1	< 1	< 1	< 1
4-Chlorophenyl phenyl ether	0.32		< 1	< 1	< 1	< 1
Bis(2-chloroethyl) ether	0.012		< 1	< 1	< 1	< 1
Hexachloro-1,3-butadiene	0.86		< 1	< 1	< 1	< 1
Hexachlorobenzene	0.042		< 1	< 1	< 1	< 1
N-nitrosodi-n-propylamine	0.0096		< 1	< 1	< 1	< 1
Pentachlorophenol	0.56		< 3	< 3	< 3 J	< 3
<b>PAH (8270C) (µg/L)</b>						
Benzo[a]pyrene	0.0029		< 0.022		< 0.022	< 0.023
Dibenz[a,h]anthracene	0.0029		< 0.02		< 0.02	< 0.021
<b>Pesticides (8081) (µg/L)</b>						
Aldrin	0.004		< 0.018	< 0.017	< 0.017	< 0.018
alpha-BHC	0.011		< 0.017	< 0.016	< 0.016	< 0.017
Chlordane	0.19		< 0.34	< 0.33	< 0.33	< 0.34
delta-BHC		0.008	< 0.018	< 0.017	< 0.017	< 0.018
Dieldrin	0.0042		< 0.019	< 0.018	< 0.018	< 0.019
Heptachlor epoxide	0.0074		< 0.022	< 0.021	< 0.021	< 0.022
Toxaphene	0.061		< 0.59	< 0.57	< 0.56	< 0.59
<b>PCB (8082) (µg/L)</b>						
PCB-1221	0.0068		< 0.31	< 0.3	< 0.31	< 0.3
PCB-1232	0.0068		< 0.48	< 0.47	< 0.48	< 0.47
PCB-1242	0.034		< 0.33	< 0.33	< 0.33	< 0.33
PCB-1248	0.034		< 0.4	< 0.4	< 0.41	< 0.4
PCB-1254	0.034		< 0.31	< 0.3	< 0.31	< 0.3
PCB-1260	0.034		< 0.39	< 0.39	< 0.4	< 0.39
<b>Explosives (8330) (µg/L)</b>						
2,4-dinitrotoluene	0.22		< 0.9	< 0.9	< 0.9	< 0.9
Nitrobenzene	0.12		< 1.2	< 1.2	< 1.2	< 1.2
o-Nitrotoluene	0.31		< 1.1	< 1.1	< 1.1	< 1.1
RDX	0.61		< 0.9	< 0.9	< 0.9	< 0.9
<b>Metals (6020A, 7470A, 7471A) (mg/L)</b>						
Arsenic	0.000045			< 0.0026	< 0.0026	< 0.0026
<p><i>Legend</i>                      USEPA RSL = USEPA Regional Screening Level for tap water (December 2009). One-tenth of the RSL for non-carcinogenic chemicals (except for lead) is used for comparison.                      NYSTOGS = New York State Technical and Operational Guidance Series (TOGS) 1.1.1 Ambient Water Quality Standards and Guidance Values. NYSTOGS value is presented only if a RSL is unavailable.                      Yellow shading and bold text = Analyte concentration exceeds USEPA RSL (or NYSTOGS if RSL is not available)                      Blank cell = Analyte not detected above screening criteria                      N = Normal Sample                      FD = Field Duplicate                      J = Estimated value data qualifier                      µg/L = micrograms per liter                      mg/L = milligrams per liter                      ft bgs = feet below ground surface                      &lt; - the sample was analyzed for but not detected above the sample reporting limit. Reporting limit values are associated with non-detects.</p>						

**Table 5-11. Surface Soil - Rejected Results**

Sample Name	C3-WWTP-SO-04-0.5	C3-WWTP-SO-B(+50)500-0.5	C3-WWTP-SO-B(+50)600-0.5	C3-WWTP-SO-BP04-0.5	C3-WWTP-SO-BP05-0.5	C3-WWTP-SO-BP07-0.5	C3-WWTP-SO-BP08-0.5	C3-WWTP-SO-C(+50)300-0.5	C3-WWTP-SO-C(+50)600-0.5	C3-WWTP-SO-C400-0.5	C3-WWTP-SO-C400A-0.5	C3-WWTP-SO-C700-0.5	C3-WWTP-SO-D(+50)300-0.5
Sample Depth (ft bgs)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Sample Date	07/10/09	07/10/09	07/08/09	07/10/09	07/10/09	07/08/09	07/08/09	07/10/09	07/08/09	07/10/09	07/20/09	07/08/09	07/10/09
Parent	N	N	N	N	N	N	N	N	N	N	N	N	N
Analyte	USEPA RSL												
<b>Volatile Organic Compounds (8260C) (µg/kg)</b>													
1,1,1,2-Tetrachloroethane	1,900											< 3.9 R	< 2.9 R
1,1,1-Trichloroethane	870,000											< 3.9 R	
1,1,2,2-Tetrachloroethane	560						< 4.1 R					< 3.9 R	< 2.9 R
1,1,2-Trichloroethane	1,100											< 3.9 R	
1,1-Dichloroethane	3,300											< 3.9 R	
1,1-Dichloroethene	24,000											< 3.9 R	< 2.9 R
1,1-Dichloropropene												< 3.9 R	< 2.9 R
1,2,3-Trichlorobenzene	4,900						< 4.1 R					< 3.9 R	< 2.9 R
1,2,3-Trichloropropane	5.0						< 4.1 R					< 3.9 R	< 2.9 R
1,2,4-Trimethylbenzene	6,200											< 3.9 R	< 2.9 R
1,2-Dibromo-3-chloropropane	5.4						< 4.1 R					< 3.9 R	< 2.9 R
1,2-Dibromoethane	34											< 3.9 R	< 2.9 R
1,2-Dichlorobenzene	190,000											< 3.9 R	< 2.9 R
1,2-Dichloroethane	430											< 3.9 R	< 2.9 R
1,2-Dichloropropane	890											< 3.9 R	< 2.9 R
1,3,5-Trimethylbenzene	78,000											< 3.9 R	< 2.9 R
1,3-Dichlorobenzene	190,000											< 3.9 R	< 2.9 R
1,3-Dichloropropane	160,000											< 3.9 R	< 2.9 R
1,4-Dichlorobenzene	2,400											< 3.9 R	< 2.9 R
2,2-Dichloropropane												< 3.9 R	
2-Butanone	2,800,000		< 15 R									< 7.8 R	< 5.9 R
2-Chlorotoluene	160,000											< 3.9 R	< 2.9 R
2-Hexanone	21,000											< 7.8 R	< 5.9 R
4-Chlorotoluene	550,000											< 3.9 R	< 2.9 R
4-Isopropyltoluene												< 3.9 R	< 2.9 R
4-Methyl-2-pentanone	530,000											< 7.8 R	< 5.9 R
Acetone	6,100,000												
Benzene	1,100											< 3.9 R	< 2.9 R
Bromobenzene	30,000											< 3.9 R	< 2.9 R
Bromochloromethane												< 3.9 R	
Bromodichloromethane	270											< 3.9 R	< 2.9 R
Bromoform	61,000											< 3.9 R	< 2.9 R
Bromomethane	730	< 10 R	< 15 R	< 6.9 R	< 30 R	< 22 R	< 7.5 R	< 4.1 R	< 9.8 R	< 9.8 R	< 7.7 R	< 7.8 R	< 9.6 R
Carbon disulfide	82,000											< 3.9 R	
Carbon tetrachloride	250											< 3.9 R	
Chlorobenzene	29,000											< 3.9 R	< 2.9 R
Chloroethane	1,500,000											< 7.8 R	
Chloroform	290											< 3.9 R	
Chloromethane	12,000											< 7.8 R	
cis-1,2-Dichloroethene	78,000											< 3.9 R	
cis-1,3-Dichloropropene	1,700											< 3.9 R	< 2.9 R
Cyclohexane	700,000											< 3.9 R	
Dibromochloromethane	680											< 3.9 R	< 2.9 R
Dibromomethane	2,500											< 3.9 R	< 2.9 R
Dichlorodifluoromethane	18,000											< 3.9 R	
Ethylbenzene	5,400											< 3.9 R	< 2.9 R
Freon 113	4,300,000											< 3.9 R	
Isopropylbenzene	210,000											< 3.9 R	< 2.9 R
m,p-Xylene	340,000											< 3.9 R	< 2.9 R
Methyl acetate	7,800,000											< 3.9 R	

**Table 5-11. Surface Soil - Rejected Results**

Sample Name	C3-WWTP-SO- 04-0.5	C3-WWTP-SO-B(+50)500-0.5	C3-WWTP-SO-B(+50)600-0.5	C3-WWTP-SO- BP04-0.5	C3-WWTP-SO- BP05-0.5	C3-WWTP-SO- BP07-0.5	C3-WWTP-SO- BP08-0.5	C3-WWTP-SO-C(+50)300-0.5	C3-WWTP-SO-C(+50)600-0.5	C3-WWTP-SO- C400-0.5	C3-WWTP-SO- C400A-0.5	C3-WWTP-SO- C700-0.5	C3-WWTP-SO-D(+50)300-0.5
Sample Depth (ft bgs)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Sample Date	07/10/09	07/10/09	07/08/09	07/10/09	07/10/09	07/08/09	07/08/09	07/10/09	07/08/09	07/10/09	07/20/09	07/08/09	07/10/09
Parent	N	N	N	N	N	N	N	N	N	N	N	N	N
Analyte	USEPA RSL												
<b>Volatile Organic Compounds (8260C) (µg/kg)</b>													
Methylcyclohexane												< 3.9 R	< 2.9 R
Methylene chloride	11,000											< 7.8 R	
n-Butylbenzene												< 3.9 R	< 2.9 R
N-propylbenzene	340,000											< 3.9 R	< 2.9 R
o-Xylene	380,000											< 3.9 R	< 2.9 R
Sec-butylbenzene												< 3.9 R	< 2.9 R
Styrene	630,000											< 3.9 R	< 2.9 R
tert-butyl methyl ether	43,000											< 3.9 R	< 2.9 R
Tert-butylbenzene												< 3.9 R	< 2.9 R
Tetrachloroethylene	55											< 3.9 R	< 2.9 R
Toluene	500,000											< 3.9 R	< 2.9 R
trans-1,2-Dichloroethene	15,000											< 3.9 R	
trans-1,3-Dichloropropene	1,700											< 3.9 R	< 2.9 R
Trichloroethene	2,800											< 3.9 R	< 2.9 R
Trichlorofluoromethane	79,000											< 3.9 R	
Vinyl acetate	97,000	< 10 R	< 15 R	< 6.9 R	< 30 R	< 22 R	< 7.5 R		< 9.8 R	< 9.8 R	< 7.7 R	7.8 R	< 5.9 R
Vinyl chloride	60											< 7.8 R	
<b>Semi-Volatile Organic Compounds (8270C) (µg/kg)</b>													
3,3-dichlorobenzidine	1,100												
<i>Legend</i> USEPA RSL = USEPA Regional Screening Level for residential site use. One-tenth of the RSL for non-carcinogenic chemicals is used for comparison. Blank cell = Analyte concentration not rejected N = Normal Sample R = Rejected µg/kg = micrograms per kilogram mg/kg = milligram per kilogram ft bgs = feet below ground surface U - the sample was analyzed for but not detected above the sample reporting limit. Reporting limit values are associated with non-detects.													

**Table 5-11. Surface Soil - Rejected Results (Cont.)**

Sample Name	C3-WWTP-SO- D400-0.5	C3-WWTP-SO- DUP-01	C3-WWTP-SO- DUP-02	C3-WWTP-SO- DUP-3	C3-WWTP-SO- DUP-4	C3-WWTP-SO- DUP-5	C3-WWTP-SO- E(+50)300-0.5	C3-WWTP-SO- E(+50)600-0.5	C3-WWTP-SO- E400-0.5	C3-WWTP-SO- E500-0.5	C3-WWTP-SO- F(+50)300-0.5	C3-WWTP-SO- F(+50)600-0.5	C3-WWTP-SO- F400-0.5
Sample Depth (ft bgs)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Sample Date	07/10/09	07/08/09	07/09/09	07/09/09	07/09/09	07/10/09	07/10/09	07/10/09	07/09/09	07/09/09	07/08/09	07/09/09	07/09/09
Parent	N	FD	FD	FD	FD	FD	N	N	N	N	N	N	N
Analyte	USEPA RSL												
<b>Volatile Organic Compounds (8260C) (µg/kg)</b>													
1,1,1,2-Tetrachloroethane	1,900												
1,1,1-Trichloroethane	870,000												
1,1,2,2-Tetrachloroethane	560											< 4.2 R	< 3.7 R
1,1,2-Trichloroethane	1,100												
1,1-Dichloroethane	3,300												
1,1-Dichloroethene	24,000												
1,1-Dichloropropene													
1,2,3-Trichlorobenzene	4,900											< 4.2 R	< 3.7 R
1,2,3-Trichloropropane	5.0											< 4.2 R	< 3.7 R
1,2,4-Trimethylbenzene	6,200												
1,2-Dibromo-3-chloropropane	5.4											< 4.2 R	< 3.7 R
1,2-Dibromoethane	34												
1,2-Dichlorobenzene	190,000												
1,2-Dichloroethane	430												
1,2-Dichloropropane	890												
1,3,5-Trimethylbenzene	78,000												
1,3-Dichlorobenzene	190,000												
1,3-Dichloropropane	160,000												
1,4-Dichlorobenzene	2,400												
2,2-Dichloropropane													
2-Butanone	2,800,000	< 7.8 R											
2-Chlorotoluene	160,000												
2-Hexanone	21,000												
4-Chlorotoluene	550,000												
4-Isopropyltoluene													
4-Methyl-2-pentanone	530,000												
Acetone	6,100,000												
Benzene	1,100												
Bromobenzene	30,000												
Bromochloromethane													
Bromodichloromethane	270												
Bromoform	61,000											< 4.2 R	< 3.7 R
Bromomethane	730	< 7.8 R	< 6.7 R	< 7.7 R	< 8.3 R	< 10 R	< 8.1 R	< 19 R	< 32 R	< 8.0 R	< 8.4 R	< 8.7 R	< 8.4 R
Carbon disulfide	82,000												
Carbon tetrachloride	250												
Chlorobenzene	29,000												
Chloroethane	1,500,000												
Chloroform	290												
Chloromethane	12,000												
cis-1,2-dichloroethene	78,000												
cis-1,3-dichloropropene	1,700												
Cyclohexane	700,000												
Dibromochloromethane	680												
Dibromomethane	2,500												
Dichlorodifluoromethane	18,000												
Ethylbenzene	5,400												
Freon 113	4,300,000												
Isopropylbenzene	210,000												
m,p-Xylene	340,000												
Methyl acetate	7,800,000												

**Table 5-11. Surface Soil - Rejected Results (Cont.)**

Sample Name	C3-WWTP-SO- D400-0.5	C3-WWTP-SO- DUP-01	C3-WWTP-SO- DUP-02	C3-WWTP-SO- DUP-3	C3-WWTP-SO- DUP-4	C3-WWTP-SO- DUP-5	C3-WWTP-SO- E(+50)300-0.5	C3-WWTP-SO- E(+50)600-0.5	C3-WWTP-SO- E400-0.5	C3-WWTP-SO- E500-0.5	C3-WWTP-SO- F(+50)300-0.5	C3-WWTP-SO- F(+50)600-0.5	C3-WWTP-SO- F400-0.5
Sample Depth (ft bgs)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Sample Date	07/10/09	07/08/09	07/09/09	07/09/09	07/09/09	07/10/09	07/10/09	07/10/09	07/09/09	07/09/09	07/08/09	07/09/09	07/09/09
Parent	N	FD	FD	FD	FD	FD	N	N	N	N	N	N	N
Analyte	USEPA RSL												
<b>Volatile Organic Compounds (8260C) (µg/kg)</b>													
Methylcyclohexane													
Methylene chloride	11,000												
n-Butylbenzene													
N-propylbenzene	340,000												
o-Xylene	380,000												
Sec-butylbenzene													
Styrene	630,000												
tert-butyl methyl ether	43,000												
Tert-butylbenzene													
Tetrachloroethylene	55												
Toluene	500,000												
trans-1,2-dichloroethene	15,000												
trans-1,3-dichloropropene	1,700												
Trichloroethene	2,800												
Trichlorofluoromethane	79,000												
Vinyl acetate	97,000	< 7.8 R		< 7.7 R	< 8.3 R	< 10 R	< 8.1 R	< 19 R	< 32 R	< 8.0 R	< 8.4 R	< 8.7 R	< 8.4 R
Vinyl chloride	60												
<b>Semi-Volatile Organic Compounds (8270C) (µg/kg)</b>													
3,3-dichlorobenzidine	1,100												
<p><i>Legend</i>                      USEPA RSL = USEPA Regional Screening Level for residential site use. One-tenth of the RSL for non-carcinogenic chemicals is used for comparison.                      Blank cell = Analyte concentration not rejected                      N = Normal Sample                      FD = Field Duplicate                      R = Rejected                      µg/kg = micrograms per kilogram                      mg/kg = milligram per kilogram                      ft bgs = feet below ground surface                      U - the sample was analyzed for but not detected above the sample reporting limit. Reporting limit values are associated with non-detects.</p>													

Table 5-11. Surface Soil - Rejects Resulted (Cont.)											
Sample Name	C3-WWTP-SO- F500-0.5	C3-WWTP-SO- F700-0.5	C3-WWTP-SO- G400-0.5	C3-WWTP-SO- G500-0.5	C3-WWTP-SO- G700-0.5	C3-WWTP-SO- TNT-B0-0.5	C3-WWTP-SO- TNT-B510-0.5	C3-WWTP-SO- TNT-C640-0.5	C3-WWTP-SO- TNT-D510-0.5	C3-WWTP-SO- TNT-E640-0.5	
Sample Depth (ft bgs)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
Sample Date	07/09/09	07/09/09	07/08/09	07/08/09	07/09/09	07/20/09	07/09/09	07/09/09	07/09/09	07/09/09	
Parent	N	N	N	N	N	N	N	N	N	N	
Analyte	USEPA RSL										
<b>Volatile Organic Compounds (8260C) (µg/kg)</b>											
1,1,1,2-Tetrachloroethane	1,900										
1,1,1-Trichloroethane	870,000										
1,1,2,2-Tetrachloroethane	560	< 5.4 R	< 4.6 R			< 7.6 R					
1,1,2-Trichloroethane	1,100										
1,1-Dichloroethane	3,300										
1,1-Dichloroethene	24,000										
1,1-Dichloropropene											
1,2,3-Trichlorobenzene	4,900	< 5.4 R	< 4.6 R			< 7.6 R					
1,2,3-Trichloropropane	5.0	< 5.4 R	< 4.6 R			< 7.6 R					
1,2,4-Trimethylbenzene	6,200										
1,2-Dibromo-3-chloropropane	5.4	< 5.4 R	< 4.6 R			< 7.6 R					
1,2-Dibromoethane	34	< 5.4 R									
1,2-Dichlorobenzene	190,000	< 5.4 R									
1,2-Dichloroethane	430										
1,2-Dichloropropane	890										
1,3,5-Trimethylbenzene	78,000										
1,3-Dichlorobenzene	190,000										
1,3-Dichloropropane	160,000										
1,4-Dichlorobenzene	2,400										
2,2-Dichloropropane											
2-Butanone	2,800,000	< 11 R									
2-Chlorotoluene	160,000										
2-Hexanone	21,000										
4-Chlorotoluene	550,000										
4-Isopropyltoluene											
4-Methyl-2-pentanone	530,000										
Acetone	6,100,000							< 9.4 R			
Benzene	1,100										
Bromobenzene	30,000										
Bromochloromethane		< 5.4 R									
Bromodichloromethane	270										
Bromoform	61,000	< 5.4 R	< 4.6 R			< 7.6 R					
Bromomethane	730	< 11 R	< 9.2 R	< 7.0 R	< 7.3 R	< 15 R	< 6.6 R	< 9.4 R	< 7.6 R	< 8.6 R	
Carbon disulfide	82,000										
Carbon tetrachloride	250										
Chlorobenzene	29,000										
Chloroethane	1,500,000	< 11 R									
Chloroform	290										
Chloromethane	12,000										
cis-1,2-dichloroethene	78,000										
cis-1,3-dichloropropene	1,700										
Cyclohexane	700,000										
Dibromochloromethane	680										
Dibromomethane	2,500	< 5.4 R									
Dichlorodifluoromethane	18,000										
Ethylbenzene	5,400										
Freon 113	4,300,000										
Isopropylbenzene	210,000										
m,p-Xylene	340,000										
Methyl acetate	7,800,000										

<b>Table 5-11. Surface Soil - Rejects Resulted (Cont.)</b>											
Sample Name	C3-WWTP-SO- F500-0.5	C3-WWTP-SO- F700-0.5	C3-WWTP-SO- G400-0.5	C3-WWTP-SO- G500-0.5	C3-WWTP-SO- G700-0.5	C3-WWTP-SO- TNT-B0-0.5	C3-WWTP-SO- TNT-B510-0.5	C3-WWTP-SO- TNT-C640-0.5	C3-WWTP-SO- TNT-D510-0.5	C3-WWTP-SO- TNT-E640-0.5	
Sample Depth (ft bgs)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
Sample Date	07/09/09	07/09/09	07/08/09	07/08/09	07/09/09	07/20/09	07/09/09	07/09/09	07/09/09	07/09/09	
Parent	N	N	N	N	N	N	N	N	N	N	
Analyte	USEPA RSL										
<b>Volatile Organic Compounds (8260C) (µg/kg)</b>											
Methylcyclohexane											
Methylene chloride	11,000										
n-Butylbenzene											
N-propylbenzene	340,000										
o-Xylene	380,000										
Sec-butylbenzene											
Styrene	630,000										
tert-butyl methyl ether	43,000										
Tert-butylbenzene											
Tetrachloroethylene	55										
Toluene	500,000										
trans-1,2-Dichloroethene	15,000										
trans-1,3-Dichloropropene	1,700										
Trichloroethene	2,800										
Trichlorofluoromethane	79,000										
Vinyl acetate	97,000	< 11 R	< 9.2 R	< 7.0 R	< 7.3 R	< 15 R		< 6.6 R	< 9.4 R	< 7.6 R	< 8.6 R
Vinyl chloride	60										
<b>Semi-Volatile Organic Compounds (8270C) (µg/kg)</b>											
3,3-Dichlorobenzidine	1,100						< 770 R				
<p><i>Legend</i>                      USEPA RSL = USEPA Regional Screening Level for residential site use. One-tenth of the RSL for non-carcinogenic chemicals is used for comparison.                      Blank cell = Analyte concentration not rejected                      N = Normal Sample                      R = Rejected                      µg/kg = micrograms per kilogram                      mg/kg = milligram per kilogram                      ft bgs = feet below ground surface                      U - the sample was analyzed for but not detected above the sample reporting limit. Reporting limit values are associated with non-detects.</p>											

**Table 5-12. Subsurface Soil - Rejected Results**

Sample Name			C3-WWTP-SO- 04-11	C3-WWTP-SO-B(+50)500-10.5	C3-WWTP-SO-B(+50)600-8	C3-WWTP-SO-BP08-11	C3-WWTP-SO-C(+50)300-11	C3-WWTP-SO-C(+50)600-8.5	C3-WWTP-SO-C400-12	C3-WWTP-SO-C700-14	C3-WWTP-SO-D(+50)300-11.5	C3-WWTP-SO-D400-11.5	C3-WWTP-SO-E(+50)600-7	C3-WWTP-SO-E400-11	C3-WWTP-SO-F(+50)300-11	C3-WWTP-SO-F(+50)600-6
Sample Depth (ft bgs)			11	10.5	8	11	11	8.5	12	14	11.5	11.5	7	11	11	6
Sample Date			07/10/09	07/10/09	07/08/09	07/08/09	07/10/09	07/08/09	07/10/09	07/08/09	07/10/09	07/10/09	07/10/09	07/09/09	07/08/09	07/09/09
Parent			N	N	N	N	N	N	N	N	N	N	N	N	N	N
Analyte	USEPA RSL	SSL														
<b>Volatile Organic Compounds (8260C) (µg/kg)</b>																
1,1,1,2-Tetrachloroethane	1,900									< 3.8 R						
1,1,1-Trichloroethane	870,000	4,640														
1,1,2,2-Tetrachloroethane	560	2,500				< 3.2 R				< 3.8 R						< 3.4 R
1,1,2-Trichloroethane	1,100	485														
1,1-Dichloroethane	3,300	2,050														
1,1-Dichloroethene	24,000	3,130								< 3.8 R						
1,1-Dichloropropene										< 3.8 R						
1,2,3-Trichlorobenzene	4,900					< 3.2 R				< 3.8 R						< 3.4 R
1,2,3-Trichloropropane	5					< 3.2 R				< 3.8 R						< 3.4 R
1,2,4-Trimethylbenzene	6,200	18,500								< 3.8 R						
1,2-Dibromo-3-chloropropane	5.4					< 3.2 R				< 3.8 R						< 3.4 R
1,2-Dibromoethane	34									< 3.8 R						
1,2-Dichloroethane	430	181								< 3.8 R						
1,2-Dichloropropene	890									< 3.8 R						
1,3,5-Trimethylbenzene	78,000									< 3.8 R						
1,3-Dichloropropane	160,000									< 3.8 R						
2,2-Dichloropropane																
2-Butanone	2,800,000	6,480	< 10 R	< 6.7 R			< 11 R		< 10 R	< 7.5 R	< 7.4 R	< 7.1 R	< 12 R			
2-Chlorotoluene	160,000									< 3.8 R						
2-Hexanone	21,000									< 7.5 R						
4-Chlorotoluene	550,000									< 3.8 R						
4-Isopropyltoluene										< 3.8 R						
4-Methyl-2-pentanone	530,000	1,500,000								< 7.5 R						
Acetone	6,100,000	5,520														
Benzene	1,100	455								< 3.8 R						
Bromobenzene	30,000									< 3.8 R						
Bromochloromethane																
Bromodichloromethane	270									< 3.8 R						
Bromoform	61,000					< 3.2 R				< 3.8 R						< 3.4 R
Bromomethane	730		< 10 R	< 6.7 R	< 5.9 R		< 11 R	< 15 R	< 10 R		< 7.4 R	< 7.1 R	< 12 R	< 7.7 R	< 6.9 R	< 6.9 R
Carbon disulfide	82,000	33,000														
Carbon tetrachloride	250	5,320														
Chlorobenzene	29,000	7,280								< 3.8 R						
Chloroethane	1,500,000															
Chloroform	290	2,770														
Chloromethane	12,000	2,280														
cis-1,2-Dichloroethene	78,000	1,580														
cis-1,3-Dichloropropene	1,700									< 3.8 R						
Cyclohexane	700,000	26,200,000														
Dibromochloromethane	680									< 3.8 R						
Dibromomethane	2,500									< 3.8 R						
Dichlorodifluoromethane	18,000															
Ethylbenzene	5,400	5,770								< 3.8 R						
Freon 113	4,300,000															
Isopropylbenzene	210,000	21,200								< 3.8 R						
m,p-Xylene	340,000									< 3.8 R						
Methyl acetate	7,800,000	4,600,000														

**Table 5-12. Subsurface Soil - Rejected Results**

Sample Name	C3-WWTP-SO- 04-11	C3-WWTP-SO-B(+50)500-10.5	C3-WWTP-SO-B(+50)600-8	C3-WWTP-SO-BP08-11	C3-WWTP-SO-C(+50)300-11	C3-WWTP-SO-C(+50)600-8.5	C3-WWTP-SO-C400-12	C3-WWTP-SO-C700-14	C3-WWTP-SO-D(+50)300-11.5	C3-WWTP-SO-D400-11.5	C3-WWTP-SO-E(+50)600-7	C3-WWTP-SO-E400-11	C3-WWTP-SO-F(+50)300-11	C3-WWTP-SO-F(+50)600-6		
Sample Depth (ft bgs)	11	10.5	8	11	11	8.5	12	14	11.5	11.5	7	11	11	6		
Sample Date	07/10/09	07/10/09	07/08/09	07/08/09	07/10/09	07/08/09	07/10/09	07/08/09	07/10/09	07/10/09	07/10/09	07/09/09	07/08/09	07/09/09		
Parent	N	N	N	N	N	N	N	N	N	N	N	N	N	N		
Analyte	USEPA RSL	SSL														
<b>Volatile Organic Compounds (8260C) (µg/kg)</b>																
Methylcyclohexane																
Methylene chloride	11,000	864														
n-Butylbenzene								< 3.8 R								
N-propylbenzene	340,000							< 3.8 R								
o-Xylene	380,000							< 3.8 R								
Sec-butylbenzene		1,070						< 3.8 R								
Styrene	630,000	13,500						< 3.8 R								
tert-butyl methyl ether	43,000							< 3.8 R								
Tert-butylbenzene		1,380						< 3.8 R								
Tetrachloroethylene	550	7,890						< 3.8 R								
Toluene	500,000	4,240						< 3.8 R								
trans-1,2-dichloroethene	15,000	1,820														
trans-1,3-dichloropropene	1,700							< 3.8 R								
Trichloroethene	2,800	3,240						< 3.8 R								
Trichlorofluoromethane	79,000															
Vinyl acetate	97,000		< 10 R	< 6.7 R	< 5.9 R		< 11 R	< 15 R	< 10 R	< 7.5 R	< 7.4 R	< 7.1 R	< 12 R	< 7.8 R	< 6.9 R	< 6.9 R
Vinyl chloride	60	795				< 6.4 R										
<b>Pesticides (8081) (µg/kg)</b>																
4,4-DDD	2,000	6640000												< 2.0 R		
4,4-DDE	1,400	2600000												< 2.0 R		
4,4-DDT	1,700	85.8												< 2.0 R		
Aldrin	29	48,500												< 2.0 R		
alpha-BHC	77	62												< 2.0 R		
alpha-Chlordane	1,600	29,700												< 2.0 R		
Beta-BHC	270	254												< 2.0 R		
Chlordane	1,600													< 41 R		
delta-BHC		2,330												< 2.0 R		
Dieldrin	3	424												< 2.0 R		
Endosulfan I	37,000	2,350,000												< 2.0 R		
Endosulfan II	37,000	2,350,000												< 2.0 R		
Endosulfan sulfate	37,000	2,350,000												< 2.0 R		
Endrin	1,800	671,000												< 2.0 R		
Endrin aldehyde	1,800	305,000												< 2.0 R		
Endrin ketone	1,800	305,000												< 2.0 R		
gamma-BHC (Lindane)	520	170												< 2.0 R		
gamma-Chlordane	1,600	29,700												< 2.0 R		
Heptachlor	110	297,000												< 2.0 R		
Heptachlor epoxide	53	12,400												< 2.0 R		
Methoxychlor	31,000	1,6900,000												< 2.0 R		
Toxaphene	440													< 41 R		
<p><i>Legend</i>                      USEPA RSL = USEPA Regional Screening Level for residential site use. One-tenth of the RSL for non-carcinogenic chemicals is used for comparison.                      SSL = Site-specific Soil Screening Level                      Blank cell = Analyte concentration not rejected                      N = Normal Sample</p> <p><i>R = Rejected</i>                      µg/kg = micrograms per kilogram                      mg/kg = milligram per kilogram                      ft bgs = feet below ground surface                      U - the sample was analyzed for but not detected above the sample reporting limit. Reporting limit values are associated with non-detects.</p>																

**Table 5-12. Subsurface Soil - Rejected Results (Cont.)**

Sample Name			C3-WWTP-SO- F400-11	C3-WWTP-SO- F500-13.5	C3-WWTP-SO- F700-12	C3-WWTP-SO- G400-11	C3-WWTP-SO- G500-7	C3-WWTP-SO- G700-12	C3-WWTP-SO- TNT-B510-15	C3-WWTP-SO- TNT-C640-14	C3-WWTP-SO- TNT-C640-20	C3-WWTP-SO- TNT-D510-14	C3-WWTP-SO- TNT-E640-14
Sample Depth (ft bgs)			11	13.5	12	11	7	12	15	14	20	14	14
Sample Date			07/09/09	07/09/09	07/09/09	07/08/09	07/08/09	07/09/09	07/09/09	07/09/09	07/21/09	07/09/09	07/09/09
Parent			N	N	N	N	N	N	N	N	N	N	N
Analyte	USEPA RSL	SSL											
<b>Volatile Organic Compounds (8260C) (µg/kg)</b>													
1,1,1,2-Tetrachloroethane	1,900							< 3.5 R			< 4.5 R		
1,1,1-Trichloroethane	870,000	4,640						< 3.5 R			< 4.5 R		
1,1,2,2-Tetrachloroethane	560	2,500	< 4.0 R	< 3.5 R				< 3.5 R			< 4.5 R		
1,1,2-Trichloroethane	1,100	485						< 3.5 R			< 4.5 R		
1,1-Dichloroethane	3,300	2,050						< 3.5 R			< 4.5 R		
1,1-Dichloroethene	24,000	3,130						< 3.5 R			< 4.5 R		
1,1-Dichloropropene								< 3.5 R			< 4.5 R		
1,2,3-Trichlorobenzene	4,900		< 4.0 R	< 3.5 R				< 3.5 R			< 4.5 R		
1,2,3-Trichloropropane	5		< 4.0 R	< 3.5 R				< 3.5 R			< 4.5 R		
1,2,4-Trimethylbenzene	6,200	18,500						< 3.5 R			< 4.5 R		
1,2-Dibromo-3-chloropropane	5.4		< 4.0 R	< 3.5 R				< 3.5 R			< 4.5 R		
1,2-Dibromoethane	34							< 3.5 R			< 4.5 R		
1,2-Dichloroethane	430	181						< 3.5 R			< 4.5 R		
1,2-Dichloropropane	890							< 3.5 R			< 4.5 R		
1,3,5-Trimethylbenzene	78,000							< 3.5 R			< 4.5 R		
1,3-Dichloropropane	160,000							< 3.5 R			< 4.5 R		
2,2-Dichloropropane								< 3.5 R			< 4.5 R		
2-Butanone	2,800,000	6,480						< 7.1 R			< 9.1 R		
2-Chlorotoluene	160,000							< 3.6 R			< 4.5 R		
2-Hexanone	21,000							< 7.1 R			< 9.1 R		
4-Chlorotoluene	550,000							< 3.5 R			< 4.5 R		
4-Isopropyltoluene								< 3.5 R			< 4.5 R		
4-Methyl-2-pentanone	530,000	1,500,000						< 7.1 R			< 9.0 R		
Acetone	6,100,000	5,520			< 6.0 R						< 9.0 R	< 11 R	< 6.9 R
Benzene	1,100	455									< 4.5 R		
Bromobenzene	30,000							< 3.5 R			< 4.5 R		
Bromochloromethane								< 3.5 R		< 3.9 R	< 4.5 R		
Bromodichloromethane	270							< 3.5 R			< 4.5 R		
Bromoform	61,000		< 4.0 R	< 3.5 R				< 3.5 R			< 4.5 R		
Bromomethane	730		< 7.9 R	< 6.9 R	< 6.0 R	< 8.1 R	< 13 R	< 7.1 R	< 8.7 R		< 9.0 R	< 11 R	< 6.9 R
Carbon disulfide	82,000	33,000						< 3.5 R			< 4.5 R		
Carbon tetrachloride	250	5,320						< 3.5 R			< 4.5 R		
Chlorobenzene	29,000	7,280						< 3.5 R			< 4.5 R		
Chloroethane	1,500,000							< 7.1 R			< 9.0 R		
Chloroform	290	2,770						< 3.5 R			< 4.5 R		
Chloromethane	12,000	2,280						< 7.1 R			< 9.0 R		
cis-1,2-Dichloroethene	78,000	1,580						< 3.5 R			< 4.5 R		
cis-1,3-Dichloropropene	1,700							< 3.5 R			< 4.5 R		
Cyclohexane	700,000	26,200,000						< 3.5 R			< 4.5 R		
Dibromochloromethane	680							< 3.5 R			< 4.5 R		
Dibromomethane	2,500							< 3.5 R			< 4.5 R		
Dichlorodifluoromethane	18,000							< 3.5 R			< 4.5 R		
Ethylbenzene	5,400	5,770						< 3.5 R			< 4.5 R		
Freon 113	4,300,000							< 3.6 R			< 4.5 R		
Isopropylbenzene	210,000	21,200						< 3.5 R			< 4.5 R		
m,p-Xylene	340,000							< 3.5 R			< 4.5 R		
Methyl acetate	7,800,000	4,600,000						< 3.6 R			< 4.5 R		
Methylcyclohexane											< 4.5 R		

**Table 5-12. Subsurface Soil - Rejected Results (Cont.)**

Sample Name			C3-WWTP-SO- F400-11	C3-WWTP-SO- F500-13.5	C3-WWTP-SO- F700-12	C3-WWTP-SO- G400-11	C3-WWTP-SO- G500-7	C3-WWTP-SO- G700-12	C3-WWTP-SO- TNT-B510-15	C3-WWTP-SO- TNT-C640-14	C3-WWTP-SO- TNT-C640-20	C3-WWTP-SO- TNT-D510-14	C3-WWTP-SO- TNT-E640-14
Sample Depth (ft bgs)			11	13.5	12	11	7	12	15	14	20	14	14
Sample Date			07/09/09	07/09/09	07/09/09	07/08/09	07/08/09	07/09/09	07/09/09	07/09/09	07/21/09	07/09/09	07/09/09
Parent			N	N	N	N	N	N	N	N	N	N	N
Analyte	USEPA RSL	SSL											
Methylene chloride	11,000	864						< 7.1 R			< 9.1 R		
n-Butylbenzene								< 3.5 R			< 4.5 R		
N-propylbenzene	340,000							< 3.5 R			< 4.5 R		
o-Xylene	380,000							< 3.5 R			< 4.5 R		
Sec-butylbenzene		1,070						< 3.5 R			< 4.5 R		
Styrene	630,000	13,500						< 3.5 R			< 4.5 R		
tert-butyl methyl ether	43,000							< 3.5 R			< 4.5 R		
Tert-butylbenzene		1,380						< 3.5 R			< 4.5 R		
Tetrachloroethylene	550	7,890						< 3.5 R			< 4.5 R		
Toluene	500,000	4,240						< 3.5 R			< 4.5 R		
trans-1,2-dichloroethene	15,000	1,820						< 3.5 R			< 4.5 R		
trans-1,3-dichloropropene	1,700							< 3.5 R			< 4.5 R		
Trichloroethene	2,800	3,240						< 3.5 R			< 4.5 R		
Trichlorofluoromethane	79,000							< 3.6 R			< 4.5 R		
Vinyl acetate	97,000		< 7.9 R	< 6.9 R	< 6.0 R	< 8.1 R	< 13 R	< 7.1 R	< 8.7 R	< 7.8 R	< 9.1 R	< 11 R	< 6.9 R
Vinyl chloride	60	795						< 7.1 R			< 9.0 R		
<b>Pesticides (8081) (µg/kg)</b>													
4,4-DDD	2,000	6,640,000											
4,4-DDE	1,400	2,600,000											
4,4-DDT	1,700	85.8											
Aldrin	29	48,580											
alpha-BHC	77	62											
alpha-Chlordane	1,600	29,700											
beta-BHC	270	254											
Chlordane	1,600												
delta-BHC		2,330											
Dieldrin	30	424											
Endosulfan I	37,000	2,350,000											
Endosulfan II	37,000	2,350,000											
Endosulfan sulfate	37,000	2,350,000											
Endrin	1,800	671,000											
Endrin aldehyde	1,800	305,000											
Endrin ketone	1,800	305,000											
gamma-BHC (Lindane)	520	270											
gamma-Chlordane	1,600	29,700											
Heptachlor	110	279,000											
Heptachlor epoxide	53	12,400											
Methoxychlor	31,000	16,900,000											
Toxaphene	440												
<p><i>Legend</i>                      USEPA RSL = USEPA Regional Screening Level for residential site use. One-tenth of the RSL for non-carcinogenic chemicals is used for comparison.                      SSL = Site-specific Soil Screening Level                      Blank cell = Analyte concentration not rejected                      N = Normal Sample</p> <p>R = Rejected                      µg/kg = micrograms per kilogram                      mg/kg = milligram per kilogram                      ft bgs = feet below ground surface                      U - the sample was analyzed for but not detected above the sample reporting limit. Reporting limit values are associated with non-detects.</p>													

<b>Table 5-13. Groundwater - Rejected Results</b>					
Sample Name		C3-WWTP-MW-BP14-20	C3-WWTP-MW-BP15-19	C3-WWTP-MW-BP16-18	C3-WWTP-MW-DUP01
Sample Depth (ft bgs)		14	15	16	15
Sample Date		11/12/09	11/12/09	11/12/09	11/12/09
Sample Type/Parent Sample		Y	N	N	FD
Analyte	USEPA RSL TAPWATER				
<b>Volatile Organic Compounds (8260C) (µg/L)</b>					
2-Butanone	7,100	< 14 R	< 14 R	< 14 R	< 14 R
<b>Semi-Volatile Organic Compounds (8270C) (µg/L)</b>					
2,4-Dinitrophenol	730			< 5.1 R	
<i>Legend</i>					
USEPA RSL = USEPA Regional Screening Level for tap water (December 2009). One-tenth of the RSL for non-carcinogenic chemicals is used for comparison.					
Blank cell = Analyte concentration not rejected					
N = Normal Sample					
FD = Field Duplicate					
R = Rejected					
J = Estimated value data qualifier					
µg/L = micrograms per liter					
mg/L = milligrams per liter					
ft bgs = feet below ground surface					

### 5.2.4 Background Inorganic Compounds Comparison

A number of analytes exceeded background concentrations. In surface soil, cadmium, lithium, potassium, selenium, and vanadium exceeded the established background concentrations. In subsurface soil, cadmium, potassium, selenium, and vanadium exceeded the established background concentration. Although the Wilcoxon Rank Sum statistical analyses for vanadium and lithium indicate that concentrations are within background, other statistical evaluations (e.g., quantile test) suggest that these analytes may exceed background; therefore, as a measure of conservatism they are carried through the risk evaluation as COPCs. Background evaluation methodology and comparison tables are presented in Appendix I. In groundwater, detected constituent concentrations were compared to the BTV calculated as part of the NFSS RI. Concentrations of aluminum, barium, chromium, selenium and silver exceeded the BTV based on a point-to-point comparison of the data. The Phase II RIR (USACE/EA, 2002) and the NFSS RI (USACE/SAIC, 2007b) present the complete analytical background data sets.

### 5.3 Surface Soil Sample Analytical Results

Forty four surface soil samples were collected at the WWTP during the Phase IV RI and submitted for laboratory analysis. Forty-two surface soil samples were laboratory analyzed for VOCs, SVOCs, PAHs, pesticides, PCBs, explosives, and metals; and two surface soil samples were analyzed for PCBs only. Results from the laboratory analysis were screened against the criteria for the Phase IV RI. Table 5-13 presents surface soil sample results for constituents above the screening criteria. Figure 5-1 presents all analytical data hits associated with surface soil samples. Complete analytical data packages and summarized constituent detections for the Phase IV RI are provided in Appendix F.

### **5.3.1 VOC Exceedances**

No VOCs were detected at concentrations above the applicable USEPA RSL.

### **5.3.2 PAH Exceedances**

One surface soil sample, C3-WWTP-SO-C(+50)600-0.5, had concentrations of benz[a]anthracene (2,500 µg/kg), benzo[a]pyrene (2,300 µg/kg), benzo[b]fluoranthene (2,100 µg/kg), benzo[k]fluoranthene (2,100 µg/kg), dibenz[a,h]anthracene (680 µg/kg - estimated), and indeno[1,2,3-cd]pyrene (1,300 µg/kg) above the USEPA RSL.

### **5.3.3 Pesticide Exceedances**

No pesticide levels were detected in exceedance of the applicable USEPA RSL.

### **5.3.4 Metals Exceedances**

Eleven metal constituents were detected in surface soil samples above the screening criteria, which are USEPA RSLs and background concentrations. Eight of these metals (aluminum, arsenic, cobalt, iron, lithium, manganese, mercury, and vanadium) were detected above their RSL. Five of these metals (cadmium, lithium, potassium, selenium and vanadium) were detected above their background concentration as determined according to the background data set and statistical analysis presented in Section 3.2. Only two metals, lithium and vanadium, were detected above both the USEPA RSLs and background concentrations. However, results from the two statistical tests for both lithium and vanadium were conflicting; with the quantile test result suggesting that the metals exceed background and the Wilcoxon Rank Sum test suggesting that they didn't (see Appendix I). Therefore, as a measure of conservancy lithium and vanadium are carried through the risk evaluation as COPCs. Conflicting results indicate uncertainty in the final conclusion and these metals may not be above background.

Lithium was detected in concentrations above the USEPA RSL of 16 mg/kg in 45 surface soil samples. Concentrations above the screening criteria ranged from 18.9 mg/kg to 39.5 mg/kg. Vanadium was detected in concentrations above the USEPA RSL of 39 mg/kg in 10 surface soil samples. Concentrations above the screening criteria ranged from 39.1 mg/kg to 66.2 mg/kg.

The data presented in Table 5-13 appears to indicate that lithium and vanadium are naturally occurring based on both elements seeming to be uniformly distributed across the WWTP, and as such, do not indicate an area of release. Figure 5-1 illustrates the sample locations with corresponding lithium and vanadium results.

Lithium concentrations in surface soil range from 14 mg/kg to 39.5 mg/kg (mean 25.2 mg/kg, median 25.3 mg/kg, and standard deviation 4.7 mg/kg). This range of concentrations is very similar to area background and published values.

- Site background, 12.6 and 36.8 mg/kg, 24 mg/kg mean.
- Lithium commonly ranges between 5 and 200 mg/kg, with an average concentration of 20 mg/kg (USEPA, 1983)
- Generic soil background values for lithium based on soil type (Oak Ridge National Laboratories)

- Clay and clay-loamy soils, 10 to 64 mg/kg range, 23.5 mg/kg mean
- Light loamy soils, 9 to 46 mg/kg range, 24.5 mg/kg mean
- Organic rich soils, less than 5 to 71 mg/kg, 13 mg/kg mean
- Soil on glacial till and drift, 10 to 30 mg/kg range, 18 mg/kg mean

Vanadium concentrations in surface soil range from 9.5 mg/kg to 66.2 mg/kg (mean 34.1 mg/kg, median 33.6 mg/kg, and standard deviation 9.0 mg/kg). This range of concentrations is very similar to area background values.

- Site background, 10.8 to 35.2 mg/kg range, 21.9 mean.

As a conservative measure, both elements were further evaluated in the RI report, SLERA, and HHRA because the statistical comparisons with background concentrations were contradictory.

- The Wilcoxon Rank Sum test indicates that both are within background levels.
- The quantile test indicates that both may exceed background).

**Table 5-14. Surface Soil Results Above Screening Criteria**

Sample Name	C3-WWTP-SO-04-0.5	C3-WWTP-SO-B(+50)500-0.5	C3-WWTP-SO-B(+50)600-0.5	C3-WWTP-SO-BP03-0.5	C3-WWTP-SO-BP04-0.5	C3-WWTP-SO-BP05-0.5	C3-WWTP-SO-BP06-0.5	C3-WWTP-SO-BP07-0.5	C3-WWTP-SO-BP08-0.5	C3-WWTP-SO-BP09-0.5	C3-WWTP-SO-BP10-0.5	C3-WWTP-SO-BP11-0.5	C3-WWTP-SO-BP12-0.5	C3-WWTP-SO-C(+50)300-0.5	C3-WWTP-SO-C(+50)600-0.5	
Sample Depth (ft bgs)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
Sample Date	2009-07-10	07/10/09	07/08/09	07/10/09	07/10/09	07/10/09	07/20/09	07/08/09	07/08/09	07/08/09	07/21/09	07/08/09	07/09/09	07/20/09	07/10/09	
Parent	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Analyte	USEPA RSL															
<b>PAH (8270C) (µg/kg)</b>																
Benzo[a]anthracene	150	< 440	< 460	< 380	< 460	< 1100	< 850	< 390	< 400	< 410	< 370			< 380	< 470	<b>2500</b>
Benzo[a]pyrene	15	< 440	< 460	< 380	< 400	< 1100	< 850	< 390	< 400	< 410	< 320			< 380	< 470	<b>2300</b>
Benzo[b]fluoranthene	150	< 440	< 460	< 380	< 62	< 1100	< 850	< 390	< 400	< 410	< 49			< 380	< 470	<b>2100</b>
Benzo[k]fluoranthene	1,500	< 440	< 460	< 380	< 56	< 1100	< 850	< 390	< 400	< 410	< 44			320 J	< 470	<b>2100</b>
Dibenz[a,h]anthracene	15	< 440	< 460	< 380	< 65	< 1100	< 850	< 390	< 400	< 410	< 51			< 380	< 470	<b>680 J</b>
Indeno[1,2,3-c,d]pyrene	150	< 440	< 460	< 380	< 51	< 1100	< 850	< 390	< 400	< 410	< 40			< 380	< 470	<b>1300</b>
<b>Metals (6020, 7470A, 7471A) (mg/kg)</b>																
Aluminum	7,700	<b>16700</b>	<b>16600</b>	<b>19200</b>	<b>11700</b>	<b>23000</b>	7290	<b>14800</b>	<b>14700</b>	<b>16500</b>	<b>14600</b>			<b>13700</b>	<b>16700</b>	6280
Arsenic	0.39	<b>3.1 J</b>	<b>4.5 J</b>	<b>4.4</b>	<b>3.6 J</b>	<b>2.7 J</b>	<b>2.3 J</b>	<b>4.1 J</b>	<b>3.8 J</b>	<b>1.8 J</b>	<b>4.2</b>			<b>3.6 J</b>	<b>8.8</b>	<b>2.6 J</b>
Cadmium	7.0	0.22 J	0.26 J	0.46 J	0.21 J	0.46 J	1.6 J	0.22 J	0.38 J	0.19 J	0.22 J			0.24 J	0.4 J	0.68 J
Cobalt	2.3	<b>11.5</b>	<b>10.6</b>	<b>12.2</b>	<b>9.1 J</b>	<b>12.3</b>	<b>4 J</b>	<b>9.8 J</b>	<b>10</b>	<b>4.6</b>	<b>11.4</b>			<b>13.6 J</b>	<b>13.5</b>	<b>4.8</b>
Iron	5,500	<b>30300</b>	<b>28500</b>	<b>30600</b>	<b>24700</b>	<b>34100</b>	<b>20600</b>	<b>27900</b>	<b>24700</b>	<b>13700</b>	<b>27400</b>			<b>27800</b>	<b>73100</b>	<b>14200</b>
Lithium	16	<b>30.3</b>	<b>27.8</b>	<b>29.9</b>	<b>20.4 J</b>	<b>39.5</b>	14.3	<b>23.5</b>	<b>26.6</b>	<b>22.1</b>	<b>25</b>			<b>23.1</b>	<b>28.6</b>	14.4
Manganese	180	<b>778 J</b>	<b>1090 J</b>	<b>493 J</b>	<b>839</b>	<b>919 J</b>	<b>561 J</b>	<b>674</b>	<b>819 J</b>	148 J	<b>810</b>			<b>1270</b>	<b>1270 J</b>	<b>1010 J</b>
Mercury	0.56	0.019 J	0.017 J	0.044	0.02 J	0.079 J	<b>0.71</b>	0.014	< 0.035	0.04	0.015			0.068	0.05	< 0.031
Potassium		3510	2420	2180 J	2080	5650	1210 J	2160 J	2020 J	1130 J	2490 J			2400 J	1450	1380 J
Selenium	39	< 4.7	< 4.8	< 4	< 5.1	< 12.1	< 8.9	< 4.2	< 4.3	< 4.3	< 4.1			< 4	< 5	< 3.8
Vanadium	39	38.6	35.3	<b>42.5</b>	26.6	37.9	11.7 J	32.8 J	32.9	27	33.5 J			32 J	<b>66.2</b>	9.5
<b>Legend</b>																
USEPA RSL = USEPA Regional Screening Level for residential site use. One-tenth of the RSL for non-carcinogenic chemicals (except for lead) is used for comparison.																
Yellow shading and bold text = Analyte concentration is above the USEPA RSL																
Gray shading = Overall concentrations of these analytes are greater than background levels																
Blank cell = Sample was not analyzed for the constituent																
N = Normal Sample																
FD = Field Duplicate																
J = Estimated value data qualifier																
< = Analyte was not detected in concentrations above the reporting limit																
µg/kg = microgram per kilogram																
mg/kg = milligram per kilogram																
ft bgs = feet below ground surface																

**Table 5-14. Surface Soil Results Above Screening Criteria (cont.)**

Sample Name	C3-WWTP-SO-C400-0.5	C3-WWTP-SO-C400A-0.5	C3-WWTP-SO-C700-0.5	C3-WWTP-SO-D(+50)300-0.5	C3-WWTP-SO-D400-0.5	C3-WWTP-SO-D500-0.5	C3-WWTP-SO-D700-0.5	C3-WWTP-SO-DUP-01	C3-WWTP-SO-DUP-02	C3-WWTP-SO-DUP-3	C3-WWTP-SO-DUP-4	C3-WWTP-SO-DUP-5	C3-WWTP-SO-DUP-6	C3-WWTP-SO-DUP-7	
Sample Depth (ft bgs)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
Sample Date	07/10/09	07/20/09	07/08/09	07/10/09	07/10/09	07/20/09	07/21/09	07/08/09	07/09/09	07/09/09	07/09/09	07/10/09	07/10/09	07/20/09	
Parent	N	N	N	N	N	N	N	FD	FD	FD	FD	FD	FD	FD	
Analyte	USEPA RSL														
<b>Metals (6020, 7470A, 7471A) (mg/kg)</b>															
Aluminum	7,700	<b>11900</b>	<b>14900</b>	<b>14700</b>	<b>18500</b>	<b>16000</b>	<b>14200</b>	<b>16700</b>	<b>12300</b>	<b>16100</b>	<b>15300</b>	<b>17800</b>	<b>18100</b>	<b>13100</b>	<b>12900</b>
Arsenic	0.39	<b>2.2 J</b>	<b>4 J</b>	<b>4.3</b>	<b>4.4 J</b>	<b>3.6 J</b>	<b>3.4 J</b>	<b>3 J</b>	<b>3.2 J</b>	<b>3 J</b>	<b>3.6 J</b>	<b>3.2 J</b>	<b>3.9 J</b>	<b>4.4 J</b>	<b>3.3 J</b>
Cadmium	7.0	0.19 J	0.21 J	0.33 J	0.27 J	0.23 J	0.2 J	0.2 J	0.34 J	0.34 J	0.21 J	0.28 J	0.25 J	0.24 J	0.2 J
Cobalt	2.3	<b>5.6</b>	<b>9 J</b>	<b>9.4</b>	<b>10.4</b>	<b>9.1</b>	<b>8.3 J</b>	<b>9</b>	<b>7.5</b>	<b>10.2</b>	<b>9.1 J</b>	<b>10.1 J</b>	<b>10</b>	<b>9.6 J</b>	<b>6.8 J</b>
Iron	5,500	<b>16700</b>	<b>27000</b>	<b>24000</b>	<b>33700</b>	<b>25100</b>	<b>24000</b>	<b>26600</b>	<b>21500</b>	<b>24500</b>	<b>25200</b>	<b>29700</b>	<b>31900</b>	<b>27800</b>	<b>20400</b>
Lithium	16	14	<b>22.9</b>	<b>27.9</b>	<b>28</b>	<b>25.1</b>	<b>20.9</b>	<b>26.6</b>	<b>22</b>	<b>27.1</b>	<b>25.4 J</b>	<b>28.7 J</b>	<b>26.4</b>	<b>22 J</b>	<b>18.9</b>
Manganese	180	<b>482 J</b>	<b>627</b>	<b>783 J</b>	<b>816 J</b>	<b>1020 J</b>	<b>840</b>	<b>609</b>	<b>535 J</b>	<b>653 J</b>	<b>659</b>	<b>910</b>	<b>759 J</b>	<b>924</b>	<b>615</b>
Mercury	0.56	0.023 J	0.022	< 0.035	0.039	0.012 J	0.047	0.023	< 0.03	0.016 J	0.021 J	0.023 J	0.022 J	0.026 J	0.028
Potassium		633 J	1880 J	1950 J	2020	1970	1470 J	1970 J	1370 J	2210	2040 J	1890 J	1760	2240	1040 J
Selenium	39	< 4.4	< 4	< 4.1	< 4.5	< 4.3	< 4.2	< 4.1	1.5 J	< 4.1	< 4.1	< 4.1	< 4.1	< 5.5	< 4.2
Vanadium	39	25.6	33.8 J	30.4	<b>43</b>	31.9	32.2 J	33.6 J	30.3	36.5	34.4	35.4	<b>41.9</b>	30.2	27.9 J

*Legend*  
 USEPA RSL = USEPA Regional Screening Level for residential site use. One-tenth of the RSL for non-carcinogenic chemicals (except for lead) is used for comparison.  
 Yellow shading and bold text = Analyte concentration is above the USEPA RSL  
 Gray shading = Overall concentrations of these analytes are greater than background levels  
 N = Normal Sample  
 Blank cell = Sample was not analyzed for the constituent  
 FD = Field Duplicate  
 J = Estimated value data qualifier  
 < = Analyte was not detected in concentrations above the reporting limit  
 mg/kg = milligram per kilogram  
 ft bgs = feet below ground surface

**Table 5-14. Surface Soil Results Above Screening Criteria (cont.)**

Sample Name	C3-WWTP-SO-E(+50)300-0.5	C3-WWTP-SO-E(+50)600-0.5	C3-WWTP-SO-E400-0.5	C3-WWTP-SO-E500-0.5	C3-WWTP-SO-E700-0.5	C3-WWTP-SO-F(+50)300-0.5	C3-WWTP-SO-F(+50)600-0.5	C3-WWTP-SO-F400-0.5	C3-WWTP-SO-F500-0.5	C3-WWTP-SO-F700-0.5	C3-WWTP-SO-G400-0.5	C3-WWTP-SO-G500-0.5	C3-WWTP-SO-G700-0.5	C3-WWTP-SO-TNT-B0-0.5	
Sample Depth (ft bgs)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
Sample Date	07/10/09	07/10/09	07/09/09	07/09/09	07/21/09	07/08/09	07/09/09	07/09/09	07/09/09	07/09/09	07/08/09	07/08/09	07/09/09	07/20/09	
Parent	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Analyte	USEPA RSL														
<b>Metals (6020, 7470A, 7471A) (mg/kg)</b>															
Aluminum	7,700	<b>16700</b>	<b>17500</b>	<b>18800</b>	<b>15500 D</b>	<b>18700</b>	<b>16300</b>	<b>21200</b>	<b>18700</b>	<b>17300</b>	<b>15600</b>	<b>13200</b>	<b>11700</b>	<b>17000</b>	<b>14300</b>
Arsenic	0.39	<b>2.2 J</b>	<b>3.7 J</b>	<b>2.7 J</b>	<b>6.5 J</b>	<b>4 J</b>	<b>3 J</b>	<b>5.5</b>	<b>4.1 J</b>	<b>4.6</b>	<b>3.1 J</b>	<b>2.9 J</b>	<b>3 J</b>	<b>4.6</b>	<b>3.8 J</b>
Cadmium	7.0	0.32 J	0.31 J	0.3 J	0.29 J	0.33 J	0.29 J	0.47	0.29 J	0.37 J	0.38 J	0.34 J	0.36 J	0.3 J	0.2 J
Cobalt	2.3	<b>8.7</b>	<b>10.2 J</b>	<b>10.9 J</b>	<b>11.8 J</b>	<b>9.1</b>	<b>6.2</b>	<b>15.8</b>	<b>10</b>	<b>10.8</b>	<b>8.2</b>	<b>8.6</b>	<b>7.2</b>	<b>12.6</b>	<b>10.2 J</b>
Iron	5,500	<b>24800</b>	<b>31200</b>	<b>31400</b>	<b>29700</b>	<b>24400</b>	<b>20600</b>	<b>30400</b>	<b>25300</b>	<b>28500</b>	<b>22500</b>	<b>21500</b>	<b>20000</b>	<b>28200</b>	<b>26800</b>
Lithium	16	<b>28.6</b>	<b>30</b>	<b>32 J</b>	<b>26.1 J</b>	<b>28.1</b>	<b>23.4</b>	<b>27.7</b>	<b>25.8</b>	<b>27</b>	<b>26.3</b>	<b>23.6</b>	<b>19.6</b>	<b>27.5</b>	<b>24.1</b>
Manganese	180	<b>677 J</b>	<b>1090 J</b>	<b>686</b>	<b>839</b>	<b>1940</b>	<b>203 J</b>	<b>1600 J</b>	<b>572 J</b>	<b>723 J</b>	<b>439 J</b>	<b>641 J</b>	<b>750 J</b>	<b>848 J</b>	<b>761</b>
Mercury	0.56	0.065 J	0.096 J	0.035 J	0.014 J	0.026	0.039	0.035 J	0.038 J	0.035 J	0.035 J	< 0.032	< 0.031	0.03 J	0.02
Potassium		3670	4560	2010 J	2680 J	2560 J	1140 J	1840	1620	1700	1710	1830 J	1170 J	2530	1990 J
Selenium	39	< 8.4	< 14.4	1.2 J	< 4.2	1.4 J	< 4.5	1.9 J	< 4.7	< 4.5	< 4.1	< 4.4	< 4.2	< 4.1	< 4.3
Vanadium	39	28.2	33.3	37.6	<b>39.3</b>	28.2 J	35.8	<b>50.5</b>	<b>39.1</b>	<b>41.7</b>	<b>39.4</b>	21.5	27.6	38.5	32.8 J

*Legend*  
 USEPA RSL = USEPA Regional Screening Level for residential site use. One-tenth of the RSL for non-carcinogenic chemicals (except for lead) is used for comparison.  
 Yellow shading and bold text = Analyte concentration is above the USEPA RSL  
 Gray shading = Overall concentrations of these analytes are greater than background levels  
 N = Normal Sample  
 Blank cell = Sample was not analyzed for the constituent  
 FD = Field Duplicate  
 J = Estimated value data qualifier  
 < = Analyte was not detected in concentrations above the reporting limit  
 mg/kg = milligram per kilogram  
 ft bgs = feet below ground surface

<b>Table 5-14. Surface Soil Results Above Screening Criteria (cont.)</b>								
<b>Sample Name</b>	C3-WWTP-SO-TNT-B200-0.5	C3-WWTP-SO-TNT-B510-0.5	C3-WWTP-SO-TNT-C640-0.5	C3-WWTP-SO-TNT-D0-0.5	C3-WWTP-SO-TNT-D200-0.5	C3-WWTP-SO-TNT-D510-0.5	C3-WWTP-SO-TNT-E640-0.5	
<b>Sample Depth (ft bgs)</b>	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
<b>Sample Date</b>	07/20/09	07/09/09	07/09/09	07/20/09	07/20/09	07/09/09	07/09/09	07/09/09
<b>Parent</b>	N	N	N	N	N	N	N	N
<b>Analyte</b>								
<b>Metals (6020, 7470A, 7471A) (mg/kg)</b>								
Aluminum	7,700	<b>14900</b>	<b>15400</b>	<b>14500</b>	<b>14900</b>	<b>13700</b>	<b>15800</b>	<b>21000</b>
Arsenic	0.39	<b>3.8 J</b>	<b>3.2 J</b>	<b>2.9 J</b>	<b>4 J</b>	<b>3.4 J</b>	<b>3 J</b>	<b>3.6 J</b>
Cadmium	7.0	0.21 J	0.31 J	0.23 J	0.23 J	0.2 J	0.37 J	0.42
Cobalt	2.3	<b>10.1 J</b>	<b>9.5</b>	<b>8.3</b>	<b>11.2 J</b>	<b>9.9 J</b>	<b>9.9</b>	<b>11.1</b>
Iron	5,500	<b>26000</b>	<b>24100</b>	<b>22800</b>	<b>27300</b>	<b>23400</b>	<b>25400</b>	<b>34800</b>
Lithium	16	<b>25</b>	<b>24.2</b>	<b>22.7</b>	<b>25.2</b>	<b>23.7</b>	<b>25.2</b>	<b>34.7</b>
Manganese	180	<b>679</b>	<b>647 J</b>	<b>589 J</b>	<b>798</b>	<b>743</b>	<b>676 J</b>	<b>567 J</b>
Mercury	0.56	0.013	0.015 J	0.024 J	0.011	0.011	0.029 J	0.018 J
Potassium		2010 J	2130	1670	2110 J	1890 J	2250	3650
Selenium	39	< 4.2	1.5 J	1.2 J	< 4.2	< 4	< 4	1.9 J
Vanadium	39	31.6 J	35.3	35	33.1 J	27.9 J	36.5	<b>52.3</b>
<p><i>Legend</i>                      USEPA RSL = USEPA Regional Screening Level for residential site use. One-tenth of the RSL for non-carcinogenic chemicals (except for lead) is used for comparison.                      Yellow shading and bold text = Analyte concentration is above the USEPA RSL                      Gray shading = Overall concentrations of these analytes are greater than background levels                      N = Normal Sample                      Blank cell = Sample was not analyzed for the constituent                      FD = Field Duplicate                      J = Estimated value data qualifier                      &lt; = Analyte was not detected in concentrations above the reporting limit                      mg/kg = milligram per kilogram                      ft bgs = feet below ground surface</p>								

## 5.4 Subsurface Soil Sample Analytical Results

Forty two subsurface soil samples were collected at the WWTP during the Phase IV RI and submitted for laboratory analysis for the full suite of project-specific constituents: VOCs, SVOCs, PAHs, pesticides, PCBs, explosives, and metals. Results from the laboratory analysis were screened against the established screening criteria for the Phase IV RI. Table 5-14 presents subsurface soil sample results for constituents above the screening criteria. Figure 5-2 presents all analytical data hits associated with subsurface soil samples. Figure 5-3 illustrates analytes in subsurface soil that were above the protection of groundwater site-specific SSL. Complete analytical data packages and summarized constituent detections for the Phase IV RI are provided in Appendix F.

### 5.4.1 VOC Exceedances

No VOCs were detected at concentrations above the USEPA RSL.

### 5.4.2 Metals Exceedances

Ten metal constituents were detected at concentrations above the screening criteria. Seven metal constituents; aluminum, arsenic, cobalt, iron, lithium, manganese, and vanadium were detected in subsurface soil samples above their respective USEPA RSLs. Four metal constituents; cadmium, potassium, selenium and vanadium were detected above their respective background as determined according to the background data set and statistical analysis presented in Section 3.2. Of these 10 metals detected above screening criteria, the only metal with concentrations detected above both the screening criteria and background concentration screening criteria for the former LOOW is vanadium. However, results from the two statistical tests were conflicting; with the quantile test result suggesting that vanadium exceeds background and the Wilcoxon Rank Sum test suggesting that it was consistent with background levels (see Appendix I). Conflicting results indicate uncertainty in the final conclusion and vanadium may not be above background. Therefore, as a measure of conservatism, vanadium is carried through the risk evaluation as COPCs. Vanadium was detected above the USEPA RSL of 39 mg/kg in 8 soil samples. Concentrations above this criterion ranged from 39.3 mg/kg to 58.7 mg/kg.

The data presented in Table 5-14 appears to indicate that lithium and vanadium are naturally occurring based on the following lines of evidence:

- Both elements are uniformly distributed across the WWTP and areas of elevated concentrations, typically associated with releases to the environment, are not present.
- Figure 5-2 illustrates the sample locations with corresponding lithium and vanadium results. A majority of these samples were taken from stiff silty-clay soils which usually contain lithium naturally and were located greater than 10 ft bgs. The measured hydraulic conductivity of the silty clay soils at LOOW is low ( $10^{-6}$  to  $10^{-8}$  cm/sec) (USACE, 2002), making it unlikely that the concentrations originated from a surface soil release.

Lithium concentrations in subsurface soil range from 14.3 mg/kg to 38.7 mg/kg (mean 26.5 mg/kg, median 27.6 mg/kg, and standard deviation 4.9 mg/kg).

Vanadium concentrations in subsurface soil range from 18.2 mg/kg to 58.7 mg/kg (mean 34.7 mg/kg, median 35.7 mg/kg, and standard deviation 6.7 mg/kg).

As a conservative measure, both elements were further evaluated in the RI report, SLERA, and HHRA because the statistical comparisons with background concentrations were contradictory.

- The Wilcoxon Rank Sum test indicates that both are within background levels.
- The quantile test indicates that both may exceed background).

**Table 5-15. Subsurface Soil Above Screening Criteria**

Sample Name			C3-WWTP-SO-04-11	C3-WWTP-SO-B(+50)500-10.5	C3-WWTP-SO-B(+50)500-15	C3-WWTP-SO-B(+50)600-8	C3-WWTP-SO-BP07-11.5	C3-WWTP-SO-BP08-11	C3-WWTP-SO-BP08A-16	C3-WWTP-SO-BP09-15	C3-WWTP-SO-BP12-13	C3-WWTP-SO-C(+50)300-11	C3-WWTP-SO-C(+50)600-8.5	C3-WWTP-SO-C400-12	C3-WWTP-SO-C400A-14
Sample Depth (ft bgs)			11	10.5	15	8	11.5	11	16	15	13	11	8.5	12	14
Sample Date			07/10/09	07/10/09	07/20/09	07/08/09	07/08/09	07/08/09	07/20/09	07/21/09	07/20/09	07/10/09	07/08/09	07/10/09	07/20/09
Parent			N	N	N	N	N	N	N	N	N	N	N	N	N
Analyte	USEPA RSL	SSL													
	<b>Metals (6020, 7470A, 7471A) (mg/kg)</b>														
Aluminum	7,700	55,500,000	<b>17100</b>	<b>16300</b>	<b>15800</b>	<b>15500</b>	<b>16800</b>	<b>14100</b>	<b>14500</b>	<b>15900</b>	<b>15200</b>	<b>16300</b>	7310	<b>13900</b>	<b>16600</b>
Arsenic	0.39	5,000	<b>4.8</b>	<b>6</b>	<b>3.1 J</b>	<b>3.5 J</b>	<b>3 J</b>	<b>3.6 J</b>	<b>7.1</b>	<b>3.6 J</b>	<b>2.6 J</b>	<b>4.2 J</b>	<b>2.3 J</b>	<b>3.1 J</b>	<b>3.4 J</b>
Cadmium	7	376	0.27 J	0.23 J	0.23 J	0.42 J	0.3 J	0.35 J	0.23 J	0.23 J	0.21 J	0.26 J	0.33 J	0.26 J	0.25 J
Cobalt	2.3	496	<b>11.3</b>	<b>10.9</b>	<b>12.1 J</b>	<b>11.6</b>	<b>12.4</b>	<b>9.2</b>	<b>13.8 J</b>	<b>13</b>	<b>11 J</b>	<b>16.7</b>	<b>6</b>	<b>8.6</b>	<b>11 J</b>
Iron	5,500	7,530	<b>31600</b>	<b>29300</b>	<b>29700</b>	<b>26000</b>	<b>27500</b>	<b>25100</b>	<b>29000</b>	<b>30800</b>	<b>27700</b>	<b>30000</b>	<b>16500</b>	<b>22900</b>	<b>31700</b>
Lithium	16		<b>30.1</b>	<b>28.1</b>	<b>28.5</b>	<b>29.9</b>	<b>31.7</b>	<b>28.7</b>	<b>25.9</b>	<b>27.9</b>	<b>26.8</b>	<b>28.2</b>	14.3	<b>20.3</b>	<b>28.7</b>
Manganese	180	19,500	<b>721 J</b>	<b>668 J</b>	<b>765</b>	<b>748 J</b>	<b>804 J</b>	<b>651 J</b>	<b>1130</b>	<b>801</b>	<b>789</b>	<b>1070 J</b>	<b>813 J</b>	<b>1180 J</b>	<b>709</b>
Potassium			3400	3350	3330 J	2260 J	2580 J	2440 J	2890 J	3200 J	3200 J	3370	1210 J	1700	3520 J
Selenium	39	3000	< 4.4	< 4.4	< 4.3	< 4.2	< 4	< 4.2	< 4.4	< 4.2	1.5 J	< 4.3	< 3.9	< 4.4	< 4.2
Vanadium	39	180,000	38.5	38.4	34.6 J	35.9	36.3	34.6	32.8 J	36.3 J	37.4 J	38.4	19.8	31.3	36.4 J

*Legend*  
 USEPA RSL = USEPA Regional Screening Level for residential site use. One-tenth of the RSL for non-carcinogenic chemicals (except for lead) is used for comparison.  
 SSL = Site-Specific Screening Levels  
 Yellow shading and bold text = Analyte concentration is above the USEPA RSL  
 Gray shading = Overall concentrations of these analytes are greater than background levels  
 Green shading = Analyte concentration is above SSL  
 N = Normal Sample  
 FD = Field Duplicate  
 U = Analyte not detected. Value presented is reporting limit  
 J = Estimated value data qualifier  
 < = Analyte was not detected in concentrations above the reporting limit  
 mg/kg = milligram per kilogram  
 ft bgs = feet below ground surface

**Table 5-15. Subsurface Soil Above Screening Criteria (Cont.)**

Sample Name			C3-WWTP-SO-C700-14	C3-WWTP-SO-D(+50)300-11.5	C3-WWTP-SO-D(+50)600-15	C3-WWTP-SO-D(+50)600-2	C3-WWTP-SO-D400-11.5	C3-WWTP-SO-D500-14	C3-WWTP-SO-D700-15	C3-WWTP-SO-DUP-8	C3-WWTP-SO-DUP-9	C3-WWTP-SO-E(+50)300-3	C3-WWTP-SO-E(+50)600-7	C3-WWTP-SO-E400-11	C3-WWTP-SO-E500-16
Sample Depth (ft bgs)			14	11.5	15	2	11.5	14	15	20	15	3	7	11	16
Sample Date			07/08/09	07/10/09	07/21/09	07/21/09	07/10/09	07/20/09	07/21/09	07/21/09	07/21/09	07/10/09	07/10/09	07/09/09	07/09/09
Parent			N	N	N	N	N	N	N	FD	FD	N	N	N	N
Analyte	USEPA RSL	SSL													
<b>Metals (6020, 7470A, 7471A) (mg/kg)</b>															
Aluminum	7,700	55,500,000	<b>15800</b>	<b>8760</b>	<b>15100</b>	<b>13000</b>	<b>16500</b>	<b>15500</b>	<b>15300</b>	<b>10300</b>	<b>15800</b>	<b>15300</b>	<b>15900</b>	<b>17100</b>	<b>17300</b>
Arsenic	0.39	5,000	<b>2.1 J</b>	<b>3.2 J</b>	<b>3.8 J</b>	<b>3.2 J</b>	<b>3 J</b>	<b>3.3 J</b>	<b>3.2 J</b>	<b>2.9 J</b>	<b>2.8 J</b>	<b>3.2 J</b>	<b>6.9</b>	<b>3.7 J</b>	<b>3 J</b>
Cadmium	7	376	0.29 J	0.23 J	0.25 J	0.2 J	0.21 J	0.22 J	0.2 J	0.18 J	0.22 J	0.25 J	0.24 J	0.27 J	0.26 J
Cobalt	2.3	496	<b>10.1</b>	<b>6.7</b>	<b>12.4</b>	<b>9.1</b>	<b>11.9</b>	<b>10.7 J</b>	<b>12.9</b>	<b>7.9</b>	<b>12.1</b>	<b>10.1 J</b>	<b>11.1</b>	<b>13.6 J</b>	<b>11 J</b>
Iron	5,500	7,530	<b>26700</b>	<b>19700</b>	<b>29700</b>	<b>22700</b>	<b>29000</b>	<b>29600</b>	<b>29300</b>	<b>22200</b>	<b>29200</b>	<b>27800</b>	<b>29300</b>	<b>30300</b>	<b>30500</b>
Lithium	16		<b>30.7</b>	15.8	<b>27.4</b>	<b>22.8</b>	<b>27.6</b>	<b>26.2</b>	<b>29.3</b>	<b>19.6</b>	<b>28.8</b>	<b>26.5 J</b>	<b>28.2</b>	<b>30.3 J</b>	<b>29.3 J</b>
Manganese	180	19,500	<b>707 J</b>	<b>871 J</b>	<b>872</b>	<b>835</b>	<b>693 J</b>	<b>713</b>	<b>761</b>	<b>953</b>	<b>766</b>	<b>821</b>	<b>714 J</b>	<b>776</b>	<b>736</b>
Potassium			2790 J	1710	3000 J	2020 J	3380	3380 J	3020 J	2060 J	3390 J	3200	3420	3700 J	3800 J
Selenium	39	3000	5.8	< 4.3	< 4.3	< 4.1	< 4.4	< 4.2	< 4.4	< 4	< 4.5	< 4.1	< 4.3	< 4.2	< 4.4
Vanadium	39	180,000	36	23.5	33.6 J	27.9 J	38.8	34 J	35.7 J	24.3 J	35.9 J	33.4	35.3	38.6	<b>40</b>

*Legend*  
 USEPA RSL = USEPA Regional Screening Level for residential site use. One-tenth of the RSL for non-carcinogenic chemicals (except for lead) is used for comparison.  
 SSL = Site-Specific Screening Levels  
 Yellow shading and bold text = Analyte concentration is above the USEPA RSL  
 Gray shading = Analyte concentration is above background  
 Green shading = Analyte concentration is above SSL  
 N = Normal Sample  
 FD = Field Duplicate  
 U = Analyte not detected. Value presented is reporting limit  
 J = Estimated value data qualifier  
 < = Analyte was not detected in concentrations above the reporting limit  
 mg/kg = milligram per kilogram  
 ft bgs = feet below ground surface

**Table 5-15. Subsurface Soil Above Screening Criteria (Cont.)**

Sample Name			C3-WWTP-SO-E700-16	C3-WWTP-SO-F(+50)300-11	C3-WWTP-SO-F(+50)600-6	C3-WWTP-SO-F400-11	C3-WWTP-SO-F500-13.5	C3-WWTP-SO-F700-12	C3-WWTP-SO-G400-11	C3-WWTP-SO-G500-7	C3-WWTP-SO-G700-12	C3-WWTP-SO-TNT-B0-16	C3-WWTP-SO-TNT-B200-12	C3-WWTP-SO-TNT-B510-15	C3-WWTP-SO-TNT-B510-19
Sample Depth (ft bgs)			16	11	6	11	13.5	12	11	7	12	16	12	15	19
Sample Date			07/21/09	07/08/09	07/09/09	07/09/09	07/09/09	07/09/09	07/08/09	07/08/09	07/09/09	07/20/09	07/20/09	07/09/09	07/20/09
Parent			N	N	N	N	N	N	N	N	N	N	N	N	N
Analyte	USEPA RSL	SSL													
	<b>Metals (6020, 7470A, 7471A) (mg/kg)</b>														
Aluminum	7,700	55,500,000	7160	<b>16700</b>	<b>17300</b>	<b>16100</b>	<b>17400</b>	<b>17200</b>	<b>16400</b>	<b>9790</b>	<b>23900</b>	<b>15100</b>	<b>9010</b>	<b>15800</b>	<b>16100</b>
Arsenic	0.39	5,000	<b>2.8 J</b>	<b>3.5 J</b>	<b>3.7 J</b>	<b>2.7 J</b>	<b>3.7 J</b>	<b>3.5 J</b>	<b>2.9 J</b>	<b>4 J</b>	<b>4.1</b>	<b>3 J</b>	<b>4.5</b>	<b>5.2</b>	<b>3.2 J</b>
Cadmium	7	376	0.18 J	0.44 J	0.45	0.36 J	0.47	0.47	0.35 J	0.4 J	0.61	0.22 J	0.19 J	0.41 J	0.19 J
Cobalt	2.3	496	<b>6.4</b>	<b>15.2</b>	<b>12.2</b>	<b>10.8</b>	<b>10.7</b>	<b>10.9</b>	<b>12.7</b>	<b>6.9</b>	<b>16.8</b>	<b>10.3 J</b>	<b>7.9 J</b>	<b>12.3</b>	<b>11.9 J</b>
Iron	5,500	7,530	<b>18300</b>	<b>29400</b>	<b>29000</b>	<b>27500</b>	<b>30200</b>	<b>28900</b>	<b>28200</b>	<b>19400</b>	<b>37700</b>	<b>28600</b>	<b>21200</b>	<b>27600</b>	<b>28600</b>
Lithium	16		15.6	<b>30.7</b>	<b>27.3</b>	<b>28.2</b>	<b>29.8</b>	<b>29.2</b>	<b>31.3</b>	15.7	<b>38.7</b>	<b>26.5</b>	<b>16.5</b>	<b>25.4</b>	<b>28.6</b>
Manganese	180	19,500	<b>1120</b>	<b>899 J</b>	<b>792 J</b>	<b>691 J</b>	<b>655 J</b>	<b>677 J</b>	<b>860 J</b>	<b>721 J</b>	<b>762 J</b>	<b>721</b>	<b>960</b>	<b>760 J</b>	<b>680</b>
Potassium			1360 J	3100 J	2980	2810	3120	3190	2940 J	836 J	4420	3040 J	1640 J	2960	3560 J
Selenium	39	3000	< 4	< 4.4	< 4.1	< 4.4	1.4 J	< 4.2	< 4.3	< 4.3	< 5	< 4.4	< 4	< 4.2	< 4.2
Vanadium	39	180,000	18.2 J	<b>39.7</b>	<b>39.6</b>	<b>39.7</b>	<b>39.4</b>	<b>40.6</b>	37.6	29.3	<b>58.7</b>	33.4 J	22.5 J	33.7	33.5 J

*Legend*  
 USEPA RSL = USEPA Regional Screening Level for residential site use. One-tenth of the RSL for non-carcinogenic chemicals (except for lead) is used for comparison.  
 SSL = Site-Specific Screening Levels  
 Yellow shading and bold text = Analyte concentration is above the USEPA RSL  
 Gray shading = Analyte concentration is above background  
 Green shading = Analyte concentration is above SSL  
 N = Normal Sample  
 FD = Field Duplicate  
 U = Analyte not detected. Value presented is reporting limit  
 J = Estimated value data qualifier  
 < = Analyte was not detected in concentrations above the reporting limit  
 mg/kg = milligram per kilogram  
 ft bgs = feet below ground surface

<b>Table 5-15. Subsurface Soil Above Screening Criteria (Cont.)</b>								
<b>Sample Name</b>			C3-WWTP-SO-TNT-C640-14	C3-WWTP-SO-TNT-C640-20	C3-WWTP-SO-TNT-D0-14	C3-WWTP-SO-TNT-D200-18	C3-WWTP-SO-TNT-D510-14	C3-WWTP-SO-TNT-E640-14
<b>Sample Depth (ft bgs)</b>			14	20	14	18	14	14
<b>Sample Date</b>			07/09/09	07/21/09	07/20/09	07/20/09	07/09/09	07/09/09
<b>Parent</b>			N	N	N	N	N	N
<b>Analyte</b>	<b>USEPA RSL</b>	<b>SSL</b>						
<b>Metals (6020, 7470A, 7471A) (mg/kg)</b>								
Aluminum	7,700	55,500,000	<b>16600</b>	<b>11100</b>	<b>15500</b>	<b>14500</b>	<b>16300</b>	<b>16000</b>
Arsenic	0.39	5,000	<b>2.3 J</b>	<b>2.7 J</b>	<b>4.4</b>	<b>5.5</b>	<b>4.7</b>	<b>2.5 J</b>
Cadmium	7	376	0.39 J	0.21 J	0.24 J	0.23 J	0.49	0.49
Cobalt	2.3	496	<b>9.7</b>	<b>8.6</b>	<b>10.8 J</b>	<b>11.1 J</b>	<b>10</b>	<b>9</b>
Iron	5,500	7,530	<b>27500</b>	<b>22600</b>	<b>30600</b>	<b>29500</b>	<b>28800</b>	<b>25000</b>
Lithium	16		<b>26.6</b>	<b>21.7</b>	<b>26.9</b>	<b>26.4</b>	<b>26.9</b>	<b>27.5</b>
Manganese	180	19,500	<b>707 J</b>	<b>743</b>	<b>736</b>	<b>731</b>	<b>644 J</b>	<b>648 J</b>
Potassium			3090	2200 J	3170 J	2950 J	3000	3000
Selenium	39	3000	< 4.2	< 3.9	< 4.3	< 4.2	< 4.2	< 4.2
Vanadium	39	180,000	<b>39.3</b>	26.4 J	34 J	33.4 J	<b>42.1</b>	33.9
<p><i>Legend</i>                      USEPA RSL = USEPA Regional Screening Level for residential site use. One-tenth of the RSL for non-carcinogenic chemicals (except for lead) is used for comparison.                      SSL = Site-Specific Screening Levels                      Yellow shading and bold text = Analyte concentration is above the USEPA RSL                      Gray shading = Analyte concentration is above background                      Green shading = Analyte concentration is above SSL                      N = Normal Sample                      FD = Field Duplicate                      U = Analyte not detected. Value presented is reporting limit                      J = Estimated value data qualifier                      &lt; = Analyte was not detected in concentrations above the reporting limit                      mg/kg = milligram per kilogram                      ft bgs = feet below ground surface</p>								

### 5.5 Field Groundwater Quality Screening Results

During the purge and sample events of three newly installed groundwater MWs, field groundwater quality parameters were screened in order to make general assumptions regarding groundwater quality and to ensure connectivity with the underlying target aquifer. Table 5-15 provides the field screen groundwater quality data recorded at the time each groundwater sample was collected, which indicates that the aquifer is oxidative. An oxidative aquifer is one in which chemical reactions result in the loss of electrons and the accumulation of oxygen molecules to a substance. Complete groundwater quality data for the entire purge events is provided in Appendix D.

**Table 5-16. Field Screening Groundwater Quality Parameters**

Sample ID	Sample Date	Pumping Rate (ml/min)	pH	Specific Conductivity (mS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Temperature (degrees Celsius)	Oxygen Potential Reduction (mV)
C3-WWTP-MW-BP-14-20	11/12/09	125	7.24	1.72	20.0	7.09	12.8	147
C3-WWTP-MW-BP-15-19	11/12/09	350	7.45	1.32	22.3	10.46	13.1	178
C3-WWTP-MW-BP-16-18	11/12/09	300	7.27	2.33	108	5.88	13.4	145
<i>Legend</i> mg/L – milligrams per liter ml/min – milliliters per minute mS/cm – milliSiemens per centimeter mV – millivolts NTU – nephelometric turbidity units								

### 5.6 Groundwater Analytical Results

Groundwater samples were collected from three newly installed MWs. Each MW was purged until field screen groundwater parameters appropriately stabilized in accordance with the approved FSP (USACE/ERT/EA, 2009e). Each groundwater sample collected was laboratory analyzed for VOCs, SVOCs, PAHs, pesticides, PCBs, explosives, and total TAL metals. Results from the laboratory analysis were screened against the established screening criteria for the Phase IV RI. Table 5-16 presents groundwater sample results for constituents exceeding the screening criteria and constituents exceeding the background threshold value (BTV). Figure 5-4 presents reported constituents in groundwater. Complete analytical data packages and summarized constituent detections for the Phase IV RI are provided in Appendix F.

Two VOC constituents were detected at concentrations exceeding USEPA RSLs for drinking water. Concentrations of bromodichloromethane exceeded the USEPA RSL for drinking water (0.12 µg/L) in groundwater sample C3-WWTP-MW-BP14-20 (0.22 µg/L). Chloroform concentrations exceeded the USEPA RSL of 0.19 µg/L in groundwater samples C3-WWTP-MW-BP14-20 (0.76 µg/L) and C3-WWTP-MW-BP16-18 (0.49 µg/L).

The groundwater sample C3-WWTP-MW-BP15-19 exhibited two PAH concentrations exceeding project screening criteria. The concentration of dibenzo(a,h)anthracene (0.11 µg/L) exceeded the USEPA RSL for drinking water of 0.0029 µg/L, and the concentration of benzo(a)pyrene (0.012 µg/L) exceeded the USEPA RSL for drinking water of 0.0029 µg/L.

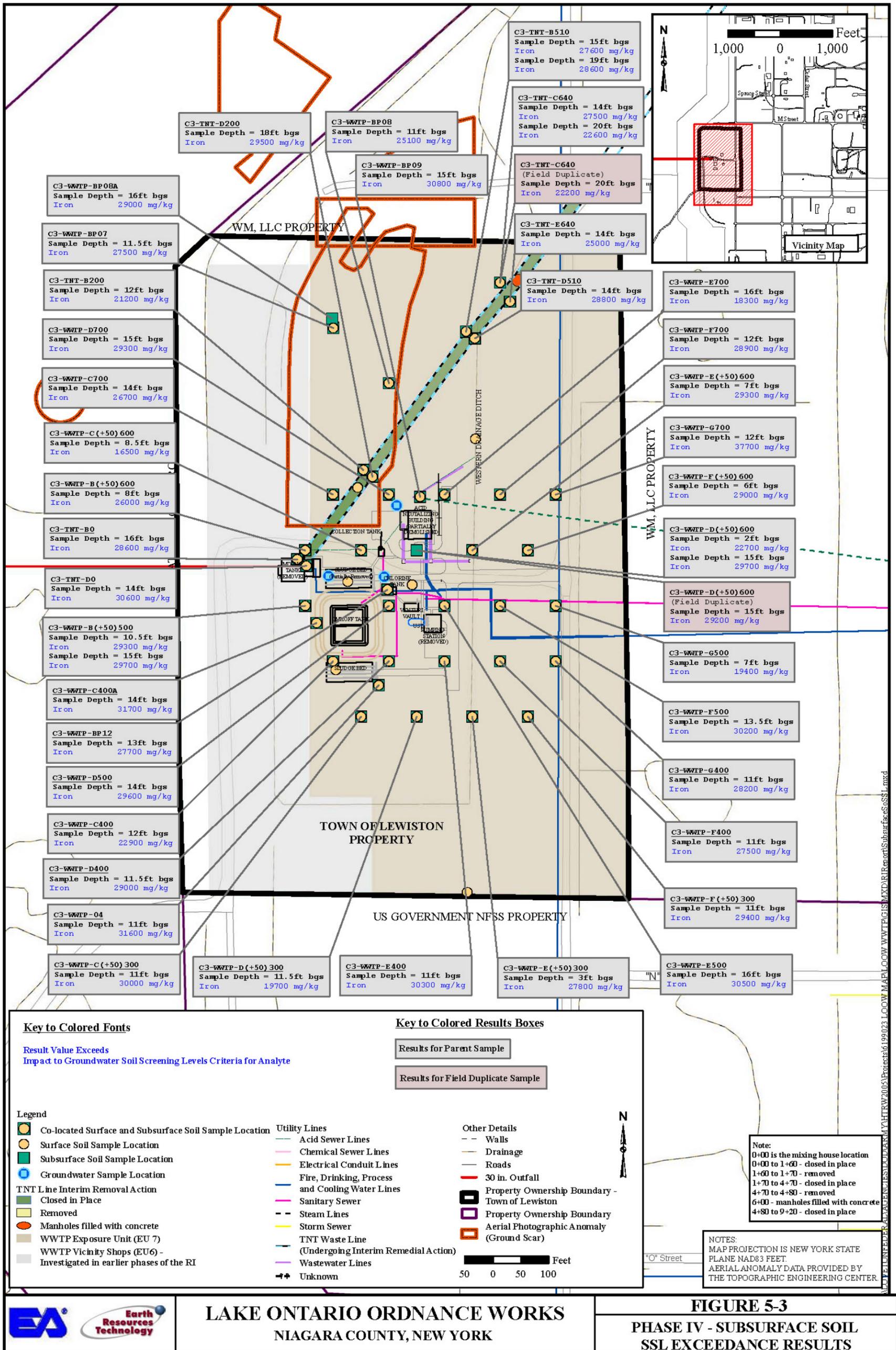
Eight metal constituents were detected at concentrations exceeding the screening criteria. Five metal constituents; aluminum, barium, chromium, selenium and silver were detected at concentrations exceeding the BTV in groundwater samples. Of the five constituents detected at concentrations above the BTV, none were detected at concentrations exceeding both the BTV and the screening criteria. Three metal constituents; arsenic, lithium and magnesium were detected at concentrations exceeding the project screening criteria, but at concentrations less than the BTV. There were no metal constituents detected at concentrations exceeding both the project screening criteria and the BTV.

**Table 5-17. Groundwater Results Above Screening Criteria**

				C3-WWTP-MW- BP14-20	C3-WWTP-MW- BP15-19	C3-WWTP-MW- BP16-18	C3-WWTP-MW- DUP01
Sample Name							
Sample Depth (ft bgs)				14	15	16	15
Sample Date				11/12/09	11/12/09	11/12/09	11/12/09
Sample type				N	N	N	FD
Analyte	USEPA RSL Tap Water	NYS TOGS	Background Threshold Value				
<b>Volatile Organic Compounds (8260C) (µg/L)</b>							
Bromodichloromethane	0.12			0.22 J	< 1	< 1	< 1
Chloroform	0.19			0.76 J	< 1	0.49 J	< 1
<b>PAH (8270C) (µg/L)</b>							
Benzo[a]pyrene	0.0029			< 0.022	0.012 J	< 0.022	< 0.023
Dibenz[a,h]anthracene	0.0029			< 0.02	0.011 J	< 0.02	< 0.021
<b>Metals, Total (6010) (mg/L)</b>							
Aluminum	3.7		0.98	0.873 J	<b>2.66 J</b>	0.785 J	<b>2.33 J</b>
Arsenic	0.000045		0.031	0.0014 J	< 0.0026	< 0.0026	< 0.0026
Barium	7.3		0.047	0.0448 J	<b>0.0716 J</b>	0.0458 J	<b>0.0745 J</b>
Chromium	5.5		0.0032	0.0026 J	<b>0.0044</b>	<b>0.006</b>	<b>0.004</b>
Lithium	0.007		1.1	0.008	0.0221	0.0274	0.0218
Magnesium		35	580	95.7	87.2	163	89.6
Selenium	0.018		0.0042	0.0028 J	<b>0.0045 J</b>	< 0.0077	0.0024 J
Silver	0.018		0.000018	<b>0.001 J</b>	<b>0.001 J</b>	<b>0.0014 J</b>	< 0.0032
<p><i>Legend</i>                      USEPA RSL = USEPA Regional Screening Level for tap water (December 2009). One-tenth of the RSL for non-carcinogenic chemicals (except for lead) is used for comparison.                      NYS TOGS = New York State Technical and Operational Guidance Series (TOGS) 1.1.1 Ambient Water Quality Standards and Guidance Values. NYS TOGS value is presented only if a RSL is unavailable.                      Yellow shading = Value above USEPA RSL or, if a RSL is unavailable, above NYS TOGS value                      Bold text = Reported concentration exceeds the background threshold value (BTV) calculated from a background groundwater data set (USACE/SAIC 2007b) (Appendix I)                      N = Normal Sample                      FD = Field Duplicate                      U = Analyte not detected. Value presented is reporting limit                      J = Estimated value data qualifier                      &lt; = Analyte was not detected in concentrations above the reporting limit                      µg/L = micrograms per liter                      mg/L = milligram per liter                      ft bgs – feet below ground surface</p>							

Place Holder for Figure 5-1. Plotted Figure included in a separate sleeve.

Place Holder for Figure 5-2. Plotted Figure included in a separate sleeve.

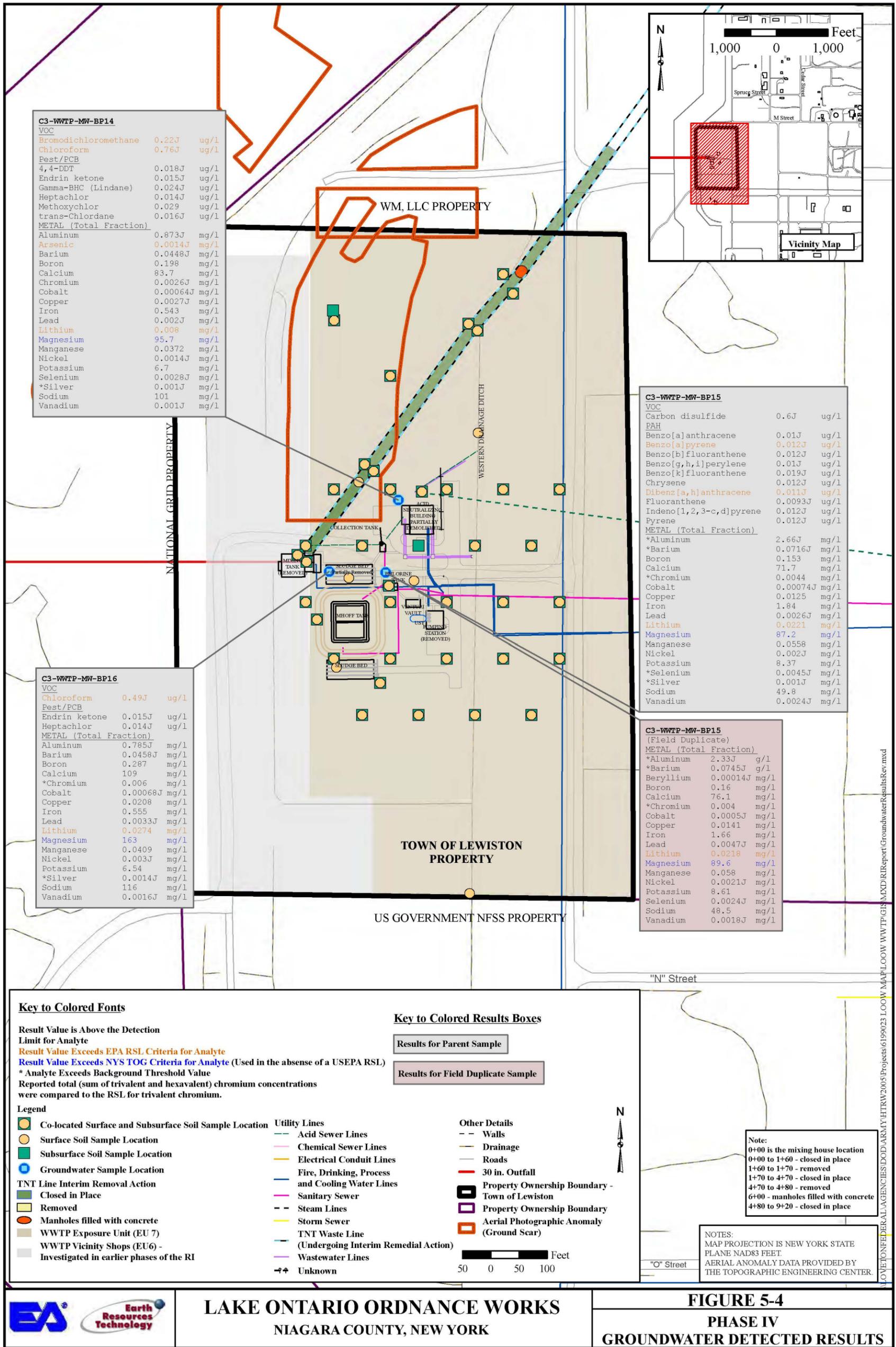


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**LAKE ONTARIO ORDNANCE WORKS**  
 NIAGARA COUNTY, NEW YORK

**FIGURE 5-3**  
 PHASE IV - SUBSURFACE SOIL  
 SSL EXCEEDANCE RESULTS



**LAKE ONTARIO ORDNANCE WORKS**  
 NIAGARA COUNTY, NEW YORK

**FIGURE 5-4**  
**PHASE IV**  
**GROUNDWATER DETECTED RESULTS**



## **6.0 CONTAMINANT FATE AND TRANSPORT**

In order to completely characterize the site, an evaluation of the environmental fate and transport of constituents that were reported at concentrations exceeding the screening criteria must be performed. During the Phase IV RI, surface soil, subsurface soil, sediment and groundwater were evaluated and detected constituents exceeding the screening criteria were evaluated for persistence in the environment and the potential for inter-media transfer and migration. The subsections detail the potential routes of constituent transport; estimate the persistence of identified COPCs based on physical, chemical and biological factors affecting fate and transport; and predict migration routes of COPCs.

Based on the history of the site, there are a number of potential sources of contamination. The very nature of former WWTP activities consisted of receiving wastewater with elevated constituent levels, treating the wastewater and discharging the treated water to the Niagara River. Various operational structures and utilities associated with the WWTP provide potential contaminant sources. In addition, although an IRA was performed on the TNT waste lines that traverse the site to the mixing house, for the purpose of this investigation it was assumed that some residual contaminants may have remained in the soil in the vicinity of the lines subsequent to the IRA.

### **6.1 Potential Routes of Migration**

Migration pathways from a source provide the route of transport for released chemicals to be transported across and between media. Migration pathways can be naturally occurring or man-made pathways. Typically, surface and subsurface soil are not considered transport media, although if sufficiently impacted, may affect the final transportation and disposition of identified COPCs.

#### **6.1.1 Airborne Transport**

Movement of surface soil particulates or off-gassing of VOCs from impacted soils via atmospheric wind is a transportation pathway. Such particulate transport is generally limited due to particle size, wind speeds and other site-specific conditions. Off-gassing of VOCs through surface soil is typically directed by chemical properties of the constituent, site-specific soil types and surface conditions at the site. Contaminant transport via wind across the former WWTP site is not likely, but possible. Surface soil generally consists of overgrown vegetation which tends to suppress erosion and the airborne transport of particulates. However, there are areas of the site (i.e., roadways) that are not overgrown with vegetation and provide potential air transport concerns.

#### **6.1.2 Soil and Sediment Transport**

Site conditions maintain the movement of surface water flow towards historic site structures (vaults, pits, etc.) and the WDD. Surface water flows tend to accumulate soil and sediment deposits which are ultimately deposited along with the surface water into drainage ditches or the historic site structures.

### **6.1.3 Surface Water Transport**

Site conditions maintain the movement of surface water flow towards historic site structures (vaults, pits, etc.) and the WDD. Surface water provides a potential critical pathway for chemical constituents to migrate from a source area. Based on the typical topography associated with the site, characterized by relatively level grade surface and a number of man-made structures associated with the treatment of wastewater. During heavy rain events, sheet flow or overland flow of surface water may result in surface water draining into the nearest drainage ditch or man-made structure. Engineering of the various drainage ditches associated with the former LOOW ultimately directs the drainage ditches discharging into local streams.

Direct infiltration of surface water to the shallow groundwater can contribute to the migration of COPCs. The overall low permeability at the site severely impacts the static groundwater conditions and does not allow for uniform groundwater conditions. The near homogeneous presence of fine-grained silt/sands and shallow UCT layer should inhibit surface water infiltration into the shallow groundwater. In addition, vegetation typically inhibits the erosion of soil particles and very few areas at the site are devoid of ground surface grass and brush vegetation.

### **6.1.4 Groundwater Transport**

Groundwater recharge at the site is from precipitation and snowmelt infiltration. As water filters through the surface soil and overburden and then into the soil pores, constituents can then be transported via groundwater flow from areas of high hydraulic head to areas of low hydraulic head. Hydraulic head is the water level pressure at a point in an aquifer which is determined by measuring the height of the water in a groundwater well and converting it to a water level height above a geodetic datum. In order to completely evaluate the groundwater migration; horizontal groundwater flow, vertical groundwater flow and residence time must be investigated.

Generally, groundwater flow at the site is within the unconsolidated deposits and conforms to the local topography. Locally, groundwater at the site flows through low permeability subsurface material to the primary series of surface drainage ditches and streams associated with the former LOOW. Regional groundwater flow is towards Lake Ontario to the north and the Niagara River to the west.

Due to local geology, perched groundwater is also present in intermittent lenses of saturated alluvium, fill or silt and sand, particularly around surface water bodies. Lateral groundwater flow is severely restricted due to the discontinuous nature of the saturated lenses and low groundwater flow rate, which was previously calculated at 0.11 ft/yr (Golder, 1993).

Groundwater may also migrate downward to the lower saturated layers, although downward recharge is expected to be minimal due to the low vertical permeability of the local strata. Groundwater presents a potential migration pathway of concern because all necessary migratory components are present at the site; infiltration, leaching, vertical flow, and advective flow.

## **6.2 Contaminant Persistence**

The main transport mechanisms in groundwater include advection, hydrodynamic dispersion, diffusion, and sorption. Advection describes the process by which solutes are transported by

flowing fluids, such as groundwater. Transport under this scenario is directly proportional to the rate of groundwater flow and proximal to the direction of the groundwater flow.

Hydrodynamic dispersion describes the process of horizontal and vertical aqueous mixing of a solute being advected that causes a blended zone to be developed between adjacent aqueous solutions or displaced aqueous solutions by the adjacent differing aqueous solution. Mixing of the two zones is continued through molecular diffusion and/or mechanical dispersion.

Acid-base reactions, volatilization, precipitation, complexation, sorption, oxidation-reduction, hydrolysis and isotopic reactions all affect constituent fate and transport.

Sorption of organic compounds to soil or sediment is quantified by a partitioning coefficient,  $K_d$ , which is defined

$$K_d = C_s/C_w$$

Where:

$C_s$  = concentration of a constituent sorbed to a specific weight of soil

$C_w$  = concentration of the same constituent dissolved in a equal weight of water (Olson et al., 1982)

The sorption coefficient is commonly expressed on an organic carbon basis and defined as:

$$K_{oc} = K_d/f_{oc}$$

Where:

$f_{oc}$  = fractional mass of organic carbon in the matrix

The sorption coefficient provides an indication of the tendency of a chemical to partition between particles containing organic carbon content and water. The greater the  $K_{oc}$ , the less likely the constituent will partition from soil to water.

The distribution coefficient,  $K_d$ , for a given solute is directly proportional to the organic content of a soil or sediment. The greater the organic carbon content, the greater the value of  $K_d$  (Karckhoff, 1979). This approach for estimating  $K_d$  is applicable only to soil typically containing organic matter greater than 0.1 percent. In soil that contains lower than 0.1 percent organic carbon, sorption of neutral organics onto the mineral phase can cause erroneous  $K_d$  estimates (Chiou, 2002). For subsurface soil at the WWTP, the average total organic carbon (TOC) concentrations (including surface and subsurface soil) is 16,500 mg/kg or 1.65 percent.

Organic compounds under naturally occurring environmental conditions will ultimately revert to elemental forms due to exposure to the air, water, bacteria, sunlight, soil or a combination of these factors. The persistence of organic constituents in the environment is directly related to its specific resistance to degradation. Utilizing published data, the organic constituents that were reported above the screening criteria were evaluated to assess applicable rates of degradation (Table 6-1).

**Table 6-1. Estimated Properties for Organic Analytes**

Analyte	Media	Half-Life Range <sup>a</sup>	K <sub>oc</sub> <sup>b</sup> (L/kg)	K <sub>d</sub> <sup>b</sup> (L/kg)	Retarded Migration Rate (ft/yr)	Solubility <sup>c</sup> (mg/L)	Vapor Pressure <sup>c</sup> (mm Hg)
<b>Volatile Organic Compounds</b>							
Bromodichloromethane	Water	16 days	5.5E+01	1.06E-05	4.3E-01	4.5E+03	50 at 20°C
Chloroform	Water	2 months – 5 years	5.3E+01	0.2.6E-01	2.1E-02	7.9E+03	100 at 10.4°C
<b>PAHs</b>							
Benzo[a]anthracene	Soil/ Water	0.3-1.9 years/ 0.6-3.7 years	4.0E+05	2.0 E+03	3.4E-06	1.4E-02	5E-09
Benzo[a]pyrene	Soil/ Water	0.2-1.5 years/ 0.3-2.9 years	1.0E+06	5.0E+03	1.3E-06	4.0E-03	5.49E-09
Benzo[b]fluoranthene	Soil/ Water	1-1.7 years/2- 3.3 years	1.2E+06	6.1E+03	1.1E-06	1.2E-03	5.0E-7 at 20°C
Benzo[k]fluoranthene	Soil/ Water	2.5-5.9 years/ 5-12 years	1.2E+06	6.1E+03	1.1E-06	1.60E-03	6.3E-7 at 20°C
Dibenz[a,h]anthracene	Soil/ Water	1-2.6 years/ 2-5.2 years	3.8E+06	1.9E+04	3.6E-07	5.00E-04	1E-10 at 20°C
Indeno[1,2,3-c,d]pyrene	Soil/ Water	1-6.2 years/ 3.3-4 years	3.5E+06	1.7E+04	3.9E-07	6.2E-02	1E-10
<i>Legend</i> <sup>a</sup> – Mackay (1992a, 1992b, 1993, 1995) <sup>b</sup> – K <sub>oc</sub> for organics and K <sub>d</sub> for metals from USEPA Region 9 or ORNL (2001) <sup>c</sup> – Assumed to be at 25°C, unless otherwise stated L/kg – liters per kilogram ft/yr – ft per year mg/L – milligrams per liter mm Hg – millimeters of mercury							

Rate of degradation is presented in half-lives; or the amount of time necessary to effectively reduce a given constituent quantity in half. Half-lives are based on the highest and lowest degradation rates associated with the dominant degradation process within a particular media.

Soil constituents are typically degraded due to biodegradation and hydrolysis. Most hydrolysis half-lives in soil are based upon rate data determined in water, since hydrolysis data in soil were rare to find (Howard, 1993). Soil half-lives provide an estimate of the natural in-situ attenuation of the target compound.

Groundwater constituents are typically degraded by biodegradation and hydrolysis. Generally, the biodegradation of constituents in groundwater occurs at a slower rate compared to surface water, due to limited microbial populations in groundwater and the enzymatic capabilities of the microbes. In addition, groundwater is more likely to be anaerobic, further limiting certain microbial populations. Dependable data are typically not accessible for groundwater constituents.

Half-lives presented, are based on estimated times of degradation from available and trusted resources. For both soil and groundwater, concentration was considered to be unaffected by additional source loading.

The migration rate of organic compounds relative to groundwater flow considering adsorption to organic matter can be estimated by calculating the retardation factor, based on  $K_d$  as follows:

$$R = 1 + K_d \times \rho_b/n$$

Where:

$\rho_b$  – soil bulk density [estimated at 1.4 g/cm<sup>3</sup> (USACE/EA, 2002)]

$n$  = effective porosity [estimated at 0.1 (USACE/EA, 2002)]

The retarded plume velocity is approximated by:

$$V_c = V/R$$

Where:

$V_c$  = plume velocity

$V$  = average groundwater flow velocity [estimated as 0.11 ft/yr for UCT (Golder, 1993)]

The estimated plume retardation velocities based on this analysis for the various organic COPCs are listed in Table 6-1. A bulk density of 1.4 g/cm<sup>3</sup> and  $F_{oc}$  of 1.65 percent is assumed. These estimated velocities do not include other transport and retardation factors. Lower retardation velocities calculated indicate limited constituent transport via groundwater.

The dissolution of soil constituents into infiltrating groundwater was considered during this assessment.

### **6.2.1 Natural Attenuation of Organic Compounds**

The natural attenuation of organic compounds refers to the reduction of contaminant mass due to naturally occurring environmental processes, including; physical processes, chemical processes, and biological processes. Physical and chemical sorption processes result in a decrease of concentration and mobility, but do not reduce the total contaminant mass. Contaminant mass may be reduced only through abiotic chemical and biological processes.

The reduction of organic compounds is the result of electron transfers between a donor and an acceptor, which occurs within an aerobic reducing environment. These chemical reactions are generally defined as biologically mediated redox reactions (Chiou, 2002) and are typically facilitated by naturally occurring microorganism populations. Naturally, microbial degradation is most effective on low to moderate organic constituent concentrations (USEPA, 1998). Normally, microorganism population capable of effectively degrading organic compounds, flourish in a pH range of between 5 and 9 (USEPA, 1998). Carbon dioxide is a by-product of the oxidation of organic compounds, which in forming carbonic acid in groundwater effectively reduces the groundwater pH. The oxygenation potential of a groundwater environment is considered the redox potential and in aerobic environments the redox potential is typically above 50 mV and a dissolved oxygen concentration of greater than 0.8 mg/L.

Microbial degradation of organic compounds typically results in an aerobic environment transforming into an anaerobic environment as electron acceptors are systematically depleted. With the introduction of organic compounds, oxygen, favored by microbial populations is depleted. Upon transitioning to an anaerobic environment, microbial populations begin to

sequentially utilize other components for respiration including nitrate, manganese oxide, ferrous oxide and sulfate.

Typical organic compound plumes exhibit aerobic degradation along the outer limits of the plume and anaerobic degradation within the center of the plume. It is not uncommon for contaminant plumes to have differing zones of reduction that are supported by specific components. Anaerobic degradation may be assisted by the occurrence compounds such as ferrous iron and manganese oxide.

Natural attenuation is generally confirmed via a series of evidence supporting the overall degradation process. Primary evidence for natural attenuation is evaluated by the accumulation of historical analytical data. There have been no groundwater samples collected previously at the WWTP site and therefore this evidence of natural attenuation is not available. Geochemical data can be used as a secondary form of evidence to support natural attenuation. Geochemical data includes groundwater quality parameters such as redox, pH and dissolved oxygen. Data from the WWTP site indicates groundwater and soil pH ranges from 7 to 8, considered a neutral pH level. Within the shallow aquifer, redox potential has been determined to be between 140 and 180 mV and dissolved oxygen has been determined to be between 5.5 and 10.5 mg/L. Such conditions are typical of supporting aerobic degradation of organic compounds.

### **6.2.2 Metals**

Metal constituents were identified in soil above background concentrations and screening levels. The potential for transport of metal analytes in the subsurface is based upon analyte specific affinity to soil and groundwater. Factors affecting transport dynamics include soil-water chemistry and charge deficiency on adsorbent surfaces, such as soil and sediment. In order to neutralize the surface charge, an accumulation of ions near the soil-groundwater interface is required. Factors including soil texture, soil chemistry, pH and redox potential also enhance or diminish the mobility of a particular metal analyte. Typically, the solubility of metals tends to increase proportional to increased acidity, and conversely under alkaline conditions.

There are numerous natural materials that strongly interact with water. Metal sorption is affected primarily by physical and chemical processes. Generally, the sorption coefficient for a metal is indicative of the relative affinity of a metal to soil, and ultimately the immobility of the metal. Physical adsorption is due to surface charges which attract ionic specie of the opposite charge. Hydrous oxides may also promote the sorption of metals. Metal ions sorbed to these surfaces become precipitated with the hydrous oxides. Chemical processes for adsorption include ion exchanges, precipitation, solid-state diffusion and isomorphic substitution. Organic matter may also result in metals sorbing to soil and sediment making them insoluble in groundwater.

### **6.3 Potential Routes of Site COPC Migration**

Fate and transport physiochemical principals and characteristics of chemicals were used to evaluate site-specific analytical data in order to identify COPCs reported above the screening levels that have the potential to persist or migrate along potential transport pathways. Four pathways were evaluated; air transport, soil erosion, surface water runoff, and groundwater flow.

Air transport of impacted soil is possible but considered unlikely due to the minimal amount of exposed soil at the site and the heavy vegetation enclosing the site.

Offsite migration of COPCs via surface water and soil erosion in exposed areas is possible on a limited basis. Dissolved VOCs in surface water will tend to migrate most efficiently. Heavier PAHs and pesticides will not readily dissolve in surface water, but will tend to adsorb to soil and degrade slowly. Metals adhered to eroded soil may be transported via surface water.

Due to the low hydraulic conductivity and discontinuous groundwater aquifer, off-site exposure to impacted groundwater is considered negligible based on the surrounding land use and absence of potable groundwater wells. The only potential exposure to impacted groundwater would result from impacted groundwater that discharges into the surface drainage ditches (specifically the WDD) and is transported to local streams. The collection of analytical data at the discharge points of the surface drainage ditches to local streams was not within the scope of this RI and was therefore not evaluated. Organic compounds dissolved in groundwater aquifers containing clay and/or organic material, in general, will tend to have a migration rate that is much less than the groundwater velocity. Since the surface and subsurface soils at the site have a high clay content, the migration rate of organic compounds is generally expected to be slow, although under variable conditions, migration is still possible. Heavier constituents and metals in groundwater typically sorb to clays and organic materials and precipitate out of groundwater. In addition, due to the predominantly aerobic and neutral pH conditions at the site, it is assumed that migration for these constituents is negligible.

## **7.0 NATURE AND EXTENT OF CONTAMINATION**

One of the objectives of the RI field activities is to characterize the nature and extent of contamination based on statistically valid analytical data. Determining the nature and extent of contamination involves evaluating potential source areas, analytical data, COPC fate and transport properties and physical site characteristics, in order to determine the likely location of COPCs and extents of migration. Based on the sampling approach presented for the Phase IV RI, an evaluation of the nature and extent of contamination is presented in the following subsections.

### **7.1 Systematic Soil Sampling**

Systematic surface soil and subsurface soil sampling was utilized to evaluate potential impacts across the former WWTP site. Acetone detected in numerous soil samples exceeding the project screening criteria, is considered to be a common laboratory contaminant at the concentrations exhibited, resulting from the USEPA Method 5035 and is not considered to be an impact to the environment.

Lithium and vanadium were detected in numerous systematic and biased surface soil samples at concentrations exceeding background concentrations and the screening criteria. Lithium and vanadium detections exceeding the background and screening criteria, do not exhibit any specific pattern indicative of a source area or action.

The surface soil sample, C3-WWTP-WO-C(+50)600-0.5, located adjacent to the roadway and northeast of the northern sludge bed indicated concentrations of several PAHs above the project screening criteria. This was the only location exhibiting PAH concentrations at levels above the project screening criteria. Based on the location of the sample it is likely that the COPC concentrations were the result of previous insecticides and/or tarring of the dirt roadway. The PAH impacts appear to be isolated to this single location in the middle of the site.

There were not widespread significant impacts to the site identified based on the systematic soil sampling activities.

### **7.2 Biased Soil Sampling**

Biased sampling was conducted to target specific site features and determine if environmental impacts exist at the site.

Two surface soil samples, C3-WWTP-SO-BP10-0.5 and C3-WWTP-SO-BP11-0.5, were collected at the former locations of transformers containing PCB-laden oil to determine if the transformers had potentially leaked or significantly impacted the adjacent surface soil. Analysis of the two samples did not detect the presence of any PCB compounds and it is therefore ascertained that the transformers did not significantly impact the environment.

Two soil samples, C3-WWTP-SO-04-0.5 and C3-WWTP-SO-04-11, were collected to confirm the presence of carbon tetrachloride concentrations previously detected during Phase II RI field screen soil sampling. Analysis of two samples, co-located as surface and subsurface samples,

collected from the previous field screen sample to the southeast of the southern sludge bed do not confirm previously identified carbon tetrachloride concentrations.

Eighteen soil samples were collected from nine locations along the former TNT waste lines and analyzed to confirm that significant impacts did not remain after completion of the IRA. During the Phase IV RI, confirmatory samples were not collected from within the remnants of the former TNT waste line, but nine of the eighteen soil samples collected in association with this area, were collected from depths equal to or below the existing structure. Explosive constituents were not detected in any of the surface or subsurface soil samples, and it can therefore be ascertained that the previous IRA along the former TNT waste lines did address all potential contaminant issues. Explosive constituents were not detected in any of the soil samples collected from across the site.

One soil sample was collected adjacent to a manhole located north of the acid neutralization building. The manhole was used as an access point to the acid sewer line and wastewater lines convergence point prior to the lines entering the acid neutralization building. Analytical results did not detect concentrations of any analytes or compounds exceeding the project screening levels. Therefore it is ascertained that there are no significant environmental impacts resulting from contents within the waste lines which may have leached from the lines due to degrading structural integrity of the convergence of waste lines as they enter the former WWTP. These sample results cannot be used to confirm or deny potential impacts resulting from the waste lines at other locations along the lines; however, underground lines were addressed in the Phase III RI.

Five soil samples; co-located surface and subsurface samples; were collected from two sample locations associated with a ground scar previously identified in the USATEC Historical Photographic Analysis Report (USATEC, 2002) in order to identify any significant impacts. Analysis of the two surface soil samples identified lithium at concentrations exceeding the project screening criteria. Analysis of three subsurface soil samples did not detect compounds or analytes exceeding the project screening criteria. Based on the analytical results from the ground scar location, it can be ascertained that no significant environmental impacts are present.

Two soil samples were collected to confirm or deny the presence of significant impacts within the northern and southern sludge beds. Vanadium was detected in the northern sludge bed at concentrations exceeding the project screening criteria. Lithium was detected in the sample collected from the northern sludge bed at a concentration exceeding the screening criteria by less than an order of magnitude. Based on the analytical results from samples collected within the sludge beds, it is ascertained that no significant environmental impacts are present.

Two soil samples were collected from within the WDD to investigate the presence of significant impacts resulting from the accumulation of COPCs. Zinc and lithium were detected in the samples at concentrations exceeding the project screening criteria. Lithium has been detected in several soil samples across the site at low concentrations. Zinc, a naturally occurring mineral is of great importance to biological and human health, is not considered to significantly impact the environment.

### **7.3 Groundwater Sampling**

Groundwater samples from three locations adjacent to former WWTP structures were collected. Analysis of the samples indicates concentrations of VOCs, PAHs, pesticides and metals exceeding the project screening criteria. Concentrations of chloroform and bromodichloromethane exceeded respective project screening levels. Chloroform and bromodichloromethane form naturally when chlorine is added to wastewater as a disinfectant, and concentrations are potentially the result of previous DoD operation at the WWTP. PAH concentrations exceeding the project screening limits may be due to SQLs that were higher than the project screening criteria. Although concentrations of PAHs above the screening criteria were only reported from the sample C3-WWTP-MW-B15-19, it cannot be confirmed or denied that the elevated PAH concentrations extend to the other groundwater sample locations, due to the SQLs being higher than the project screening criteria. PAH concentrations were not detected above the project screening criteria in any surface or subsurface soil sample collected adjacent to the groundwater sample locations. PAHs typically will strongly sorb to soils and the lack of PAH detections, is indicative that the PAH exceedances may likely be due to the SQLs not being low enough to accurately detect groundwater concentrations. Metal analytes exceeded the project screening criteria in all three groundwater samples, specifically arsenic, lithium, and magnesium. The elevated concentrations may be due to the background concentrations of metals compared to the project screening criteria. Detected concentrations of arsenic, lithium and magnesium concentrations were within the established background levels for the former LOOW.

## 8.0 HUMAN HEALTH RISK ASSESSMENT

The WWTP was identified as an EU in prior investigations of the former LOOW. An EU can contain one or more AOCs investigated during the Phase I, Phase II, and Phase III RIs (USACE/EA 1998, 2002, and 2008c). The former LOOW WWTP was identified as EU 7. Detailed site history, the identification of EUs, and descriptions of the Phase I, II, and III RI are detailed in the *Human Health Risk Assessment of Selected Exposure Units (EU 1-EU 6, EU 8, EU 9, EU 10) at the former Lake Ontario Ordnance Works* (USACE, 2008b) and the *Screening-Level Ecological Risk Assessment at Selected Exposure Units within the Former Lake Ontario Ordnance Works* (USACE, 2008d). In addition, the TNT wastewater line is evaluated within the EU 7 HHRA and separately as an AOC. The evaluation of the TNT wastewater line as a separate AOC will assess the effectiveness of the IRA. This subsection summarizes the HHRA conducted based on analytical data collected during the Phase IV RI. The complete HHRA text is presented in Appendix G of this RI report.

The HHRA incorporates the results of samples collected and analyzed as part of the following efforts:

- USACE/EA. 2008c. *Report of Results for the Phase III Remedial Investigation of Underground Utility Lines at the Former LOOW, Niagara County, NY*. April.
- USACE/ERT/EA. 2009e. *Final Field Sampling Plan Addendum for Phase IV Remedial Investigation and Feasibility Study for the Former LOOW, Niagara County, NY*. June.

The EU 7 HHRA was conducted in accordance with USEPA *Risk Assessment Guidance for Superfund (RAGS), Volume I: Human Health Evaluation Manual (Part A)* (Interim Final) (USEPA, 1989) and USEPA *RAGS, Volume 1 – Human Health Evaluation Manual (Part D), Standardized Planning, Reporting and Review of Superfund Risk Assessments* Interim Final (USEPA, 2002c).

The HHRA follows the methodologies presented in the *Human Health Risk Assessment Work Plan Form Phase IV Remedial Investigation/Feasibility Study At The Former LOOW, Niagara County, New York, Addendum To The Final Work Plan, Human Health Risk Assessment of Selected Exposure Units (EU 1 – EU 6, EU 8, EU 9) at the Former LOOW, Niagara County, New York* (USACE/EA, 2008b).

The HHRA evaluates the potential sources of contamination and routes of migration based on current and potential future site uses. The HHRA results are based upon potential exposure pathways that can currently occur or are reasonably likely to occur in the future within EU 7. NYSDOH land use restrictions, dating before the acquisition of the WWTP in 1975, are currently in effect for the property, and the restrictions specify that the property cannot be used for residential purposes, schools, and hospitals, but can be used for industrial or commercial activities. Potential cancer risk and non-cancer hazards for residential receptors are evaluated in the HHRA for completeness, even though future residential land use is unlikely due to present land use restrictions and site location. The HHRA is conducted to determine baseline risks associated with exposure to the former LOOW site and evaluates the reasonable maximum exposure that has a potential to occur at the site. The baseline risk assumes no remedial actions or other means of exposure reduction (i.e., the use of PPE, digging restrictions, etc.). As a result,

risks calculated in the HHRA are considered potential and should be used as a guideline in making risk management decisions. The HHRA methodology involves a four-step process:

1. Hazard Assessment – the identification of COPCs,
2. Exposure Assessment – the calculation of exposure point concentrations (EPCs) representative for each COPC and identification of potential receptors and exposure pathways,
3. Toxicity Assessment – the consideration of the types of potential adverse health effects associated with exposures to COPCs, and
4. Risk Characterization - the estimation of chemical intakes for the identified receptor populations and quantitative estimate of both carcinogenic and non-carcinogenic risks.

### **8.1 Hazard Assessment**

A risk-based screening is conducted to eliminate chemicals that are not detected at levels resulting in unacceptable risk to identified potential receptors. Risk-based screening is conducted by comparing maximum detected chemical concentrations for each media to USEPA RSLs. A chemical in any medium, for which the maximum detected concentration exceeded the RSL, is retained and evaluated further.

### **8.2 Exposure Assessment**

The second step of the HHRA process is the exposure assessment. In the exposure assessment, the receptors of concern and exposure pathways are identified. For EU 7, a human health site conceptual model is developed to identify the receptors and exposure pathways evaluated in this HHRA. Media of concern within EU 7 are surface soil, total soil [surface soil and subsurface soil combined), wastewater (from the underground utilities – investigated during the Phase III RI [USACE/EA, 2008c]), sludge (from the underground utilities), and groundwater. In the HHRA, receptors evaluated include adolescent and adult trespassers, operations/maintenance worker, commercial worker, construction worker, and resident adult and child. Potential cancer risk and non-cancer hazards for residential receptors are evaluated in the HHRA for completeness, even though future residential land use is unlikely due to present land use restrictions and site location. In addition, the soil samples collected along the TNT wastewater line are evaluated separately to confirm the IRA was complete and that there are no concerns for human health.

The exposure assessment also includes the estimation of COPC EPCs and the calculation of exposure intakes. Reported concentrations of COPCs are used to calculate the 95th percentile upper confidence limit on the mean (95UCLM) in each media of concern. The 95UCLM is determined based on the USEPA ProUCL program version 4.00.04. The EPC is used to estimate COPC intakes for each pathway considered in the HHRA. The COPCs in site media are converted into systemic doses, taking into account rates of contact (e.g., ingestion rates) and absorption rates of different COPCs. The magnitude, frequency, and duration of these exposures are then integrated to obtain estimates of daily doses over a specified period of time (e.g., lifetime, activity-specific duration).

### **8.3 Toxicity Assessment**

The toxicity assessment considers the types of potential adverse health effects and related uncertainties. Both non-carcinogenic and carcinogenic effects are considered in the HHRA. For

lead, blood-lead level modeling is conducted utilizing USEPA recommended models. Where lead is a COPC in soil for a residential or trespasser scenario, lead risks for potential future residents are evaluated using USEPA's Integrated Exposure Uptake Biokinetic (IEUBK) Lead Model. When lead is a COPC in soil for the industrial scenarios, potential lead risk is also modeled using *Recommendations of the Technical Review Workgroup for Lead, An Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil*.

#### **8.4 Risk Characterization**

Risk characterization focuses on COPC comparisons to USEPA recommended toxicity values. Carcinogenic risks and non-carcinogenic hazards are evaluated for each receptor on a cumulative basis across all pathways and media. Risk thresholds are defined as cumulative carcinogenic risks that exceed the risk range of 1 in 1 million ( $1 \times 10^{-6}$ ) to 1 in 10,000 ( $1 \times 10^{-4}$ ) or non-carcinogenic hazards that exceed 1.0 (USEPA, 1990).

#### **8.5 Exposure Unit Conclusions**

##### ***Exposure Unit 7 – Wastewater Treatment Plant***

The EU 7 HHRA evaluates potential cumulative risks for the adult and adolescent trespasser, operations/maintenance worker, commercial worker, construction worker, and resident adult and child for exposure to soil and to sludge from open pits and vaults (not from within the underground utilities). If a resident built a house on the site, it is highly unlikely the developer would leave open pits and vaults in the vicinity for obvious liability reasons. In addition, the construction worker and resident adult and child are evaluated for exposure to sludge and wastewater from within the underground utilities. The results indicate there are no exceedances of the carcinogenic or non-carcinogenic risk thresholds for adult and adolescent trespasser, operations/maintenance worker, and commercial worker.

The EU 7 HHRA indicates an exceedance of the risk thresholds for the construction worker and resident adult and child. For the construction worker, exposure to PAHs and PCB Aroclor 1254 in sludge identified during the Phase III RI results in an exceedance of the risk thresholds. For the resident adult and child (included as hypothetical most sensitive receptors for completeness), exposure to PAHs in soil and sludge, and PCBs (Aroclor 1254) in sludge, result in an exceedance of the risk thresholds.

##### ***TNT Waste Line***

The TNT waste line was also evaluated separately to determine if the IRA successfully removed any concerns for human exposure. Evaluation of soil samples collected along the TNT wastewater line does not reveal a concern for human exposure. As a result, the IRA was effective in remediating chemical hazards associated with soil adjacent to the former line.

## 9.0 SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT

A Screening Level Ecological Risk Assessment (SLERA) consisting of Steps 1, 2, and 3b of the 8-step SLERA paradigm was conducted for the former LOOW WWTP which has been designated as EU 7. Risks were assessed to terrestrial receptors potentially exposed to surface soil at EU 7. The ecological receptors included plants, soil invertebrates, and avian and mammalian receptors. This subsection summarizes the SLERA conducted based on analytical data collected during the Phase IV RI. The complete SLERA text is presented in Appendix H of this RI report.

Surface soil at EU 7 exhibited negligible risks to ecological receptors. Most metals/inorganic concentrations (including boron, cobalt, copper, manganese, mercury and selenium) were lower than background concentrations and had low calculated hazard quotients (HQs). Although the Wilcoxon Rank Sum statistical analyses for vanadium and lithium indicate that concentrations are within background, other statistical evaluations (e.g., quantile test) suggest that these analytes may exceed background; therefore, as a measure of conservatism they are carried through the risk evaluation as COPCs. Lithium and vanadium concentrations, minimally exceeded the HQ of 1.0, but there was no evidence of ecological effects. Boron exceeded an HQ of 1.0; however, due to the limited number of detections in the site data set, a conclusion as to whether boron exceeded background could not be made. However, there was no evidence of ecological effects. In addition, other analytes presented negligible risks to ecological receptors on-site based on low HQs and limited detections of high molecular weight polycyclic aromatic hydrocarbons. Given this information, risks are judged to be negligible at EU 7.

At the conclusion of a SLERA, ecological risk assessment guidance recommends a Scientific Management Decision Point (SMDP). This involves communication of the SLERA results by the Risk Assessor to the project team and remedial manager. The latter then decides whether risks are negligible, or whether they are sufficient to invoke additional evaluation, including possibly a Baseline Ecological Risk Assessment. No sensitive environments or significant habitat are contained in EU 7. Further, none of the exposure units are presently managed, or are expected to be managed for ecological purposes. Because of this, general management of these sites should focus on the avoidance of lethal impacts to receptors in these exposure units. There is no evidence that ecological receptors have been damaged at EU 7 and ecological risks identified are not high.

## **10.0 PHASE IV REMEDIAL INVESTIGATION SUMMARY AND CONCLUSIONS**

Risk-based screening criteria for surface soil, subsurface soil and groundwater from the USEPA RSLs were utilized as conservative screening values to evaluate constituents detected in environmental samples collected during the Phase IV RI. In addition, site-specific soil screening values for the protection of groundwater and a statistical comparison of background concentrations were used to further evaluate detected constituent concentrations. Several surface soil sample concentrations of PAHs and metals exceeded risk-based screening values and were subsequently evaluated in the HHRA and SLERA. Several subsurface soil sample concentrations of metals exceeded risk-based screening values and were subsequently evaluated in the HHRA and SLERA. Several groundwater sample concentrations of VOCs, PAHs, and metals exceeded the risk-based screening values and were subsequently evaluated in the HHRA and SLERA.

### **10.1 Summary and Conclusions**

The former WWTP is inactive and various structures have been partially and/or completely demolished. The former mixing house has been completely demolished and removed. The former pump house has been demolished and removed to the structures foundations. A slab and subsurface vault area remains in place. The former acid neutralization building has been partially demolished and the structural elements remain in place. One of the former sludge beds has been demolished and removed to its foundation. Underground utilities associated with the operations of the former WWTP remain in place in unknown conditions. Other structures such as the venturi vault, Imhoff tank and one of the two sludge beds remain in place in various overgrown and decaying conditions. The former TNT waste lines which terminated at the mixing house were partially removed and the insides scoured during a remedial action conducted in 1999 (Radian International, 2000).

In total, 45 soil borings were advanced; 86 soil samples and two terrestrial sediment samples were collected and analyzed. Soil borings were distributed in both a random systematic and biased fashion in order to investigate potential site-wide and structure specific impacts to the environment.

Systematic soil sampling did not indicate widespread impacts associated with structures at the former WWTP. Based on the analytical results, the number of samples and sample spacing was adequate to characterize the site. Biased soil sampling at the site targeted a number of identified locations of concern. Two sample locations identified as potential former transformer locations did not detect PCBs and therefore there were no significant impacts associated with potential PCB-laden fluid utilized by the transformers. Two sample locations associated with a previously identified ground scar in the northwest portion of the site did not detect significant impacts. One soil sample, collected adjacent to a manhole located north of the acid neutralization building, did not detect significant impacts. The sample was collected to assess potential impacts resulting at the junction of the acid waste and wastewater line convergence prior to entering the acid neutralization building, acid sewer line or overflow line. Two samples collected within the northern and southern sludge beds did not identify significant impacts. One soil sample allocated to confirm the previous detection of carbon tetrachloride at a location to the southeast of the southern sludge bed did not detect any VOCs exceeding the screening criteria. Two samples allocated to the WDD did not detect significant impacts. PAH concentrations above the

USEPA RSLs were identified in one surface soil sample (C3-WWTP-SO-C(+50)600-0.5) located immediately north of a former mixing tank that has been removed.

Three groundwater MWs were installed in the vicinity of the former acid neutralization building, the Imhoff tank and the chlorination tank; groundwater samples were collected and analyzed from each newly installed MW. Two VOCs, chloroform and bromodichloromethane, were detected in groundwater samples at concentrations above project screening criteria, but at concentrations not indicative of significant impacts. Two PAHs, benzo(a)pyrene and dibenzo(a,h)anthracene, were detected in one groundwater sample at concentrations above project screening criteria. Three metals; arsenic, lithium and magnesium, were detected in groundwater samples at concentrations exceeding project screening criteria. However, these metals were within the established background levels for the former LOOW; therefore, further evaluation of metals as potential DoD contaminants in groundwater is not necessary.

Based on the results of the SLERA, there are no identified significant impacts to ecological receptors associated with the former WWTP.

The HHRA specifically evaluated risk associated with exposure two receptor groups: construction workers and potential future resident adults and children. Potential cancer risk and non-cancer hazards for residential receptors were evaluated in the HHRA for completeness; even though future residential land use is unlikely due to present land use restrictions (NYSDOH, 1974). Land use restrictions imposed by NYSDOH, dating before the acquisition of the WWTP in 1975, are currently in effect for the property, and the restrictions specify that the property cannot be used for residential purposes, schools, and hospitals, but can be used for industrial or commercial activities.

Based on the results of the HHRA, there are no identified impacts related to human receptors associated with the former TNT waste lines. Therefore, it is considered that the IRA completely addressed risk associated with soil in the vicinity of the former TNT lines.

The HHRA identified elevated risk for potential future resident adult and child exposure to PAHs in soil and sludge, and to PCBs (Aroclor 1254) in sludge. Elevated risk for the future resident adult and child associated to exposure to PAHs in soil is due to the presence of a single sample location with elevated PAH concentrations above the project screening criteria. There is no evidence of widespread significant impacts related to PAHs in soil. However, due to the current land-use control prohibiting residential development on the former WWTP property, the exposure pathway for residential receptors is not currently possible (NYSDEC, 1974).

The HHRA identified elevated risks for construction worker exposure to PAHs and PCBs (Aroclor 1254) in sludge contained within various former WWTP structures. These risks for construction workers should be further evaluated in an FS.

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