ESC

ENVIRONMENTAL STRATEGIES CORPORATION

Four Penn Center West ▪ Suite 315 ▪ Pittsburgh, Pennsylvania 15276 ▪ (412) 787-5100 ▪ Fax (412) 787-8065

FINAL

REMEDIAL INVESTIGATION REPORT
REVISION NO. 3

TRI-CITIES BARREL SUPERFUND SITE
FENTON, NEW YORK

VOLUME I
TEXT

PREPARED

BY

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1.0 Introduction

This Remedial Investigation (RI) report documents the nature and extent of constituents present in the soil, groundwater, surface water, and sediments at the Tri-Cities Barrel Superfund site in Fenton, New York. The RI consisted of four phases of data collection and was conducted in accordance with an Administrative Order on Consent (AOC; Index No. II CERCLA-10220) for the Remedial Investigation/Feasibility Study (RI/FS). The effective date of the AOC was May 14, 1992.

On behalf of the Tri-Cities Barrel potentially responsible parties (PRPs), Environmental Strategies Corporation (ESC) prepared the Work Plan for the RI/FS. The Work Plan outlined a phased approach for the RI and indicated that subsequent phases would be needed and would be built on the data collected during the previous phase(s). The December 24, 1992, Work Plan was approved by the U.S. Environmental Protection Agency (EPA) on January 6, 1993. The Phase II Work Plan Addendum was submitted to the EPA on July 22, 1994, and was approved by the EPA on August 4, 1994. A Phase III Work Plan Addendum was prepared by ESC and submitted to the EPA on September 29, 1995. This addendum was approved by the EPA on October 6, 1995. The Phase IV Work Plan Addendum was submitted to the EPA on October 2, 1997, and was conditionally approved by the EPA on October 9, 1997. In a letter dated October 14, 1997, ESC, on behalf of the PRPs, responded to the EPA's comments presented in its October 9, conditional approval letter.

All field sampling activities and data analysis were performed in accordance with the Field Sampling Plan (FSP) and the Quality Assurance Project Plan (QAPjP) which comprise the Sampling and Analysis Plan (SAP) for the Tri-Cities Barrel site. These plans, dated May 21, 1993, were also prepared by ESC and approved by the EPA on June 29, 1993. The RI field activities were conducted from July 29, 1993, through December 19, 1997. Selected site photographs documenting the RI activities are provided in Appendix A.

In accordance with the SAP, ESC performed field audits of the field activities and laboratory audits of each of the primary laboratories (Enseco-Wadsworth/Alert Laboratories and Ceimic Corporation) used on this project. The audit reports for each of the audits are provided in Appendix B.

The purpose of the RI was to collect and compile site information using a phased approach. The field investigations were conducted to fulfill the following primary data objectives:

- identify constituents of concern
- identify and characterize potential source areas

- characterize the extent of constituents of concern in the various environmental media (soil, sediment, surface water, groundwater, plants, and wildlife)
- identify the depth to bedrock beneath the site
- characterize the hydrogeology (direction and rate of groundwater flow) of the unconsolidated and bedrock water bearing zones
- identify potential exposure pathways and potential receptors for the constituents detected in the site media
- collect sufficient information to identify candidate remedial technologies for the site

This RI report demonstrates that the data objectives for the site have been met. This report discusses the nature and extent of constituents of concern in the soil, groundwater, sediments, and surface water; analyzes the fate and transport mechanisms for the constituents of concern; and summarizes the potential risks to human health and the environment from the identified constituents of concern at the Tri-Cities Barrel site. The summary of the potential risks is primarily based on the information presented in the Final Baseline Risk Assessment - Human Health Evaluation dated December 13, 1996, the Final Baseline Risk Assessment - Ecological Risk Assessment dated January 6, 1997, and the Revised Addendum to the Baseline Risk Assessment – Human Health Evaluation dated June 1, 1998. The risk assessments were prepared by Life Systems, Inc. and Roy F. Weston, Inc. (Weston), on behalf of the EPA. The overall goal of this RI report is to factually present the RI characterization data and minimize any speculative discussion regarding the data.

1.1 Site Background

1.1.1 Site Description

The Tri-Cities Barrel Superfund site is located approximately 5 miles northeast of Binghamton, adjacent to Old Route 7, in the town of Fenton, Broome County, New York (Figure 1-1). The site comprises approximately 14.9 acres and is bordered by rural residential areas, farmland, and woodlands.

For discussion purposes, the site is divided into three portions. The portion of the site north of Interstate 88 (I-88) is referred to herein as "north of I-88" and includes approximately 5.1 acres. This parcel is bordered to the north by Osborne Creek and to the south by the former operating portion of the site. Sampling points located within the highway median of I-88 are grouped with the "north of I-88" data points. The portion of the site south of I-88 and north of Osborne Hollow Road is referred to herein as "south of I-88" and includes approximately 6.9 acres. This parcel is bordered to the north by I-88 and to the south by

Osborne Hollow Road. The far southern portion of the site (referred to herein as "south of Osborne Hollow Road") includes approximately 2.9 acres and is bordered to the north by Osborne Hollow Road and to the south by the D&H railroad tracks. The layout of the site is presented in Figure 1-2.

The former operational portion of the site occupies approximately 3.5 acres within the portion of the site south of I-88. The former operational portion included a process building, pole barn, 3-sided garage, barrel burner, two aboveground oil storage tanks, four aboveground propane tanks, two underground fuel tanks, numerous empty drums, partially full drums, and miscellaneous tools and equipment. During July 1995, a perimeter fence was constructed to surround and secure the former operational portion of the site, and "Keep Out" signs were posted along all sides of the fence.

The southern portion of the site is relatively flat, except in the vicinity of I-88, where the ground surface slopes steeply down to the highway. North of I-88 the ground surface slopes gradually northward toward Osborne Creek. In the vicinity of Osborne Creek, the ground surface slopes steeply to the creek and the associated floodplain. The elevation of the site ranges from 930 feet (at Osborne Creek) to 1,025 feet above mean sea level (MSL; south of Osborne Hollow Road).

Two small unnamed intermittent streams parallel the eastern and the western sides of the site. The eastern tributary is located outside the property boundary of the site; while the western tributary is located within the property boundary of the site. Both streams collect the surface water runoff from south of the site including Osborne Hollow Road, Old Route 7, and the railroad tracks, and they both flow north discharging into Osborne Creek.

A man-made pond (former lagoon) north of I-88 occupies approximately 6,000 square feet (approximately 0.14 acre). However, the size of the pond varies greatly with seasonal precipitation and is often dry or nearly dry during the summer months. Based on our field observations, the pond covers the greatest amount of land surface and is deepest (approximately 2-3 feet) during the spring. Currently, the pond receives water from precipitation directly into the pond and stormwater runoff from I-88 and the area between I-88 and the pond.

1.1.2 Site History

The information presented below is based on discussions with Gary Warner and aerial photographs of the site dated April 18, 1948; July 4, 1955; April 19, 1958; 1965; April 16, 1967; April 29, 1968; May 7, 1973; April 1981; November 17, 1991; and April 28, 1993. Gary Warner is the former operator of the site and president of the Tri-Cities Barrel Company, and his father, Francis Warner, is the owner of the site. The site operated as a barrel reclamation facility from 1955 to 1992. An aerial photograph from 1948 shows the site as a farm. In the 1948 aerial photograph, the site appears to be a farm consisting of farmland in the northern portion of the site and several buildings located on the southern portion of the site. In the 1955 aerial photograph, the initial operations of the Tri-Cities Barrel Company are evident. The original process building is located adjacent to Osborne Hollow Road. Additionally, the grass cover around the building is disturbed. A water drainage pattern and the process building are visible in the 1958 aerial photograph. It also appears that the areas around the building were used for drum storage. An offsite junkyard is located on the property to the southeast of the site. In the 1967 aerial photograph, the original process building, office addition to the process building, and a 3-side structure near the eastern property boundary are present at the site. The former lagoons are oriented north-south across the site, and drum storage is apparent on all sides surrounding the main building. The junkyard to the southeast is also present. Construction of interstate I-88, which trends roughly east-west through the site, dividing the site into two areas, is first observed in the 1968 aerial photograph. Coincident with the construction of I-88 is observed a change in the configuration and number of the lagoons (oriented east-west, no longer oriented north-south). Drum storage is still evident on the property, as is the junkyard to the southeast. In the 1973 aerial photograph, an addition along the western side of the process building is evident. The east-west orientation of the lagoons, the other structures, the drum storage, and the junkyard to the southeast are similar to the 1968 aerial photograph. Thus, based on the aerial photographs, the property located southeast of the site and south of Osborne Hollow Road was used as a junkyard from at least 1958 to 1973. In the 1981 aerial photograph, the lagoons are no longer present (filled with soil) and the pole barn was added on the northern side of the process building. Drum storage is still evident on the property; however, the junkyard to the southeast of the process building is no longer present. In the 1991 aerial photograph, drums are still visible on the property; however, there are less of them and they are organized in a more orderly fashion. A house is now evident on the former junkyard property southeast of the process building.

Barrel reclamation operations ceased at the facility in spring 1992, in accordance with a cooperation agreement between the Tri-Cities Barrel PRPs and Gary Warner. Gary Warner is the former operator of the site and president of the Tri-Cities Barrel Company, and his father, Francis Warner, is the owner of the site. During 1992 and 1993, the Warners used the site to sell clean drums that were brought to the site from an offsite source and to sell the existing inventory of empty plastic drums. Since 1994, no operations have been conducted at the site, and since January 1997 (subsequent to the removal action) the site has been vacant. The removal action included the demolition of all structures and the removal and offsite disposal of debris, equipment, drums, and wastes.

The former drum reclamation process involved cleaning the interior and exterior of drums and barrels through a combination of physical, chemical, and mechanical means which included burning adhered material present on drum and barrel interiors, particle blasting, scraping by rolling drums and barrels with chains, and rinsing with a 10 percent sodium hydroxide solution. The source of the water used to clean and rinse the drum was the onsite production well. Following cleaning, the drums and barrels were reformed, if necessary, and repainted.

In general, drums were received on the western side of the process building and staged west and north of the process building. The reclamation process was initiated at the drum decapitation shed where the tops of closed-top drums were removed. Next, the drums were processed through the barrel burner and then transferred inside the process building for the remainder of the reconditioning process which included particle blasting, chemical cleaning using a 10 percent sodium hydroxide solution, reforming, and repainting. Reconditioned drums were staged in box trailers and outdoors, east of the process building. Aerial photographs dating back to 1965 show that much of the available property south of I-88 was used for drum storage. Figure 1-3 identifies the approximate extent of drum storage on the property based on review of aerial photography.

According to Gary Warner, between 1955 and the early 1960s, wastewater from the reconditioning process was reportedly discharged to the ground and allowed to flow downslope toward Osborne Creek. This practice created a distinctive drainage pattern surface feature, which is visible in a 1958 aerial photograph of the site (Appendix C). From the early 1960s to 1980, discharged wastewater was directed to a series of unlined lagoons. The first lagoon acted as an oil/water separator, the second lagoon received the sodium hydroxide solution, and the third contained rinsewater. These lagoons were reportedly 3 feet to 4 feet deep. Based on evidence from historical aerial photographs, as many as seven lagoons located north of the former process building were used between the early 1960s and 1980. The number and locations of the lagoons in use at the site changed during the period between the 1960s and 1980. Figure 1-3 shows the various configurations of the lagoons through time. In a 1967 aerial photograph, five lagoons were located north of the former process building and were aligned along a north-south line in the same general area as the 1958 discharge pattern. Construction of I-88, which trends roughly east-west through the site, dividing it in two, is first observed in a 1968 aerial photograph. Coincident with the construction of I-88, a change in the configuration and number of lagoons is observed. In 1968, three of the five original lagoons were no longer present and a new, sixth lagoon (L-6) was located south of I-88. A 1973 aerial photograph indicates that three lagoons were active south of I-88 and are configured in a line parallel to I-88, trending east to west. According to Mr. Warner, wastewater was directed through them from east to west across the site, and the wastewater from these lagoons was reportedly allowed to flow to the western tributary. The remnants of one lagoon (L-5) located north of I-88 are evident in the 1973 photograph. This lagoon was formerly active pre-1968 before I-88 was constructed, but received no further wastewater discharges following the construction of I-88. The remnants of this lagoon still exist today. However, the water present in this lagoon is derived solely from the collection of precipitation and surface water runoff.

Under a Consent Order with the New York State Department of Environmental Conservation (NYSDEC), the practice of discharging wastewater to the lagoons was discontinued. In 1980 the three lagoons present south of I-88 were pumped out and backfilled with approximately 7,000 cubic yards of fill which was transported to the site from property owned by Francis Warner located south of Old Route 7. Following the closure of the lagoons, the wastewater generated in the barrel cleaning process was collected in a holding tank and reportedly hauled offsite for disposal. Once the closed-loop wastewater recirculating system was installed (CLOW system), only infrequent offsite disposal of the wastewater was necessary.

1.1.3 Remedial Investigation Project History

The site was listed on the National Priorities List (NPL) on October 4, 1989. The primary reason the site was listed was due to the proximity of the site to several private water supply wells. This rationale is outlined in the hazard ranking system (HRS) report and in the "Engineering Investigation at Inactive Hazardous Waste Sites in the State of New York," Phase I (June 1983) and Phase II (June 1986) reports prepared for the NYSDEC. While the proximity of the residences with private water supply wells was the primary driving force for the NPL listing, it is important to note that these residential wells have been sampled on at least four occasions from 1985 to 1995 and no constituents of concern related to the site have been detected in these wells. All of the residential water supply wells are completed in the bedrock water bearing zone and are located upgradient of or sidegradient to the site. A complete discussion of the residential water supply well sampling events and results is provided in Section 4.2.5 of this report, and information regarding the location and known well construction details for the residential water supply wells is provided in Section 3.6.1 of this report.

The PRPs entered into the AOC with the EPA on May 14, 1992, and retained ESC as the environmental consultant to conduct the RI/FS. The Phase I RI field activities were conducted from July 29 through November 4, 1993. Phase I sampling activities included installing 3 piezometers and collecting 6 soil samples from the piezometer boreholes; conducting two rounds of groundwater sampling from the existing monitoring wells; collecting groundwater elevation measurements from the monitoring wells, piezometers, and staff gauge (installed in Osborne Creek); excavating seven trenches and collecting 32 soil samples for laboratory analysis from the trenches; and collecting 7 surface water samples, 10 sediment samples, 2 process water samples, 1 process sediment sample, 13 building samples, 12 soil samples from a depth of 0-6 inches, 12 soil samples from a depth of 30-36 inches, and 6 subsurface soil samples (Figures 1-

4 and 1-5). The Phase I implementation procedures and results were documented in the May 12, 1994, "Interim Site Summary Report." Based on the results of the Phase I RI, a Phase II RI was conducted.

The Phase II RI Work Plan Addendum was prepared by ESC on behalf on the PRPs and approved by the EPA on August 4, 1994. With the exception of the inspection of two sumps, which was conducted between April 10 and April 12, 1995, the Phase II RI field activities were conducted from August 29 through October 27, 1994. The Phase II field activities included installing 11 monitoring wells and 14 soil borings; conducting 16 falling and rising head slug tests; collecting groundwater elevation measurements of the wells and piezometers; and collecting 17 groundwater samples, 17 sediment samples, 46 surficial soil samples, 18 subsurface soil samples, 8 plant samples, and 7 earthworm samples (Figures 1-6). The Phase II implementation procedures and results were documented in the February 22, 1995, "Contamination Summary Report." Based on the results of the Phase II field activities and a meeting with EPA on July 27, 1995, Phase III field activities were deemed necessary to complete the investigation of the site.

The Phase III RI Work Plan Addendum was prepared by ESC and approved by the EPA on October 6, 1995, and field activities were conducted from October 16 through December 18, 1995. The Phase III field activities included installing 8 monitoring wells and 10 soil borings; collecting two rounds of groundwater elevation measurements from the wells and piezometers; and collecting 26 groundwater samples, 2 sediment samples, 28 surficial soil samples, and 17 subsurface soil samples (Figure 1-7).

From October 14, 1996, to January 10, 1997, and on behalf of the Tri-Cities Barrel PRPs, ESC conducted a time critical removal action as set forth in the AOC for Removal Actions, Index Number II-CERCLA-96-0207, dated September 25, 1996. The objectives of the removal action were to locate, characterize the contents, if any, and properly dispose of all containers, drums, tanks, and wastes located on the site; decontaminate and remove remaining equipment that was previously used during operations at the site; and decontaminate, demolish, and dispose of all buildings and structures located on the site. The objectives of the removal action were successfully achieved. Specifically, all liquid wastes and fluids that were present in tank, sumps, and drums were removed from the site as part of the removal action. Additionally, the removal action significantly reduced the mobility and toxicity of the total mass of hazardous constituents present at the site. During the removal action, all hazardous constituents present in drums, containers, tanks, tanker trucks, and building materials were removed from the site, leaving only the constituents present in the soils, groundwater, and sediments. A total of approximately 470,000 pounds of hazardous constituents were removed from the site during the removal action. Consequently, because of the extensive removal actions, the principle threats at the site have been eliminated.

The site is currently vacant; the only remaining structures include the security fence, the concrete foundations of the former building and pole barn, and a CLOW machine, which was decontaminated and wrapped in polyethylene sheeting. Mr. Warner requested that the CLOW machine be decontaminated but not disposed of by the PRPs. Reportedly, Mr. Warner is making arrangements for the offsite reuse of this piece of equipment. A complete summary and thorough discussion of the removal action is presented in the Removal Action Final Report which was submitted to the EPA on February 7, 1997.

On November 22, 1996, a Grant of Easement and Declaration of Restrictive Covenants was executed between the Tri-Cities Barrel Company, Inc., and the Tri-Cities Barrel Superfund site PRP Group. A copy of the Grant of Easement and Declaration of Restrictive Covenants is provided in Appendix D. This legal document restricts the future use of the property and specifically prohibits the development of the site for residential uses. The development and use restrictions established by the Grant of Easement and Declaration of Restrictive Covenants markedly reduce the potential for human exposure to hazardous substances which exist at or beneath the property. Reducing the potential for human exposure in turn reduces the potential for adverse human health consequences. Use of a Grant of Easement and Declaration of Restrictive Covenants to control future land use is consistent with the May 25, 1995, EPA directive regarding the identification of future land use in making remedy selection decisions under CERCLA at NPL sites (OSWER Directive No. 9355.7-04). The PRPs also acknowledge that the Grant of Easement and Declaration of Restrictive Covenants serves as a supplemental measure to ensure the permanence of engineering controls and that it will help achieve remedial action objectives, but in and of itself, is not an exclusive solution.

The EPA and its subcontractors (Weston and Life Systems) presented a summary of the potential risks posed by the site to the PRPs in the risk assessment documents dated December 13, 1996 and January 6, 1997. On behalf of the PRPs, ESC incorporated the results of the risk assessments into the RI Report, dated April 10, 1997. The EPA provided the PRPs with comments to the RI report in a comment letter received on June 9, 1997. The PRPs provided a response to each comment in a letter dated July 31, 1997. Additionally, in response to one of the EPA's comments, on August 13, 1997, a groundwater sample was collected from MW-12S and submitted for laboratory analysis to further assess the concentration of bis(2-ethylhexyl)phthalate in the groundwater at this portion of the site. These results were provided to the EPA in a letter dated September 5, 1997.

A meeting with representatives of the EPA, NYSDEC, Weston, PRPs, and ESC was held on September 10, 1997. The purpose of the meeting was to discuss the RI results and the need for characterization of the bedrock groundwater quality. In a letter dated September 12, 1997, the EPA requested that the PRPs prepare a work plan addendum for the installation of bedrock monitoring wells and provided an evaluation of adequacy of the PRP's response to comments dated July 31, 1997.

The October 2, 1997, Phase IV RI Work Plan Addendum was prepared by ESC and conditionally approved by the EPA on October 9, 1997. The field activities were conducted from October 13, 1997, through December 19, 1997. The Phase IV field activities included installing 3 bedrock monitoring wells; collecting 2 rounds of groundwater elevation measurements from the wells and piezometers; abandoning the former production well (MW-4); and collecting 23 groundwater samples, 10 sediment samples, 3 subsurface soil samples, and 6 Shelby tube soil samples (Figure 1-8). Figure 1-9 includes all RI sampling locations collected during all 4 phases.

On June 19, 1998, the PRPs received the Revised Addendum to the Baseline Risk Assessment – Human Health Evaluation dated June 1, 1998. A revised RI report (revision No. 1) dated August 18, 1998, incorporated the results of the revised addendum and addressed the EPA's comments to the original April 10, 1997, RI report. On October 21, 1998, the EPA provided the PRPs with comments to the August 18, 1998, RI report. On December 1, 1998, the PRPs submitted a letter to the EPA, which outlined the PRPs' position regarding the significant unresolved RI issues. On December 9, 1998, a meeting to discuss the RI and FS was held at the EPA's office in New York City. The purpose of the meeting was to reach agreement on the salient RI and FS issues. The PRPs documented the discussions and agreements reached at the meeting in a letter dated December 15, 1998. This revised RI report (revision No. 2) addresses the EPA's comments presented in the October 21, 1998, letter and includes the technical agreements reached at the December 9, 1998, technical meeting.

1.1.4 Previous Investigations

This summary of pre-RI activities is based on a review of reports documenting the various investigations conducted at the site from 1983 through 1986. Specifically, the following reports were reviewed:

- "Phase I Investigation Report", prepared by Engineering-Science and Dames & Moore for the NYSDEC, June 1983.
- "Phase II Investigation Report, Tri-Cities Barrel Site", prepared by Engineering-Science and Dames & Moore for the NYSDEC, June 1986.

Official public inquiries into the status of the Tri-Cities Barrel facility began in 1980 when the NYSDEC issued a Consent Order requiring the facility to close three onsite wastewater lagoons. The three lagoons were backfilled with approximately 7,000 cubic yards of clay, silt, and gravel fill material from property located south of Old Route 7.

In 1983, Engineering-Science, in conjunction with Dames & Moore, conducted a Phase I engineering investigation and evaluation of the Tri-Cities Barrel site. This investigation was conducted for the purpose of calculating a HRS score for the site to determine the site's potential for inclusion on the NPL. A second objective of the Phase I engineering investigation was to evaluate potential remedial alternatives and associated costs for the site. Based on historical data and site information obtained during this investigation, insufficient data were available to determine a HRS score for the site. A Phase II investigation was recommended to provide additional geophysical data and groundwater, surface water, soil, sediment, and air data. Consequently, a Phase II investigation conducted by Engineering-Science, in conjunction with Dames & Moore, began in August 1985 and was completed in December 1985.

The Engineering-Science Phase II investigation included a geophysical investigation consisting of electrical resistivity and magnetometer surveys. The purpose of this investigation was to evaluate the continuity of subsurface conditions, identify contaminant plumes, if possible, and locate any buried drums present at the site. A Bison 235OB Earth Resistivity Meter was used to conduct vertical soundings and horizontal electrical profiles. Initial soundings that were conducted to a depth of 100 feet indicated that the top of weathered or fractured bedrock ranges from 48-52 feet below the ground surface (bgs). A number of anomalous areas were identified during the electrical resistivity survey at the site. The anomalous areas identified are believed to be the abandoned lagoons, roadway reinforcement material, and a roadway drainage ditch.

The magnetometer survey was performed on a tightly spaced grid pattern in the vicinity of the three abandoned lagoons to delineate lagoon boundaries and locate any buried ferromagnetic objects that may have been deposited in the lagoons as they were closed. A Geometrics Model G816/826A magnetometer was used to conduct the initial survey using a 10-foot by 10-foot grid as station locations.

Four areas of ferromagnetic highs were found within the survey grid. Three of the areas were associated with drum piles located aboveground on the site. The fourth area represented a truck trailer parked on the site. The magnetic survey did not detect any ferromagnetic material buried in the survey area.

Three surface water samples were collected in November 1985 as part of the Engineering-Science Phase II investigation. These samples were analyzed for metals and organics. No organic compounds were detected in any of the surface water samples. Three sediment samples were also collected in November 1985 as part of the investigation. These samples were analyzed for metals and organics. Fluoranthene, pyrene, and chrysene were detected at estimated levels below the instrument quantification limit in one sample collected from the eastern tributary south of I-88.

Three soil samples were also collected in November 1985. The soil sample designated SS-1 was a background surface soil sample taken near old Route 7. The other two samples (SS-2 and SS-3) were collected from fill material over the former lagoon area. SS-2 was a surface soil sample, and SS-3 was collected from a depth of 4 feet bgs in an auger hole. These samples were analyzed for metals and organic constituents. Seventeen metals, five volatile organic compounds (VOCs), and 30 polycyclic aromatic hydrocarbons (PAHs) were detected in the soil samples. Fluoranthene, pyrene, and chrysene were detected in the background sample but not in the samples collected from the former lagoon area. Whereas, tetrachloroethene, 1,1-dichloroethane, trans-1,2-dichloroethene, 1,1,1-trichloroethane, and trichloroethene were detected in the samples collected from the former lagoon area but not in the background sample.

Three monitoring wells (MW-1 through MW-3) were installed as part of the Engineering-Science Phase II investigation. A fourth well was drilled and later filled with grout because of potentially inadequate well construction procedures. MW-1 (originally identified as CW-1) was placed upslope/upgradient, south of Osborne Hollow Road. MW-2 and MW-3 (originally identified as CW-2B and CW-3) were installed in the area of the former lagoons. In October 1985, groundwater samples were collected from the three monitoring wells and the onsite production well (designated during the RI as MW-4), and were analyzed for organic constituents. One organic compound (Di-n-butylphthalate) was detected in MW-1 at 1.7 µg/l, 4 organic compounds were detected in MW-2 at concentrations less than 7.6 µg/l for each of the compounds, 14 organic compounds were detected in MW-3 at concentrations less than 24 µg/l for each of the compounds, and 2 organic compounds were detected in MW-4 at concentrations less than 3 µg/l for each of the compounds.

An HNu meter was used to analyze the air above the site for organic contaminants. Additionally, the air above the borings was monitored using an HNu meter during drilling operations to monitor for the potential release of organic contaminants to the environment. No readings greater than 1 ppm were recorded.

The final Engineering-Science Phase II investigation report was submitted to the NYSDEC in June 1986. Based on the HRS score, the site was included on the NPL on October 4, 1989.

1.2 Report Organization

This RI report contains the following eight sections:

- Section 1:
  Introduction

- Section 2:
  Study Area Investigation (describes investigative techniques used to characterize the site)

- Section 3:
  Physical Characteristics of Study Area (describes regional and onsite characteristics including surface features, meteorology, surface water, soils and geology, hydrogeology, demography, and ecology)

- Section 4:
  Nature and Extent of Contamination (discusses the occurrence of constituents of concern in soils, groundwater, surface water, sediments, air, building materials, and ecological media)

- Section 5:
  Contaminant Fate and Transport (discusses the chemical and physical characteristics of the constituents of concern that affect their ability to persist and migrate in different environmental media)

- Section 6:
  Summary of Baseline Risk Assessments (summarizes and discusses the baseline risk assessments and revised addendum which were prepared by Life Systems and Weston on behalf of the EPA)

- Section 7:
  RI Summary and Conclusions (summarizes the results of the Phase I, Phase II, Phase III, and Phase IV investigations)

- Section 8:
  References

This format follows the outline for an RI report as specified in the Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (EPA 1988).

2.0 Study Area Investigation

This section provides an overview of each phase of the RI and describes the field investigation methods and procedures followed. In addition, data on the physical characteristics of the site and surrounding area were collected to define potential transport pathways and receptor populations and to provide sufficient engineering data for development and screening of potential remedial action alternatives. A summary of all samples and analyses conducted during the RI is provided as Table 2-1, and a summary of the analytical methods is provided as Table 2-2. The RI included assessments of the soil, groundwater, surface water, sediment, building materials, ecological media, and air. In addition, because some of the RI soil, surface water, sediment, and ecological samples were collected from offsite properties, access agreements with the owners of various offsite properties were necessary. In all cases, access was granted.

2.1 Surface Features

The investigation of surface features was conducted by reviewing topographic and geologic maps, current and historical aerial photographs and survey plats, and by site observations. A topographic map of the site with 2-foot contour intervals and a horizontal scale of 1 inch equals 50 feet was prepared by Aerial Data Reduction Associates, Inc., from an aerial photograph taken on April 28, 1993 (Appendix E). The site drainage is included on the topographic map to depict where stormwater flows (e.g., to which tributary of Osborne Creek). As part of the Phase III RI, ESC also reviewed the NYSDOT construction diagrams for the portion of I-88 near the site. The drawings reviewed included general plans, typical sections, and profiles. The purpose of this review was to gain a better understanding of the potential for groundwater to migrate along the fill material used as the subbase during the construction of I-88.

Following completion of sampling activities for each phase of the investigation, all sampling locations, monitoring wells, and piezometers were surveyed by a New York state licensed land surveyor. Hartmann Associates, Inc., of Pittsburgh, Pennsylvania conducted the Phase I surveying activities during the week of September 6, 1993, the Phase II surveying activities during the week of October 3, 1994, and the Phase III surveying activities during the week of November 13, 1995. Hawk Engineering, Inc., of Binghamton, New York conducted the Phase IV surveying activities on November 13, 1997.

Lastly, a Stage IA Archeological Survey of the site was performed by the Public Archaeology Facility of Binghamton, New York, before initiating the Phase I RI field activities. The purpose of the survey was to identify if any significant archeological findings were present at the site.

2.2 Contaminant Source Investigations

The primary sources of potential contamination at the site were determined based on verbal information provided by Mr. Warner, a review of historical material handling practices, historical aerial photographs, and observed site conditions. The primary source areas north of I-88 include the former process wastewater discharge area (i.e., 1958 discharge pattern) and the former wastewater lagoon which currently exists but has not received any wastewater since 1968. The primary source areas south of I-88 include the former process wastewater discharge area (i.e., 1958 discharge pattern), the former unlined wastewater discharge lagoons, the drum decapitation shed and barrel burner, and the drum storage areas that covered much of the former operating portion of the site. Due to the small size of the former operating portion of the site, drums awaiting reconditioning were stored over much of the site to the west and north of the former process building and were moved around to accommodate storage and processing needs. Thus, elevated levels of contaminants in surficial soils could be expected on much of the site located south of I-88. Other potential sources of contamination include the former sumps located beneath equipment inside the process building and the former septic tank and drain field. Finally, the primary source areas south of Osborne Hollow Road include the limited former empty drum storage areas and the former storage shed that was used to store empty drum lids and empty fiber drums containing powdered pesticide residues.

To thoroughly evaluate the nature and extent of contamination at the site, the RI sampling locations were selected to correlate with the identified primary source areas.

2.3 Meteorological Investigations

Meteorological data concerning precipitation, wind speed, and wind direction were obtained from the National Oceanographic and Atmospheric Administration's local climatological publication for 1991 for Binghamton, New York.

2.4 Surface Water and Sediment Investigations

During Phase I sampling activities, surface water and sediment samples were collected from Osborne Creek and its tributaries and from the manmade pond (former lagoon) located north of I-88. During Phase II sampling activities, sediment samples were collected from Osborne Creek and its tributaries and from the manmade pond and associated wetlands located north of I-88. During Phase III sampling activities, sediment samples were only collected from the western tributary at the same location as previous sample, SED-5. During the Phase IV sampling activities, sediment samples were collected from Osborne Creek, the eastern and western tributaries, and the manmade pond located north of I-88. No surface water samples were collected during the Phase II, Phase III, or Phase IV activities. A total of 39 sediment samples and 7 surface water samples were collected during the RI field activities.

Surface water samples were collected by dipping the edge of a laboratory-cleaned sampling bottle into the flowing water of the stream, just beneath the stream surface, and filling the sample bottle. At sampling points where surface water and sediment samples were collected from the same location, surface water samples were collected before the sediment samples to prevent introducing sediment into the water. Additionally, the downstream surface water and sediment samples were collected first, and sampling proceeded progressively toward the most upstream locations.

Sediment samples were collected at each location, with the exception of the Phase III sampling at SED-5, using a precleaned, stainless steel, manually advanced bucket auger (hand auger). The Phase III samples collected at SED5 were collected using split spoon sampling equipment and a truck-mounted drilling rig. A precleaned stainless steel spoon was used to transfer the sample from the bucket auger or split spoon to a precleaned stainless steel bowl, and the sample was homogenized using the cone and quartering method. Care was taken to thoroughly homogenize the samples. The sample was then transferred to laboratory-prepared, labeled sample bottles. Sediment samples collected for VOC analyses were not homogenized, but were transferred directly from the bucket auger or split spoon to the laboratory prepared sample jars.

With the exception of the sediment samples for total organic carbon (TOC) analysis, all surface water and sediment samples collected during the Phase I activities were analyzed by Enseco-Wadsworth/Alert Laboratories of Pittsburgh, Pennsylvania. The Phase I sediment samples for TOC analysis were analyzed by Ecology and Environment, Inc., of Buffalo, New York. All Phase II, III, and IV sediment samples were analyzed by Ceimic Corporation of Narragansett, Rhode Island.

The surface water samples were identified following the format: SW1-1. The first group of symbols (SW1) identifies the sample location, and the second symbol (1) identifies the sampling round. The sediment samples were identified following the format: SED1-1. The first group of symbols (SED1) identifies the sample location. The second symbol (1) identifies the sampling round.

2.4.1 Phase I Sampling Activities

The Phase I surface water and sediment sampling activities were conducted on October 6 and 7, 1993. Before collecting the surface water or sediment samples for laboratory analysis at each location, a sample of the surface water was collected and tested in the field for pH, specific conductance, temperature, and dissolved oxygen.

A total of seven surface water samples were collected. Two samples were collected from the tributaries to Osborne Creek (SW7 and SW8); one sample was collected from the manmade pond north of I-88 (SW4); and four samples were collected from Osborne Creek (SW2, SW5, SW6, and SW9). The surface water samples were analyzed for VOCs, semi-volatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), metals, and hardness.

Three quality assurance (QA) samples, consisting of one duplicate (SW61-1, a duplicate of SW8) and two trip blanks (SW81-1 and SW82-1), were collected in association with the surface water sampling activities.

A total of 10 sediment samples were collected during the Phase I activities. Six samples were collected from the tributaries to Osborne Creek (SED1 through SED6); one sample was collected from the manmade pond north of I-88 (SED7); and three samples were collected from Osborne Creek (SED8 through SED10). These sediment samples were analyzed for VOCs, TOC, SVOCs, pesticides, PCBs, and metals.

In addition, three QA samples were collected in association with the Phase I sediment sampling activities. The QA samples consisted of one duplicate (SED61-1, a duplicate of SED5) and two equipment blanks (SED71-1 and SED72-1).

2.4.2 Phase II Sampling Activities

The Phase II sediment sampling activities were conducted on September 10, 1994. No surface water sampling was conducted as part of the Phase II RI.

A total of 17 sediment samples were collected. Seven sediment samples (SED5, SED20 through SED25) were collected from the two tributaries to Osborne Creek; seven samples (SED13 through SED19) were collected from the manmade pond and associated wetlands north of I-88; and three samples were collected from Osborne Creek (SED26 through SED28). Two QA samples consisting of one equipment blank (SED70-2) and two duplicate samples (SED60-2 is a duplicate of SED14 and SED61-2 is a duplicate of SED13) were collected in association with the Phase II sediment sampling event.

The 7 sediment samples collected from the two tributaries to Osborne Creek included 3 samples (SED20 through SED22) which were collected from the eastern tributary and 4 samples (SED5 and SED23 through SED25) which were collected from the western tributary. SED5 was collected from the same location as sample SED5 which was collected during the Phase I RI to confirm the Phase I RI sampling results. All tributary sediment samples were collected from the stream bottoms to depths of approximately 1 foot using a hand auger and analyzed for SVOCs, pesticides, PCBs, and metals.

Of the 7 total sediment samples collected from the pond and associated wetlands area, 4 samples (SED13 through SED16) were collected from the pond sediments and 3 samples (SED17 through SED19) were collected from the surrounding wetland. SED13 through SED15 were collected near the edge of the pond from a depth of 0-1 foot to delineate the horizontal extent of constituents in the pond sediments. SED16 was collected near the center of the pond, in the vicinity of the Phase I sample SED7, at a depth of 2-3 feet. This sample was collected to determine the vertical extent of the constituents in the sediments beneath the pond. The wetland associated with the pond north of I-88 is located on the southern side of the pond and covers approximately 6,000 square feet. The wetland is described as palustrine, emergent, and persistent with a seasonally flooded/saturated water regime (PEM1E). To characterize the horizontal extent of constituents in the soils of the wetland, SED17 through SED19 were collected from 0-1 foot. The sediment samples collected from the pond and associated wetlands were analyzed for SVOCs, pesticides, PCBs, and metals.

To confirm the Phase I Osborne Creek sediment sampling results, the 3 sediment samples (SED26 through SED28) were collected from Osborne Creek from the same sediment sampling locations identified as SED8 through SED10 during the Phase I field activities. The samples were collected from a depth of 0-1 foot and analyzed for pesticides and PCBs. To obtain the highest level of precision, the samples were extracted using EPA Method 3630B - Silica Gel Cleanup (Test Methods for Evaluating Solid Waste, Physical and Chemical Methods, SW-846, Third Edition, Proposed Update II, 1992) to minimize the possibility of matrix interferences in the analytical results.

2.4.3 Phase III Sampling Activities

The Phase III sediment sampling activities were conducted on October 30, 1995. No surface water samples were collected during the Phase III RI.

Two sediment samples were collected from a single borehole located at the same location as the Phase I and Phase II sample SED5. The two samples (SED5-3(a) and SED5-3(b)) were collected from depth intervals of 2.5-3.0 feet and 5.0-5.5 feet, respectively, and analyzed for SVOCs, pesticides, TOC, and grain size analyses. These samples were collected to assess the vertical extent of the constituents in the western tributary in the vicinity of SED5.

In addition, two QA samples were collected in association with the Phase III sediment sampling activities. The QA samples consisted of one duplicate (SED60-3, a duplicate of SED5-3(a)) and one equipment blank, B76-3, which was collected from the split spoon.

2.4.4 Phase IV Sampling Activities

The Phase IV sediment sampling activities were conducted on October 21 and 22, 1997. No surface water sampling was conducted as part of the Phase IV RI.

A total of 10 sediment samples were collected and analyzed for TOC. Six sediment samples (SED20 through SED25) were collected from the two tributaries to Osborne Creek; one sample (SED16) was collected from the manmade pond north of I-88; and three samples were collected from Osborne Creek (SED26 through SED28). All Phase IV samples were collected from a depth of 0-1 foot using a hand auger. These samples were collected to gather the necessary data for calculating site-specific sediment criteria.

Two QA samples consisting of one equipment blank (SED70-4) and one duplicate sample (SED60-4 is a duplicate of SED23) were collected in association with the Phase IV sediment sampling event.

2.5 Soil Investigations

The principal classes of potential constituents of concern in soils at the site are VOCs, SVOCs, pesticides, PCBs, and metals. This determination was made based on the historical use of the property and on identification of the primary sources of potential contamination at the site.

Characterization of the nature and extent of soil contamination at the Tri-Cities Barrel site was conducted in four phases. Phase I soil sampling activities were conducted to characterize the potential source areas and to identify the constituents of concern in soils. Phase II and Phase III soil sampling activities were conducted to delineate the lateral and vertical extent of constituents of potential concern in the onsite soils. Phase IV soil sampling activities were conducted to gather data on the physical characteristics of the soil and TOC content.

Continuous soil samples were collected from boreholes for lithologic logging and field headspace analysis in accordance with the American Society for Testing and Materials (ASTM) method D1586 and ESC's Standard Operating Procedures (SOPs) manual. Samples were continuously collected from borings advanced by a drilling rig using a 2.0-inch diameter stainless steel, split spoon sampler. Immediately on opening each split spoon sampler, the soil was screened using a photoionization detector (PID) equipped with an 11.7-eV lamp. A portion of each split spoon sample was transferred to a 4-ounce sample jar to obtain a field headspace reading for the soil. The jar threads were covered with Teflon tape and the jar mouth covered by aluminum foil before closing the jar. Any organic vapors on the sample were allowed to volatilize by placing the jar upside down in a warm area for approximately 15 minutes. The field headspace reading was obtained by removing the lid of the jar and piercing the aluminum foil with the tip of the PID probe. The PID was calibrated at the beginning of each day.

Soil samples were transferred from the bucket auger or the split spoon sampler to a clean stainless steel bowl and homogenized using the cone and quarter method before being transferred to laboratory prepared sample bottles. Samples collected for VOC analysis were not homogenized but were transferred directly from the bucket auger or split spoon sampler to the laboratory prepared sample bottles.

Surficial soil samples collected during the Phase I and for some Phase II and III samples were identified using the following scheme: SS1(a)-1-S. The first group of symbols (SS1(a)) identifies the sample location and depth ("a" for 0-6 inches and "b" for 30-36 inches). The second symbol (1) identifies the sampling round. The third symbol (S) identifies the matrix of the sample as soil. For Phase II and III, most of the hand auger surficial soil samples were identified as follows: SS13-2. The first group of symbols (SS13) identifies the sample location and the second symbol (2) identifies the RI phase (e.g., 2 for Phase II and 3 for Phase III). For Phases II, III, and IV, the soil samples collected from borings were identified as follows: B1-1. The first group of symbols (B1) identifies the boring location and the second number (1) identifies the split spoon number. A split spoon number of 1 correlates to a sample collected from a depth of 0-2 feet, a split spoon number of 2 correlates to a sample collected from a depth of 2-4 feet. Similarly, the soil samples collected from the borings advanced for the installation of monitoring wells were identified following the same approach: MW6-1. The Shelby tube soil samples collected during Phase IV were identified as follows: ST-2B-4/6. The first group of symbols (ST) identifies the sample as a Shelby tube sample, the second group of symbols (2B) identifies the bedrock monitoring well (MW-2B), and the third group of symbols (4/6) identifies the depth interval (in this example 4-6 feet).

All soil samples collected during the Phase I activities were analyzed by Enseco-Wadsworth/Alert Laboratories of Pittsburgh, Pennsylvania. With the exception of two surficial soil samples analyzed for dioxins during Phase II, all soil samples collected during the Phase II and Phase III activities were analyzed by Ceimic Corporation of Narragansett, Rhode Island. The Phase II soil samples collected for dioxins analyses were analyzed by Quanterra of Knoxville, Tennessee. The Phase IV soil samples collected for TOC analysis were analyzed by Ceimic Corporation. The Phase IV samples collected for various geotechnical analyses were analyzed by Parratt Wolff, Inc. of East Syracuse, New York.

2.5.1 Surficial Soil Sampling

A total of 98 surficial soil samples were collected during the Phase I, Phase II, and Phase III RI field activities to delineate the lateral extent of constituents of potential concern at the site. No surficial soil samples were collected during Phase IV. Surficial soil samples (samples collected from a depth of less than 3 feet) were collected using either a hand auger or a split spoon sampler driven by a truck-mounted drilling rig. All sampling equipment was decontaminated before use at each sampling location.

2.5.1.1 Phase I Sampling Activities

Twenty-four surficial soil samples (SS1 through SS12) were collected from 12 sampling locations and submitted for chemical analyses during the Phase I sampling activities conducted from August 25 through September 1, 1993. The soil samples were collected from depths of 0-6 inches and 30-36 inches bgs at each location. Of the 24 samples, 10 were collected from the portion of the site north of I-88, 8 were collected from the portions of the site south of I-88 and Osborne Hollow Road, and 6 were collected from background locations off the site.

Four QA samples, consisting of two equipment blanks (SS70-1 and SS71-1) and two duplicate samples (SS60(a)-1 is a duplicate of SS12(a) and SS61(b)-1 is a duplicate of SS7(b)), were collected in association with the Phase I surficial soil sampling. The soil samples and QA samples were analyzed for VOCs, SVOCs, pesticides, PCBs, and metals.

2.5.1.2 Phase II Sampling Activities

Forty-six surficial soil samples were collected and submitted for chemical analysis during the Phase II field activities. Phase II surficial soil sampling was performed from August 30 through September 25, 1994. Fourteen samples were collected from 14 sampling locations north of I-88 and analyzed for VOCs, SVOCs, pesticides, and PCBs. South of I-88 and Osborne Hollow Road, 30 samples were collected from 27 sampling locations and analyzed for VOCs, SVOCs, pesticides, PCBs, and metals. Two samples were also collected from two locations in the vicinity of the former barrel burner and analyzed for 2,3,7,8-tetrachlorodibenzo-p-dioxin.

Phase II surficial soil sampling north of I-88 included collecting soil samples from the boreholes of two monitoring wells (MW6 and MW7) and seven soil borings (B1 through B7), as well as collecting soil samples from five locations sampled by hand auger (SS13 through SS17). Surficial soil samples from the monitoring well and soil boring locations were collected from 0-2 feet bgs. The samples from the hand auger locations were collected from 0-1 foot bgs. SS13 and SS14 were collected from the wooded areas to the east and west of the open grassy area north of I-88. Based on the 1958 aerial photograph, these sampling locations are outside of the area believed to be affected by the former discharge pattern. These samples were collected to confirm that these areas were unaffected. SS15 through SS17 were collected along the terrace located between the pond and Osborne Creek. Specifically, these samples were collected to delineate further the compounds detected in this area during the Phase I.

South of I-88 and Osborne Hollow Road, the Phase II surficial soil sampling was conducted to delineate the lateral extent of compounds in the soil near the former lagoon area, drum storage areas, and drum processing area. This portion of the investigation included the collection of soil samples from the boreholes of 4 monitoring wells (MW1SA (B14), MW2S, MW5S, and MW8) and 6 soil borings (B8 through B11, B13, and B1D). Additionally, 20 soil samples were collected by hand auger from 17 locations (SS18 through SS31 and SS34 through SS36). The surficial soil samples from the monitoring well and soil boring locations were collected from 0-2 feet bgs. The 14 hand augered samples (SS18 through SS31) were collected from 0-1 foot. At three of the hand augered sampling locations (SS34 through SS36) two samples were collected from each location; one sample from a depth of 0-0.5 foot and a second sample from a depth of 2.5-3.0 feet.

The surficial soil sampling locations south of I-88 were distributed so that 7 samples (MW2S, B9, and SS18 through SS22) were collected in the vicinity of the former lagoon area. B8 was located in an area south of I-88 in a topographic low downslope of the former lagoon area. Eleven samples (MW5S, B10, B11, and B13, and SS23 through SS29) were collected in the vicinity of the former drum storage and processing areas. Specifically, B13 was advanced in the vicinity of the former leachfield. B10 was located between the lagoons and the pole barn. Based on the 1958 aerial photograph, this area may have been affected by the drainage pattern and former site operations. Two samples (SS30 and SS31) were collected along the eastern property boundary. Six samples were collected from three locations (SS34 through SS36) and were located in the triangular parcel of land between Osborne Hollow Road and Old Route 7. Three samples (MW1SA (B14), MW8, and B1D) were collected at upgradient locations parallel to Old Route 7.

Additionally, surficial soil sampling specifically for analysis of dioxins was conducted by collecting 2 surficial soil samples (SS-32 and SS-33) from a depth of 0-1 foot using a stainless steel hand auger. These samples were collected in the vicinity of the drum burning unit to assess whether 2,3,7,8-tetrachlorodibenzo-p-dioxin was present in the surficial soils near this unit. These two surficial soil samples were analyzed for dioxin using EPA Method 8290.

Eighteen QA samples consisting of 12 equipment blanks (SS70-2 through SS72-2, and B-70 through B-78) and 6 duplicate samples (SS60-2 is a duplicate of SS15, SS61-2 is a duplicate of SS20, SS62-2 is a duplicate of SS33, B60-1 is a duplicate of B11, B61-1 is a duplicate of B5, and MW60-1 is a duplicate of B1D) were collected in association with the Phase II surficial soil sampling. Additionally, as specified by the EPA Region II Quality Assurance Project Plan (QAPjP) and Stelios Gananzolinis, QA Chemist of EPA Region II, the equipment blank of the auger used to collect the sample for dioxin analysis (SS72-2) was collected using isopropanol.

2.5.1.3 Phase III Sampling Activities

To complete the horizontal delineation of identified constituents of concern across the site, 28 surficial soil samples were collected and submitted for chemical analyses during the Phase III sampling activities. Four of the 28 surficial soil samples were collected from offsite locations for use in determining background metals concentrations in soils.

North of I-88, a total of 6 surficial soil samples were collected from 6 sampling locations. Two of the samples (SS44 and SS45) were collected using a hand auger and analyzed for pesticides and PCBs to complete delineation of these constituents north of the former lagoon and surficial drainage pattern. Four samples were collected from the boreholes of monitoring wells (MW9, MW10, MW11S, and MW12S) using a split spoon sampler and analyzed for VOCs, SVOCs, pesticides, PCBs, and metals. The soil samples from the boreholes of the monitoring wells were collected to assess the quality of the soils at each well location.

South of I-88 and Osborne Hollow Road, 18 surficial soil samples were collected from 18 sampling locations and analyzed for VOCs, SVOCs, pesticides, PCBs, and metals. Eleven samples were collected using a hand auger (SS37 through SS43, SS46 through SS48, and SS51). Eight samples were collected from the boreholes of 6 soil borings (B17 through B20, B22, and B23) and 1 monitoring well (MW13S). SS37 and MW13S were located adjacent to the western tributary to assess the quality of the soils near SED5. SS38 through SS43 were located within the western portion of the property between the former drum storage area and the western tributary. [Note: two samples were proposed to be collected from SS40 at depths of 0-2 feet and 3-5 feet using a hand auger. The 0-2-foot sample was successfully collected. Field personnel made several attempts to collect the 3-5-foot sample but repeatedly encountered auger refusal at a depth of 2-3 feet. Because the portion of the site south of I-88 is fenced, it was not possible to mobilize mechanical equipment to this portion of the site without removing a portion of the fence. Consequently, ESC was unable to collect the sample from 3-5 feet.] SS46 through SS48 were located north and parallel to Osborne Hollow Road, and SS51 was located in the vicinity of the former lagoons. B17 through B20, B22, and B23 were located adjacent to and within the former process building and pole barn.

To complete the determination of background metals concentrations in soils, 4 surficial soil samples were collected from 3 offsite locations (SS-49, SS-50(a), and SS-50(b)) west of the site. The samples were collected using a hand auger and analyzed for VOCs, SVOCs, pesticides, PCBs, and metals. The background samples were analyzed for all parameters to ensure that the selected locations were indicative of background conditions.

Twelve QA samples consisting of 10 equipment blanks (SS70-3 through SS72-3, B71-3, B72-3, and B74-3 through B78-3) and 2 duplicate samples (SS60-3 is a duplicate of SS40 and B61-3 is a duplicate of MW10) were collected in association with the Phase III surficial soil sampling.

2.5.1.4 Phase IV Sampling Activities

No surficial soil samples were collected during the Phase IV RI.

2.5.2 Soil Boring Program and Subsurface Soil Sampling

During the Phase I, Phase II, Phase III, and Phase IV RI field activities, a total of 50 subsurface soil samples were collected to assess the vertical distribution of constituents of concern at identified areas of potential concern and to gather geotechnical data for evaluating the fate and transport of contaminants present in the soils at the site. For the purposes of this RI, subsurface samples are soil samples which were collected from a depth of 3 or more feet bgs.

The subsurface soil samples were collected during advancement of boreholes for lithologic logging and sampling purposes and for the installation of monitoring wells and piezometers. The samples were collected with a 2-inch diameter split spoon sampler which was driven into the soil through hollow stem augers, using a truck-mounted drilling rig. All downhole drilling equipment was decontaminated between boreholes and the split spoon samplers were decontaminated between samples. With the exception of the soil cuttings from B17 and B24, the soil cuttings from each borehole were returned to their respective borehole, and the top approximately 3 feet were filled with bentonite cement grout. B17 and B24 were advanced during the Phase III torefusal near the bottom of the unconsolidated deposits, and as a result, the entire borehole was filled with bentonite cement grout. The soil cuttings from these borings were placed in Department of Transportation (DOT)-approved, 55-gallon drums.

2.5.2.1 Phase I Sampling Activities

During the Phase I RI, six subsurface soil samples were collected from the boreholes advanced for the installation of piezometers P-1, P-2, and P-3, which were all located south of I-88. The subsurface soil samples were collected from August 4 to August 17, 1993.

Based on field observations and the results of the field headspace analysis, two vadose zone soil samples were collected from each borehole and analyzed for VOCs, SVOCs, pesticides, PCBs, and metals.

From the borehole of P1, the subsurface soil samples were collected from depths of 2-6 feet and 6-8 feet. A 4-foot interval was necessary for the one sample because extra volume was needed to collect the matrix spike/matrix spike duplicate sample (MS/MSD) and for the EPA representative to collect a split sample. From the borehole of P2, the soil samples were collected from depths of 6-8 feet and 10-12 feet. A duplicate sample (P60) was also collected from a depth of 6-8 feet. From the borehole of P3, the soil samples were collected from depths of 2-4 feet and 8-10 feet.

An equipment blank of the decontaminated split spoons and the stainless steel sampling bowls and spoons was collected during each day of sampling. The equipment blanks were identified as P70 through P75.

2.5.2.2 Phase II Sampling Activities

During the Phase II RI, a total of 18 subsurface soil samples were collected from soil boring and monitoring well locations across the site. North of I-88, seven samples were collected from soil boring locations (B1 through B7) and analyzed for VOCs, SVOCs, pesticides, and PCBs, and two samples were collected from monitoring well locations (MW6 and MW7) and analyzed for VOCs, SVOCs, pesticides, and PCBs.

B1 through B4 were installed along the eastern portion of the open grassy area. Based on a review of the historical aerial photographs, these borings were located outside of the eastern limit of the former surface discharge pattern, as depicted in the 1958 aerial photograph. B5 through B7 were installed along the western portion of the open grassy area. Based on the 1958 aerial photographs, B5 through B7 were located near but outside of the western limit of the former surface discharge pattern. The soil samples from these borings were collected from a depth of 8-10 feet.

North of I-88, two subsurface soil samples were collected from the boreholes advanced for the installation of MW6 at a depth of 16-18 feet and MW7 at a depth of 18-20 feet. These samples were collected to characterize the quality of the soils at each of these well locations.

South of I-88, nine subsurface soil samples were collected for laboratory analysis. Six samples were collected from soil boring locations (B8 through B13), and two samples were collected from monitoring well locations (MW2S and MW5S). South of Osborne Hollow Road, one subsurface soil sample was collected from soil boring B1D. All nine samples were analyzed for VOCs, SVOCs, pesticides, PCBs, and metals.

B8 was located in an area south of I-88 in a topographic low downslope of the former lagoon area. MW2S and B9 were collected in the vicinity of the former lagoon area. B10 was located between the lagoons and the pole barn. Based on the 1958 aerial photograph, this area may have been affected by the drainage pattern and former site operations. MW5S and B11 through B13 were located in the vicinity of the former drum storage and processing areas. Specifically, B13 was advanced in the vicinity of the former leachfield. B1D was located south of Osborne Hollow Road and adjacent to MW1S.

The samples collected for laboratory analysis from B8 through B12 were obtained from a depth of 8-10 feet. At B13, the soil sample was collected from a depth of 6-8 feet to ensure that soils immediately below the depth of the former leachfield were collected. The soil samples collected from the boreholes advanced for the installation of MW2S and MW5S were obtained from depths of 20-22 feet and 10-12 feet. These samples were collected to characterize the quality of the soils at each of these well locations.

An equipment blank of the decontaminated split spoons and the stainless steel sampling bowls and spoons was collected during each day of sampling. The equipment blanks were identified as B70, B71, and B73 through B77. While no duplicate samples were collected of the subsurface soils, the duplicate sampling frequency for soil samples was adhered to by collecting the duplicates from the surficial soil samples.

2.5.2.3 Phase III Sampling Activities

During the Phase III RI, a total of 17 subsurface soil samples were collected from soil boring and monitoring well locations at the site. No subsurface soil samples were collected south of Osborne Hollow Road during the Phase III RI.

To complete the vertical delineation of the constituents of potential concern in soils north of I-88 and to assess the soil quality at each well location, 4 subsurface soil samples were collected from boreholes advanced during the installation of MW9, MW10, MW11S, and MW12S. All the samples were collected from the vadose zone at a depth of 8-10 feet and analyzed for VOCs, SVOCs, pesticides, PCBs, and metals. To complete vertical delineation of the constituents of potential concern in soils south of I-88, 13 subsurface soil samples were collected and analyzed for VOCs, SVOCs, pesticides, PCBs, and metals. B15 and B16 were collected from depths of 10-12 feet in the former drum storage area, and the soil sample collected from the borehole of MW13S was collected from a depth of 8-10 feet to assess the soil quality above this monitoring well. B17 through B24 were located adjacent to and within the former process building and pole barn. With the exception of B17 and B24, the soil samples were collected from a depth of 8-10 feet at each boring location. Two samples were collected from B17 at depths of 8-10 feet and 40-42 feet, and two samples were collected from B24 at depths of 8-10 feet and 46-47.3 feet.

B17 and B24 were advanced to refusal near the bottom of the unconsolidated deposits to assess the soil conditions at depth in the vicinity of the onsite process buildings. The September 29, 1995, Work Plan Addendum for the Phase III RI identified borings B17 and B18 as the borings planned for advancement to bedrock. However, due to space and access limitations encountered at the site, it was not possible to advance B18 to the top of bedrock as planned. As a result, boring B24, located approximately 20 feet east of B18, was added to the scope of work during field activities as a substitute location from which to collect the deep soil sample. This modification was communicated to the EPA in a letter dated October 24, 1995. To prevent potential cross-contamination of deep soils by surficial constituents of concern, a 10-inch diameter steel surface casing was set at a depth of 10 feet in each boring. Following a minimum 24-hour curing period for the cement grout, each borehole was advanced through the casing to the final depth.

The boreholes for B17 and B24 were advanced until refusal of the hollow stem augers was encountered. At the time of the Phase III RI, auger refusal was thought to be the top of the weathered bedrock. It was not until the bedrock monitoring wells were installed during the Phase IV RI that the depth to bedrock was determined to be greater than originally believed.

2.5.2.4 Phase IV Sampling Activities

During the Phase IV RI, nine subsurface soil samples were collected from the boreholes advanced for the installation of bedrock monitoring wells MW1B, MW2B, and MW14B. MW1B is located south of Osborne Hollow Road and MW2B and MW14B are located south of I-88. The subsurface soil samples were collected from October 14 - 16, 1997. During the advancement of each of the bedrock boreholes, a soil sample was collected from a depth of 2-4 feet and analyzed for TOC. A duplicate sample (B60-4) was also collected from MW14B at a depth of 2-4 feet and analyzed for TOC. An equipment blank of the split spoon and decontaminated stainless steel bowl used to composite the soil sample was collected on October 15, 1997. The equipment blank was identified as B70-4.

Additionally, six soil samples for geotechnical analyses were collected from MW2B and MW14B (three from each borehole). The samples collected from the borehole of MW2B were obtained from depths of 4-6 feet, 18-20 feet, and 28-30 feet. The samples collected from the borehole of MW14B were obtained from depths of 4-6 feet, 13-15 feet, and 28-30 feet. The objective of the sampling depths was to collect geotechnical samples from both the vadose and saturated zones. The geotechnical samples were collected using a 3-inch diameter split spoon containing an acetate liner. On retrieval of the split spoon, the acetate liner was carefully removed from the split spoon to minimize disturbance of the sample, and the ends of the acetate liner were capped in preparation for shipment to the geotechnical laboratory. The six geotechnical samples were analyzed for hydraulic conductivity, grain size, specific gravity, moisture content, and bulk soil density. In accordance with the Phase IV RI Work Plan Addendum, no duplicate sample of the geotechnical samples was collected, and because the geotechnical samples were collected to measure physical and not chemical properties, no equipment blank of the geotechnical sampling equipment was collected.

2.5.3 Exploratory Trenching and Soil Sampling

2.5.3.1 Phase I Sampling Activities

Excavation and sampling of the seven trenches were conducted from August 9 through August 24, 1993. CODE Environmental Services, Inc., was retained as the excavation subcontractor. The purpose of the trenching activities was to characterize the soils in the vicinity of potential source areas. These areas include the former lagoons located north of the process building and south of I-88, the former drum storage area located in the western portion of the site, and the former drum processing area located west of the onsite buildings. The locations of the trenches are identified on Figure 1-4, and the sample designations used on the figure correlate to the sample number as indicated in Table 2-3.

Each trench was excavated using a large hydraulic excavator to a maximum depth of 12 feet, unless perched groundwater was encountered during excavation. When perched groundwater was encountered, as occurred during the excavation of the trenches located in the former lagoon areas of the site (south of I-88), ESC discontinued further excavation to minimize the potential for migration of any constituents present in the perched groundwater to affect the underlying soils. Because of the uncertainty of what would be encountered while excavating, excavation activities were conducted in Level C personal protective equipment (PPE).

In the former lagoon area, north of the onsite buildings, four trenches (1 through 4) were excavated for a total length of approximately 540 feet. In the former drum storage area, two trenches (5 and 6) were excavated for a total length of approximately 270 feet. A single trench (7), approximately 140 feet long, was excavated immediately west of the former drum processing area.

Initially, a backhoe was used to conduct the excavation activities. However, due to the compactness of the clay-rich soils, it was determined that a trackhoe would be needed to efficiently conduct the trenching activities. On August 11, CODE secured a Komatsu PC220 equipped with a 28-inch bucket to continue the excavation activities.

During excavation, the lithology of the soils was described on a trenching log for every 10-foot interval along the trench. The trenching logs are provided in Appendix F. Headspace samples were collected for field analysis using an HNu PID every 10 feet along the trench and at depths of 2 feet, 5 feet, and at the bottom of the excavation. All samples were collected from the bucket of the excavator using a stainless steel spoon. Due to the potential hazards of confined space entry, no personnel were permitted to enter the trenches. All excavated soils were temporarily placed on polyethylene sheeting adjacent to the trench. Following sample collection, the excavated soils were placed back in the trench.

Samples for laboratory analysis were collected based on visual observations, variations in the materials encountered, horizontal and vertical distribution of samples, and the total VOC levels detected with the PID while excavating. Visual observations included potentially stained or abrupt color changes of the soils. Material composition variations included lithology changes or a layer of paint chips, organic materials, burn pile ashes, buried drum lids or debris. Samples were collected directly from the trackhoe bucket in accordance with the procedures outlined in the approved SAP. A total of 32 soil samples were collected and analyzed for VOCs, SVOCs, pesticides, PCBs, and metals. A duplicate sample of TS6-3(2) (TS60-6(3)) was collected and equipment blanks (TS70 through TS77 and P75) of the decontaminated stainless steel bowls and spoons were collected during each day of sampling.

The trench soil samples were identified following the format TS1-1(5)-1-S. The first group of symbols (TS1) identifies the trench number. The second symbol (1) identifies the horizontal location of the sample from the starting end of each trench (i.e., 1 corresponds to 10 feet from the beginning edge of the trench and 9 corresponds to 90 feet from the beginning edge of the trench). The third symbol ((5)) identifies the depth of the sample bgs. The fourth symbol (1) identifies the sampling round, and the fifth symbol identifies the matrix of the sample as soil.

2.5.3.2 Phase II, Phase III, and Phase IV Sampling Activities

No trenching activities were conducted during the Phase II, Phase III, or Phase IV RI.

2.6 Groundwater Investigations and Procedures

Groundwater investigations were conducted as part of the Phase I, Phase II, Phase III, and Phase IV RI. These investigations included installing and developing 3 piezometers and 22 monitoring wells; installing a staff gauge in Osborne Creek; performing 7 rounds of groundwater sampling and several rounds of elevation monitoring of the monitoring wells, piezometers, and staff gauge; and performing 16 sets of rising and falling head slug tests on selected wells and piezometers. MW-1 through MW-3 were installed in the 1980s as part of the pre-RI HRS scoring and characterization of the site. MW-4 (former production well for the facility) was reportedly installed in the 1950s and was completed as an open hole bedrock well). Boring logs and as-built monitoring well construction forms were prepared for each well installed during the RI (Appendices G and H).

All monitoring wells and piezometers were installed in the unconsolidated material overlying bedrock. Wells designated with an S (e.g., MW5S) and the 3 piezometers were installed with screens bracketing or near the surface of the water table. Wells designated with a B (e.g., MW2B) were installed as bedrock monitoring wells. The other wells were installed near the base of the unconsolidated deposits. Table 2-4 provides well construction details for all monitoring wells and piezometers which were installed or sampled during the RI. The soil cuttings generated during the installation of the Phase I and II piezometers and monitoring wells were placed on and covered with polyethylene sheeting adjacent to each well. With the exception of MW14, the soil cuttings generated during the installation of the Phase III monitoring wells were placed in labeled, DOT-approved 55-gallon drums and staged south of I-88 within the security fence. The soil cuttings from MW14 were placed on plastic adjacent to the well. During the time critical removal action, the drummed soils were disposed of offsite. The soil cuttings generated during the installation of the Phase IV bedrock monitoring wells were placed on and covered with plastic near each monitoring well. In accordance with the EPA guidance document, Management of Investigation-Derived Waste During Site Inspections (May 1991), it is acceptable to place soil cuttings on plastic. These cuttings will be addressed and incorporated into the final remedy for the site. The bedrock cores from the installation of the bedrock monitoring wells were transported to ESC's Pittsburgh office for storage.

At the initiation of all groundwater sampling events, groundwater elevation monitoring was performed to assess the groundwater elevations across the site and to check for any non-aqueous phase liquids (NAPLs) in the wells. Immediately following the opening of each well, the total concentration of organic vapors in the air inside each well casing was measured using an HNu PID equipped with an 11.7-eV lamp. Next, the depth to groundwater and total depth of each well were measured using an oil/water interface probe. After measuring the depth to the water table and checking for light non-aqueous phase liquids (LNAPLs), the oil/water interface probe was lowered down the well, through the standing column of water until the probe touched the bottom of the well. The total depth of the well was then measured directly from the interface probe tape. The interface probe was left in the operating mode as it was lowered through the water column, allowing the operator to monitor for dense non-aqueous phase liquids (DNAPLs) while obtaining the total depth measurement of the well.

During the Phase I and Phase II sampling events, a minimum of three well volumes was purged from each well using a disposable polyvinyl chloride (PVC) bailer before sampling. During the collection of the Phase III and Phase IV RI groundwater samples, the most current version of the draft EPA Region II Groundwater Sampling SOP was followed even though the SOP was not finalized until March 1998. In accordance with revision 9 of the draft EPA Region II Groundwater Sampling SOP dated May 24, 1995, a positive displacement groundwater sampling pump (a bladder pump) was used to purge each well and to collect the groundwater samples (except MW-1S) during the Phase III sampling event. The Phase IV groundwater samples (except the samples collected during Round 5 and MW-2S collected during Round 6) were collected in accordance with revision 14 of the draft EPA Region II Groundwater Sampling SOP dated January 15, 1997. During Phase III, because a limited thickness of groundwater was present in MW-1S, this well was sampled using a Teflon bailer. Because the groundwater sample collected from MW-12S during Round 5 was only analyzed for SVOCs, it was sampled using a Teflon bailer. The groundwater samples collected from the bedrock boreholes of MW-2B and MW-14B were also obtained using a Teflon bailer because the packer system installed in the wells to collect these samples limited the available space which prevented the use of the bladder pump to collect the samples. The VOC groundwater sample collected from MW-2S during Round 6 was collected using a bladder pump; all other analytes were collected using a Teflon bailer. During the sampling of MW-2S, the hoses on the bladder pump were clogging with frozen water which precluded collection of all analytes using the bladder pump.

The following paragraphs describe the procedures followed during the Phase I and Phase II groundwater sampling events, and the Phase III and Phase IV exceptions. Any deviations from these procedures are discussed in the appropriate subsections of this report. Throughout the purging process, the temperature, pH, and specific conductance of the water were monitored following the removal of each well volume. The field instruments were rinsed with deionized water before use and between readings. Purging of the wells continued until the indicator parameters (pH, conductivity, and temperature) did not vary more than 10 percent between two successive well volumes. In accordance with the NYSDEC Technical and Administrative Guidance Memorandum No. 4015, the turbidity of the water in each well was measured at the end of the purge process. The NYSDEC guidance recommends that the turbidity of the groundwater be equal to or less than 50 NTUs. Due to the high clay content of the unconsolidated glacial till deposits at the site, it was not practical to purge all of the wells during groundwater sampling until the turbidity was at or below 50 NTUs, even though significant effort was taken during the development of each well and the NYSDEC goal of 50 NTUs or less was obtained at each well during well development activities. Because of the difficulties reaching 50 NTUs during the Phase I and II investigations, the Phase III Work Plan Addendum stated that, "If development of the wells to less than 50 NTUs is not possible, both filtered and unfiltered samples will be collected for metal analysis."

Even though the procedures for purging the wells and collecting the groundwater samples using the low flow groundwater sampling SOP were strictly followed, select wells were unable to attain the 50 NTU criterum. The likely cause for turbidity in the purge water is the abundance of fine-grained clays present within the till of the unconsolidated deposits at the site (e.g., natural conditions).

To limit cascading effects during the Phase I and Phase II purge process, care was taken to prevent evacuating the well to complete dryness during well purging. Bailer cord made of nylon rope with a Teflon coated wire leader was used to lower the bailer into the well and samplers wore clean protective disposable gloves at each well.

The Phase I, Phase II, Phase III (MW1S), and Phase IV (MW12S-5, MW2B-5, MW14B-5, and MW2S-6) groundwater samples were collected using disposable Teflon bailers and the sampling procedures outlined in the approved SAP. The disposable Teflon bailers used to collect the groundwater samples from each well were cleaned and placed in sealed polyethylene bags by the supplier, Voss Technologies. Voss Technologies cleaned the bailers by washing them thoroughly with Liquinox laboratory detergent, rinsing with distilled water, rinsing with a 10 percent nitric acid solution, rinsing thoroughly with distilled water, rinsing with isopropanol, and drying in a closed room. Before use in the field, the bailers were removed from the sealed polyethylene bags and rinsed twice using laboratory grade analyte-free water.

To sample the wells using a Teflon bailer, the bailer was lowered into the groundwater column until it was entirely submersed. After the bailer filled with water, it was slowly retrieved from the casing.

During collection of VOC samples, precautions were taken to avoid agitation of the water sample and no bubbles remained in the container. Following the filling of the VOC sample containers, the remaining containers were filled. The final field parameter measurements were taken on a separately collected sample.

During the Phase III and Phase IV sampling events, the monitoring wells were purged and the groundwater samples collected following the low stress purging and sampling procedures detailed in the draft EPA Region II Groundwater Sampling SOPs (revisions 9 and 14). To implement this procedure, ESC used a TIMCO brand bladder pump constructed of Teflon and fit with a Teflon water discharge hose and a polyethylene air supply hose. At each well, after conducting the groundwater elevation monitoring procedures, the bladder pump was slowly inserted in the groundwater column and suspended in the well. The bladder pump was positioned such that the bladder intake was situated at the approximate midpoint of the screened interval of the well. In situations where the static groundwater level was lower than the top of the screened interval, the bladder intake was positioned at the approximate midpoint between the bottom of the well and the static water level.

The bladder pump flow rate was adjusted until a steady flow rate of approximately 250 - 500 milliliters (ml) of groundwater per minute were produced from each well. Care was taken to prevent groundwater drawdown greater than 0.3 foot. During this low flow purge process, the purged groundwater physical parameters were monitored using field instruments. The purged groundwater was monitored during Phase III for pH, temperature, conductivity, Eh (redox potential), and turbidity and during Phase IV for pH, temperature, conductivity, turbidity, and dissolved oxygen. During Phase III sampling activities, duplicate pH measurements were obtained to verify instrument accuracy and precision. The field parameter measurements were obtained approximately every 4 to 5 minutes throughout the purge process.

The Phase III groundwater samples were collected at each well after the field parameter readings had stabilized, remaining within 10 percent variation for 3 consecutive readings. The Phase IV groundwater samples were collected at each well after the field parameter readings had stabilized within 0.1 for pH, 3 percent for specific conductance, and 10 percent for dissolved oxygen and turbidity. The groundwater samples were collected by filling the laboratory prepared sample bottles directly from the bladder pump groundwater discharge tube.

The bladder pump was thoroughly decontaminated before use and between wells to prevent cross-contamination between the wells. The pump was decontaminated in accordance with the draft EPA SOP that was in effect at the time of the sampling. A series of four water and detergent solutions were pumped through the pump and used to rinse the exterior of the pump. Because new, clean Teflon tubing and polyethylene tubing were used at each well, the tubing was not field decontaminated. The pump was flushed with 5 gallons of potable water, followed by 5 gallons of a non-phosphate detergent and water solution, followed by 5 gallons of potable water, and finally flushed with 5 gallons of distilled water.

Care was taken to ensure that there were no air bubbles included in the VOC containers during all sampling events. All aqueous samples submitted for VOC analysis were preserved with hydrochloric acid, aqueous samples submitted for metals analysis were preserved with nitric acid, and aqueous samples submitted for cyanide analysis were preserved with sodium hydroxide. All samples were preserved by storing and shipping the samples in an ice chest cooled to 4 degrees C. The groundwater samples were shipped to the laboratory under strict chain of custody protocol.

Decontamination water, purge water, and development water generated at each well were placed in DOT-approved 55-gallon containers or a polytank and relocated to a central staging area on the site (immediately north of the pole barn). Each container was properly sealed, labeled, and staged onsite until the liquid was removed by Clean Harbors Environmental Services, Inc. via vacuum truck for disposal at the Clean Harbors facility in Cleveland, Ohio. As required by the AOC, before transporting the aqueous investigation-derived waste (IDW) to the Clean Harbors facility in Cleveland, Ohio, the treatment facility was approved by the EPA and both the EPA and the Ohio EPA were notified of the offsite shipment. The empty drums were removed from the site as part of the time critical removal action. All IDW generated during the RI was managed in accordance with the EPA guidance document, "Management of Investigation-Derived Wastes During Site Inspections" (EPA OERR Directive 9345.3-02, May 1991). In accordance with the approved Phase IV Work Plan Addendum, the purge and development water from the bedrock monitoring wells were discharged to the ground surface at least 10 feet from the well head and on the downgradient side of the well.

All Phase I RI groundwater samples were analyzed by Enseco-Wadsworth/Alert Laboratories of Pittsburgh, Pennsylvania, and all Phase II, III, and IV RI groundwater samples were analyzed by Ceimic Corporation of Narragansett, Rhode Island.

The groundwater samples collected during the RI were identified using the following scheme: MW1-1. The first group of symbols (MW1) identifies the well number and the second symbol (1) identifies the sampling round. Note: two rounds of sampling (1 and 2) were conducted during Phase I of the RI, the third round was conducted during Phase II, the fourth round was conducted during Phase III, and the fifth, sixth, and seventh rounds were conducted during Phase IV. Note: The fifth round includes the resampling of MW12S on August 13, 1997, and the collection of the groundwater samples from the open boreholes of MW2B and MW14B using packers on November 10 and 11, 1997.

2.6.1 Phase I

2.6.1.1 Piezometer and Staff Gauge Installation

During the Phase I RI, three piezometers (P-1, P-2, and P-3) were installed in the southern portion of the site and a staff gauge was installed in Osborne Creek, north of the site. The locations of the piezometers and staff gauge are identified on Figure 1-4.

The piezometers were installed by Environmental Products and Services, Inc., using a drilling rig equipped with 4.25-inch inside diameter (ID) hollow stem augers, following the procedures outlined in the approved SAP. Continuous split spoon samples were collected for lithologic logging and field headspace measurements. P-1 was installed to a depth of 19.4 feet, P-2 to a depth of 28.5 feet, and P-3 to a depth of 30.5 feet. Each piezometer was fitted with a bottom end cap and constructed with 2.0-inch inside diameter, schedule 40 PVC casing and a 10.0-foot section of 0.010-inch machine-slotted screen. Each piezometer was completed with a stickup steel protective casing cemented in place. Piezometer construction details are summarized in Table 2-4. The drill rig, augers, and drilling tools were decontaminated between each borehole using a steam cleaner. The split spoon samplers were steam cleaned and further decontaminated by ESC field personnel between each sample following the procedures outlined in the SAP.

Following installation, the piezometers were developed over a period of several weeks. Due to slow recharge, each piezometer was bailed dry after the removal of approximately 3 gallons. During development, the pH, temperature, specific conductance, and turbidity were monitored. A summary of the well development, including the total gallons of groundwater removed, is presented in Table 2-5.

2.6.1.2 Groundwater Monitoring and Sampling

Weekly groundwater elevation monitoring was conducted at the three existing monitoring wells (MW-1, MW-2, and MW-3) from July 29 through September 7, 1993. Groundwater elevation monitoring was also conducted at the three piezometers (P-1, P-2, and P-3) and staff gauge following their installation in August. Additional groundwater elevation measurements of the existing wells, new piezometers and staff gauge were also collected on October 8 and November 4, 1993. The depth to groundwater in each well or piezometer was measured using an oil/water interface probe or a Hazco Services Dipmeter which was decontaminated between each well measurement. The elevation of Osborne Creek was measured using a tape measure; subtracting the distance between the surface of the creek from the surveyed point on the gauge provided the elevation of the creek.

To identify the constituents of potential concern in groundwater beneath the site, two rounds of groundwater samples were collected from the three previously installed monitoring wells (MW1 through MW3) and MW4 (former production well). The groundwater samples were analyzed for VOCs, SVOCs, pesticides, PCBs, total metals, and cyanide.

The first round of groundwater sampling from the existing monitoring wells was collected on July 31, 1993. One trip blank (MW80-1), an equipment blank of the Teflon bailer (MW70-1), and a duplicate sample of MW3 (MW60-1) were also collected. On August 4, 1993, a groundwater sample was collected from the out-of-service production well, MW4, in accordance with the procedures outlined in the approved SAP. A trip blank (MW81-1) was submitted to the laboratory with the groundwater sample collected from MW4 and analyzed for VOCs.

Before sampling, the depth to water was measured in MW4; however, because the tape measure of the water level indicator was only 100 feet, ESC was unable to determine the total depth of the well, other than it exceeds 100 feet. In turn, it was not possible to accurately calculate a purge volume to be removed from the well. As a result, an estimated purge volume was calculated based on an estimated well depth of 100 feet, and approximately 221 gallons of groundwater were purged from the well before the sample was collected.

On September 2, 1993, the second round of groundwater samples was collected from the existing monitoring wells (MW1, MW2, and MW3) and the out-of-service production well (MW4). Because of the large quantity of groundwater that needed to be purged from MW4, a 2-inch submersible pump was used to purge the well during the second round of groundwater sampling rather than a bailer. The pump was thoroughly decontaminated before it was placed in the well. The groundwater samples were collected using a clean Teflon bailer at each well. The samples were analyzed for VOCs, SVOCs, pesticides, PCBs, total metals, and cyanide. A trip blank (MW80-2), equipment blank of the Teflon bailer (MW70-2), and a duplicate sample of MW4 (MW60-2) were also collected.

2.6.2 Phase II

2.6.2.1 Monitoring Well Installation

During the Phase II field activities in September 1994, eleven groundwater monitoring wells (MW1S, MW1SA, MW2S, MW3S, MW5S, MW6S, MW6, MW7S, MW7, MW8S, and MW8) were installed by Parratt Wolff in the unconsolidated material at the site. The shallow wells (MW1SA, MW2S, MW3S, MW5S, MW6S, MW7S, and MW8S) were installed such that the well screen extended across the water table at the time they were installed. The screens of the deep wells (MW1S, MW6, MW7, and MW8) were installed near the base of the unconsolidated material. Because of the small thickness of the unconsolidated deposits and the depth of the water table at MW1S, even though MW1S was installed near the base of the unconsolidated materials, the well screen also extends across the water table. Monitoring well construction details, including total depth and screened interval, are provided in Table 2-4.

Continuous split spoon samples were collected for lithologic logging and field headspace analysis from the boreholes advanced for the installation of MW1S, MW1SA, MW2S, MW3S, MW5S, MW6, MW7, and MW8. Lithologic information obtained from the boreholes of the deep wells (MW6, MW7, and MW8) was used to characterize the nature of the interface between the unconsolidated material and weathered bedrock. Because the boreholes for MW6S, MW7S, and MW8S were advanced in the immediate vicinity of MW6, MW7, and MW8, samples were collected at 5-foot intervals at these well locations.

The borings were advanced with 4.25-inch ID hollow stem augers and the monitoring wells were installed through the augers. All monitoring wells were fit with a bottom and top cap. Each well was constructed with flush-threaded, 2.0-inch ID, schedule 40 PVC casing attached to a section of 0.010-inch machine-slotted screen. All of the wells were constructed with a 10.0-foot length of screen, except MW5S, which was constructed with a 5.0-foot length of screen. The monitoring wells were completed with a stick-up steel protective casing which was cemented in place.

To assess the groundwater quality upgradient of the site, MW1S was installed south of Osborne Hollow Road and south of Old Route 7 (between Old Route 7 and the Delaware and Hudson Railroad tracks). The base of this well was positioned at the top of the weathered bedrock surface (approximately 24 feet bgs). For several weeks following construction, MW1S was a dry well, and therefore not useful for sampling purposes. Because groundwater sampling at MW1S was not possible, additional wells were installed south of Osborne Hollow Road to further assess upgradient groundwater quality. MW1SA (initially identified as soil boring B14) was installed adjacent to the existing monitoring well MW1 and a well pair (MW8S and MW8) was installed on the northern side of Old Route 7, south of Osborne Hollow Road.

Based on the Phase I groundwater monitoring data, the direction of groundwater flow beneath the site is toward the north-northwest. Thus, MW-5S was installed hydraulically downgradient of the former drum storage area to intercept groundwater from the western portion of the site. MW-5S is screened at 10-15 feet bgs.

Downgradient of the former lagoons, shallow wells (MW2S and MW3S) were installed adjacent to existing deep wells, MW2 and MW3. MW2 and MW3 are screened at a depth of approximately 40-50 feet bgs, while MW2S is screened at 15-25 feet bgs and MW3S is screened at 10-20 feet bgs. MW2S and MW3S monitor the upper portion of the water bearing zone immediately downgradient of the former lagoons.

North of I-88, two well pairs (MW6S/MW6 and MW7S/MW7) were installed to further characterize the horizontal extent of compounds in the groundwater of the unconsolidated deposits and to assess the vertical component of groundwater flow in the northern portion of the site. The well pair MW6S/MW6 was installed downgradient of the pond in the northern portion of the site to assess groundwater quality downgradient of the former operating site, the pond, and the historical surficial discharges. The well pair MW7S/MW7 was installed in the northwestern, downgradient portion of the site to monitor the downgradient groundwater quality.

Monitoring well development was conducted in each of the 11 monitoring wells using either a 2-inch submersible pump or by hand bailing. Five of the wells (MW6, MW6S, MW7, MW8, and MW8S) were developed using a submersible pump. The remaining 5 wells (MW2S, MW3S, MW5S, MW7S, and MW1SA) as well as the piezometers (P1, P2, and P3) were developed using dedicated disposable PVC bailers. Because MW1S was dry during most of the Phase II field activities, it was not developed. A summary of the well development, including the total gallons of groundwater removed, is presented in Table 2-5. Field measurements of pH, conductivity, temperature, and turbidity were monitored throughout the development process. All wells were developed until the water turbidity was 50 NTUs or less. If a monitoring well evacuated to dryness during development, it was allowed to recover before development continued. All development water was placed in DOT-approved, 55-gallon drums and labeled appropriately. The drums were relocated to a central staging area south of I-88.

2.6.2.2 Groundwater Monitoring and Sampling

During the week of October 4, 1994, groundwater samples were collected from the 3 existing monitoring wells (MW1 through MW3), the out-of-service production well (MW4), the 3 existing piezometers (P1 through P3), and 10 of the 11 newly installed monitoring wells (MW1SA, MW2S, MW3S, MW5S, MW6S, MW6, MW7S, MW7, MW8S, and MW8). Monitoring well MW1S was not sampled because no groundwater collected in the well for several weeks following installation or during monitoring well development activities at the site. MW1S began to produce small amounts of groundwater during October 1994, and the water level in the well appeared to reach equilibrium by the sixth round of Phase II groundwater elevation monitoring, conducted on October 24, 1994.

In accordance with the NYSDEC Division Technical and Administrative Guidance Memorandum No. 4015, turbidity was measured during purging of wells in addition to pH, temperature, and specific conductance. All 17 groundwater samples were collected using clean Teflon bailers and analyzed for VOCs, SVOCs, pesticides, and PCBs. In addition, the groundwater samples collected from MW1SA, MW2S, MW3S, MW3, MW5S, MW6S, and MW6 were analyzed for total metals. In addition, during the Phase II, the total depth of MW-4 was measured and determined to be 125 feet.

Two trip blanks (MW80-3 and MW81-3) and three equipment blanks of the Teflon bailers (MW70-3, MW71-3, and MW72-3) were collected during the Phase II groundwater sampling. Duplicate groundwater samples of MW7 (MW60-3) and MW8 (MW61-3) were also collected.

2.6.3 Phase III

2.6.3.1 Monitoring Well Installation

To implement the Phase III scope of work, a Highway Work Permit No 9-95-0278 was required and obtained from the New York State Department of Transportation (NYSDOT). The permit required the set up of signs along I-88 warning the oncoming traffic that the shoulders were closed. Thus, while conducting Phase III RI activities in the median of I-88 (e.g., installation, development, and sampling of MW9/9S and MW10/10S), traffic signs were set up and taken down at the beginning and end of each day in accordance with the Highway Work Permit. As required by the permit, the original highway work permit was returned to the NYSDOT to inform them that the work was complete.

During the October 1995, Phase III field activities, eight groundwater monitoring wells (MW9, MW9S, MW10, MW10S, MW11S, MW12S, MW13S, and MW14) were installed by Parratt Wolff in the unconsolidated material at the site. The shallow wells (MW9S, MW10S, MW11S, MW12S, MW13S) were installed such that the well screen extended across the water table at the time they were installed. The screens of the deep wells (MW9, MW10, and MW14) were installed near the base of the unconsolidated material. Monitoring well construction details, including total depth and screened interval for each well, are provided in Table 2-4.

Continuous split spoon samples were collected for lithologic logging and field headspace analysis from the boreholes advanced during the installation of MW9, MW10, MW11S, MW12S, MW13S, and MW14. Lithologic information obtained from the boreholes of the deep monitoring wells (MW9, MW10, and MW14), and the deep soil borings (B17 and B24), was used to further characterize the unconsolidated material. Samples were collected at 5-foot intervals during advancement of the boreholes for MW9S and MW10S because these boreholes were advanced in the immediate vicinity of MW9 and MW10.

The borings were advanced with 4.25-inch ID hollow stem augers and the monitoring wells were installed through the augers. All monitoring wells were fit with bottom and top caps. Each well was constructed with flush-threaded, 2.0-inch ID, schedule 40 PVC casing attached to a section of 0.010-inch machine-slotted screen. All of the wells were constructed with a 10.0-foot length of screen, except MW9 and MW10, which were constructed with a 5.0-foot length of screen. In these wells, auger refusal was encountered at a depth of approximately 29 feet, and the shorter length of screen (5 feet) was necessary in these deep wells to allow for installation of well pairs (MW9/9S and MW10/10S) which would monitor discreet upper and lower zones within the saturated, unconsolidated water bearing zone.

MW11S, MW12S, MW13S, and MW14 were completed with stick-up steel protective surface casings, which were cemented in place. MW9, MW9S, MW10, and MW10S were completed with traffic rated, flush-mounted protective surface casings, which were cemented in place.

Monitoring well development activities were conducted over 2 weeks in November 1995. Development was conducted at each of the newly installed monitoring wells by purging a minimum of 20 times the casing volume of groundwater from each well using dedicated, disposable, polyethylene bailers and a decontaminated submersible Grundfos pump. Approximately 20 gallons of heavily silty groundwater was purged from MW10S using a dedicated polyethylene bailer before using the submersible pump to complete development. MW10 and MW14 were completely developed using the submersible pump. Development of MW9, MW9S, MW11S, MW12S, and MW13S was conducted using dedicated polyethylene bailers. MW1S, which was installed during Phase II but not developed due to a lack of groundwater, was able to be developed during Phase III. Physical parameters of the groundwater (pH, temperature, conductivity, and turbidity) were monitored throughout the purging process and recorded in the field notebook. A summary of the well development, including the total gallons of groundwater removed, is presented in Table 2-5.

2.6.3.2 Groundwater Monitoring and Sampling

During the period from November 29 through December 15, 1995, 26 groundwater samples were collected from the 14 existing monitoring wells (MW1, MW1S, MW1SA, MW2, MW2S, MW3, MW3S, MW5S, MW6, MW6S, MW7, MW7S, MW8, and MW8S), the 3 existing piezometers (P1, P2, and P3), the out-of-service production well (MW4), and the 8 newly installed monitoring wells (MW9, MW9S, MW10, MW10S, MW11S, MW12S, MW13S, and MW14).

With the exception of MW1S, all monitoring wells were purged using a low flow, positive displacement pump (a bladder pump) in accordance with the draft U.S. EPA Region II Low Stress Purging and Sampling SOP (revision 9). Groundwater samples were collected by filling the laboratory prepared sample bottles directly from the discharge of the pump. Because MW1S did not produce a sufficient quantity of water to submerge and operate the pump, MW1S was purged using a clean polyethylene bailer and sampled using a clean Teflon bailer. MW1S has extremely poor groundwater recovery characteristics and was bailed dry during the purge process and during the sampling process. All groundwater samples were analyzed for VOCs, SVOCs, pesticides, PCBs, and metals.

In accordance with the NYSDEC Division Technical and Administrative Guidance Memorandum No. 4015, the purged groundwater was monitored for pH, temperature, specific conductance, Eh, and turbidity. The NYSDEC goal for maximum turbidity in groundwater samples is 50 NTUs. At 18 of the sampling locations (MW1SA, MW2, MW2S, MW3, MW3S, MW4, MW5S, MW6, MW6S, MW7, MW8, MW8S, MW10, MW11S, MW12S, MW13S, P1, and P3) the turbidity goal was met and only unfiltered groundwater samples were collected from each of these wells for metals analysis. Due to the clayey and silty nature of the glacial till deposits at the site, it was not possible to obtain the 50 NTU goal at all wells. At 8 sampling locations (MW1, MW1S, MW7S, MW9, MW9S, MW10S, MW14, and P2) the turbidity goal was not met despite the fact that the other physical parameters (pH, temperature, specific conductance, and Eh) had stabilized during the purge process. For those wells that did not meet the turbidity goal of 50 NTUs, both unfiltered and filtered groundwater samples were collected for metals analyses.

Twelve trip blanks (MW80-4 through MW89-4, MW180-4, and MW181-4) and 13 equipment blanks of the decontaminated bladder pump (MW70-4 through MW79-4, MW170-4, MW171-4, and MW172-4) were collected during the Phase III groundwater sampling. In addition, duplicate groundwater samples of P2 (MW60-4) and MW2 (MW61-4) were collected.

2.6.4 Phase IV

2.6.4.1 Monitoring Well Installation

During the Phase IV RI, three bedrock monitoring wells (MW-1B, MW-2B, and MW-14B) were installed at the site. MW-1B is located south of Osborne Hollow Road, near MW-1SA and MW-1. MW-2B and MW-14B are located south of I-88 and were installed near MW-2S and MW-2 and near MW-14 and P-2, respectively. The locations of the bedrock monitoring wells are identified on Figures 1-8 and 1-9.

The bedrock monitoring wells were installed by Parratt Wolff using a CME 75 drill rig and a combination of hollow stem auger, air rotary, air hammer, mud rotary, and rock coring drilling techniques. MW-1B was installed as a double-cased well and MW-2B and MW-14B were installed as triple-cased wells. Because the installation of each monitoring well differed, a description of the procedures followed for each is provided below. Monitoring well construction details, including total depth, casing depths, and screened intervals, are provided in Table 2-4.

The borehole for MW-14B was advanced using 10.25-inch ID hollow stem augers to a depth of approximately 31 feet. 8.25-inch steel casing with flush-threaded end joints was installed inside the augers. The bottom of the steel casing was installed at 31.7 feet (slight settling of the casing in the unconsolidated deposits occurred). The casing was grouted in place with a tremmie pipe using approximately 200 gallons of bentonite-cement grout. One centralizer placed at a depth of approximately 16.7 feet was used to center the casing in the borehole. Once the grout for the 8.25-inch casing had cured (minimum of 48 hours), drilling continued inside the casing to a depth of 70 feet using the mud rotary drilling technique. Competent bedrock was encountered at approximately 67 feet. A 6-inch ID steel casing with centralizers set at 65 feet, 42 feet, and 18 feet was installed; the bottom of the steel casing was positioned at 70 feet. The 6-inch casing was grouted in place with a tremmie pipe using approximately 90 gallons of bentonite-cement grout. Once the grout for the 6-inch casing had cured, a falling head hydrostatic test was performed to check the tightness of the casing seal. The results of the hydrostatic test were acceptable (water decreased less than 0.1 inch in an hour). Next, the bedrock was continuously cored to a depth of 100.5 feet using a 2-inch diameter and 5-foot long core barrel. Because it was difficult to determine which portion of the bedrock was producing water, packer testing of the borehole was conducted. This was not specified in the Phase IV RI Work Plan Addendum, but was necessary to determine the appropriate interval for screening the bedrock wells (i.e., identify rock unit with greatest potential to yield groundwater). The intervals from 75 -85 feet and from 85 - 95 feet were tested. The 75 – 85-foot interval was able to accept approximately 0.2 gallons per minute (gpm) under 7 pounds per square inch (psi). The 85 – 95-foot interval was able to accept approximately 8.4 gpm under 5 psi. The lithology of the bedrock consisted of predominantly shale; however, a fractured siltstone was present in the borehole of MW-14B at a depth of 87 feet to 89.5 feet. Based on the packer test results, the fractured siltstone appeared to be the zone accepting the majority of the water in the 85 – 95-foot interval. Following completion of the packer testing, the borehole was enlarged from a 2-inch diameter borehole (diameter of core barrel) to a 5.875-inch diameter borehole using the air hammer drilling technique. The enlarged borehole was advanced to a depth of 97 feet.

Before installing the monitoring wells, Aqua-Freed of Newburgh, New York video logged each of the bedrock boreholes, including MW-4. A copy of the video log is provided with the transmittal of this RI report (revision 1).

The bedrock monitoring wells were all fit with bottom and top caps. Each well was constructed with flush-threaded, 2.0-inch ID, Schedule 40 PVC casing attached to a section of 0.010-inch machine-slotted screen. All of the wells were constructed with a 10.0-foot length of screen, and the wells were completed with surface stickup casings that lock.

For the installation of MW-14B, centralizers were placed at depths of 91.5 feet, 81.5 feet, 61.5 feet, 41.5 feet, and 21.5 feet. The borehole from 97 feet to 92.5 feet was filled with bentonite pellets, and the bottom of the well was placed at 91.5 feet. A sand pack was placed from 92.5 feet to 78.5 feet, and a 0.5-foot thick fine-grained filter sand was added above the sand pack. Bentonite slurry was placed above the sand and extended up into the 6-inch casing to a depth of 66.5 feet (bottom of 6-inch casing is at 70 feet). The remaining annular space was filled with a bentonite-cement grout.

The borehole for MW-2B was advanced using 4.25-inch ID hollow stem augers and enlarged using

10.25-inch ID hollow stem augers to a depth of approximately 30.5 feet. 8.25-inch steel casing with flush-threaded end joints was installed inside the augers to a depth of 30.5 feet. The casing was grouted in place with a tremmie pipe using approximately 200 gallons of bentonite-cement grout. One centralizer placed at a depth of approximately 15.5 feet was used to center the casing in the borehole. Once the grout for the 8.25-inch casing had cured (minimum of 48 hours), drilling continued inside the casing to a depth of 62 feet using hollow stem augers, and continuous split spoon samples were collected from 32 feet to 62 feet. From 62 feet to 65 feet the mud rotary drilling technique was used to advance the borehole. Competent bedrock was encountered at approximately 62 feet. A 6-inch ID steel casing with centralizers set at 57 feet and 22 feet was installed; the bottom of the casing was installed to a depth of 65 feet. The 6-inch casing was grouted in place with a tremmie pipe using approximately 80-90 gallons of bentonite-cement grout. Once the grout for the 6-inch casing had cured, a falling head hydrostatic test was performed to check the tightness of the casing seal. The results of the hydrostatic test were acceptable (water decreased less than 0.1 inch in an hour). Next, the bedrock was continuously cored to a depth of 91.7 feet using a 2-inch diameter and 5-foot long core barrel. The fractured siltstone, encountered in MW-14B, was present in the borehole of MW-2B at a depth of 83.6 feet to 86.8 feet. [Note: According to the Phase IV RI Work Plan Addendum, coring was only to be conducted in the borehole for MW-14B. However, to adequately locate the fractured siltstone, which was the unit producing the best yield, coring of all bedrock boreholes was conducted.] The borehole was enlarged from a 2-inch diameter borehole (diameter of core barrel) to a 5.875-inch diameter borehole using the air hammer drilling technique. The enlarged borehole was advanced to a depth of 91.6 feet.

To install MW-2B, centralizers were placed at depths of 90 feet, 80 feet, 60 feet, 40 feet, and 20 feet. The borehole from 91.6 feet to 90.5 feet was filled with bentonite pellets, and the bottom of the well was placed at 90 feet. A sand pack was placed from 90.5 feet to 77 feet, and a 0.5-foot thick fine grained filter sand was added above the sand pack. A bentonite slurry was placed above the sand and extended up into the 6-inch casing to a depth of 62 feet (bottom of casing is at 65 feet). The remaining annular space was filled with a bentonite-cement grout.

The borehole for MW-1B was advanced using 4.25-inch ID hollow stem augers and enlarged using 10.25-inch ID hollow stem augers to a depth of approximately 35 feet. Drilling continued, initially with air rotary, and then with mud rotary because air rotary drilling was ineffective. Using mud rotary, the borehole was advanced to 40 feet (competent bedrock was encountered at approximately 36.5 feet), and a 6-inch ID steel casing with centralizers set at 33 feet and 15 feet was installed; the bottom of the casing was set at 40 feet. The 6-inch casing was grouted in place with a tremmie pipe using approximately 270 gallons of bentonite-cement grout. Once the grout for the 6-inch casing had cured, a falling head hydrostatic test was performed to check the tightness of the casing seal. The results of the hydrostatic test were acceptable (no water decrease in an hour). Assuming that the fractured siltstone was gently sloping to flat lying and continuous across the site, the depth to the siltstone was calculated. As a result, the borehole was advanced to 85 feet using air hammer and the cuttings from the air hammering were logged. Rock coring commenced at a depth of 85 feet to 120 feet using a 2-inch diameter and 5-foot long core barrel. The fractured siltstone, encountered in MW-2B and MW-14B, was present in the borehole of MW-1B at a depth of 113.3 feet to 116.5 feet. The borehole was enlarged from a 2-inch diameter borehole (diameter of core barrel) to a 5.875-inch diameter borehole using the air hammer drilling technique. The enlarged borehole was advanced to a depth of 114 feet using air hammer drilling technique and to 120.5 feet using a 5.875-inch roller bit. A mechanical problem was encountered with the air hammer equipment at a depth of 114 feet, which necessitated changing the drilling method from air hammer to air rotary.

To install MW-1B, centralizers were placed at depths of 119 feet, 109 feet, 89 feet, 69 feet, 49 feet, and 29 feet. The borehole from 120.5 feet to 119.3 feet was filled with bentonite pellets, and the bottom of the well was placed at 119 feet. A sand pack was placed from 119.3 feet to 106 feet, and a 0.5-foot thick fine-grained filter sand was added above the sand pack. Bentonite slurry was placed above the sand to a depth of 90 feet; the remaining annular space was filled with a bentonite-cement grout.

Monitoring well development activities were conducted during November 1997. Development was conducted at each of the newly installed monitoring wells by pumping a minimum of 105 gallons of groundwater from each well using a submersible Grundfos pump. Development continued until the turbidity of the water was below 50 NTUs. Physical parameters of the groundwater (pH, temperature, conductivity, and turbidity) were monitored throughout the purging process and recorded in the field notebook. During development of the bedrock wells, the pH, temperature, and conductivity meter malfunctioned. Because these measurements are not critical to the development of the wells (turbidity is the primary indicator), development activities were not delayed so that a replacement meter could be sent to the site. During development, MW-1B was pumped dry after removing 45 gallons. The well was allowed to recover before development continued. A total of 105 gallons of groundwater was removed from MW-1B and the turbidity was reduced to 37.8 NTUs. MW-2B and MW-14B were able to be continuously pumped without going dry, and the turbidity of both wells was reduced to less than 50 NTUs. A summary of the well development, including the total gallons of groundwater removed, is presented in Table 2-5.

2.6.4.2 Production Well Abandonment

During the video logging of MW-4, it became apparent that MW-4 was blocked with wood, concrete, plastic, and silt at a depth of 44 feet. During previous phases of work, MW-4 was open to a depth of 125 feet. On November 12 and 13, 1997, air rotary drilling was used to remove the obstructions. Obstructions were encountered from 44 feet to 78 feet and from 112 feet to 120 feet. In a November 17, 1997, letter to the EPA, the PRPs requested permission to abandon this well which was verbally approved on November 18, 1997. The EPA requested that, because MW-4 would be abandoned, MW-3 would be added to the Phase IV sampling program. Details on the abandonment of MW-4 are provided below.

As indicated above, the EPA authorized the PRPs to abandon MW-4, the former production well installed at the facility sometime in the 1950s. On November 24 and 25, 1997, and in accordance with New York State well abandonment procedures, the 6-inch steel casing was overdrilled to 55 feet using 10.25-inch hollow stem augers. The driller (Parratt-Wolff) made several attempts to pull the casing and spin the casing but was unable to free the casing so that it could be removed. Because 10.25-inch augers are not readily available and not commonly used, Parratt Wolff had no additional 10.25-inch auger flights that it could mobilize to the site. ESC discussed the situation with Catherine Klatt of the NYSDEC, and Ms. Klatt indicated that it would be acceptable to fill inside the rock borehole and casing (123 feet to ground surface) and outside the casing (between the casing and the borehole created with the 10.25-inch augers) with grout, as the augers were removed. The borehole created by the 10.25-inch augers was approximately 15 inches in diameter. Thus, a 15-inch diameter bentonite and cement plug exists at MW-4 to a depth of 55 feet and a 6-inch diameter plug exists from 55 feet to 123 feet.

2.6.4.3 Groundwater Monitoring and Sampling

To conduct the Phase IV RI groundwater elevation monitoring, a Highway Work Permit No 9-97-0353 was obtained from the NYSDOT. This permit was required to measure the groundwater elevation in the four groundwater monitoring wells located in the median of I-88. As required by the permit, on January 12, 1998, the original highway work permit was returned to the NYSDOT to inform them that the work was complete.

From August 13 through December 19, 1997, 23 groundwater samples were collected from select existing and newly installed monitoring wells at the site. These wells included MW-1SA, MW-1, MW-1B, MW-2S, MW-2, MW-2B, MW-3, MW-12S, P-2, MW-14, and MW-14B. The Phase IV RI groundwater sampling occurred during 3 rounds (Rounds 5, 6, and 7). Round 5 included the collection of a groundwater sample from MW-12S for SVOC analysis on August 13, 1997, and the collection of groundwater from the open boreholes of MW-2B and MW-14B using packers on November 10 and 11, 1997. The sampling of the MW-2B and MW-14B open boreholes was not specified in the Phase IV RI Work Plan Addendum, but was agreed to during a teleconference call with EPA on October 31, 1997. The purpose of this sampling was to collect a sample of the groundwater near the base of the 6-inch steel casings in MW-2B and MW-14B before completing the borehole with a 2-inch PVC monitoring well. Once the well was installed and grouted in place, it would not be possible to collect a sample of the groundwater near the base of the steel casing (i.e., from the top of the fractured bedrock). To collect these samples, the upper portion of each borehole was isolated using a packer which were thoroughly decontaminated before and after use in each well. The packer in MW-14B was set at 76 feet (isolating the interval from 76 to 70 feet for sampling), and the packer in MW-2B was set at 70 feet (isolating the interval from 70 feet to 65 feet for sampling). Once the packers were inflated (200 psi), the isolated zone was purged using a submersible pump. Approximately 200 gallons were removed from MW-14B; MW-2B was pumped dry after removing approximately 55 gallons.

Ten monitoring wells (three well pairs and MW-3) were sampled during Rounds 6 and 7 and included: MW-1SA, MW-1, MW-1B, MW-2S, MW-2, MW-2B, P-2, MW-14, MW-14B, and MW-3. Round 6 groundwater samples were collected from November 22 through November 24, 1997, and Round 7 groundwater samples were collected on December 16, 18, and 19, 1997.

With the exception of Round 5 samples and MW-2S during Round 6, all monitoring wells were purged using a low flow, positive displacement pump (bladder pump) in accordance with the draft EPA Region II Low Stress Purging and Sampling SOP (revision 14). Groundwater samples were collected by filling the laboratory prepared sample bottles directly from the discharge of the pump. The Round 5 samples and MW-2S Round 6 sample were collected using a Teflon bailer following the procedures employed during the Phase I and II RI. The groundwater sample collected from MW-12S during Round 5 was analyzed for SVOCs; all other groundwater samples were analyzed for VOCs, SVOCs, pesticides, PCBs, and metals. In addition, two samples during Round 6 (MW-1 and MW-2S) and three samples during Round 7 (MW-1, MW-3, and P2-2) were also analyzed for dissolved metals and filtered in the field because the turbidity of the groundwater in these wells during sampling was not less than 50 NTUs. The purge groundwater was monitored for pH, temperature, specific conductance, dissolved oxygen, and turbidity.

The QA samples collected with MW-12S during Round 5 included a duplicate sample (MW60-5) and an equipment blank of the Teflon bailer (MW70-5). The QA samples collected during the sampling of MW-2B and MW-14B open boreholes included a duplicate sample (MW60-5 of MW-14B), and equipment blank of the Teflon bailer (MW70-5), and a trip blank. The equipment blank sample containers for SVOCs, pesticides, and PCBs were inadvertently not sent to the analytical laboratory. As a result, these data do not exist. During Round 6 the QA samples included a duplicate sample of MW-2B (MW60-6), three equipment blanks (MW70-6, MW71-6, and MW72-6), and two trip blanks (MW80-6 and MW81-6). During Round 7 the QA samples included a duplicate sample of MW-2B (MW60-7), three equipment blanks (MW70-7, MW71-7, and MW72-7), and two trip blanks (MW80-7 and MW81-7).

2.6.5 Slug Testing Procedures

During the Phase II RI, rising and falling head slug tests were performed in MW1, MW1SA, MW2S, MW2, MW3S, MW3, MW5S, MW6S, MW6, MW7S, MW7, MW8S, MW8, P1, P2, and P3 to assess the hydraulic conductivity of the unconsolidated water bearing zones across the site. Hydraulic conductivity values obtained from analysis of the slug test data were used to estimate the groundwater flow velocity within the unconsolidated deposits.

The slug tests were performed by creating an instantaneous change in the equilibrium water level in the well by either inserting or withdrawing a closed volume slug. The rate of change in head as the water in the well casing returns to equilibrium yields data which were used to calculate the hydraulic conductivity of the water bearing zone in the vicinity of the well screen. A two-channel automatic data recorder (Hermit Model 1000 B) with 10-pounds per square inch (psi) pressure transducers were used to record the changes in water levels in the well during the test. Two sets of slug test data were generated for each well. The data collected after the slug is inserted into the water column comprises the falling-head data set and the data collected following slug withdrawal from the water column comprises the rising-head data set.

2.7 Air Investigation

Air investigations were conducted during the Phase I, Phase II, Phase III, and Phase IV RI field activities to ensure the health and safety of site workers and to monitor for possible VOC releases during the Phase I RI trenching activities.

Before initiating intrusive activities each day, an ambient air survey of the work area was conducted using an HNu PID to measure the background levels of VOCs present in the area of that day's activities. During intrusive activities, air quality in the breathing zone was periodically checked using the HNu PID. Additionally, on August 3, 1993, an ambient air quality survey of the site and inside the onsite buildings was conducted using a PID equipped with an 11.7-ev lamp. The monitoring was conducted to determine if any areas at the site posed a threat to onsite workers.

During trenching activities conducted during Phase I, air monitoring procedures were expanded. During trenching, the portion of the trench being excavated was monitored using an HNu PID and oxygen/explosimeter. Personal air monitoring was also conducted using personal air monitoring pumps

(MIE PDM-3 Miniram direct reading monitor) placed on the equipment operator and an ESC scientist during all excavation activities. This monitoring was conducted to ensure the health and safety of the site workers.

In addition, perimeter air monitoring was conducted at three locations around the work area during each day of trenching activities. Thirty-six samples were analyzed for VOCs following EPA Method TO1 to monitor for possible VOC releases during trenching. Three high volume air monitoring pumps equipped with Tenax tubes were used to collect the samples. These air samples were analyzed by PACE, Inc., of Golden, Colorado. The three air monitoring locations were selected based on the location of each day's activity and the wind direction, which was monitored using a portable weather station. The perimeter air monitoring pumps were placed both upwind and downwind of the excavation activities.

All air monitoring equipment was calibrated daily to the appropriate flow rate. The equipment was calibrated before use and recalibrated after use to ensure that a constant flow rate had been maintained during sampling.

2.8 Building Investigations

2.8.1 Phase I Sampling Activities

On August 26, 1993, a sediment sample (SED11) was collected from the sump below the smoke washing unit which was an air emissions scrubbing system for the former barrel burner. This sample was collected using a sample jar attached to a section of PVC piping and was analyzed for VOCs, SVOCs, pesticides, PCBs, and metals. SED11 was also to be analyzed for TOC; however, the laboratory inadvertently lost the sample. Because all of the sediment in the sump was removed to collect the sample, it was not possible to resample the sump to collect another sample for TOC analysis. An equipment blank (SED70) of the sample collection container and stainless steel sampling bowl and spoon was also collected.

On August 27, 1993, water samples were collected from the sump below the smoke washing unit (SW1) and from the septic tank (SW3). These samples were collected by dipping the edge of the sampling bottle into the water and were analyzed for VOCs, SVOCs, pesticides, PCBs, metals, and hardness. A duplicate sample (SW60) of SW1 was collected, and a trip blank (SW80) that accompanied the samples was submitted to the laboratory for VOC analysis. No sediment was present in the septic tank; as a result, it was not possible to collect sample SED12. These samples were analyzed by Enseco-Wadsworth/Alert Laboratories of Pittsburgh, Pennsylvania.

On August 5, 1993, building material samples (e.g., concrete chips, wooden rafters, and dust/accumulated solids) were collected from 13 locations and analyzed for SVOCs, pesticides, PCBs, metals, and cyanide to determine if constituents of potential concern were present in the onsite buildings. The layout of the former buildings is provided as Figure 1-5. The building material sampling locations are identified on Figure 1-5 and summarized in Table 2-6.

The samples were collected either by scraping material present on a building surface using a decontaminated putty knife or by chipping the building surface using a decontaminated hammer and chisel. The sampling procedures outlined in the approved SAP were followed. Because of the unknown characteristics of the material present on the building surfaces and the potential for particles to become airborne during sampling activities, all sampling was conducted in Level C PPE.

An equipment blank of the sampling tools and the stainless steel sampling bowl and spoon (BS70-1) and a duplicate sample of BS5-1 (BS60-1) were also collected for QA purposes.

2.8.2 Phase II Sampling Activities

During the Phase II investigation, a building inspection was conducted by ESC personnel to identify any drains and discharge points from the buildings and to assess the integrity of two sumps. These activities were conducted to assess the potential for the constituents detected in the building during the Phase I investigation to be released to the environment.

Two floor drains, including one that had been filled with concrete, were identified in the former process building during the Phase II building inspection. Additionally, seven exhaust fans were identified on the building exterior walls. The locations of the drains and exhaust fans are identified on Figure 1-5.

In April 1995, as part of the Phase II RI, two sumps located in the floor of the onsite building were emptied, steam-cleaned, and visually inspected to assess their integrity and potential for communication with the environment. One sump was situated beneath the smoke washing unit and the other sump was situated beneath the blaster unit. Standing water and ice in both sumps were removed, and the sumps were steam cleaned to facilitate a thorough visual inspection of the sumps. Following cleaning of the sump walls and floors, the sumps were visually inspected for signs of cracks, pitting, and seepage. Photographs of both sumps were taken to document their condition. To determine whether fluid in the sumps could communicate with shallow groundwater outside the sumps, the empty sumps were inspected for several hours following cleaning to determine if water was seeping into the clean sumps.

The wastewater removed from the sumps and the cleaning fluids were collected and transported to the Clean Harbors facility in Cleveland, Ohio for treatment. To remove this material from the site, the PRPs obtained an EPA ID number for the site. The EPA issued the PRPs the same ID number that the site owner used while operating the site (NYD002245264). A total of 5,000 gallons of liquid wastewater were transported to the Clean Harbors facility. Two Uniform Hazardous Waste Manifests (document no.

NYB6833754 and no. NYB6833763) were completed and accompanied the waste during transport. Copies of both manifests were submitted to the New York State Department of Environmental Conservation (NYSDEC), Division of Hazardous Substance Regulation, and the Ohio Department of Natural Resources, Division of Hazardous Waste, by certified mail on April 13, 1995. A detailed description of these activities was provided to the EPA and the NYSDEC in a letter dated April 19, 1995.

2.8.3 Phase III and Phase IV Sampling Activities

No building investigations were conducted as part of the Phase III or Phase IV RI. However, during fall 1996, as part of the time critical removal action, all waste materials, drums, and miscellaneous equipment and debris were removed from the site, and all onsite structures were decontaminated, demolished, and disposed of offsite.

2.9 Human Population Survey

Information on human populations in the vicinity of the Tri-Cities Barrel facility was obtained from census data collected for the years 1990 and 1992, and from the Baseline Human Health Risk Assessment prepared by Life Systems.

2.10 Ecological Investigations

Information on ecological populations in the vicinity of the Tri-Cities Barrel site was obtained from the Baseline Ecological Risk Assessment prepared by Life Systems. Additionally, site-specific information on ecological populations at the Tri-Cities Barrel site is based on the ecological survey conducted at the site during the Phase II by Environmental Design & Research (EDR) of East Syracuse, New York. In addition to the site-specific ecological survey, ecological sampling was conducted during the Phase II field activities in September, 1994. The ecological sampling involved collecting samples of plants and earthworms for chemical analyses. The survey and sampling were conducted to characterize the distribution of plant and wildlife species and habitats present at the site and to assess the impact, if any, of constituents of potential concern on the identified species.

2.10.1 Ecological Surveys

An ecological survey (vegetation and wildlife inventory) of the site was performed by wildlife biologists John Hechlau and Barbara Reuter of EDR. The purpose of this survey was to identify potential ecological receptors that could be affected by onsite contaminants. The ecological survey was conducted in September, while the plants were still viable, to ensure that a comprehensive inventory of resident flora and fauna was compiled.

The ecological survey qualitatively identified the predominant plant, wildlife, and aquatic species at the site. Dominant plant types were recorded to characterize the vegetative communities. Wildlife habitat was evaluated for each vegetation cover type (i.e., grassy field, deciduous forest). For each cover type, the biologist recorded both the signs of wildlife (i.e., scat, prints) and the wildlife observed. The portions of the site which provide potential shelter, food, and nesting areas were noted within each cover type to further identify wildlife that would be expected to inhabit the area.

The ecological survey also characterized animal species likely to migrate or spend a portion of their life cycle in the study area. The Natural Heritage Program was contacted for information on threatened or endangered species known to exist in the project area. Although the Natural Heritage Program was previously contacted during the Phase I and no threatened or endangered species were identified, follow up correspondence was performed to ensure no new records existed that identify any threatened, endangered, or sensitive species in the survey area.

The ecological survey report prepared by EDR was included as an appendix to the revised Fish and Wildlife Impact Analysis (FWIA) report, which was submitted to the agencies on March 6, 1995. The FWIA was prepared by ESC in accordance with the guidance issued by the NYSDEC, "Fish and Wildlife Impact Analysis for Inactive Hazardous Waste Sites" (1991). The FWIA report addressed Step I (Site Description) and Steps IIA (Pathway Analysis) and IIB (Criteria-Specific Analysis) of the NYSDEC guidelines. The purpose of the FWIA report was to assess potential impacts to fish and wildlife habitats.

Additionally, before initiating the Phase I RI field activities, a wetland survey was performed to identify the locations of all wetlands at the site. This was conducted to ensure that no wetlands would be disturbed due to implementation of the RI. The findings of the wetland survey were documented in the Wetlands Investigation Report which was provided to the agencies on July 21, 1993. In addition, this report was attached to the Joint Federal/State Wetlands Nationwide permit application which was submitted to the EPA, NYSDEC, and Army Corps of Engineers on July 26, 1993. In a July 29, 1993, letter, the Army Corps of Engineers authorized the RI activities that were proposed for the site.

2.10.2 Ecological Sampling

Forage base vegetation and earthworms were identified as the likely sources for bioaccumulation of chemicals within the food web at the Tri-Cities Barrel site. To assess the potential for trophic transfer of contaminants in the ecosystem, vegetation and earthworm samples were collected and analyzed for the presence of SVOCs, pesticides, and PCBs. Earthworms are especially good indicators of chemical bioaccumulation through the soil media because soils adsorb to worms and worms continually ingest soil for feeding.

The plant and earthworm samples were initially collected on September 22, 1994. However, because insufficient volume of each sample was collected for the laboratory to complete the required analyses, a second round of sampling was conducted to obtain additional sample volume. The second round of samples were collected during the week of October 3, 1994, at the same locations as the original sampling locations. The original ecological samples collected during September were maintained in a frozen condition, and because there are no holding times for ecological samples as long as they remain frozen, the two sample sets were composited. The ecological samples were analyzed by Hazelton Environmental Services of Madison, Wisconsin. The ecological samples were identified using the following scheme: ESP1-1 or ESW1-1. ESP identifies the plant samples and ESW identifies the earthworm samples. The first group of symbols (ESP1 or ESW1) identifies the sampling location, and the second symbol (1) identifies the sampling round. Only one round of ecological sampling was conducted.

Plant sample species were selected by the EDR field biologist based on abundance and potential use as forage base for area wildlife. Earthworm samples were also collected in the vicinity of each plant sampling location. Different plant and animal communities are present north and south of I-88. South of I-88, the site is predominantly disturbed land as a result of former facility operations. North of I-88 the vegetative cover and animal habitats are more varied. As a result, 3 sampling locations were identified south of I-88 and 3 north of I-88. Four locations (ES1, ES2, ES4, and ES6) corresponded to known areas of affected soil based on the Phase I RI results. ES3 and ES5 were located in areas likely to be traversed by wildlife. In addition, to ensure ecological samples were representative of site-specific, rather than regional environmental conditions, two background plant and worm samples (ES7 and ES8) were collected. The plant species that comprise ESP7 were similar to the species that comprise ESP1 through ESP3 and the plant species that comprise ESP8 were similar to those species that comprise ESP4 through ESP6.

Plant samples were collected by cutting vegetation with stainless steel scissors. The scissors were decontaminated between sampling locations to avoid cross contamination. The plant samples were wrapped in aluminum foil, placed in a plastic bag, frozen on dry ice, and shipped to the laboratory. At each location, a variety of plant types were sampled (i.e., clover, grasses, and woody shrubs) and mixed together before placing the sample in its appropriate container. At the laboratory, each plant sample was ground and analyzed for SVOCs, pesticides, and PCBs.

Earthworm samples were collected from manually dug holes in the vicinity of the corresponding plant samples. The earthworms were rinsed with distilled water to remove any soil and placed in sterile glass sample jars. It was not possible to collect an earthworm sample from ESW-5. Several holes were dug in the vicinity of this sampling location and no earthworms were found. It is suspected that no earthworms were present in this area due to the high percentage of sand, low percentage of organic matter, and the close proximity of the sampling location to the flood plain of Osborne Creek. The earthworm samples were frozen and shipped to the laboratory on dry ice in a cooler. The earthworm samples were also ground at the laboratory and analyzed for SVOCs, pesticides, and PCBs. Approximately 20 grams were collected for each of the plant and earthworm samples.

A duplicate sample from each medium, ESP60-1 and ESW60-1, were collected from ESP7 and ESW7.

3.0 Physical Characteristics of the Study Area

3.1 Surface Features

The elevation of the site ranges from approximately 930 feet to 1,025 feet amsl. The highest elevation is at the southern portion of the site, south of Osborne Hollow Road and Old Route 7. The lowest elevation is at the northern portion of the site, along the floodplain of Osborne Creek. As discussed above, the site is separated into 3 main parcels by roads that transect the site. Most prominent of these is I-88 which separates the former operating portion of the site from the land located north of the interstate. As part of the Phase III RI, ESC reviewed the construction drawings for I-88 obtained from the New York Department of Public Works Division of Construction in Binghamton, New York. The portion of I-88 that traverses the site is represented by the roadway construction details between stations 280+00 and 288+00 and consists of the following:

- The native soil ground surface was graded (cut and filled) to prepare the ground surface for construction. Certain areas were cut into the native soils to allow smooth changes in roadway elevations. Based on the rip rap covered slope on the southern side of I-88 at the site, it appears that a cut was made in the vicinity of the site.

- The construction of I-88 in the vicinity of the site includes 8 inches of granular subbase course (course material), 4 inches of select granular subbase course, and 9 inches of concrete pavement.

The shoulders of I-88 consist of native soil overlain by 8 inches of granular subbase course, 4 inches of select granular subbase course, and 4 inches of asphalt pavement. A drainage ditch is located along the southern side of I-88. The ditch invert is located a minimum of 4 feet below the elevation of the top of the shoulder and a minimum of 2.5 feet below the elevation of the bottom of the 8 inches of granular subbase course. The ground surface along the northern side of I-88 slopes away from the roadway toward Osborne Creek.

The other roads that transect the site include Osborne Hollow Road and Old Route 7 which are located south of the former operating portion of the site. Before the construction of I-88, the operations of the site included the area from Osborne Hollow Road to Osborne Creek, although most of the operations occurred near the former process buildings. Following the construction of I-88, all of the operations occurred south of I-88, and the portion of the site south of Osborne Hollow Road was used only for the storage of empty drums.

As part of the RI, a Stage 1A archaeological survey was performed. The New York State Office of Parks, Recreation, and Historic Preservation in Albany, New York lists no known archaeological resources in or adjacent to the site. According to file information at the New York State Museum in Peebles Island, New York, no archaeological sites are listed on or adjacent to the site, but Parker (1992) reports traces of prehistoric occupation along the Chenango River which is located west of the site. The nearest known prehistoric site is an undated lithic scatter in Chenango Bridge on the north side of the Chenango River, which is more than two miles from the site (Quilty et al, 1979).

3.1.1 North of I-88

North of I-88 the ground surface slopes gradually northward toward Osborne Creek. In the vicinity of Osborne Creek, the ground surface slopes steeply to the creek and the associated floodplain. The floodplain of Osborne Creek is wide, and the creek consists of a main channel and in the vicinity of the site, a side channel that likely formed as a result of past flood events. The slope down to Osborne Creek and the floodplain contain thick vegetative cover.

A man-made pond (remnant of a former lagoon) occupies approximately 6,000 square feet (approximately 0.14 acre). However, the size of the pond varies greatly with seasonal precipitation and is often dry or nearly dry during the summer months. Based on field observations during the RI, the pond covers the greatest amount of land surface and is deepest (approximately 2-3 feet) during the spring. The pond has an unconsolidated silty clay bottom, which is covered with wetland vegetation that transitions to upland vegetation away from the former lagoon.

The results of the Stage 1A archaeological survey indicate the following findings north of I-88: two outbuilding foundations (one constructed of fieldstones and one constructed of early concrete), one fieldstone foundation of a 19th century house, remnants of a dug well, and a fieldstone foundation of a 19th century mill (Figure 1-9). Access to these structures was formerly from Osborne Hollow Road along a right-of-way access road that paralleled the eastern property boundary of the site. With the construction of I-88, this access road was abandoned. According to the Burr map (1829-1839), a mill is present on the site. The mill was reportedly built in 1832 by Samuel Andrews. The sawmill and a home labeled as the S. Cole residence located west of the mill are present on the 1866 Beers map. The mill on Osborne Creek is no longer present on a 1908 map. The findings north of I-88 appear to represent a 19th century residence which was abandoned or removed in the 20th century.

3.1.2 South of I-88

The southern portion of the site is relatively flat, except in the vicinity of I-88, where the ground surface (covered by rip rap) slopes steeply down to the highway. The process buildings were formerly located in this portion of the site. During the fall of 1996, all tanks, drums, equipment, and structures were removed from the site as part of a time critical removal action. In addition, until approximately 1980, 3 lagoons were located north of the pole barn. These lagoons were closed by filling them with imported soils.

Currently, the only surface features that remain south of I-88 include the concrete foundations of the former process buildings and the security fence.

The results of the Stage 1A archaeological survey indicate only one finding south of I-88: possibly a milk cooler (Figure 1-9). Note: the portion of the site south of I-88 largely consists of disturbed ground (grading, construction of post-1945 buildings) with only sparse, scattered areas of intact soils. Thus, any cultural resources that may possibly have been historically present were disturbed by site operations.

3.1.3 South of Osborne Hollow Road

The portion of the site south of Osborne Hollow Road includes two parcels: the triangular parcel bounded by Osborne Hollow Road and Old Route 7 and a parcel bounded by Old Route 7 and the D&H railroad. Based on aerial photographs and discussions with Mr. Warner, no operations or surface features reportedly occurred or were present on the parcel between Old Route 7 and the D&H railroad. Until 1996, a small wooden structure (former barn) used to store empty drums and drum lids was located on the triangular parcel. In addition, a few areas of the triangular parcel were used to store empty steel and plastic drums.

The results of the Stage 1A archaeological survey indicate the following findings south of Osborne Hollow Road: a gravestone, a pre-1945 barn, and a fieldstone cellar hole (approximately 15 feet by 15 feet; Figure 1-9). The gravestone is on its side, and it is uncertain if it marks the location of a burial or was placed there from another location. The gravestone contains some inscriptions, much of which has been eroded away. The inscriptions that remain include the word "MARY" and possibly "PORTH". The date of the gravestone is unknown. The cellar hole is situated in the vicinity of either the 1855 J. Prentice residence or one of three 1908 structures. The findings south of Osborne Hollow Road appear to represent a 19th century farmstead which was abandoned or removed in the mid 20th century. No other surface features are present.

A significant offsite surface feature (junkyard) was formerly located south of Osborne Hollow Road adjacent to the triangular parcel. This junkyard is first evident in the 1958 aerial photograph of the site. It is also present in the 1965, 1967, 1968, and 1973 photographs, and is no longer visible in the 1981 photograph. The headwaters for the eastern tributary transect through this former junkyard. A visual inspection of this portion of the tributary indicated the presence of car parts, including motors in the streambed. Other than the materials present in the streambed of the tributary, no other evidence of the junkyard exists today. Currently, a residential dwelling owned by Dennis and Sheree McGonnigal is located on this property.

3.2 Meteorology

The Tri-Cities Barrel site, located in Broome County, is part of the Eastern Plateau Climatic Division of New York State (National Oceanic and Atmospheric Administration (NOAA 1988a). Global atmospheric circulation brings a great variety of air masses to the area. Masses of cold, dry air come from the northern interior of the continent. Warm, humid air originating at the Gulf of Mexico and adjacent tropical waters flows from the south. These two air masses provide the dominant characteristics of the local climate. The climate is thus classified as "humid continental" by the modified Koppen classification system (NOAA 1974). This climate is categorized by severe winters, moist seasons with precipitation evenly distributed throughout the year, and short, warm summers.

During most of the year, high and low-pressure systems move generally west to east through the area. During the winter months, high pressure tends to move northwest to southeast, and low pressure often moves from southwest to northeast. During the summer months, a high-pressure system called the Bermuda High may extend over the area for several days at a time with little significant movement. During the late summer, cold fronts (known as "back door" cold fronts) may move from the northeast through the area, although most cold fronts move from the northwest. Warm fronts tend to originate from the south.

The nearest National Weather Service station is at Binghamton, 5 miles to the southwest. The source of numeric data for climatological parameters discussed in the following subsections is the National Climatic Data Center (NCDC), a branch of NOAA. Summer temperatures generally peak in the low 80s °F (degrees Fahrenheit) in July, with low temperatures in July down to the 60s °F. The lowest annual temperatures in Binghamton generally occur in January and February with average daily minimums in the upper teens and low 20s °F during that period (NOAA 1988). The NCDC annual average temperature (1951 to 1980) for Binghamton, New York is 45.7 °F, with July being the warmest month (with an average temperature of 68.9 °F) and January being the coldest (averaging 21.2 °F). The record extreme temperatures at Binghamton are –20 °F and 98 °F during a 67-year period ending in 1988.

The mean annual precipitation, averaged over the years 1952 through 1991, is 37.6 inches. Most precipitation occurs between April and September. The maximum rainfall recorded in Binghamton in a single month was 9.18 inches recorded in June 1972. The maximum recorded 24-hour rainfall event was 3.88 inches, recorded in October, 1955. It should be noted that the mean annual precipitation has gradually increased throughout the entire Eastern Plateau region. Since a drought period from 1962 to 1967, annual average precipitation through 1988 has been nearly 45 inches per year. Binghamton averages approximately 161 days per year with at least 0.01 inch of precipitation. Thunderstorms occur approximately 30 days per year on the average.

Based on wind data collected through 1963, the prevailing winds in the Binghamton area are generally from the west, with a southwesterly component during the warmer months and a northwesterly component prevailing in the colder months. Mean windspeeds range between 8.3 and 11.7 miles per hour (mph). Maximum recorded wind gusts were measured at 59 mph during June 1988.

The relative humidity in Broome County is generally high with annual daily averages from a low of 63 percent at 1:00 p.m. to a high of 82 percent at 7:00 a.m.. Throughout the year, humidity does not fluctuate greatly, and monthly averages range from 76 percent at 7:00 a.m. during April to 90 percent at 7:00 a.m. during September.

3.3 Surface Water Hydrology

Broome County is in the Susquehanna Hills section of the Appalachian Uplands. This area is a dissected plateau with flat-topped hills and narrow valleys and is drained by the Chenango River, a tributary of the Susquehanna River.

The Tri-Cities Barrel site is located south of Osborne Creek. The streambed of Osborne Creek largely consists of gravel and cobble size deposits. According to Bill Pasquale, resident engineer of the NYSDOT, channel clearing of Osborne Creek was conducted approximately 10 years ago (Telecommunication 1993). The sediments were not removed from the creek channel, rather they were moved from the center of the creek to the outer part of the creek channel. During a site visit conducted by ESC on May 5, 1993, no evidence of the dredged sediments existed. According to Public Archaeology Facility personnel, Osborne Creek flooded during the spring of 1993 which eroded the creek channel and flood plain sediments and deposited new sediments in the flood plain. Osborne Creek joins the Chenango River at Port Crane, approximately 1.3 miles west of the site. The Chenango River joins the Susquehanna River at Binghamton, New York. Federal Emergency Management Agency flood boundary mapping for the site (Community Panel Number 360046 0015 B, Panel 15 of 20, effective date August 3, 1981) shows that the land immediately adjacent to Osborne Creek, for a width of approximately 50 feet, is within the 100-year floodplain; no other portion of the site or adjacent property is within the 100-year floodplain. In the vicinity of the site, the 500-year floodplain is generally coincident with the 100-year floodplain. This is not surprising given the steep slope that extends down to Osborne Creek.

Two small, unnamed intermittent streams parallel the eastern and the western sides of the site. The eastern tributary is located outside the property boundary of the site; while the western tributary is located within the site property boundary. Both streams collect the surface water runoff from south of the site including Osborne Hollow Road, Old Route 7, and the railroad tracks. They both flow to the north discharging to Osborne Creek and flow under I-88 within culverts. The streambeds of these intermittent streams are approximately 2-5 feet wide. The streams have moderately sorted rock and cobble streambeds underlain by gravel and sand with little clay or silt.

A man-made pond (remnant of a former lagoon) north of I-88 occupies approximately 6,000 square feet (approximately 0.14 acre). However, the size of the pond varies greatly with seasonal precipitation and is often dry or nearly dry during the summer months. Based on field observations during the RI, the pond covers the greatest amount of land surface and is deepest (approximately 2 to 3 feet) during the spring. The pond has an unconsolidated silty clay bottom, which is covered with wetland vegetation that transitions to upland vegetation away from the former lagoon.

According to the NYSDEC, the nearest registered wetland is approximately 3 miles northeast of the site (Cotterill, November 14, 1985). A review of the New York State Freshwater Wetlands map (1973) for the project site identified no wetlands of state importance. A review of the U.S. Fish and Wildlife Service National Wetlands Inventory map (1990), identified the pond (former lagoon), north of I-88, as palustrine unconsolidated bottom, seasonally flooded, dike impounded (PuBfh).

The results of the three-parameter wetland delineation study for the site indicate that limited wetlands appear to be associated with the two tributaries that parallel the eastern and western property boundaries, Osborne Creek, and the man-made pond north of I-88. The locations and extent of these wetlands are shown on Figure 1-2. The wetlands associated with the tributaries and Osborne Creek are classified as upper perennial riverine unconsolidated cobble/gravel mud bottom (R2UB1/3). Both tributaries and Osborne Creek are well shaded with American hornbeam (Carpinus caroliniana), American sycamore (Platanus occidentalis), red maple (Acer rubrum), willow oak (Quercus phellos), river birch (Betulla nigra), and honey locust (Gleditsa triacanthos). Within the floodplain of Osborne Creek sedge (Carex sp.) and spice bush (Lindera benzoin) are also present. Along the western tributary, both south of I-88 and near its confluence with Osborne Creek, are emergent areas classified as palustrine, emergent, persistent with a seasonally flooded/saturated water regime (PEM1E). Dominant vegetation in this area consists of red maple in the overstory, American hornbeam and honey locust in the understory, and cattail (Typha latifolia) and sedge as ground cover. The pond north of I-88 is classified as a palustrine open water (POW). A low area adjacent to the southern edge of the open water is classified as PEM1E. Dominant vegetation in this area consists of sedge and soft rush (Juncus effusus).

3.4 Soils

The surficial deposits of eastern Broome County are predominantly glacial till on hillsides and hilltops with glacial outwash in the larger valleys. Quaternary alluvium lies along the floors of the smaller valleys.

Soils at the Tri-Cities Barrel site were mapped by the U.S. Department of Agriculture Soil Conservation Service (SCS; March 1971). Two soil associations, the Tioga-Chenango-Howard association and the Volusia-Mardin association, are present at the site. Within these soil associations are three soil series. The predominant soil series that occurs at the site is the Volusia series. A small pocket of the Mardin series and the Chenango and Howard series are located on the northeast and northwest portions of the property. Alluvial land is present adjacent to Osborne Creek.

The Volusia series consists of deep, strongly acidic, somewhat poorly drained loamy soils that formed on very firm, dense glacial till. It exists extensively throughout Broome County. These soils are nearly level to moderately steep, have slow runoff or receive excessive runoff from higher areas. The Volusia channery silt loam (VoC), 8-15 percent slopes, is present at the site. The Mardin series consists of deep, gently sloping to steep, well-drained and moderately well-drained soils. The Mardin channery silt loam (MhC), 8-15 percent slopes, is found at the site in side slopes of large hills. The Chenango and Howard series consist of deep, well-drained, medium-textured gravelly soils that formed from glacial outwash derived from acidic sandstone and shale. These soils are typically found on valley floors and terraces. The Chenango and Howard gravelly loams (ChA), 0-5 percent slopes, are present at limited areas of the site (USDA SCS 1971).

Alluvial land, 0-5 percent slopes, also exists at the site in areas adjacent to Osborne Creek, the northernmost border of the project site. This land is subject to frequent flooding and occurs as low terraces and bottom lands (USDA SCS 1971). Alluvial land is listed by the SCS as a hydric soil in New York. The other soil series that occur on the project site are not listed as hydric soils in New York (USDA SCS 1971).

In addition, on February 14, 1995, ESC consulted the SCS of Broome County to determine if significant agricultural lands exist on or adjacent to the site. This task was conducted to comply with the Farmland Protection Policy Act and its implementing regulations (7 CFR 658). According to Greg Currier of the SCS, no significant agricultural lands exist on or adjacent to the site.

3.5 Geology

Broome County is located in the Susquehanna Hills section of the Appalachian Uplands. This area is a stream-dissected plateau with flat-topped hills and narrow valleys. Specifically, Broome County is a transition area between the rugged relief of the Catskill Mountains to the east and the dissected plateau to the west (Coates 1981).

Bedrock underlying Broome County is identified as marine siltstones and shales of the Upper Devonian Sonyea Group. The Sonyea Group was deposited in a shallow sea as distal muds of the Catskill Delta (Karig and Elkins 1986). It is approximately 450 feet (130 m) thick and is part of an 8,000-foot (2,400 m) thick sequence of lower and middle Paleozoic sedimentary rocks that overlie granitic Precambrian basement (Karig and Elkins 1986). The topography of the hills is controlled by the bedrock's relative resistance to erosion and its structural dip. Gentle, southerly dipping units of siltstone and shale control the form of the asymmetric hills. Northern faces are steep, while the gentler southern faces are dipslopes. Valleys are formed in zones of less resistant shale or along closely-spaced joint sets.

The structure of the area is relatively simple. The rocks form a large regional homocline that dips southward 10 to 50 feet/mile (Bloom 1986; Coates 1981). The homocline is mildly deformed by gentle, asymmetric, regional, east-west trending folds with steep south limbs. The amplitude of the folds is approximately 330 feet (100 m), and their wavelength is approximately 6 miles (10 km). The east-west striking axis of the Horseheads Syncline lies south of the site.

The region was glaciated 4 to 10 times (Bloom 1986). Each successive glacial event scoured weathered rock and material which had been deposited by previous glaciations. The effects of glacial scour is more pronounced in the pre-existing valleys than on the nearby hilltops. The valleys were deepened into U-shaped cross-sections while only a relatively small amount of scour occurred on the ridges.

Thus, the surficial deposits of eastern Broome County are predominantly till on the hillsides and hilltops and outwash in the larger valleys. Alluvium lies along the floors of the smaller valleys. Kame terraces occur along the valley walls of Osborne Creek and the Chenango River. Economically viable deposits of sand and gravel have been mined from the outwash in the valley floors of this area.

The area is characterized by numerous umlaufbergs, or bedrock outliers in the valley bottom. The umlaufbergs are bedrock hills that are surrounded by thick deposits of alluvium or outwash. They were formed when glacial meltwaters scoured a deep notch into a valley spur. An umlaufberg lies at Chenango Bridge, approximately 2 miles west of the site. The Chenango River valley contains a thick (greater than 60 foot) section of stratified glacial deposits, including outwash and lacustrine silt and clay. The outwash and lake deposits overlie ice-contact sand and gravel (subaqueous outwash) and are interbedded with valleyside kames (Coates 1981; Holecek 1982).

Valley orientation controlled the intensity of glacial erosion. Valleys that were parallel to the ice flow, such as the Chenango Valley, were deeply eroded. Valleys that were not oriented parallel to the glacial movement, such as the Osborne Creek valley, were not deeply eroded and consequently "hang" on the deeply-scoured valleys.

Valley orientation also controlled the deposition of sediment during glacial advance and retreat. Thick wedges of glacial till were deposited on the lee (down-ice) side of hills and thin drift accumulated on the stoss (up-ice side) of uplands or hills. Thus, even though the average till thickness in the region is 60 feet, south-facing slopes can contain 6 to 10 times that thickness (Coates 1981).

The relationship between ice flow direction and topography determined the composition of the ice-contact deposits, especially of the glacial tills. Most of the material carried by the glacier was eroded from nearby sources. Approximately 90 percent of the material in a till sheet was carried only 10 miles or so. Some material traveled much longer distances, particularly in the north-south valleys (Coates 1981). The ice in the uplands of the site area deposited clay or silt-rich sediment scraped from the surrounding shales. These sediments are the "drab drift" of southern New York State (Coates 1981).

During glacial retreat, proglacial lakes were trapped in valleys that dipped into the ice front. A small ice-marginal lake likely existed in the Osborne Creek valley by the glacier in the Chenango Valley. Fine-grained poorly sorted sediment accumulated in these valleys. Meltwater drained freely from valleys that dipped away from the ice front. As a result, well sorted clean deposits of fluvial sand and gravel accumulated in valleys downstream of the ice front.

Information regarding the geology beneath the site is based on lithologic logging of boreholes advanced at the site. The shale bedrock below the Tri-Cities Barrel site is overlain by a dense, silty clay till. During advancement of the bedrock boreholes, a fractured siltstone that is approximately 2.5-3.2 feet thick was encountered within the predominantly shale bedrock at a depth of approximately 113.3 feet at MW-1B, 83.6 feet at MW-2B, and 87 feet at MW-14B. The elevation of the top of the siltstone is approximately 909.7 feet amsl at MW-1B, 916.6 feet amsl at MW-2B, and 916.1 feet amsl at MW-14B. The top of weathered bedrock at the site ranges from approximately 35.5 feet in the far southern portion of the site (MW-1B), south of Old Route 7, to more than 60 feet in the northern portion of the site (MW6). At MW-2B, weathered bedrock was encountered at 61 feet, and at MW-14B, it was encountered at 62 feet. The thickness of the weathered bedrock varied from 1 foot in MW-1B and MW2B to 5 feet in MW-14B. As expected, the thickness of the till deposits increase toward Osborne Creek. Lithologic logging of the soil borings advanced at the site identifies the unconsolidated deposits as brown, silty and clayey till, with thin, sand and gravel lenses. The amount of boulders and cobble size material increases with depth. The transect line of cross section A-A' trends north-south, cross section B-B' trends northwest-southeast, and cross sections C-C' and D-D' trend east-west, as shown on Figure 3-1. Geologic cross-sections which depict the site geology and hydrogeology are provided as Figures 3-2 through 3-4. A bedrock contour map is provided as Figure 3-5.

3.6 Hydrogeology

3.6.1 General

Broome County is in the glaciated central groundwater region. Groundwater in the site area is present in recent alluvial and colluvial deposits, in unconsolidated deposits of glacially derived deposits, and in bedrock. The recent alluvial/colluvial sediments and the permeable glacial outwash deposits are generally found at the base of slopes and stream valleys. Several potential aquifers in northeastern Broome County include both large outwash-filled valleys and small tributary valleys (MacNish and Randall 1989; Miller 1988). These aquifers are both unconfined and confined, and exhibit yields from 10 to over 100 gallons per minute (Miller 1988).

The larger valley aquifers, which are over 40 feet thick (MacNish and Randall 1989; Holecek 1982), are comprised of glacial deposits, especially outwash and kames, that are the primary sources of groundwater in the region. Within the region, glacial outwash commonly yields large quantities of groundwater (MacNish and Randall 1989; Holecek 1982). The smaller tributary valleys (i.e., Osborne Creek) have drainage areas of less than 30 square miles. They generally contain permeable material that is less than 10 feet thick which is confined along the floor of the stream valley and "pinches out" up-valley (Holecek 1982). Osborne Creek has cut through over 50 feet of glacial deposits since the glacier retreated from the area (17,000 years ago according to Cadwell 1981) and alluvium has since been deposited along its floodplain. The stream's base level is controlled by the Chenango River.

The Tri-Cities site is approximately 1.3 miles from the eastern edge of the Endicott-Johnson city aquifer. The nearest municipal water well field (River Road Water Association) is developed in the Endicott-Johnson City aquifer, approximately 2 miles from the site. This well field is on the opposite side of the Chenango River from the confluence of Osborne Creek.

The Tri-Cities Barrel site is on a till terrace that is covered by fill material and mantled in some portions of the site with a thin veneer of colluvium. The terrace where the site is located is underlain by approximately 60 feet of dense silty clay till. Sand lenses are present within the dense, clay-rich till. The amount of continuity of the sand lenses increases to the north, as expected, in the vicinity of the Osborne Creek valley. The till deposits form the unconsolidated water bearing zone at the site. Because of the slow recharge of the onsite wells and low hydraulic conductivity of the till, the groundwater present in the till is referred to as a water bearing zone and does not qualify as an aquifer. In summary, groundwater in the unconsolidated water bearing zone flows to the north towards Osborne Creek, and limited groundwater is present in the unconsolidated till material at the site.

A single bedrock well (MW-4, former production well), which was approximately 125 feet deep, was located south of I-88. This well was reportedly installed in the 1950s in bedrock and was abandoned in 1997. To gain further information on the construction of the former production well and nearby residential water supply wells, also completed in bedrock, on September 22, 1994, ESC attempted to locate and review available boring logs and well construction records. However, no well records, permits, or construction records were available for review at the Fenton Town Hall, Broome County Department of Environmental Health, or New York State Department of Environmental Health. As part of the Phase III RI, ESC interviewed all of the adjacent property owners to gather further information on the nearby residential wells. The following residents were interviewed on the date and approximate times indicated below.

- Mrs. Lance, November 12, 1995 @ 1600
- Mr. & Mrs. Stahl, November 12, 1995 @ 1630
- Mrs. McGonnigal, November 12, 1995 @ 1700
- Mr. Lee, November 12, 1995 @ 1715
- Mr. Duval, November 12, 1995 @ 1730
- Mrs. Vail, December 14, 1995 @ 1630
- Mrs. Smith, December 14, 1995 @ 1700

All residents were asked to provide any known information regarding the construction of their drinking water well. Specifically, they were asked for the name and address of the driller who installed the well, when it was installed, the total depth of the well, the depth to groundwater in the well, and copies of well completion forms or boring logs. Generally, the residents were cooperative and willing to provide whatever information of which they were aware. Unfortunately, most of the residents were not aware of many specifics and in all cases the information provided is based on their memories. The location of these residences relative to the site is presented on Figure 3-6. The following is a summary of information provided by each resident.

Mrs. Lance

- Well is 117 feet deep
- Installed 15 years ago
- Installed by Bob Schmidt of Water Systems at 492 Oak Hill Road (648-6010)
- The well was sampled in October 1995 by the DOH, and Mrs. Lance received a letter from the DOH informing her that small amounts of xylenes were detected in her water

Mr. & Mrs. Stahl

- Well is 165 feet deep
- 6-inch diameter casing is set to a depth of 135 feet
- Open borehole from 135 feet to 165 feet
- Production pump is set at approximately 115 feet to 120 feet and is normally under a 70-foot thick water column
- They do not know when the well was installed; however, it was present when they moved in about 30 years ago
- The house is 200 years old
- The well was sampled in October 1995 by the DOH; they have not received any results from the DOH

Mrs. McGonnigal

- Well was estimated to be 110 feet deep
- Well was installed during the construction of the home in 1985 or 1986, as part of the new home construction deal, which was done by Hawkins & Flannery (a modular home construction company) on Route 7 in Belden

Mr. Lee

- Depth of well is unknown
- Well was present when they moved in 1971
- A new well pump was installed in the well by Palmiter Wells of Afton, New York

Mr. Duval

- Well was estimated to be approximately 110 feet deep
- The house and well were estimated to be approximately 35 years old

Mrs. Vail

- Well is approximately 65 feet deep
- The age of the well is not known
- The current house on the property is 8 years old; the previous house was destroyed by fire

Mrs. Smith

- Well is approximately 187 feet deep
- The house is 20 to 25 years old; presumably the well is the same age as the house

3.6.2 Slug Testing

During the Phase II RI, rising and falling head slug tests were performed in MW1, MW1SA, MW2S, MW2, MW3S, MW3, MW5S, MW6S, MW6, MW7S, MW7, MW8S, MW8, P1, P2, and P3 to assess the hydraulic conductivity of the unconsolidated water bearing zone across the site. The hydraulic conductivity values obtained from analysis of the slug test data were, in turn, used to estimate the groundwater flow velocity within the unconsolidated deposits.

After completing the slug test in the wells, the data were analyzed to determine the hydraulic conductivity of the water bearing zone using the Bouwer and Rice Method (1976 and 1989). Using this method, the natural log of the recorded water levels in feet was plotted against time. In the equation for calculating the hydraulic conductivity, the term (1/t) ln (Yo/Yt) is equal to the negative slope of the graphed line. Thus, for each straight line segment, a linear regression was performed to determine the slope (X-coefficient) of the line segment. The negative slope (m) was then substituted into the following equation to calculate hydraulic conductivity:

$$K = \frac{(r_c^2) * \ln[(R_e)/(R_w)] * m}{2L_e}; \qquad \text{where}$$

K	is the hydraulic conductivity
r_c	is the casing radius of the well
R_e	is the effective radius of the well
R_w	is the radial distance between the undisturbed aquifer and well center
L_e	is the length of the well screen

The slug test data collected during the Phase II RI are provided in Appendix I.

The input parameters used to calculate the hydraulic conductivity for each well are provided in Table 3-1. The lithology at the facility is a silty clay till with minor sand and gravel lenses. These relatively high permeability sand and gravel lenses are surrounded by low permeability glacial till deposits. The hydraulic conductivity results calculated from analysis of the rising and falling head slug test data are presented in Table 3-2. Based on the results of the rising head tests, the hydraulic conductivity for the water bearing zone at the site ranges from 1.5 X 10^{-7} cm/sec to 3.8 X 10^{-3} cm/sec. The hydraulic conductivity values, based on the falling head slug test data range from 1.2 X 10^{-6} cm/sec to 2.8 X 10^{-3} cm/sec. According to Bouwer and Rice (1989), rising head slug test results are more reliable than falling head slug test results, especially for wells with screens that bracket the water table. Nonetheless, the rising and falling head slug test results are similar for each well. The rate of groundwater flow calculated for the site is based on the results of the rising head slug tests.

According to Fetter (1980), the hydraulic conductivity of glacial till deposits typically ranges from 10^{-6} cm/sec to 10^{-4} cm/sec. The hydraulic conductivity values calculated from the rising head slug tests at the Tri-Cities Barrel site generally fall within this range. A few monitoring locations (MW-2, MW-6S, MW-6, MW-7S, and P-2) have hydraulic conductivity values of 10^{-3} cm/sec. A review of the boring logs and construction diagrams for these monitoring locations indicate that the well screens extend across a sandy lense or till containing sand and gravel rock fragments.

3.6.3 Groundwater Elevation Monitoring

Twenty groundwater elevation measuring events were conducted during the RI field activities. Groundwater elevation data for all 20 events are presented in Table 3-3. No immiscible layers (LNAPLs or DNAPLs) were detected in any of the monitoring wells or piezometers. The measurements collected on November 27, 1995 and November 21, 1997, were selected for construction of groundwater contour maps (Figures 3-7 and 3-8) because the measurements collected on these dates consist of the most complete set of data points (all monitoring wells and piezometers installed at the site are included).

Based on the groundwater elevation data, the direction of groundwater flow in the unconsolidated deposits at the site is to the north, toward Osborne Creek. The hydrogeologic data are consistent with topographic influences observed at the site and vicinity and the suspected groundwater recharge areas (tops of ridges) and discharge areas (Osborne Creek). Groundwater elevations in the unconsolidated deposits range from approximately 1,012 feet amsl in MW1SA, MW1, MW8, and MW8S (at the far southern portion of the site) to approximately 936 feet amsl in MW6, MW6S, MW7, and MW7S (at the far northern portion of the site). Based on these data (comparing MW1SA and MW7S and comparing MW1 and MW7), the average horizontal hydraulic gradient in the unconsolidated water bearing zone is approximately 0.08. This gradient is the same for wells screened near the water table and for wells screened near the base of the unconsolidated deposits. It is important to note that the hydraulic gradient at the site is relatively steep, as expected in low hydraulic conductivity deposits. The water table drops approximately 80 feet from the most southern portion of the site to the most northern portion of the site (Osborne Creek). Therefore, seasonal variability of the groundwater flow direction is highly unlikely. Regardless of the season, groundwater will flow to the north discharging to Osborne Creek.

Groundwater elevations in the bedrock range from approximately 957.5 feet amsl in MW1B to approximately 952 feet amsl in MW14B. Based on the bedrock groundwater elevation monitoring data, the average horizontal hydraulic gradient is approximately 0.01.

Comparing the groundwater elevations south of I-88 (MW2/2S and MW3/3S), the difference in water elevations between the shallow and deep wells is approximately 15 feet, and the average vertical hydraulic gradient in the unconsolidated water bearing zone south of I-88 is determined to be downward at approximately 0.57. Comparing the groundwater elevations north of I-88 (MW6/6S and MW7/7S) and within the median of I-88 (MW9/9S and MW10/10S), the difference in the water elevations is less dramatic than south of I-88 (less than 0.5 foot as compared to 15 feet). The vertical hydraulic gradient north of I-88 (MW6/6S and MW7/7S) is very slight (approximately 0.02 and less). As expected, these data indicate that the portion of the site south of I-88 is a recharge area and the portion of the site within the median of I-88 and north of I-88 is within the transition area between the above mentioned recharge area and the discharge area (Osborne Creek).

The total depth of the former out-of-service production well (MW4) was measured at 125 feet below ground surface, and the depth to groundwater in MW4 is approximately 60 feet. During the installation of the bedrock monitoring wells, shale bedrock was encountered at approximately 36.5 feet in MW1B (987.4 feet amsl), 61 feet in MW2B (939.2 feet amsl), and 62 feet in MW14B (941 feet amsl). Thus, the bedrock surface slopes to the north, as expected. A 2.5-foot to 3.2-foot thick fractured siltstone was encountered within the predominantly shale bedrock at an elevation of approximately 909.7 feet amsl in MW1B, 916.6 feet amsl in MW2B, and 916.1 feet amsl in MW14B. The bedrock monitoring wells are screened across the fractured siltstone. The depth to groundwater in the bedrock monitoring wells varies from approximately 48 feet in MW2B to approximately 67 feet in MW1B. The elevation of the potentiometric surface in the bedrock ranges from approximately 952 feet amsl in MW14B to 957.5 feet amsl in MW1B. Based on the elevation of the fractured siltstone and the elevation of the groundwater potentiometric surface in the monitoring wells, the groundwater in the fractured siltstone is present under pressure (confined conditions) and flow is to the north-northeast, as expected. A schematic of the potentiometric surface map for the bedrock monitoring wells is provided in Figure 3.9.

Comparing the groundwater elevations in each of the bedrock clusters (MW1SA, MW1, and MW1B; MW2S, MW2, and MW2B; and P2, MW14, and MW14B) indicate that the groundwater elevation is higher in the unconsolidated water bearing compared to the bedrock. An approximately 50-foot difference exists at the MW1 cluster, 16-foot difference at the MW2 cluster, and 31-foot difference at the MW14 cluster. These data indicate that the theoretic movement of groundwater is from the unconsolidated water bearing zone to the bedrock aquifer. However, because of the dense nature of the unconsolidated glacial till deposits, the hydraulic connectivity between the unconsolidated water bearing zone and the bedrock aquifer is suspected to be negligible, if any, thereby limiting the vertical movement of groundwater.

As discussed above in Section 3.1, the construction of I-88 includes approximately 12 inches of granular subbase course and select granular subbase course below the concrete pavement. The median of I-88 is approximately 2 feet lower than that of the concrete pavement. Thus, the granular subbase of I-88 is at a higher elevation than the ground surface of the median of I-88. The depths to groundwater in MW9 and MW9S are approximately 4 feet, and as much as 10 feet, below the ground surface. Thus, the groundwater is at least 4 feet below the granular subbase of I-88 and has no potential to migrate laterally along the subbase.

3.6.4 Groundwater Flow

The hydraulic conductivity values obtained from analysis of the slug test data were used to estimate the groundwater flow velocity within the unconsolidated deposits at the site.

Using Darcy's Law ($V = iK/n_e$) where:

V = velocity

i = horizontal hydraulic gradient

K = hydraulic conductivity

n_e = effective porosity,

the rate of groundwater flow within the unconsolidated water bearing zone was calculated. Using the low and high hydraulic conductivities calculated from the rising head slug tests (1.5×10^{-7} cm/sec to 3.8×10^{-3} cm/sec), a hydraulic gradient of 0.08, and an average effective porosity of 0.13 for till (Walton 1988), the rate of groundwater flow is calculated to range between 9.2×10^{-8} cm/sec and 2.3×10^{-3} cm/sec. Converting these groundwater flow rates to feet per day, the flow in the unconsolidated water bearing zone is between 2.6×10^{-4} foot per day and 65.2 feet per day. As indicated above, the upper range of the hydraulic conductivities is for the sand lenses within the till; these sand lenses are believed to be encapsulated within the low permeability till deposits. Thus, the upper range for the groundwater flow rate is restricted to the sand layers, and the lower end of the range is more representative of the majority of the groundwater flow at the site given that much of the unconsolidated deposits underlying the site consist of silty and clayey till. This conclusion is also supported by the analytical data which indicate little, if any, transport of chemical constituents in groundwater. Using the median hydraulic conductivity calculated from the slug tests (5.18×10^{-4} cm/sec), a hydraulic gradient of 0.08, and an average effective porosity of 0.13 for till, the average rate of groundwater flow is calculated to be 3.2×10^{-4} cm/sec (0.9 foot per day).

3.7 Demography and Land Use

Based on 1990 census data, approximately 212,000 people reside in an estimated 81,843 households in Broome County (CACI 1993). The population of Broome County is predominantly Caucasian (approximately 203,000), and the median age is 34.1. Approximately 19.3 percent (41,109) of the population is 14 years of age or younger, and approximately 15 percent (31,825) of the population is 65 years of age or older.

The nearest residence is located adjacent to the eastern border of the Tri-Cities Barrel site (approximately 150 feet from the site), along Osborne Hollow Road. The other rural residential dwellings located near the site are all either along Osborne Hollow Road or Old Route 7. All of the residents near the site obtain their groundwater from domestic bedrock water supply wells. In addition, approximately 0.5 mile southeast of the site (topographically and hydraulically upgradient of the site) is a trailer park.

An estimated 6,600 residents live within 3 miles of the site and, of these, approximately 3,300 are expected to use groundwater as a residential water source. Surface water is used for irrigation at two berry farms located approximately 1 mile north of the intersection of I-88 and Route 369 (approximately 3 miles northwest of the site). Residents of the area who rely on groundwater for domestic use are located upgradient or cross-gradient of the site. There are no groundwater users located immediately downgradient of the Tri-Cities Barrel site, and no residences are located between the facility and Osborne Creek which is the discharge area for groundwater.

Surface water in the site vicinity includes the Chenango River, located approximately 1.5 miles west of the site, which receives discharge from Osborne Creek, located adjacent to the site's northern border. There are numerous smaller perennial and intermittent streams in the site vicinity, including two unnamed tributaries to Osborne Creek, which are located adjacent to the eastern and western borders of the Tri-Cities Barrel site. The Chenango River and, to a much lesser extent, Osborne Creek, are used for recreational activities including fishing and swimming.

The land use in the vicinity of the site is characterized by rural residential dwellings, farmland, and forested land. The rural residential dwellings are primarily located along Osborne Hollow Road and Old Route 7. The greatest concentration of residences is located approximately 1 mile west of the site in the village of Port Crane. Farmland is located northwest of the site (north of I-88) and south of the D&H railroad which is located south of the site. Forested land is located primarily north of Osborne Creek. Additionally, an abandoned commercial facility, Don Snow Trucking, is located on Osborne Hollow Road approximately 500 feet southeast of the site.

3.8 Ecology

The Tri-Cities Barrel site is located in a semi-rural residential area. An ecological assessment of the site performed by EDR in September 1994, indicates that plants and animals identified at the site include native and non-native species common to western New York. No occurrences of rare plant or animal species are known to exist at the site, nor do the natural communities identified at the site provide the habitat necessary to support rare species.

Five different vegetative covers/habitats were identified at the site. Old field/shrub upland is the dominant habitat, occupying 74 percent of the land area. This habitat is distinctive of land that was disturbed by site operations. Conifer Plantations represent approximately 11 percent of the site. This cover is represented primarily by 40-year old trees located north of I-88 within the western portion of this northern parcel. The remaining portions of the site are represented by stream/flood plain (8 percent), deciduous forest (4 percent), and wetland (2 percent). The remaining 1 percent of the site was covered by buildings and structures which have been removed.

Summary descriptions of the vegetation and wildlife characteristics of the site, natural resource identification, and habitat value assessment for each of the three main areas of the site are provided in the following sections. Additional detailed information is provided in the EDR report (EDR January 1995).

3.8.1 North of I-88

Two areas designated as a stream/floodplain and conifer plantation are the prevalent vegetative cover types/habitats in the area north of I-88. Each of these cover types represents approximately 30 percent of this area, or a total of 60 percent of the land area north of I-88. Both cover types provide for a variety of habitats (mammals, birds, reptiles and amphibians, and fish). Other portions of the area north of I-88 include old field/shrub upland, deciduous forest, and wetlands and the associated former lagoon; these covers provide only limited habitat.

The conifer plantation cover is present in the central and western portions of this area and is bound to the west by the intermittent stream and to the north by the Osborne Creek floodplain. Due to the dense canopy provided by this cover, there is little to no ground layer which somewhat limits the habitat.

The stream/floodplain extends along the northern boundary of the site, between the western and eastern intermittent streams and inclusive of Osborne Creek. Although limited vegetation exists immediately adjacent to the stream channel, the surrounding area supports small trees and shrubs and provides a ground layer. This type of vegetation, combined with the variety of potential habitats provided by Osborne Creek, the undeveloped nature of the land north of Osborne Creek (creating a large contiguous area for habitat development), and limited human access, poses the most significant habitat area at the site.

The overall habitat value of the area immediately north of I-88 is somewhat limited by the presence of the interstate, the presence of the old field/upland shrub (which represents approximately 30 percent of this area and supports only limited habitat), and the limited size of the conifer plantation and deciduous forest.

Osborne Creek represents the significant natural resource at the site. A game fish population has not been identified in the stream and, it is unlikely to be used for sport fishing. The wetland area and associated former lagoon in this area are of lesser significance due to their limited size and past use, and because they are not representative of a larger wetland system. It is also important to note that the wetlands associated with the former lagoon are not natural but rather are a result of the construction and past use of the area as a lagoon.

3.8.2 South of I-88

Approximately 50 percent of the area south of I-88 and north of Osborne Hollow Road is comprised of old field/shrub upland. The old field is concentrated along the perimeter of the former facility buildings and operational areas and Osborne Hollow Road and bound to the west and north by shrub upland. Both types of cover are distinctive of recently disturbed land. The remaining half of this area is represented by the former site operations area/disturbed area (30 percent), a recent conifer plantation (10 percent), and intermittent stream/wetland areas (less than 3 percent and associated with the tributaries).

Old field cover is largely limited to herbaceous species. This type of cover provides for limited habitats (small birds and small mammals). The perimeter of this cover is represented by shrub upland which are typified by small- to moderate-size tree species. This type of cover provides for food and travel corridors for a variety of mammals and birds. However, the absence of adjacent forested areas or other large areas of habitat in the area south of I-88 limits utilization of the area by a diverse community of wildlife.

Habitation is also limited by the presence of the former site operations area, which is represented by the disturbed area. The disturbed area, which represents approximately 27 percent of this area, is typified by barren soil areas (associated with roadways), sparse grass near the former buildings, and small trees and shrubs at the perimeter of the former process areas. An additional factor in the current absence or future potential for habitats in this area is the presence of I-88 immediately to the north, Osborne Hollow Road to the south, and residential development to the east and west.

3.8.3 South of Osborne Hollow Road

Approximately 96 percent of the area between Osborne Hollow Road and the D&H rail line is occupied by old field/shrub upland. A wetland area located between Old Route 7 and the rail line occupies the remaining 4 percent of this area.

As stated above, the old field/shrub upland provides limited habitat. The habitat is further aggravated by the absence of adjacent forested areas or other large areas of habitat, the adjacent roads (Osborne Hollow Road and Old Route 7), rail line, the intersection of the area by Osborne Hollow Road and Old Route 7, and residential development to the east and west.

The wetland area represents no significant habitat development due to its limited size, because it is not representative of a larger wetland system, and because the surrounding old field/shrub upland cover provides little habitat value.

4.0 Nature and Extent of Contamination

The principle goals of the RI at the Tri-Cities Barrel site are to identify the chemicals present in the soils, groundwater, surface water, sediments, and potential ecological receptors; to delineate the degree and extent of constituents in each of the above media; and to characterize the physical properties that affect fate and transport of the identified classes of constituents present at the site. This section of the RI report presents the results of the Phase I, II, III, and IV investigations and provides an analysis of the results relative to the objectives of the RI. As indicated in Section 1.0, the study area is divided into 3 broad areas (north of I-88, south of I-88, and south of Osborne Hollow Road), and the soil sampling results for each of these areas are presented separately. Because most of the operations occurred within the parcel designated as south of I-88, this parcel was further subdivided to facilitate the presentation, evaluation, and interpretation of the soil sampling data. These subdivisions include the former process buildings, former lagoons, former drum processing area, former incoming drum storage area, former reconditioned drum storage area, and downslope of the incoming drum storage area and lagoons. The approximate boundaries of each of these areas are presented on Figure 4-1.

The data validation reports and comprehensive data tables for Phases I, II, III, and IV of the RI are presented as Appendices J through M. The data tables included as part of the data validation reports list all constituents analyzed for and the corresponding method detection limits; while the data summary tables referenced in this section of the report only include the constituents detected above the estimated quantitation limit. Thus, those constituents not detected are not included on the data summary tables. Furthermore, the data summary tables do not include the results of equipment blank and trip blank samples; these results are included on separate summary tables provided in Appendix N.

The chain-of-custody forms for all RI samples are provided in Appendix O. Because numerous samples were collected during the RI, the various laboratories contracted with during the RI shipped boxes of bottles to the ESC field representatives. The laboratory did not ship pre-labeled bottles to the site. Each shipment was sent either directly to the site or to the local Federal Express office for pick up by the ESC field representatives. On receipt of bottle shipments, the ESC field representatives inspected each shipment for any signs of tampering. No evidence of tampering with the sample bottle shipments was ever noted. Sample bottles were temporarily stored in the onsite trailer, which was locked when it was not occupied, until the sample bottles were used. Following collection of samples each day, the ESC field representatives completed an ESC chain-of-custody form to accompany the samples during shipment to the analytical laboratory. Thus, while the chain-of-custody forms do not reflect relinquishing signatures from either the delivery or laboratory personnel, strict control of the sample bottles was maintained at all times throughout the RI.

Based on the validation of the RI data, the data, with qualification, are of acceptable quality and usable for the purpose of this remedial investigation. A technical overview of the reliability of the laboratory analytical data is provided below.

Laboratory data for the four phases of field sampling were evaluated for overall technical reliability and usability to assess the extent of environmental contamination at the Tri-Cities Barrel Superfund site. The data meet the data quality objectives (DQOs) for the project as specified in the QAPjP, are representative of field conditions at the site, and provide an excellent overall view of environmental contamination at the site. The data are greater than 95 percent complete. Each phase of the RI was conducted in the late summer and fall of 1993, 1994, 1995, and 1997, and, other than groundwater sampling, little resampling of the same location was conducted. Consequently, few data are available to make conclusions regarding the seasonal variation of the data.

Samples were collected in a consistent manner according to ESC SOPs and EPA requirements, as specified in the EPA Region II approved work plans. The laboratories used the same approved EPA methods during each phase of the sampling for each type of analysis (e.g., VOCs, SVOCs). This provides good comparability of the data from phase to phase. A few samples in each phase were analyzed outside of the required holding times. Data were either qualified as estimated (J/UJ) or rejected (R) according to the EPA functional guidelines and EPA Region II SOPs for data validation. Qualification of the data is documented in the Phase I – IV Data Validation Reports.

Laboratory precision and accuracy was judged to be acceptable according to criteria established in the laboratories' QAPPs and the CLP guidelines. Detection limits for most data met the contract required quantitation limits (CRQLs) for organic analyses and contract required detection limits (CRDLs) for metals and cyanide. CRQLs and CRDLs for solid matrices are based on wet weight and were higher because data are reported on a dry weight basis. Exceptions include samples that were diluted due to a high concentration of target analytes outside the calibration range of the instrumentation, and dilutions performed because of interference from the sample matrix. A summary of each phase of sampling results is presented below.

Phase I

All samples were analyzed within the required method holding times. One sediment sample for TOC was lost due to laboratory subcontractor error. Sample results for VOCs and SVOCs were qualified when the QC criteria for surrogate recoveries, calibration, blanks and internal standards were not met. Several SVOC sample results were qualified as estimated because the mass spectral tune was outside of QC limits. Pesticide/PCBs data were qualified when QC criteria for surrogates, calibration and quantitation differences between columns were outside of specified limits. Several pesticide/PCB results were rejected because the percent difference between columns was greater than 90 percent. Several of the pesticide/PCB results were confirmed by GC/MS. Many of the pesticide/PCB results could not be confirmed by GC/MS because the concentration of analytes was not sufficient. Most of the SVOC and pesticide/PCB results were qualified because of matrix interference.

Metals data were qualified due to CRDL standards, matrix spike, laboratory control sample, post digestion spike recovery, and ICP serial dilutions that were outside of EPA Region II QC limits. Several metals results were considered undetected due to blank contamination.

Ninety-two individual pesticide/PCB results and 148 metals results were rejected due to QC criteria outside of specified limits. The majority of these rejected results were due to matrix interference.

Based on the above review, the data, with qualification, are of acceptable quality and usable for the purpose of the Phase I RI/FS.

Phase II

Three samples exceeded the method holding times, and data for these samples were qualified in accordance with EPA Region II criteria. Sample results for VOCs and SVOCs were qualified when the QC criteria for calibration, blanks, or internal standards were not met. Pesticide/PCBs data were qualified when QC criteria for surrogates, calibration, and quantitation differences between columns were outside of specified limits. Many of the pesticides/PCBs results were confirmed as TICs in the GC/MS analyses of SVOCs. Many of the pesticides/PCBs results could not be confirmed because the concentration of the analytes was too low to be detected by GC/MS. The majority of the pesticides/PCBs results that were qualified are due to matrix interference. Several undetected SVOCs and pesticides/PCBs were reported at elevated detection limits; these samples had to be analyzed at dilution due to matrix interference. Attempts by the laboratory to further clean up these samples to reach lower detection limits were not successful because of sample solubility problems.

The metals data were qualified due to CRDL standards, matrix spike, laboratory control sample, post digestion spike recovery, and ICP serial dilutions that were outside of QC limits specified by EPA Region II.

Only six analyte results were rejected (R). The undetected results for mercury in sample SED70-2 was rejected (R) because the sample was analyzed past the holding times. The undetected results for hexachlorocyclopentadiene in samples B10-2, and B13-2; and for di-n-octylphthalate in B8-1, B8-5, B9-5, B10-1, B10-5, B12-5, and MW25-11 were rejected (R) because the percent difference in the continuing calibration was greater than 100.

The 2,3,7,8-TCDD results were qualified as estimated, due to matrix interference and because the equipment blank could not be reported due to zero recovery of the internal standard.

Based on the above review, the data, with qualification, are of acceptable quality and usable for the purpose of the Phase II RI/FS.

Phase III

Three samples exceeded the method of holding times. Data for these samples were qualified in accordance with EPA Region II criteria. Sample results for VOCs and SVOCs were qualified when the QC criteria for calibration, blanks, or internal standards were not met. Pesticide/PCBs data were qualified when QC criteria for surrogates, calibration, and quantitation differences between columns were outside of specified limits. Several of the pesticides/PCBs results were confirmed as TICs in the GC/MS analyses for SVOCs. Many of the pesticides/PCBs results could not be confirmed because the concentration of the analytes was too low to be detected by GC/MS. The majority of the pesticides/PCBs results that were qualified are due to matrix interference. Several undetected target VOCs, SVOCs, and pesticides/PCBs were reported at elevated detection limits; these samples had to be analyzed at dilution due to matrix interference. Attempts by the laboratory to further clean up these samples to reach lower detection limits were not successful because of sample solubility problems.

The metals data were qualified due to CRDL standards, matrix spike, laboratory control sample, post digestion spike recovery, and ICP serial dilutions that were outside of QC limits specified by EPA Region II.

Only seven analyte results were rejected (R). The undetected result for mercury in sample B19-5 was rejected (R) because the sample was analyzed past the holding time. The undetected results for 3,3'-benzidine in samples SS38-3, SS40(a)-3, and SS60-3; methylene chloride in samples MW78-4, MW60-4; 1,2-dibromo-3-chloropropane in sample MW89-4 were rejected (R) because the percent difference in the continuing calibration was greater than 90.

Based on the above review, the data, with qualification, are of acceptable quality and usable for the purpose of the Phase III RI/FS.

Phase IV

Four soil samples, and eight sediment samples collected for TOC characterization were analyzed outside the EPA Region II recommended holding time of 14 days. The data were qualified as estimated (J). Common laboratory contaminants including methylene chloride and acetone in the VOCs, and phthalate esters in the SVOCs were detected in several of the laboratory, trip and equipment blanks. Sample results were qualified as undetected if the concentration of common contaminants in the samples were less than 10 times the concentration in the blank. For other analytes, a multiplier of 5 was used. Sample results for VOCs and SVOCs were qualified when QC criteria for surrogates, calibration and blanks were not met. In most cases the effect on the data is minimal. MS/MSD data were not qualified. This information is used to assess the effect of the sample matrix on the analysis.

PCBs were tentatively identified as detected in one sample. The PCB result could not be confirmed by GC/MS because the concentration was too low. The effect on the data was minimal because the target analytes that were outside of QC limits were not detected in the corresponding samples. Several VOC samples were reanalyzed at dilution because several target compounds exceeded the calibration range of the method. The target VOCs were reported from both the original run and the diluted sample, and the results from the diluted sample are flagged with a "D".

Selenium in the samples collected November 22 – 24, 1997, and aluminum in the samples collected on December 16 and 18, 1997, were qualified as estimated because the matrix spike was outside of QC limits. All other metals data were within acceptable QC limits.

Based on the above review, the data, with qualification, are of acceptable quality and usable for the purpose of the Phase IV RI/FS.

4.1 Soils and Vadose Zone

Surficial soil samples (samples collected from depths of 3 feet or less) and subsurface soil samples (samples collected from depths of more than 3 feet) were collected during each of the four phases of the RI. A discussion of the soil sampling analytical results by area (e.g., north of I-88, south of I-88) and by depth (i.e., surficial and subsurface) is provided in this section. Because the field headspace soil sampling results are qualitative, little emphasis or discussion of these results is provided in this section. However, these results are provided in Appendix P.

As part of the data evaluation process, the soil sampling results were compared to the ARARs established for the site (Table 4-1). The primary source for the chemical-specific criteria for the soil ARARs is the NYSDEC Technical and Administrative Guidance Memorandum (TAGM - 4046)

Determination of Soil Cleanup Objectives and Cleanup Levels. According to TAGM 4046, "Attainment of these generic soil cleanup objectives will, at a minimum, eliminate all *significant* threats to human health and/or the environment posed by the inactive hazardous waste site. Project Managers should use these cleanup objectives in selecting alternatives in the Feasibility Study (FS). Based on the proposed selected remedial technology (outcome of FS), final site-specific soil cleanup levels are established in the Record of Decision (ROD) for these sites. It should be noted that even after soil cleanup levels are established in the ROD, these levels may prove to be unattainable when remedial construction begins. In that event, alternative remedial actions or institutional controls may be necessary to protect the environment." Furthermore, the soil criteria presented in TAGM – 4046 apply only to the protection of human health; criteria for wildlife have not been established. Concentrations that pose wildlife hazards are identified in the site-specific ecological risk assessment.

4.1.1 Background Soils

During the RI, 12 soil samples were collected from 7 locations situated offsite and upgradient of the former Tri-Cities Barrel site to establish background soil conditions for the site and vicinity. All of the samples were analyzed for VOCs, SVOCs, pesticides, PCBs, and metals, and the results were compared to the ARARs for soils as well to the onsite sampling results. The sampling locations (SS7, SS8, SS9, SS49, SS50A, SS50B, and B1D) are shown on Figure 1-9 and the analytical results are presented in Table 4-2. Additionally, a summary of the constituents detected in the background samples is provided in Figure 4-2.

Four VOCs, 17 SVOCs, 6 pesticides, and 23 metals were detected in the background soil samples. None of the VOCs exceeded the ARAR concentrations. The concentrations of total VOCs in these background samples ranged from non-detect in 7 samples to 11 µg/kg in SS50B. Similarly, none of the pesticides exceeded the ARAR concentrations and, in fact, were well below the ARAR levels.

Most of the organic constituents detected in the background samples are SVOCs. The concentrations of total SVOCs ranged from non-detect in 2 samples to 104,820 µg/kg in SS8(b). Three of the locations (SS8(b) at 2.5-3 feet; SS9(a) at 0-0.5 foot; and SS49(a) at 0-0.5 foot) contained concentrations of 7 SVOCs that exceed the ARAR levels. SS8 and SS9 were collected from the Vail property and SS49 was collected from the Smith property. Both properties are located to the west/southwest of the site and are upslope and hydrologically upgradient of the former Tri-Cities Barrel site. The SVOCs detected at elevated concentrations include benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene. The elevated levels of SVOCs detected in the background samples may be related to the road surface materials used during construction and repair of the adjacent road (Old Route 7), runoff from the upslope railroad track, or the house fire that occurred on the Vail property. These are all likely sources; given the topographic and downwind location of the site, the former site operations are an unlikely source for the concentrations of SVOCs in the background soil samples.

The PAHs detected in the soil samples collected on the Tri-Cities Barrel site were compared to the average concentrations of the constituents detected in the background soil samples. To calculate the average background PAH concentrations, the concentrations of PAHs in SS8(a) and SS8(b) were excluded. Because a previous house fire near this sampling location appears to have caused elevated concentrations of PAHs in soil. Furthermore, to calculate the average, only the detectable concentrations were included in the average. The comparison of the site PAH data to the offsite background PAH data indicates that the former site operations and offsite incidents have been a source for the PAHs. PAHs can be present in the environment at "background" concentrations due to their pervasiveness in materials used by humans (e.g., road surfacing materials) and as a result of non-industrial human activity (e.g., house fire).

Site background is identified as the ARAR for several metals. To estimate the site background concentration for each metal, the arithmetic average of the 12 background soil samples was calculated and multiplied by a factor of two. The SS8 metals data were included in these calculations because evaluation of the data indicates that it is similar to the other metal background data. For samples with constituents reported as non-detect, half the reported detection limit was included in the average. Table 4-3 presents the average metals concentrations in the background soil samples.

The criterion of two times the average concentration detected in the background soil samples was used at the direction of EPA, even though the PRPs believe that a factor of three times the average is an acceptable criterion. The suggested use of three times the average concentration detected in the background samples is based on the Hazard Ranking System Final Rule (December 14, 1990, Federal Register, Volume 55, Pages 51532 through 51667) which states that a result is significant when concentrations are three times or more above the background concentrations. Exceedence, however, does not imply a threat to human health and the environment for exposure to metals in the soils. Alternatively, for those constituents that do not rely on site background but rather specify a unique criterion, that number was used for screening purposes. Thus, the metal results for the onsite soil samples were compared to the ARARs following the criteria described above.

4.1.2 Surficial Soils North of I-88

Thirty surficial soil samples were collected north of I-88 during the RI. The analytical results for these samples are provided in Table 4-4. In addition, 8 samples were collected from within and near the former lagoon north of I-88. The analytical results for these samples are provided in Table 4-5. Because this site feature is a remnant of a former lagoon, is not connected to other surface water bodies, is dry part of the year, does not support aquatic life, and has a vegetated soil bottom, the results for the samples collected from the former lagoon were evaluated as soil samples, even though they were designated for nomenclature purposes only as sediment samples (e.g., SED7). However, to satisfy the EPA and NYSDEC, these results were also compared to available sediment criteria. The sampling results that exceed the soil and sediment ARARs for the surficial soil samples collected from north of I-88 are identified on Figure 4-3.

The focus of this investigation was to assess the affect of the former discharges of wastewaters to the ground surface north of I-88 (i.e., the 1958 discharge pattern) and to assess the soils associated with the former lagoon.

Seven VOCs (benzene, toluene, acetone, bromomethane, methylene chloride, 2-butanone, 1,1,2,2-tetrachloroethane) were detected in the surficial soils north of I-88. However, none were detected at concentrations exceeding ARARs. The concentrations of total VOCs ranged from non-detect in 16 of the samples to 32 μg/kg in SS15. The concentrations of total VOC TICs ranged from non-detect to 202 μg/kg in B6-1. Additionally, during Phase IV of the RI a sample was collected from the former lagoon north of I-88 (SED16) and analyzed for TOC. The TOC concentration in this sample was 5,630,000 μg/kg .

Eight SVOCs (2-methylphenol, 4-methylphenol, di-n-butyl phthalate, butyl benzyl phthalate, bis(2-ethylhexyl)phthalate, di-n-octylphthalate, benzo(a)pyrene, and benzo(g,h,i)perylene) were detected in the surficial soils north of I-88. Only the concentrations of 2-methylphenol (290 μg/kg) and benzo(a)pyrene (110 μg/kg) detected in SED17 (collected from the former lagoon) exceed the ARAR concentrations. It is notable that benzo(a)pyrene was also detected in four offsite background soil samples at an average concentration of 204.3 μg/kg. Thus, the concentration of benzo(a)pyrene detected in SED17 does not warrant consideration for remediation. The concentrations of total SVOCs ranged from non-detect in 10 of the samples to 31,000 μg/kg in SED7. The concentrations of total SVOC TICs ranged from non-detect to 679,000 μg/kg in SS2(a).

Thirteen pesticides were detected in the surficial soils north of I-88. Only the concentrations of dieldrin (120 μg/kg) in SED7, alpha-chlordane (660 μg/kg) and dieldrin (76 μg/kg) in SED18, and dieldrin (470 μg/kg) in SS11(a) exceeded the ARAR concentrations for these constituents. At two of the above sampling locations (SED7 and SS11(a)) a deeper sample was collected. SED16 was collected adjacent to SED7, but at a depth of 2 - 3 feet, and SS11(b) was collected from the same augered hole as SS11(a), but at a depth of 2.5 - 3 feet. The concentrations of dieldrin in these deeper samples were below the ARAR concentration.

PCBs (Aroclor-1248 and Aroclor-1254) were detected in the surficial soils north of I-88. Twenty-five of the 38 samples collected north of I-88 contained a detectable concentration of at least one Aroclor. The 13 samples that did not contain detectable concentrations of PCBs include SED19, B3-1, B4-1, B7-1, MW7-1, MW9-1, MW10-1, MW11S-1, MW12S-1, SS3(b), SS13, SS14, and SS15. These 13 sampling locations are largely situated outside the area known to have been affected by the 1958 drainage pattern and the former lagoon. Conversely, the concentrations of PCBs in 13 samples exceeded the ARAR of 1,000 µg/kg for surficial soils. These 13 samples include SED7, SED13, SED14, SED15, SED17, SED18, B5-1, B6-1, SS1(b), SS2(a), SS2(b), SS11(a), and SS16. These samples are generally located within the influence of the former lagoon or the former surficial discharge pattern.

It is notable to compare the total concentrations of pesticides and PCBs in the 6 surficial sample sets collected north of I-88. Six samples were collected from a depth of 1 foot or less and 6 were collected from the same location only deeper (2 to 3 feet bgs).

Sample ID	Depth (ft.)	Total Pesticides (µg/kg)	Total PCBs (µg/kg)
SED7	0-0.5	193.1	6,200
SED16	2-3	1.9	560
SS1(a)	0-0.5	1.8	203
SS1(b)	2.5-3	92	4,900
SS2(a)	0-0.5	144	11,800
SS2(b)	2.5-3	10	2,040
SS3(a)	0-0.5	74.6	1090
SS3(b)	2.5-3	ND	ND
SS10(a)	0-0.5	80.6	540
SS10(b)	2.5-3	7.5	39
SS11(a)	0-0.5	774	6,300
SS11(b)	2.5-3	40.5	320

With the exception of SS1(a)/SS1(b), the concentrations are always greater in the shallow surficial soil sample (less than 1 foot) compared to the deeper surficial soil sample (2 to 3 feet). Based on these results, it is evident that the concentrations of pesticides and PCBs that may potentially be of concern are in most cases restricted to the top 2 feet or less.

All 23 TAL metals, except antimony, were detected in the surficial soil samples collected north of I-88. The metals that exceeded two times the background concentration or the specified ARAR concentration include beryllium, lead, manganese, mercury, silver, sodium, thallium, and zinc. The concentrations of beryllium in SED7, SED14, SED18 and SS1(a); lead in SED18, SS1(a), and SS2(a); manganese in SED18; silver in SED19 and SS2(a); thallium in MW12S; and zinc in SS1(a) and SS11(b) exceeded the ARAR criteria. The concentrations of mercury exceeded the criteria in several samples: SED7, SED13, SED14, SED15, SED16, SED17, SED18, SED19, SS1(a), SS1(b), SS2(a), SS2(b), and SS11(a). The concentrations of sodium exceeded the criteria in the following samples: SED7, SED13, SED14, SED15, SED17, SED18, MW9-1, MW10-1, SS1(a), SS2(a), SS10(a), SS10(b), and SS11(b). With the exception of sodium, the sampling locations that exceeded the metal criteria are situated within the former discharge pattern or the former lagoon. It is notable that although the concentration of lead in SED18, SS1(a) and SS2(a) exceeded two times the site background concentration, it is considerably less than the EPA's interim lead hazard guidance level of 400 mg/kg.

Other constituents detected in the surficial soil samples north of I-88 and associated with the former man-made lagoon that exceeded the general sediment criteria include: alpha-chlordane, heptachlor epoxide, heptachlor, gamma-chlordane, dieldrin, PCBs, and manganese. These samples were also compared to sediment screening criteria at the request of the NYSDEC.

In summary, for the surficial samples collected north of I-88, the constituents with concentrations exceeding the ARAR or background concentrations included SVOCs (2-methylphenol and benzo(a)pyrene), pesticides (dieldrin, alpha-chlordane, gamma-chlordane, heptachlor epoxide, heptachlor), PCBs, beryllium, lead, manganese, mercury, silver, sodium, thallium, and zinc. However, the concentrations of benzo(a)pyrene, lead, and sodium detected in the samples are likely representative of background conditions for the area. The samples containing constituent concentrations (not including sodium) above ARARs include SS1(a), SS1(b), SS2(a), SS2(b), SS3(a), B5, B6, SED7, SED13, SED14, SED15, SED17, SED18, SED19, SS11(a), SS16, and MW12S. All of these sampling locations are either within the former lagoon or the former surficial discharge drainage pattern.

With the exception of the concentrations of sodium detected in MW9-1 and MW10-1 and thallium in MW12S-1, no constituents were detected at concentrations of potential concern in the four samples collected from the right-of-way of I-88 (MW9-1, MW10-1, MW11S-1, and MW12S-1). The concentrations of sodium are attributable to roadway deicing rather than former site operations.

4.1.3 Subsurface Soils North of I-88

Thirteen subsurface soil samples were collected north of I-88 during the RI. The analytical results for these samples are provided in Table 4-6. The purpose of these samples was to assess the affect, if any, of the former discharges of wastewaters to the ground surface north of I-88 (i.e., the 1958 discharge pattern) and the former lagoon on the subsurface soils. The sampling results that exceed ARARs for the subsurface soil samples collected from north of I-88 are identified on Figure 4-4.

Eight VOCs (benzene, toluene, acetone, bromomethane, methylene chloride, 2-butanone, 1,1,2,2-tetrachloroethane, and 4-methyl-2-pentanone) were detected in the subsurface soils north of I-88. However, none were detected at concentrations exceeding ARARs. The concentrations of total VOCs ranged from non-detect in 5 of the samples to 7 µg/kg in MW10-5. The concentrations of total VOC TICs ranged from non-detect to 95 µg/kg in B3-5.

Two SVOCs (bis(2-ethylhexyl)phthalate and di-n-octylphthalate) were detected in the subsurface soils north of I-88; however, neither exceeded the ARAR concentrations. The concentrations of total SVOCs ranged from non-detect in 7 of the samples to 790 µg/kg in B3-5. The concentrations of total SVOC TICs ranged from 110 µg/kg in MW10-5 to 7,472 µg/kg in B3-5.

Two pesticides (alpha-chlordane and gamma-chlordane) were detected in only one subsurface soil sample (MW9-5) collected north of I-88. The concentrations of alpha- and gamma-chlordane were 4.3 µg/kg and 5.6 µg/kg, which are two orders of magnitude lower than the ARAR concentrations. No other pesticides were detected in the subsurface samples collected north of I-88.

Aroclor-1254 was detected in two samples (B2-5 and B6-5) at concentrations of 91 µg/kg and 63 µg/kg. These concentrations are over two orders of magnitude lower than the ARAR for PCBs in subsurface soils. No other PCBs were detected in the subsurface samples collected north of I-88.

Nineteen of the TAL metals were detected in the subsurface soil samples collected north of I-88. Only one metal (mercury) in one sample (120 µg/kg in MW9-5) exceeded the NYSDEC ARAR of 100 µg/kg and the background concentration calculated for the site of 94.2 µg/kg.

In summary, for the subsurface soil samples collected north of I-88, only the concentration of mercury in MW9-5 exceeds the NYSDEC ARAR and the calculated background concentrations. Based on these results, it is evident that the former lagoon and the former surficial discharge drainage pattern have not affected the subsurface soils north of I-88.

4.1.4 Surficial Soils South of I-88

4.1.4.1 Former Incoming Drum Storage Area

During the Phase I RI, two trenches (trench nos. 5 and 6) were excavated through the former incoming drum storage area. During excavation, the lithology of the soils was described on a trenching log for every 10-foot interval along the trench. The trenching logs are provided in Appendix F, and a summary of the observations of each trench are provided in Appendix P. Using either a hand auger or the backhoe bucket during the trenching activities, 10 surficial soil samples (SS18, SS23, SS24, SS25, SS26, SS46, TS5-13(3), TS6-3(2), TS6-12(2), and MW5S-1) were collected from the former incoming drum storage area. The analytical results for the surficial soil samples are provided in Table 4-7. The sampling results that exceed ARARs for the surficial soil samples collected in the former incoming drum storage area are identified on Figure 4-5.

Seven VOCs (acetone, tetrachloroethene, vinyl chloride, methylene chloride, 1,1-dichloroethane, 1,2-dichloroethene, and trichloroethene) were detected in the samples collected from the former incoming drum storage area. The concentrations of all VOCs were less than the ARAR concentrations. The concentrations of total VOCs ranged from non-detect in 3 samples to 63 µg/kg in SS18, and the concentrations of total VOC TICs were non-detect for all samples, except SS46 (18 µg/kg). Thus, VOCs are not a concern in these surficial soils.

Eighteen SVOCs were detected in the 10 samples. The concentrations of total SVOCs ranged from 48 µg/kg in TS6-3(2) to 17,290 µg/kg in SS25, and the concentrations of total SVOC TICs ranged from 200 µg/kg in TS6-3(2) to 66,070 µg/kg in SS23. Of the 18 SVOCs detected, only the concentrations of 2 SVOCs (benzo(a)pyrene and phenol) exceeded the ARAR concentrations. The concentration of phenol was only exceeded in one sample (SS25) at 200 µg/kg. It is notable that the concentrations of benzo(a)pyrene (100 µg/kg in SS24 and 70 µg/kg in SS46) are less than the average background concentration in soil. Thus, benzo(a)pyrene is believed to be similar to the concentrations detected in the offsite, background soil samples.

The concentrations of 7 pesticides (delta-BHC, heptachlor, heptachlor epoxide, dieldrin, endrin, alpha-chlordane, and gamma-chlordane) exceeded the ARAR levels. The samples containing elevated levels of pesticides include SS23, SS24, SS25, and TS6-12(2). The concentrations of Aroclor-1248 and Aroclor-1254 exceeded the ARAR concentration of 1,000 µg/kg in 4 samples (SS25, SS26, SS46, and TS6-12(2)). In these samples the concentrations of total PCBs ranged from 2,490 µg/kg in SS46 to 47,000 µg/kg in SS25.

All 23 TAL metals were detected in the samples. The concentrations of 11 metals (antimony, barium, beryllium, chromium, copper, lead, mercury, silver, sodium, thallium, and zinc) were detected above the background concentrations. The concentrations of antimony, barium, beryllium, thallium, and zinc were only exceeded in one sample each (antimony in MW5S, barium, beryllium, and zinc in SS23). The concentrations of sodium were only slightly exceeded in two samples (SS46 and TS6-12). Lead was detected above background concentrations in 6 samples (SS23, SS24, SS25, SS26, TS6-12, and MW5S) at up to 1,440 mg/kg, which also exceeds the EPA's interim lead hazard guidance level of 400 mg/kg.

In summary, phenol, 7 pesticides, PCBs, and 11 metals were detected at concentrations above ARAR levels or background concentrations. Of the 10 surficial soil samples collected within the former incoming drum storage area, only the concentrations of constituents detected in 1 sample (TS6-3(2)) were all below the ARAR levels.

4.1.4.2 Former Drum Processing Area

During the Phase I RI, a trench (trench no. 7) was excavated through the former drum processing area. During excavation, the lithology of the soils was described on a trenching log for every 10-foot interval along the trench. The trenching logs are provided in Appendix F, and a summary of the observations of each trench are provided in Appendix P. Using either a hand auger or the backhoe bucket during the trenching activities, 8 surficial soil samples (B11-1, SS4(a), SS4(b), SS5(a), SS5(b), SS27, S28, and TS7-3(2)) were collected from the former drum processing area. The analytical results for the surficial soil samples are provided in Table 4-8. The sampling results that exceed ARARs for the surficial soil samples collected in the former drum processing area are identified on Figure 4-6.

Seventeen VOCs were detected in the samples collected from the former drum processing area. Ten VOCs (toluene, ethylbenzene, xylenes, 4-methyl-2-pentanone, carbon tetrachloride, acetone, 1,1,1-trichloroethane, 1,1-dichloroethane, 2-butanone, and trichloroethene) were detected at concentrations above the ARAR levels. With the exception of SS27, SS28, and TS7-3(2), all samples contained concentrations of VOCs that exceeded ARARs. SS27, SS28, and TS7-3(2) are located along the western and southern edges of this area, between the former drum processing area and former incoming drum storage area. The concentrations of total VOCs ranged from 2 µg/kg in SS28 to 158,460 µg/kg in the duplicate sample of B11-1, and the concentrations of total VOC TICs ranged from 6 µg/kg in SS28 to 121,000 µg/kg in SS5(a).

Thirty-two SVOCs were detected in the 8 samples. The concentrations of total SVOCs ranged from 5,800 µg/kg in SS27 to 13,094,000 µg/kg in SS4(a), and the concentrations of total SVOC TICs ranged from 7,300 µg/kg in SS27 to 6,490,000 µg/kg in SS4(a). Of the 32 SVOCs detected, the concentrations of 22 SVOCs exceeded the ARAR concentrations. Like the VOCs, the samples impacted by SVOCs are all located within the core of the former drum processing area and include sampling locations B11, SS4, and SS5. The samples collected on the edge of the former drum processing area are largely unaffected by former site operations and include SS27, SS28, and TS7-3(2).

Thirteen pesticides were detected in the former drum processing area, and the concentrations of 9 pesticides (heptachlor, aldrin, endosulfan II, dieldrin, endrin, alpha-chlordane, gamma-chlordane, 4,4'-DDD, and 4,4'-DDT) exceeded the ARAR concentrations. The samples containing levels of pesticides above ARARs with their corresponding total pesticide concentrations include B11-1 (83,600 µg/kg), SS4(a) (743,400 µg/kg), SS5(b) (3,700 µg/kg), SS28 (2,983 µg/kg), and TS7-3(2) (1,212 µg/kg). The concentrations of Aroclor-1248 and Aroclor-1254 exceeded the ARAR concentration of 1,000 µg/kg in 4 samples (SS4(a), SS5(b), SS28, and TS7-3(2)). In these samples the concentrations of total PCBs ranged from 2,200 μg/kg in SS5(b) to 99,000 μg/kg in SS4(a).

All 23 TAL metals were detected in the samples. The concentrations of 13 metals (antimony, barium, beryllium, calcium, chromium, cobalt, copper, lead, mercury, nickel, silver, sodium, and zinc) were detected above the background concentrations. SS4(a) was the only sample that contained cobalt and nickel above the background concentrations.

In addition, two samples, SS32 and SS33, were collected adjacent to the former barrel burner and analyzed for the dioxin 2,3,7,8-TCDD (Table 4-9). Both samples contained detectable concentrations of 2,3,7,8-TCDD; however, the detected concentrations are below the NYSDEC maximum allowable soil concentration of 0.6 μg/kg and the NYSDEC soil cleanup objective to protect groundwater quality of 60 μg/kg. The maximum concentrations of 2,3,7,8-TCDD were 0.198 μg/kg in SS32, 0.101 μg/kg in SS33, and 0.185 μg/kg in SS62, the duplicate of SS33. Thus, dioxin is not a concern in the portion of the site where it would be most likely to be found, if it were present.

In summary, 10 VOCs, 22 SVOCs, 9 pesticides, PCBs, and 13 metals were detected at concentrations above ARAR levels or background concentrations. In general, the most affected samples were those collected within the center of the area (B11, SS4, and SS5). The samples collected along the edge of the area (SS27, SS28, and TS7-3(2)) contained lower concentrations and only had ARAR exceedences for 5 SVOCs, pesticides, PCBs, and metals. In fact, SS27 only contained metals at concentrations that exceeded ARAR levels. Thus, the surficial soils in the former drum processing area, especially those in the center of the area and adjacent to the former barrel burner and drum decapitation shed, have been affected by former site operations.

4.1.4.3 Former Process Building Area

Eleven surficial soil samples (B17-1 through B20-1, B22-1, B23-1, SS6(a), SS6(b), SS29, SS47, and SS48) were collected from around and under the former process building area. The analytical results for the surficial soil samples are provided in Table 4-10. The results that exceed ARARs are identified on Figure 4-7.

Fifteen VOCs were detected in the 11 samples collected from the former process building area. The concentrations of total VOCs ranged from non-detect in 4 samples (B17-1, B20-1, SS6(a), and SS47) to 2,272,900 μg/kg in B22-1, and the concentrations of total VOC TICs ranged from non-detect in two samples to 367,000 μg/kg in B22-1. Nine VOCs (toluene, ethylbenzene, xylene, tetrachloroethene, 1,1,1-trichloroethane, vinyl chloride, 1,1-dichloroethane, 1,2-dichloroethene, and trichloroethene) were detected in B22-1 at concentrations above the ARAR levels. None of the concentrations of VOCs detected in the other process building samples exceeded the ARAR concentrations. B22-1 was collected from below the concrete floor of the pole barn and thus, represents an isolated area of VOCs.

Twenty-two SVOCs were detected in the 11 samples. The concentrations of total SVOCs ranged from non-detect in three samples (B17-1, B20-1, and SS48) to 61,400 μg/kg in SS29, and the concentrations of total SVOC TICs ranged from non-detect in SS48 to 492,000 μg/kg in B22-1. Of the 22 SVOCs detected, the concentrations of 4 SVOCs (phenol, benzo(a)anthracene, chrysene, and benzo(a)pyrene) exceeded the ARAR concentrations in only one sample (SS47). Phenol was detected in SS47 at 98 μg/kg; the ARAR for phenol is 30 μg/kg.

The concentrations of 3 pesticides (dieldrin at 64 μg/kg, alpha-chlordane at 780 μg/kg, and gamma-chlordane at 570 μg/kg) detected in one of the 11 samples (SS29) exceeded the ARAR concentrations. None of the other samples contained pesticides at concentrations exceeding the ARAR levels. Similarly, PCBs (Aroclor-1248 and Aroclor-1254) were only detected in one of the 11 samples (SS47) at concentrations that exceeded the ARAR concentration of 1,000 μg/kg.

All 23 TAL metals were detected in the samples collected from the process building area. Of the 23 metals detected, the concentrations of 11 metals (antimony, barium, beryllium, chromium, copper, lead, mercury, nickel, silver, sodium, and zinc) were detected above the background concentrations. Barium, beryllium, and nickel were only detected above the background concentrations in 1 sample (B22-1 for barium and beryllium, and SS6(a) for nickel). The concentrations of lead exceeded the background concentration in 6 samples, but all concentrations were less than the EPA's interim lead hazard guidance level of 400 mg/kg.

In summary, VOCs were detected at concentrations exceeding ARARs in only 1 sample (B22-1) which is located below the concrete floor of the pole barn, and 4 SVOCs were also detected at concentrations exceeding the ARARs in only one sample (SS47). Three pesticides (dieldrin, alpha-chlordane, and gamma-chlordane) and two PCBs (Aroclor-1248 and Aroclor-1254) were present in one of the two samples (SS29 and SS47 - collected adjacent to the former drum processing area) at concentrations exceeding the ARAR levels. Eleven metals exceeded background levels; these metals were distributed throughout the former process building area.

4.1.4.4 Former Lagoon Area

During the Phase I RI, 4 trenches (trench nos. 1 through 4) were excavated through the former lagoon area. During excavation, the lithology of the soils was described on a trenching log for every 10-foot interval along the trench. The trenching logs are provided in Appendix F, and a summary of the observations of each trench are provided in Appendix P. Using either a hand auger or the backhoe bucket during the trenching activities, 14 surficial soil samples (B9-1, B10-1, B13-2, MW2S-1, SS19, SS20, SS21, SS22, SS51, TS1-12(3), TS1-14(2.5), TS2-4(3), TS3-7(3), and TS4-1(3)) were collected from the former lagoon area. The analytical results for the surficial soil samples are provided in Table 4-11. The sampling results that exceed ARARs for the surficial soil samples collected in the former lagoon area are identified on Figure 4-8.

Twelve VOCs were detected in the 14 samples collected from the former lagoon area. Two VOCs (xylenes and tetrachloroethene) were detected in two of the 12 samples at concentrations above the ARAR levels. Xylene (2,000 µg/kg) and tetrachloroethene (10,000 µg/kg) were detected in sample TS1-14(2.5) and xylenes (2,000 µg/kg) were detected in TS2-4(3). The concentrations of total VOCs ranged from non-detect in B9-1 to 12,430 µg/kg in TS1-14(2.5), and the concentrations of total VOC TICs ranged from non-detect in 9 samples to 59,000 µg/kg in TS1-14(2.5).

Twenty SVOCs were detected in the 14 samples. The concentrations of total SVOCs ranged from non-detect in SS51 to 85,600 µg/kg in TS1-14(2.5), and the concentrations of total SVOC TICs ranged from 901 µg/kg in B10-1 to 414,600 µg/kg in SS51. Of the 20 SVOCs detected, only the concentrations of 2 SVOCs (phenol and bis(2-ethylhexyl)phthalate) detected in two samples (B13-2 and TS1-14(2.5)) exceeded the ARAR concentrations.

Twelve pesticides were detected in the former lagoon area, and the concentrations of 6 pesticides (heptachlor, heptachlor epoxide, dieldrin, endrin, alpha-chlordane, and gamma-chlordane) exceeded the ARAR concentrations. The samples containing levels of pesticides above ARARs include B13-2, SS22, SS51, TS1-12(3), TS1-14(2.5), and TS2-4(3). The concentrations of Aroclor-1248, Aroclor-1254, and Aroclor-1260 exceeded the ARAR concentration of 1,000 µg/kg in 7 samples (B13-2, SS20, SS21, SS51, TS1-12(3), TS1-14(2.5), and TS2-4(3)). In these samples, the concentrations of total PCBs ranged from 2,100 µg/kg in SS20 to 169,900 µg/kg in B13-2.

All 23 TAL metals were detected in the samples. The concentrations of 16 metals (antimony, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, mercury, nickel, silver, sodium, thallium, and zinc) were detected above the background concentrations. Except for TS3-7(3), all of the samples contained at least one metal at concentrations above the background levels.

In summary, 2 VOCs (xylenes and tetrachloroethene), 2 SVOCs (phenol and bis(2-ethylhexyl)phthalate), 6 pesticides, PCBs, and 13 metals were detected at concentrations above ARAR levels or background concentrations. The samples with concentrations of organic compounds exceeding ARAR levels included B13-2, SS20, SS21, SS22, SS51, TS1-12(3), TS1-14(2.5), and TS2-4(3). In general, the samples collected from the far eastern and western portions of this area (MW2S-1, SS19, and B9-1) are unaffected and only the concentrations of mercury were exceeded in these samples. Thus, based on these data, the surficial soils in the former lagoon area have been affected by former site operations, particularly those soils due north of the former process buildings. In addition, comparing the locations of the former lagoons with the sample data indicate that affected samples generally correspond to the locations of the former lagoons and surface discharges.

4.1.4.5 Downslope of the Former Incoming Drum Storage and Lagoons Areas

Nine surficial soil samples (B8-1, MW13S-1, and SS37 through SS43) were collected from the area topographically downslope of the former incoming drum storage and former lagoon areas. This portion of the site was not used as part of the former site operations but was investigated to assess if these soils were affected by runoff from the former site operations. The analytical results for the surficial soil samples are provided in Table 4-12. The sampling results that exceed ARARs for the surficial soil samples collected in this topographically downslope area are identified on Figure 4-9.

Two VOCs (methylene chloride at 4 μg/kg and acetone at up to 20 μg/kg) were detected in these samples. The concentrations of both were less than the ARAR concentration. The concentrations of total VOC TICs were non-detect for all nine samples.

Twenty-one SVOCs were detected in the 9 samples. The concentrations of total SVOCs ranged from non-detect in two samples (SS38 and SS40) to 16,713 μg/kg in SS41, and the concentrations of total SVOC TICs ranged from 3,640 μg/kg to 19,870 μg/kg. Of the 21 SVOCs detected, the concentrations of 5 SVOCs (benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(a)pyrene, and dibenzo(a,h)anthracene) exceeded the ARAR concentrations. It is notable that while the concentrations of benzo(a)pyrene (120 μg/kg) in SS-37 and benzo(a)anthracene (320 μg/kg) in SS-42 exceed the ARAR concentrations, these concentrations were less than the average concentrations detected in the background samples (204.3 μg/kg and 325 μg/kg). Thus, these constituents at these locations do not warrant consideration for remediation. Of the nine samples collected from the downslope area, only 3 locations (, SS39, SS41, and SS42) contained concentrations of SVOCs above the ARAR concentrations and above the average concentration calculated for the background samples. It is notable that these locations are along or near the western tributary. The offsite background sample (SS8), which contained elevated concentrations of PAHs, is also located near the western tributary and upstream of the site. The concentrations of PAHs detected in SS8 were approximately 5 times or more greater than the highest concentrations detected in the downslope area. Thus, runoff from this upstream source may have impacted the portion of the downslope area near the western tributary. Based on this information, the SVOCs in these samples are likely to be related, both to the former site operations and to the background conditions of the area.

Only the concentration of one pesticide (dieldrin at 100 µg/kg) detected in one sample (MW13S-1) exceeded the ARAR concentration of 44 µg/kg. None of the other samples contained pesticides at concentrations exceeding the ARAR levels. Similarly, only the concentration of Aroclor-1254 (2,700 µg/kg) detected in MW13S-1 exceeded the ARAR concentration of 1,000 µg/kg. Sample B8-1 contained no detectable concentrations of pesticides or PCBs.

Of the 21 metals detected in the samples, the concentrations of 6 metals (antimony, beryllium, lead, mercury, thallium, and zinc) were detected above the background concentrations. Lead was only detected in two samples (SS42 and SS43) at 83.1 mg/kg and 59.8 mg/kg. Although this lead concentration exceeds two times the site background concentration, it is less than the EPA's interim lead hazard guidance level of 400 mg/kg.

This downslope area is bordered to the west by the western tributary. To the west of the western tributary (land located on the other side of the western tributary from the site), the land slopes up away from the tributary. As a result, the western extent of constituents detected in SS39, SS41, and SS42 is the western tributary. This conclusion is supported by the topographic lay of the land relative to the tributary and by the data from SS37 which was collected west of the western tributary and near SED5 (a contaminated portion of the western tributary). This sample, SS37, contained only one constituent (thallium at 2.7 mg/kg) above ARAR levels.

In summary, no VOCs and five SVOCs were detected at concentrations exceeding ARARs. One pesticide (dieldrin) and one PCB (Aroclor-1254) were only detected at elevated concentrations at one sampling location, MW13S. It is notable that this location is within approximately 25 feet of the western tributary sediment sampling location (SED5) that contains elevated concentrations of pesticides. The concentrations of antimony, beryllium, lead, mercury, thallium, and zinc also exceed the ARAR concentrations in the samples collected from the downslope area.

4.1.4.6 Former Reconditioned Drum Storage Area

Three surficial soil samples (P3-2/4, SS30, and SS31) were collected from the former reconditioned drum storage area during the Phase I and II field activities. This portion of the site was primarily used as a storage area for reconditioned drums and polyethylene drums. The analytical results for the surficial soil samples are provided in Table 4-13. The sampling results that exceed ARARs for the surficial soil samples collected from the former reconditioned drum storage area are identified on Figure 4-10. No VOCs were detected in these samples, and VOC TICs at 1,240 µg/kg were only detected in one sample (P3-2/4).

Fifteen SVOCs were detected in the 3 samples; the concentrations of total SVOCs ranged from 779 µg/kg in P3-2/4 to 7,186 µg/kg in SS30. Only the concentrations of two SVOCs (benzo(a)anthracene and benzo(a)pyrene) detected in SS30 exceeded the ARAR concentrations. However, it is notable that the concentration of benzo(a)anthracene in SS30 is less than the average concentration detected in the offsite background soil samples. As highlighted below, the concentration of benzo(a)anthracene in SS30 is less than that detected in the background sample, and the concentration of benzo(a)pyrene in SS30 only slightly exceeds the average background concentration.

	Concentration in SS30	Average Concentration in Background Samples
Benzo(a)anthracene	280 µg/kg	325 µg/kg
Benzo(a)pyrene	270 µg/kg	204.3 µg/kg

Seven pesticides were detected in the surficial soil samples collected from the former reconditioned drum storage area; however, none were detected at concentrations that exceeded the ARARs. Similarly, Aroclor-1248 and Aroclor-1254 were detected in the three soil samples, but none were detected at concentrations that exceeded the ARARs.

Of the 21 metals detected in the samples, 5 metals (copper, lead, mercury, silver, and zinc) were detected in SS30 and SS31 above the background concentrations. Although the concentration of lead detected in SS30 exceeds two times the site background concentration, it is less than the EPA's interim lead hazard guidance level of 400 mg/kg.

In summary, no VOCs, pesticides, or PCBs were detected at concentrations exceeding ARARs and, therefore, are not a concern in this portion of the site. While the concentrations of benzo(a)anthracene exceeds the ARAR level, it is less than the average concentration detected in the site background samples. The concentrations of benzo(a)pyrene, copper, lead, mercury, silver, and zinc exceeded the ARAR concentrations in the samples collected from the reconditioned drum storage area.

It is important to note that the underground diesel fuel and gasoline underground storage tanks that were formerly located within the reconditioned drum storage area were removed during 1996, as part of the removal action. The tanks were removed under the oversight of Gary Peterson of the NYSDEC and the EPA removal action oversight representative. Following removal of the tanks, the underlying soils contained a fuel-type odor. Thus, the tank cavity was over excavated approximately 2 feet, and these soils were transported to the High Acres Landfill in Fairport, New York, for disposal as nonhazardous soils. No staining or odor was observed following the excavation of the 2 feet of soil. In January 1997, two confirmatory soil samples (TCB-10 and TCB-11) were collected and analyzed for VOCs and SVOCs. Only three constituents were detected in the samples (n-butylbenzene at 2.4 µg/kg, p-isopropyltoluene at 1.2 µg/kg, and naphthalene at 3.1 µg/kg). A comparison of these results to the levels listed in the NYSDEC

Spill Technology and Remediation Series Memorandum #1 (STARS Memo) indicate that the concentrations detected in the confirmation samples are below all standards including the levels specified for the protection of groundwater. A letter from Mr. Peterson of the NYSDEC states that no further remediation for the tanks is necessary.

4.1.5 Subsurface Soils South of I-88

4.1.5.1 Former Incoming Drum Storage Area

During the RI, two trenches (trench nos. 5 and 6) were excavated through the former incoming drum storage area, and 4 soil borings (B15, B16, P1, and MW5S) were advanced within the former incoming drum storage area. Twelve subsurface soil samples (B15-6, B16-6, TS5-1(11), TS5-3(5), TS5-4(4), TS5-7(11), TS5-9(6), TS6-6(5), TS6-9(11), P1-2/6, P1-6/8, and MW5S-6) were collected from the former incoming drum storage area. The depths of these samples ranged from 4-12 feet bgs. The analytical results for the subsurface soil samples are provided in Table 4-14. The sampling results that exceed ARARs for the subsurface soil samples collected from the former incoming drum storage area are identified on Figure 4-11.

Eleven VOCs were detected in the subsurface samples collected from the former incoming drum storage area. The concentrations of total VOCs ranged from non-detect in 8 samples to 1,315,000 µg/kg in TS5-4(4), and the concentrations of total VOC TICs ranged from non-detect in 7 samples to 470,000 µg/kg in TS5-4(4). Seven of the 11 VOCs (toluene, ethylbenzene, xylenes, 4-methyl-2-pentanone, tetrachloroethene, acetone, and trichloroethene) were detected in two samples (TS5-3(5) and TS5-4(4)) at concentrations above the ARAR levels. The concentration of acetone (260 µg/kg) detected in TS5-3(5) was the only sample that contained acetone at a concentration above the ARAR level. All other VOC exceedences were detected in sample TS5-4(4). It is notable that the two samples containing VOCs at concentrations exceeding ARARs were collected from a depth of 5 feet or less. The deeper samples (6 feet and greater) collected from the former incoming drum storage area contained no VOCs or very low concentrations of total VOCs (12 µg/kg). For example, B15-6 and B-16-6 were collected from a depth of 10 to 12 feet and at the same general locations as TS5-4(4) and TS5-3(5) which were collected from depths of 4 feet and 5 feet, respectively. No VOCs were detected in B15-6 and B16-6, while 1,315,000 µg/kg and 635 µg/kg of total VOCs were detected in TS5-4(4) and TS5-3(5), respectively. Thus, VOCs at concentrations above the ARAR levels were only detected in the shallow subsurface soil samples (samples collected from depths of 4 and 5 feet), and the vertical extent of VOCs in former incoming drum storage area is defined.

Twenty-seven SVOCs were detected in the 12 samples. The concentrations of total SVOCs ranged from non-detect in 5 samples to 115,580 µg/kg in TS5-4(4), and the concentrations of total SVOC TICs ranged from 100 µg/kg in TS6-6(5) to 310,000 µg/kg in TS5-4(4). Of the 27 SVOCs detected, only the concentrations of 6 SVOCs (phenol, 2-methylphenol, 4-methylphenol, benzo(a)anthracene, chrysene, and benzo(b)fluoranthene) exceeded the ARAR concentrations. In addition, only 2 of the 12 samples (B15-6 and TS5-4(4)) contained concentrations of SVOCs above the ARAR levels. The only SVOCs detected in B15-6 at a concentration above the ARAR level was phenol at 280 µg/kg. All other SVOCs detected in this area at concentrations above the ARAR levels were present in TS5-4(4). Thus, like the VOCs results, the soils at TS5-4(4) contain the highest concentrations of SVOCs. Additionally, the sample collected at the same location as TS5-4(4) but at a greater depth (B15-6) contained only phenol above the ARAR level and at a much lower concentration.

The concentrations of 5 pesticides (heptachlor, dieldrin, endrin, alpha-chlordane, and gamma-chlordane) exceeded the ARAR concentrations. The samples containing elevated levels of pesticides include B15-6, TS5-4(4), and P1-2/6. It is notable that all three of these samples were collected from the southwestern portion of the former storage area. A soil sample was collected from P1 at a depth of 6-8 feet, and no pesticides were detected at concentrations exceeding ARARs. Thus, the vertical extent of pesticides in the vicinity of P1 is defined. In addition, the concentrations of pesticides detected in B15-6 are much less than those detected in the shallower sample TS5-4(4). Furthermore, the exceedences detected in B15-6 are slight (gamma chlordane at 610 µg/kg, ARAR 540 µg/kg; dieldrin at 46 µg/kg, ARAR 44 µg/kg). Thus, the vertical extent of pesticides detected in the vicinity of TS5-4(4) have been adequately defined by the sample results for B15-6.

The concentrations of Aroclor-1248 and Aroclor-1254 exceeded the ARAR concentration of 10,000 µg/kg in 2 samples (TS5-4(4) and P1-2/6). In these samples the concentrations of total PCBs were 150,000 µg/kg in TS5-4(4) and 20,000 µg/kg in P1-2/6. However, exceedences of PCB concentrations were not encountered in the corresponding deeper samples B15-6 and P1-6/8. Thus, the vertical extent of PCBs detected in the vicinity of TS5-4(4) and P1 is defined.

All 23 TAL metals were detected in the samples. The concentrations of 12 metals (antimony, barium, beryllium, chromium, cobalt, copper, iron, lead, mercury, nickel, silver, and zinc) were detected above the background concentrations. The samples containing concentrations of more than 1 metal above the background levels include B15-6, TS5-3(5), TS5-4(4), and P1-2/6. These 4 samples were collected from the southwestern portion of the former storage area. All other samples contained either no metals or only 1 metal above the background concentrations.

It is notable that the samples containing several exceedences of soil ARARs in the former incoming drum storage area are all located in the southwestern portion of this area. According to Gary

Warner, this portion of the site was filled during the late 1960s to expand the incoming drum storage area. Thus, it is not surprising that concentrations exceeding ARARs, including anthropogenically-derived PAHs, are detected in the subsurface soils in this portion of the site.

In summary, 7 VOCs, 6 SVOCs, 5 pesticides, PCBs, and 12 metals were detected at concentrations above ARAR levels or background concentrations. Of the 12 subsurface soil samples collected within the former incoming drum storage area, the affected samples include TS5-3(5), TS5-4(4), B15-6, and P1-2/6. All 4 of these samples were collected from the southwestern portion of the incoming drum storage area, and except for B15-6, all were collected from a depth of 6 feet or less. The highest concentrations are present in the shallow subsurface soils (4-5 feet bgs) with the concentrations decreasing dramatically with depth.

4.1.5.2 Former Drum Processing Area

During the RI, a trench (trench no. 7) was excavated through the former drum processing area, and 3 soil borings (B11, B12, and B21) were advanced within the former drum processing area. Six subsurface soil samples (B11-5, B12-5, B21-5, TS7-6(5), TS7-8(10), and TS7-21(5)) were collected from the former drum processing area. The depths of these samples ranged from 5-10 feet bgs. The analytical results for the subsurface soil samples are provided in Table 4-15. The sampling results that exceed ARARs for the subsurface soil samples collected in the former drum processing area are identified on Figure 4-12.

Sixteen VOCs were detected in the samples collected from the former drum processing area; however, none were detected above the ARAR levels. The concentrations of total VOCs ranged from non-detect in B21-5 to 2,024 μg/kg in TS7-12(5), and the concentrations of total VOC TICs ranged from non-detect in B21-5 to 14,300 μg/kg in TS7-8(10).

Twenty SVOCs were detected in the 6 samples; however, none were detected above the ARAR levels. The concentrations of total SVOCs ranged from non-detect in B21-5 to 10,430 μg/kg in TS7-6(5), and the concentrations of total SVOC TICs ranged from 3,090 μg/kg in B21-5 to 98,000 μg/kg in TS7-6(5).

Eight pesticides were detected in the former drum processing area; however, none were detected above the ARAR levels. In addition, no detectable concentrations of pesticides were present in TS7-12(5), which was collected from a depth of 5 feet. Aroclor-1248 and Aroclor-1254 were only detected in 1 of the 6 subsurface soil samples but at concentrations below the ARAR level. Thus, the pesticides and PCBs detected in the surficial soil samples in the former drum processing area are not migrating to any appreciable extent.

Except for selenium and silver, all 23 TAL metals were detected in the samples. Only the concentrations of beryllium, lead, mercury, thallium, and zinc were detected above the background concentrations, and concentrations exceeding background levels were detected in samples B11-5, B12-5, B21-5, and TS7-6(5). Although lead was detected in the soils at concentrations exceeding two times the site background concentration, it is less than the EPA's interim lead hazard guidance level of 400 mg/kg.

In summary, no VOCs, SVOCs, pesticides, or PCBs were detected at concentrations above ARAR levels or applicable background concentrations. Only the concentrations of 5 metals were detected above the background concentrations. In contrast, 10 VOCs, 22 SVOCs, 9 pesticides, PCBs, and 13 metals were detected at concentrations above ARAR levels or background concentrations in the surficial soil samples collected from this area. It is notable that the 6 subsurface soil samples were all collected from the center portion of the former drum processing area which, based on the surficial soil sampling results, was the most impacted part of this area. Based on these results, the constituents detected in the surficial soils in this area are not migrating to depth. Thus, only the surficial soils in this area have been impacted by the former site operations.

4.1.5.3 Former Process Building Area

During the RI, 9 subsurface soil samples were collected from 7 soil borings (B17, B18, B19, B20, B22, B23, and B24) advanced within the former process building area. The depths of these samples ranged from 8-47.3 feet bgs. The analytical results for the subsurface soil samples are provided in Table 4-16. The sampling results that exceed ARARs for the subsurface soil samples collected in the former process building area are identified on Figure 4-13.

Sixteen VOCs were detected in the samples collected from the process building area. The concentrations of total VOCs ranged from non-detect in B17-5 to 3,930 µg/kg in B19-5, and the concentrations of total VOC TICs ranged from non-detect in 4 samples to 5,442 µg/kg in B19-5. Four VOCs (xylene, acetone, 2-butanone, and 1,2-dichloroethene) were detected in B18-5, B19-5, and B22-5 at concentrations above the ARAR levels.

Only 2 SVOCs were detected in the 9 samples; however, neither was detected at a concentration above the ARAR levels. The concentrations of total SVOCs ranged from non-detect in 7 samples to 110 µg/kg in B18-5, and the concentrations of total SVOC TICs ranged from non-detect in B17-21 to 22,640 µg/kg in B22-5.

Two pesticides (alpha-chlordane at 1,100 µg/kg and gamma-chlordane at 1,300 µg/kg) were detected in one of the 9 samples (B17-5) at concentrations exceeding the ARAR levels. No pesticides were detected in 6 of the 9 samples, and in 2 of the 9 samples pesticides were detected but at concentrations below the ARAR levels. Similarly, PCBs were detected in 2 of the 9 samples but at concentrations below the ARAR level.

Except for antimony, cadmium and mercury, all 23 TAL metals were detected in the samples collected from the process building area. Of the 20 metals detected, only the concentrations of silver, sodium, and thallium were above the background concentrations. Sodium and thallium were each only detected at elevated concentrations in one sample (B22-5).

In summary, 4 VOCs (xylene, acetone, 2-butanone, and 1,2-dichloroethene), and 2 pesticides (alpha-chlordane and gamma-chlordane), were detected at concentrations exceeding ARARs. The samples with concentrations of VOCs or pesticides exceeding ARARs include B17-5, B18-5, B19-5, and B22-5. B17 through B19 were located north and east of the exterior walls of the former pole barn, and B22 was advanced below the concrete floor of the former pole barn. Silver, sodium, and thallium were the only metals detected in the subsurface soil samples that exceeded the background levels. It is notable that except for silver, the samples collected near the bottom of the unconsolidated deposits in B17 and B24 (depths of 40 to 42 feet and 46 to 47.3 feet) contained no constituents above ARAR or background levels.

4.1.5.4 Former Lagoon Area

During the RI, 4 trenches (trench nos. 1 through 4) were excavated through the former lagoon area, and 4 soil borings (B9, B10, B13, and MW2S) were advanced within the former lagoon area. Seventeen subsurface soil samples were collected from this area. The depths of these samples ranged from 4.5-22 feet bgs. Additionally, during the Phase IV RI, a sample was collected from MW2B at a depth of 2-4 feet and analyzed for TOC. The analytical results for the subsurface soil samples are provided in Table 4-17. The sampling results that exceed ARARs for the subsurface soil samples collected in the former lagoon area are identified on Figure 4-14.

Nineteen VOCs were detected in the samples collected from the former lagoon area. Ten VOCs (toluene, ethylbenzene, xylenes, 4-methyl-2-pentanone, tetrachloroethene, carbon tetrachloride, 1,1,1-trichloroethane, methylene chloride, 1,1-dichloroethane, trichloroethene) were detected in 6 of the 17 samples at concentrations above the ARAR levels. These samples include TS1-1(5), TS1-9(4.5), TS1-16(5), TS1-17(5), TS4-4(6), and TS4-6(11). It is notable that all of the VOC affected soils are located east of trench no. 3. The concentrations of total VOCs ranged from 11 µg/kg in B13-4 to 10,760,000 µg/kg in TS4-4(6), and the concentrations of total VOC TICs ranged from non-detect in 4 samples to 3,000,000 µg/kg in TS4-4(6). It is notable that except for TS4-6(11), all of the samples with VOC concentrations exceeding ARARs were collected from a depth of 6 feet or less. The VOCs detected in TS4-6(11) that exceeded ARARs include acetone at 990 µg/kg and 2-butanone at 1,000 µg/kg. These concentrations only slightly exceed the ARARs for these compounds (e.g., concentrations within the same order of magnitude as the ARAR concentration). The TOC concentration in the sample collected from MW2B was 1,400 mg/kg.

Eighteen SVOCs were detected in the 17 samples. Of the 18 SVOCs detected, the concentrations of 8 SVOCs (phenol, 1,2-dichlorobenzene, 2-methylphenol, 4-methylphenol, 1,2,4-trichlorobenzene, 2,4,5-trichlorophenol, diethylphthalate, and bis(2-ethylhexyl)phthalate) detected in 5 samples (TS1-9(4.5), TS1-12(7), TS1-17(5), TS4-4(6), and TS4-6(11)) exceeded the ARAR concentrations. It is notable that, like the VOC results, all of the SVOC affected soils are located east of trench no. 3, and except for sample TS4-6(11), all affected soils are at a depth of 7 feet or less. The concentrations of total SVOCs ranged from non-detect in TS1-1(5) and TS1-4(6) to 3,390,000 µg/kg in TS4-4(6), and the concentrations of total SVOC TICs ranged from 2,000 µg/kg in TS1-4(6) to 5,300,000 µg/kg in TS4-4(6).

Nine pesticides were detected in the former lagoon area, and the concentrations of 6 pesticides (Endosulfan I, dieldrin, alpha-chlordane, gamma-chlordane, 4,4'-DDD, and 4,4'-DDE) exceeded the ARAR concentrations. The samples containing elevated levels of pesticides include TS1-9(4.5), TS1-17(5), TS3-5(11), and TS4-4(6). The concentrations of Aroclor-1248 and Aroclor-1254 exceeded the ARAR concentration of 10,000 µg/kg in 3 samples (TS1-9(4.5), TS1-17(5), and TS4-4(6)). In these samples the concentrations of total PCBs ranged from 19,900 µg/kg in TS1-17(5) to 3,600,000 µg/kg in TS4-4(6). Like the VOC and SVOC results, the pesticide and PCB affected soils are located east of trench no. 3 and are generally restricted to the shallow subsurface soils.

All 23 TAL metals were detected in the samples. The concentrations of 15 metals (antimony, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, mercury, nickel, selenium, silver, sodium, and zinc) were detected above the background concentrations. The samples containing concentrations of more than 1 metal above the background levels include B10-5, TS1-9(4.5), TS1-12(7), TS1-17(5), TS3-3(6), and TS4-4(6). Again, these samples were all collected from the portion of the former lagoon area that is east of trench no. 3.

In summary, 10 VOCs, 8 SVOCs, 6 pesticides, PCBs, and 15 metals were detected at concentrations above ARAR levels or background concentrations. The samples with concentrations of organic compounds exceeding ARAR levels or with more than 1 metal exceeding background concentrations included TS1-1(5), TS1-9(4.5), TS1-12(7), TS1-16(5), TS1-17(5), TS3-5(11), TS4-4(6), and TS4-6(11). Except for sample TS3-5(11) which was collected from trench no. 3, all samples with concentrations exceeding ARARs were collected from the portion of the former lagoon area that is located east of trench no. 3. In addition, except for samples TS3-5(11) and TS4-6(11), all samples with concentrations exceeding ARARs were collected from depths of 4.5-7 feet. It is not surprising that concentrations of constituents above ARARs were largely encountered in the samples collected from depths of 4.5-7 feet, given that the bottoms of the lagoons, prior to their closure, were likely 4 to 6 feet below the current ground surface.

4.1.5.5 Downslope of the Former Incoming Drum Storage and Lagoons Areas

During the RI, 2 subsurface soil samples (B8-5 and MW13S-5) were collected from 2 borings advanced downslope of the former incoming drum storage and lagoon areas. The depths of these samples ranged from 8-10 feet below the ground surface. The analytical results for the subsurface soil samples are provided in Table 4-18. The sampling results that exceed ARARs for the subsurface soil samples collected in this downslope area are identified on Figure 4-15.

No VOCs or VOC TICs were detected in these samples.

One SVOC (bis(2-ethylhexyl)phthalate) was detected in B8-5 at 100 µg/kg; however, the concentration was below the ARAR level. The concentrations of total SVOCs were non-detect in MW13S-5 and 100 µg/kg in B8-5, and the concentrations of total SVOC TICs were 2,221 µg/kg in B8-5 and 2,434 µg/kg in MW13S-5.

Only 2 pesticides (alpha-chlordane and gamma-chlordane) were detected in one of the two subsurface soil samples (MW13S-5). Neither was detected at concentrations exceeding the ARAR levels. Similarly, only Aroclor-1254 was detected in MW13S-5 but at a concentration that is below the ARAR level.

Of the 22 metals detected in the samples, the concentrations of 3 metals (antimony, mercury, and potassium) were detected above the background concentrations.

In summary, no VOCs, SVOCs, pesticides, or PCBs were detected at concentrations exceeding ARAR levels in the subsurface soils collected downslope of the former incoming drum storage and lagoon areas. Three metals (antimony, mercury, and potassium) were detected above the background concentrations. It is notable that the only organic exceedences in the surficial soil samples collected from the downslope area were 1 pesticide and PCBs in the sample collected from MW13S and select PAHs in SS39, SS41, and SS42. The subsurface sampling results for this area indicate that these constituents are not elevated below a depth of 8 feet.

4.1.5.6 Former Reconditioned Drum Storage Area

During the RI, 3 subsurface soil samples (P2-6/8, P2-10/12, and P3-8/10) were collected from 2 borings (P2 and P3) which were advanced within the former reconditioned drum storage area. The depths of these samples ranged from 6-12 feet below the ground surface. Additionally, during the Phase IV RI, a sample was collected from MW14B at a depth of 2-4 feet and analyzed for TOC. The analytical results for the subsurface soil samples are provided in Table 4-19. The sampling results that exceed ARARs for the subsurface soil samples collected from the former reconditioned drum storage area are identified on Figure 4-16.

No VOCs or VOC TICs were detected in these samples. The TOC concentration in the sample collected from MW14B was 49,400 mg/kg.

Two SVOCs (phenanthrene and bis(2-ethylhexyl)phthalate) were detected in the 3 samples; however, the concentrations were below the ARAR levels. The concentrations of total SVOCs ranged from 72 µg/kg in P3-8/10 to 370 µg/kg in the duplicate sample collected from P2-6/8, and the concentrations of total SVOC TICs ranged from 1,500 µg/kg in P2-10/12 to 5,100 µg/kg in P3-8/10.

Eight pesticides were detected in the subsurface soil samples collected from the former reconditioned drum storage area; however, none were detected at concentrations that exceeded the ARARs. Similarly, Aroclor-1248 and Aroclor-1254 were detected in two of the three soil samples, but none were detected at concentrations that exceeded the ARARs.

Seventeen metals were detected in the samples; however, only two metals (beryllium and potassium) were detected at concentrations that exceeded the background concentrations in only one sample each.

In summary, No VOCs, SVOCs, pesticides, or PCBs were detected at concentrations exceeding ARARs or background levels in the subsurface soils collected from the former drum reconditioning area. Two metals (beryllium and potassium) were detected above the background concentrations.

4.1.6 Surficial Soils South of Osborne Hollow Road

Ten surficial soil samples were collected from the portion of the site south of Osborne Hollow Road during the Phase I and Phase II field activities. During operation of the site, south of Osborne Hollow Road had limited use and was used primarily for storage of empty drums. The analytical results for the surficial soil samples are provided in Table 4-20. The purpose of these samples was to assess the affect, if any, of the limited former use of this area for empty drum storage on the soils. The sampling results that exceed ARARs for the surficial soil samples collected from south of Osborne Hollow Road are identified on Figure 4-17.

Six VOCs, 14 SVOCs, 7 pesticides, 1 PCB, and 23 TAL metals were detected in the surficial soil samples collected south of Osborne Hollow Road. The concentrations of total VOCs ranged from non-detect in 3 samples to 63 µg/kg in SS12(b), and the concentrations of total VOC TICs ranged from non-detect to 63 µg/kg in B14-1. No VOC concentrations exceeded the ARARs in any of the samples collected from south of Osborne Hollow Road.

The concentrations of SVOCs ranged from 95 µg/kg in SS12(b) to 8,930 µg/kg in SS35(a), and the concentrations of total SVOC TICs ranged from 1,027 µg/kg in SS35(b) to 19,436 µg/kg in SS36(a). The samples collected from 4 locations (SS12(a), SS34(a), SS35(a), SS36(a)) contained at least one of three

SVOCs (benzo(a)anthracene, benzo(a)pyrene, or benzo(b)fluoranthene) at concentrations in exceedence of the ARARs. It is notable that these SVOCs were detected in the offsite background soil samples at concentrations above the ARAR levels. As highlighted below, the concentrations of the SVOCs in the samples south of Osborne Hollow Road are less than the average background concentrations.

	Highest Concentration South of Osborne Hollow Road	Average Concentration in Background Samples
Benzo(a)anthracene	290 µg/kg	325 µg/kg
Benzo(a)pyrene	160 µg/kg	204.3 µg/kg
Benzo(b)fluoranthene	340 µg/kg	370.6 µg/kg

Of the 7 pesticides detected in the surficial soil samples south of Osborne Hollow Road, only one pesticide (endrin at 120 µg/kg) in one sample (SS36(a)) exceeded the ARAR concentration of 100 µg/kg.

At least one of five metals (antimony, lead, mercury, silver, and zinc) was detected at concentrations higher than the site background levels in all 10 surficial soil samples, except SS12(b). The concentrations of lead exceeded the background levels in only 3 samples (SS12, SS35, and SS36) which were collected from a depth 0 to 0.5 foot. Although these concentrations exceed two times the site background concentrations, they are less than the EPA's interim lead hazard guidance level of 400 mg/kg. None of the lead concentrations in the deeper samples (2.5 to 3.0 feet) collected from SS12, SS35, and SS36 exceeded the background concentrations. The concentration of antimony, detected in only one sample (B14-1), and the concentration of zinc, detected in two samples (SS35(a) and SS36(a)), exceeded the background level. The concentrations of mercury and silver exceeded the background levels in several of the samples collected from south of Osborne Hollow Road.

In summary, 6 compounds (endrin, antimony, lead, mercury, silver, and zinc) exceeded ARAR and background concentrations in the samples collected from a depth of 0-0.5 foot. Conversely, only 2 compounds (silver and mercury) exceeded ARAR and background concentrations in the samples collected from a depth of 2.5 to 3.0 feet. In addition, the concentrations of benzo(a)pyrene, benzo(a)anthracene, and lead detected in the samples are likely representative of background conditions for the area. Endrin only slightly exceeded the ARAR, and zinc was detected in only one isolated area (SS36(a)).

4.1.7 Subsurface Soils South of Osborne Hollow Road

Except for the background soil sample B1D-6 and the soil sample collected from MW1B for TOC analysis, no subsurface soil samples were collected from this portion of the site. The results for B1D-6 are presented above with the background soil sampling results. The TOC concentration in the sample collected from MW1B was 2,480 mg/kg.

In summary, no constituents were detected in B1D-6 at concentrations that exceeded ARARs.

4.1.8 Geotechnical Sampling Results

Six soil samples for geotechnical analyses were collected from MW2B and MW14B (three from each borehole). The samples collected from the borehole of MW2B were obtained from depths of 4-6 feet, 18-20 feet, and 28-30 feet. The samples collected from the borehole of MW14B were obtained from depths of 4-6 feet, 13-15 feet, and 28-30 feet. The six geotechnical samples were analyzed for hydraulic conductivity, grain size, specific gravity, moisture content, and bulk soil density. These results are summarized on Table 4-21, and the raw laboratory data are provided in Appendix R.

The mean hydraulic conductivities for the 6 samples ranged from 3.58 X 10^{-8} cm/sec to 1.75 X 10^{-6} cm/sec. Based on the sieve analyses, the soils consist of clay, silt, sand, and gravel. The percentage of the soil capable of passing the no. 200 sieve (amount of clay and silt) ranged from 31.1 percent in the sample collected from MW2B at 4-6 feet to 73.2 percent in the sample collected from MW14B at 28-30 feet. The specific gravity of the samples ranged from 2.73 to 2.78, the bulk soil density (dry) ranged from 108 to 134.2 pounds per cubic foot, and the bulk soil density (moist) ranged from 112.8 to 145.7 pounds per cubic foot. The moisture content as percentage of dry weight ranged from 4.4 to 15.3 and the moisture content increased at both locations (MW2B and MW14B) with depth.

4.2 Groundwater

Seven rounds of groundwater sampling were conducted as part of the Phase I, Phase II, Phase III, and Phase IV field activities. Two rounds (1 and 2) were conducted during Phase I, one round each was conducted during Phases II and III (rounds 3 and 4), and three rounds (5-7) were conducted as part of Phase IV. A discussion of the groundwater monitoring and sampling results, as well as the results of the NYSDOH domestic well sampling, is provided below.

The results of the field parameter measurements (pH, specific conductance, temperature, Eh, turbidity, and dissolved oxygen) and the purge volumes removed from each well before sampling are provided in Table 4-22. The analytical results from each of the seven groundwater sampling events are presented in Tables 4-23 through 4-29. A summary of the bedrock groundwater quality data from Rounds 6 and 7 is provided in Table 4-30. Following compilation of the data, the analytical results were compared to the ARARs established for the site (Table 4-1). The sources used for the groundwater ARARs include the EPA maximum contamination levels (MCLs), New York State Department of Health, State Sanitary Code for Public Water Systems, New York Water Quality Standards, and the groundwater standards/criteria specified in the New York State TAGM 4046. It is notable that these standards are largely risk-based and assume that groundwater will be used as a potable water supply. Thus, these standards/criteria are identified as the ARARs for the site solely to identify if potential risks exist. These standards/criteria are not intended to be used as final remediation goals or final risk management standards that must be achieved for the site.

Figure 4-18 was created to illustrate the lateral distribution of all compounds detected at concentrations in exceedence of the ARARs during Phases I and II. Figures 4-19 and 4-20 were prepared to illustrate the distribution of organic compounds and inorganic compounds detected at concentrations in exceedence of the ARARs during Phase III. Figure 4-21 illustrates the organic and inorganic compounds that exceed ARARs from the sampling of the open boreholes of MW-2B and MW-14B (top of bedrock). Figures 4-22 and 4-23 were prepared to illustrate the distribution of organic and inorganic compounds detected at concentrations in exceedence of the ARARs during Rounds 6 and 7 of the Phase IV RI.

4.2.1 Phase I - Groundwater Sampling

During Phase I, groundwater samples were collected from three existing monitoring wells (MW1 through MW3) and from the out-of-service production well (MW4). All samples were analyzed for VOCs, SVOCs, pesticides, PCBs, total metals, and cyanide.

New York State water quality standards (part 703.3) define the acceptable pH range for groundwater to be 6.5-8.5 pH units. The pH of the groundwater samples at the site was neutral to slightly basic, ranging from 6.81 in MW1 to 8.69 in MW2. The specific conductance ranged from 463 µmhos in MW4 to 1,261 µmhos in MW1. The temperature ranged from 37.7° F in MW2 to 40.6° F in MW3. Turbidity was not measured during the Phase I groundwater sampling events at the site and was not required by the FSP, but was subsequently measured during the other Phases, at the request of the NYSDEC.

During the Phase I sampling events, total VOC concentrations ranged from non-detect to 34.4 µg/l in MW2. None of the VOCs detected in MW1, MW3, and MW4 exceeded ARARs. In MW2, the concentrations of vinyl chloride (11 µg/l), 1,1-dichloroethane (6 µg/l), cis-1,2-dichloroethene (7 µg/l), and trichloroethene (9 µg/l) exceeded the ARAR concentrations. The concentrations of total VOC TICs were non-detect in all samples except in MW1-1 (40 µg/l) and MW2-2 (1 µg/l).

No target SVOCs were detected in any of the groundwater samples collected. The concentrations of total SVOC TICs ranged from 48 µg/l in MW4-1 to 1,020 µg/l in MW2-1. One pesticide (4,4'-DDE) was detected in MW1-2 at an estimated concentration of 0.031 µg/l, which is below the NYSDEC groundwater quality standard of 0.2 µg/l.

Only one PCB (Aroclor-1242) was detected in one sample (MW1-2) at a concentration which exceeded the ARAR. Aroclor 1242 was detected at 0.37 µg/l, and the ARAR is 0.09 for New York State and 0.5 for EPA. It is important to note that this constituent was not detected in MW1 during the other 5 rounds in which this well was sampled (Rounds 1, 3, 4, 6, and 7). No other pesticides or PCBs were detected in any of the other Phase I groundwater samples collected.

Twenty-one 21 metals were detected in the Phase I groundwater samples. Three common metals (iron, manganese, and sodium) were detected at concentrations that exceed ARARs. These three metals were detected in all wells onsite, including MW1 which is upgradient of the primary area of site operations. Because the concentrations of metals detected in the sample collected from MW1 are either greater than or similar to the concentrations detected in the downgradient monitoring wells, the metals are representative of background concentrations for the area.

4.2.2 Phase II - Groundwater Sampling

From October 4 through October 7, 1994, groundwater samples were collected from the 14 groundwater monitoring wells (MW1, MW1SA, MW2, MW2S, MW3, MW3S, MW4, MW5S, MW6S, MW6, MW7S, MW7, MW8S, and MW8) and the 3 piezometers (P1 through P3) at the site. All samples were analyzed for VOCs, SVOCs, pesticides, and PCBs. Additionally, samples from seven locations (MW1SA, MW2S, MW3S, MW3, MW5S, MW6S, and MW6) were analyzed for total metals.

Based on the Phase II field data, the groundwater beneath the site is neutral to moderately acidic, with pH readings at 5 locations (MW2S, MW5S, MW7, MW7S, and P1) below the lower limits of the New York State acceptable pH range; however, none of the wells exhibited pH readings higher than the upper limit of the range. The pH of the final purge water ranged from 3.1 to 8.4. It is important to note that with the exception of P1, the 5 locations with the low pH measurements were all within the acceptable range during the Phase III RI (which was confirmed using 3 pH meters).

The specific conductance of the final purge water ranged from 218 µmhos in MW7 to greater than 2,000 µmhos in MW1SA. The temperature of the groundwater ranged from 36.7° F to 39.6° F. The final turbidity measurements ranged from 31.5 NTUs to greater than 200 NTUs at 7 locations. These turbidity measurements are in exceedence of the NYSDEC standard of 50 NTUs; even though the 50-NTU standard had been achieved at each well during monitoring well development. The 50-NTU standard could not be achieved during well purging associated with sampling activities due to the high clay content of the unconsolidated till water bearing zone.

Five of the groundwater samples (MW2S, MW2, MW3S, MW3, and P2) contained at least one of the 11 target VOCs detected in the samples. Total VOC concentrations ranged from non-detect in 12 samples (MW1SA, MW1, MW4, MW5S, MW6S, MW6, MW7S, MW7, MW8S, MW8, P1, and P3) to 10,000 µg/l in MW3S. With the exception of MW2S (112 µg/l), VOC TICs were not detected in any of the samples. It is notable that the monitoring locations with detectable concentrations of VOCs are all located near the former lagoons, along the northern edge of the portion of the site referred to as south of I-88. Eight VOCs (chloroethane, 1,1-dichloroethane, cis-1,2-dichloroethene, 1,2-dichloropropane, methylene chloride, trichloroethene, 1,1,1-trichloroethane, and vinyl chloride) were detected at concentrations that exceed ARARs. VOC ARAR exceedances occurred at four monitoring locations (MW2S, MW2, MW3S, and P2). The concentration of 1,1,1-trichloroethane (110 μg/l) in P2 was higher than the New York state standard of 5 μg/l but less than the EPA MCL of 200 μg/l. Similarly, the concentrations of cis-1,2-dichloroethene in MW2S and MW2 were higher than the New York state standard of 5 μg/l, but less than the EPA MCL of 70 μg/l.

Twelve target SVOCs were detected at 10 groundwater sampling locations. Total SVOC concentrations ranged from non-detect in seven of the samples (MW1, MW5S, MW6S, MW7, MW8, P2, and P3) to 20,588 μg/l in MW3S. Seven SVOCs (1,2-dichlorobenzene, phenol, 2,4-dichlorophenol, 2-methylphenol, 4-methylphenol, 2,4,5-trichlorophenol, and naphthalene) were detected in MW3S at concentrations exceeding ARARs, and phenol (15 μg/l) was detected in MW3 at concentrations exceeding ARARs. Both of these wells are located within the former lagoon area. No other samples contained concentrations of SVOCs that exceeded ARARs. The concentrations of total SVOC TICs ranged from 3 μg/l in MW7S to 5,960 μg/l in MW3S (which had the highest concentration of target SVOCs).

Pesticides were not detected in any of the Phase II groundwater samples. One PCB, Aroclor-1242, was detected in one sample, MW-5S, at 1.6 μg/l which exceeds ARARs.

As shown in Figure 4-18, exceedences of ARARs for organic compounds (VOCs, SVOCs, and PCBs) occurred in only 6 of the 17 sampling locations (MW2S, MW2, MW3S, MW3, MW5S, and P2) during the Phase II sampling event. All exceedences occurred in the wells located within (or adjacent to) or immediately downgradient of the former lagoons and incoming drum storage area. Additionally, the highest concentrations of total organic compounds were detected in the two shallow wells located within (or immediately adjacent to) the former lagoons. These wells (MW-2S and MW-3S) are screened at or near the water table, within the unconsolidated material. Specifically, the top of the well screen in MW2S is at 15 feet and the top of the well screen in MW3S is at 10 feet below ground surface. The bottom of the former lagoons is estimated to have been at approximately 6 feet. Thus, the distance between the bottom of the lagoons and the top of the well screens is small. Given that MW3S was installed through a former lagoon and that MW2S was installed near, if not through the edge of, a former lagoon (i.e., directly in or near the source area), the concentrations of VOCs and SVOCs detected in MW2S and MW3S are not surprising. Furthermore, MW2 and MW3 were installed by a NYSDEC contractor in the mid-1980s, as part of the data collection for the HRS. It is important to note that these wells were constructed as single-cased wells and were advanced through or near a former lagoon and to a depth of approximately 50 feet. As a result, it is possible that the contamination noted in MW2 and MW3 may be due, in part, to the drilling augers dragging the contamination downward during well installation activities. However, since contamination concentrations in MW2 have remained relatively steady, persisting over time (over ten years), it is also possible that these concentrations are, in part, a result of contaminant plume migration.

It is notable that the concentrations of total organic compounds (VOCs and SVOCs) detected in the associated deep wells (MW-2 and MW-3) are much lower than the concentrations in the corresponding shallow wells; for example:

	Total VOCs	Total SVOCs
MW2S	527 μg/l	2 μg/l
MW2	44 μg/l	2 μg/l
MW3S	10,000 μg/l	20,588 μg/l
MW3	3 μg/l	25 μg/l

Twenty-one of the 23 TAL metals were detected in the groundwater samples. Silver and selenium were not detected in any of the samples. Nine metals (arsenic, antimony, cadmium, iron, lead, manganese, nickel, sodium, and thallium) were detected at concentrations that exceed ARARs. Each of the seven wells that were sampled and analyzed for total metals contained at least one metal exceedence. It is notable that the concentrations of iron, manganese, sodium, and thallium detected in MW1SA (upgradient of site operations) also exceed ARARs. The elevated concentrations of arsenic, cadmium, and lead were only present in one well (MW6S), and the elevated concentration of antimony was also only present in one well (MW2S). It is notable that during subsequent phases the concentrations of arsenic, cadmium, lead, and antimony were below the ARAR concentration in the unconsolidated water bearing zone. The nickel exceedences were only detected in the groundwater samples collected from MW2S and MW3S, which are located within or near the former lagoons.

4.2.3 Phase III - Groundwater Sampling

From November 29 through December 15, 1996, all 26 wells and piezometers at the site were sampled and analyzed for VOCs, SVOCs, pesticides, PCBs, and total metals. The Phase III groundwater sampling event was the most comprehensive event in terms of the number of wells sampled. Because it was not possible to meet the NYSDEC recommended maximum turbidity guideline of 50 NTUs at eight of the sampling locations (MW1, MW1S, MW7S, MW9, MW9S, MW10S, MW14, and P2), additional field filtered samples were collected from those eight locations and analyzed for dissolved metals.

The groundwater pH was mildly acidic to slightly basic. The pH readings from two sampling locations (P1; 6.46 and MW6S; 5.7) were below the lower limits of the New York State water quality standards (part 703.3) acceptable pH range, while the pH reading from one sampling location (MW4; 8.82) was higher than the upper limit of the range. The pH of samples from all other locations were within the acceptable range. Specific conductance ranged from 149 μmhos in MW6S to 5,850 μmhos in MW3S; Eh ranged from -100 in MW3S to 189 in MW12S; temperature ranged from 33.4° F to 48.2° F; and turbidity ranged from 1.55 NTUs to greater than 1,000 NTUs. The final turbidity measurements exceeded the NYSDEC sampling guideline of 50 NTUs in eight of the 26 groundwater sampling locations.

Seven of the 26 groundwater samples (MW2S, MW2, MW3S, MW6, MW10S, MW11S, and P2) contained at least one of 17 target VOCs. Total VOC concentrations in these 7 samples ranged from 1 μg/l in MW10S to 54,110 μg/l in MW3S. It is notable that the concentration of total VOCs detected in MW3S is two orders of magnitude greater than the next highest total VOC concentration (536 μg/l, detected in MW2S). The total VOC concentrations in the 7 wells are as follows:

MW2S -	536 μg/l
MW2 -	83 μg/l
MW3S -	54,110 μg/l
MW6 -	2 μg/l
MW10S -	1 μg/l
MW11S -	2 μg/l
P2 -	103 μg/l

It is also notable that the 4 monitoring locations with total VOC concentrations greater than 2 μg/l are all located within or near the former lagoons located south of I-88. The concentrations of VOC TICs ranged from non-detect in 22 of the samples to 500 μg/l in MW-3S.

Only 4 of the 26 samples (MW2S, MW2, MW3S, and P2) contained at least one of the 13 VOCs (vinyl chloride, chloroethane, 1,1-dichloroethane, 1,2-dichloroethane, 1,2-dichloropropane, cis-1,2-dichloroethene, trichloroethene, 1,1,1-trichloroethane, 2-Butanone, benzene, toluene, total xylenes, and ethylbenzene) that were detected at concentrations in exceedence of the ARARs. For the other 22 monitoring locations, VOCs were either not detected or the detected concentrations did not exceed ARARs. All four of the samples (MW2S, MW2, MW3S, and P2) are located south of I-88 and are within or near the former lagoon area. 1,1,1-Trichloroethane was the only VOC detected in P2 that exceeded ARARs. Although the concentration of 1,1,1-trichloroethane (100 μg/l) detected in P2 was higher than the New York state standard of 5 μg/l, it was less than the EPA MCL of 200 μg/l. Furthermore, the concentration of 1,1,1-trichloroethane detected in P2 during Phase III was very similar to the concentration detected during Phase

II (110 μg/l). Overall, the highest concentrations of VOCs at the site were detected in shallow wells, MW2S and MW3S. Although VOCs were detected in the deep well MW2, the total detected VOC concentration was approximately an order of magnitude lower in MW-2 than in MW-2S. No VOCs were detected in the deeper well MW-3. These data indicate that VOCs are generally not migrating vertically, as expected based on the tight nature of the till that underlies the site.

No exceedences of ARARs for VOCs were detected in any samples collected from within the median of I-88, north of I-88, south of Osborne Hollow Road, or in the out-of-service production well. The data indicate that groundwater impacted by VOCs is restricted to the groundwater in the unconsolidated water bearing zone in the vicinity of the former lagoon area. Total VOC isopleth maps for the Phase III RI groundwater sampling data for the upper and lower portions of the unconsolidated water bearing zone are provided in Figures 4-24 and 4-25.

The results are summarized as follows:

- MW-2S and MW-3S were installed in (or immediately adjacent to) the former lagoons and monitor the source concentrations of the chemicals of concern in the upper unconsolidated aquifer (Figure 4-24 and Table 4-26).

- There is little vertical transport of VOCs, as indicated by the concentrations in samples obtained from MW-2 and MW-3 installed in the lower unconsolidated aquifer (Figure 4-25 and Table 4-26).

- There is minimal horizontal transport of VOCs, as indicated by the nondetectable concentrations of VOCs in samples from the MW-9 and MW-10 clusters of wells in the median of I-88, and the MW-6 and MW-7 clusters of wells north of I-88 (Figure 4-24, Figure 4-25, and Table 4-26).

Seven of the groundwater samples (MW1SA, MW3S, MW5S, MW6, MW12S, P2, and P3) contained at least one of five target SVOCs (phenol, 2-methylphenol, 4-methylphenol, 2,4-dimethylphenol, and bis(2-ethylhexyl)phthalate) that were detected in the groundwater samples. Total SVOC concentrations in these 7 samples ranged from 1 μg/l in MW1SA to 16,590 μg/l in MW3S. The concentration of total SVOCs detected in MW3S is more than one order of magnitude greater than the next highest concentration (440 μg/l, detected in MW12S). The total SVOC concentrations in the 7 wells are as follows:

MW1SA -	1 µg/l
MW3S -	16,590 µg/l
MW5S -	2 µg/l
MW6 -	2 µg/l
MW12S -	440 µg/l
P2 -	4 µg/l
P3 -	12 µg/l

The concentration of SVOC TICs ranged from none detected in 15 of the 26 groundwater samples to 17,400 µg/l in MW3S.

Only 3 of 26 groundwater samples (MW3S, MW12S, and P-3) contained concentrations of SVOCs that exceeded ARARs. The concentration of bis(2-ethylhexyl)phthalate detected in MW12S (440 µg/l) and P3 (12 µg/l) exceeded the ARAR concentration of 5 µg/l (formerly 50µg/l). The concentrations of phenol (690 µg/l), 2-methylphenol (1,100 µg/l), and 4-methylphenol (13,000 µg/l) detected in MW3S exceeded the ARAR concentrations for these compounds of 1 µg/l, 5 µg/l, and 50 µg/l. MW12S is located in the right-of-way of I-88, just north of the highway. Because of its location, the presence of bis(2-ethylhexyl)phthalate in MW12S was suspected to be due to laboratory contamination. As a result, MW12S was resampled during Phase IV, Round 5. For the other 23 monitoring locations, SVOCs were either not detected or the detected concentrations did not exceed ARARs. As with the VOCs, it is notable that while the highest concentrations of SVOCs were detected in MW3S, no SVOCs were detected in MW3.

It is also notable that the concentrations of total organic compounds (VOCs and SVOCs) detected in the associated deep wells (MW2 and MW3) are significantly lower than the concentrations in the corresponding shallow wells; for example:

	Total VOCs	Total SVOCs
MW2S	536 µg/l	0 µg/l
MW2	83 µg/l	0 µg/l
MW3S	54,110 µg/l	16,590 µg/l
MW3	0 µg/l	0 µg/l

Thus, these data also indicate that SVOCs are generally not migrating vertically, as expected based on the tight nature of the till that underlies the site and the fate and transport characteristics of SVOCs. Total SVOC isopleth maps for the Phase III RI groundwater sampling data for the upper and lower portions of the unconsolidated water bearing zone are provided in Figures 4-26 and 4-27.

Three pesticides (heptachlor, alpha-chlordane, and gamma-chlordane) and one PCB (Aroclor-1242) were detected in only 3 of the 26 groundwater samples (MW3S, MW5S, and MW13S). Twenty-three of the samples did not contain any pesticides or PCBs. Only 4 exceedences of the ARARs are noted for pesticides and PCBs in groundwater at the site. The concentrations of alpha-chlordane (0.11 µg/l) and gamma-chlordane (0.1 µg/l) in MW13S exceed the New York state standard of 0.05 µg/l but do not exceed the EPA MCL of 2 µg/l. It is notable that MW13S is located approximately 25 feet from the western tributary, where chlordanes were detected in SED5. Similarly, the concentration of heptachlor (0.089 µg/l) in MW3S exceeds the New York state standard of 0.04 µg/l, but does not exceed the EPA MCL of 0.4 µg/l. As indicated above, MW3S is located within the former lagoon area. Finally, Aroclor-1242 at 0.57 µg/l in MW5S (within former incoming drum storage area) exceeded the New York State standard of 0.09 µg/l and the EPA standard of 0.5 µg/l. It is notable that Aroclor-1242 was also only detected in MW5S during the Phase II RI at an estimated concentration of 1.6 µg/l.

The total metals analyses performed on the unfiltered groundwater samples reported that 19 of the 23 TAL metals were detected; antimony, beryllium, selenium, and silver were not detected in any of the samples. The dissolved metals analyses reported that 13 of the 23 TAL metals were detected in the field filtered groundwater samples. Seven metals (arsenic, cadmium, iron, manganese, nickel, sodium, and thallium) were detected at concentrations that exceed ARARs in unfiltered samples, and only 3 metals (iron, manganese, and sodium) were detected at concentrations that exceed ARARs in filtered samples. Arsenic and cadmium were only detected at concentrations exceeding ARARs in the sample collected from MW3S, and nickel was only detected at concentrations exceeding ARARs in the samples collected from MW2S and MW3S. Thallium was detected at concentrations exceeding the ARAR (2 µg/l) in the upgradient sample (MW1SA) and in select downgradient samples (MW2S, MW6, and MW11S). It is notable that the concentration of thallium was higher in the upgradient sample (5 µg/l) than in any of the downgradient samples (highest concentration 4 µg/l). The other 3 metals (iron, manganese, and sodium) were detected at concentrations exceeding the ARARs in most groundwater monitoring locations (23 of the 26). It is notable that iron, manganese, and sodium are common, naturally occurring metals and that all of them were detected in MW1S, MW1, and MW1SA, which are upgradient monitoring wells for the site. Furthermore, with the exception of the wells located within the former lagoons, the concentrations of iron and manganese detected in MW1S were generally similar to or higher than the concentrations detected in the other wells at the site. The concentrations of iron, manganese, sodium, and thallium are representative of background groundwater quality.

4.2.4 Phase IV – Groundwater Sampling

On August 13, 1997, a groundwater sample was collected from MW-12S and analyzed for SVOCs. On November 10 and 11, 1997, groundwater samples were collected from the boreholes of MW-2B and MW-14B (top of bedrock) before completing these boreholes as a groundwater monitoring well. MW-2B was collected from 65 feet to 70 feet below ground surface and MW-14B was collected from 70 feet to 76 feet below ground surface. Both of these samples were collected using packers to seal off the targeted interval (i.e., top of bedrock). These samples were analyzed for VOCs, SVOCs, pesticides, PCBs, and metals. The samples collected on August 13 and November 11 and 12, 1997, constitute Round 5 of the RI groundwater sampling. From November 22 to November 24 (Round 6), groundwater samples were collected from MW-1SA, MW-1, MW-1B, MW-2S, MW-2, MW-2B, MW-3, P-2, MW-14, and MW-14B and analyzed for VOCs, SVOCs, pesticides, PCBs, and total metals. Because it was not possible to meet the NYSDEC recommended maximum turbidity guideline of 50 NTUs at MW-1 and MW-2S, additional field filtered samples were collected from these two locations and analyzed for dissolved metals. On December 16, 18, and 19, 1997 (Round 7), groundwater samples were again collected from MW-1SA, MW-1, MW-1B, MW-2S, MW-2, MW-2B, MW-3, P-2, MW-14, and MW-14B and analyzed for VOCs, SVOCs, pesticides, PCBs, and total metals. Because it was not possible to meet the NYSDEC recommended maximum turbidity guideline of 50 NTUs at MW-1, MW-3, and P-2, additional field filtered samples were collected from these three locations and analyzed for dissolved metals.

During Rounds 6 and 7, the groundwater pH of the unconsolidated water bearing zone was neutral to slightly basic. None of the pH readings were below 6.5; however, the pH of four monitoring wells (MW-2, MW-3, MW-14, and P-2) exceeded 8.5. Specific conductance ranged from 207 µmhos in MW-14 to 2,390 µmhos in MW-1SA; temperature ranged from 42.8° F to 49.5° F; turbidity ranged from 9.1 NTUs to greater than 200 NTUs; and dissolved oxygen ranged from 8.59 to 11.72.

During Rounds 6 and 7, the groundwater pH of the bedrock aquifer was neutral to slightly basic. None of the pH readings were below 6.5; however, all three bedrock monitoring wells had at least one pH reading that exceeded 8.5. The highest reading was 10.28 recorded in MW-1B during Round 6. Specific conductance ranged from 388 µmhos in MW-14B to 990 µmhos in MW-1B; temperature ranged from 46.2° F to 48.2° F; turbidity ranged from 0.7 NTUs to 15.9 NTUs; and dissolved oxygen ranged from 10.12 to 11.

4.2.4.1 Round 5 Sampling Results

The only SVOC detected in the groundwater sample collected from MW-12S during the August 1997 sampling event was bis(2-ethylhexyl)phthalate at 2 µg/l in the duplicate sample (Table 4-27). Bis(2-ethyhexyl)phthalate was also present in the equipment blank at 1 µg/l. This concentration is below the NYSDEC water quality standard of 5 µg/l. Consequently, the detection of bis(2-ethylhexyl)phthalate in MW-12S at 440 µg/l during Phase III of the RI is believed to be due to laboratory contamination, as originally expected.

Two VOCs (2-butanone and toluene) were detected in the bedrock groundwater samples collected from the boreholes of MW-2B and MW-14B. The interval sampled consisted of the 5- to 6-foot section of the open borehole below the steel casing installed into the top of competent bedrock. Total VOC concentrations in these 2 samples were 39 µg/l (MW-2B) and 0.9 µg/l (MW-14B), and the VOC TIC concentrations were 10 µg/l in MW-2B and non-detect in MW-14B. The NYSDEC water quality standard for toluene (5 µg/l) was exceeded in MW-2B. However, the concentration detected in this sample (34 µg/l) was significantly less than the EPA MCL of 1,000 µg/l.

Two SVOCs (di-n-butylphthalate and bis(2-ethylhexyl)phthalate) were detected in the borehole groundwater samples collected from MW-2B and MW-14B. Total SVOC concentrations in these samples were 18 µg/l (MW-2B) and 2 µg/l (MW-14B), and the SVOC TIC concentrations were 354 µg/l in MW-2B and 13 µg/l in MW-14B. The NYSDEC water quality standard for bis(2-ethylhexyl)phthalate (5 µg/l) was slightly exceeded in MW-2B.

No pesticides were detected in these samples. One PCB (Aroclor-1248) was detected in MW-2B at 0.5 µg/l. The NYSDEC water quality standard for PCBs is 0.09 µg/l; however, the EPA MCL is 0.5 µg/l. Thus, while the concentration of PCBs in this sample exceeded the NYSDEC standard, it was equal to the EPA MCL.

The total metals analyses performed on the unfiltered groundwater samples reported that 20 of the 23 TAL metals were detected; beryllium, cadmium, and selenium were not detected in either sample. Six metals (antimony, chromium, iron, manganese, nickel, and sodium) were detected at concentrations that exceed ARARs in the samples. All 6 metals were present in MW-2B at concentrations that exceed the NYSDEC ARAR. In the groundwater sample and associate duplicate sample collected from MW-14B, only 4 metals (antimony, iron, manganese, and sodium) were detected at concentrations that exceed the NYSDEC water quality standards. It is notable that the concentration of antimony detected in MW-14B is less than the EPA MCL, and the concentration of chromium detected in MW-2B is less than the EPA MCL. Thus, if commonly occurring metals are disregarded (i.e., iron, manganese, and sodium) and the EPA MCLs are used, only the concentration of antimony detected in MW-2B is an exceedence (MCL is 6 µg/l and concentration in well is 10 µg/l).

4.2.4.2 Round 6 Sampling Results

During Round 6, groundwater samples were collected from 10 monitoring wells (3 bedrock well clusters and MW-3). Eleven VOCs were detected in the groundwater samples at total concentrations ranging from non-detected in 6 wells to 375 µg/l detected in MW-2S. The four wells containing detectable concentrations of target VOCs included MW-1B, MW-2S, MW-2, and P-2. Seven of the 11 VOCs detected in the groundwater samples were present at concentrations above the applicable ARARs. These VOCs include vinyl chloride, choroethane, 1,1-dichloroethane, cis-1,2-dichloroethene, 1,1,1-trichloroethane, trichloroethene, and tetrachloroethene. It is notable that the concentrations of cis-1,2-dichloroethene and 1,1,1-trichloroethane exceed the NYSDEC water quality standards but are below the EPA MCLs. Consistent with previous sampling events, the concentrations of VOCs are greatest in MW-2S and the concentrations decrease in MW-2 indicating that vertical migration is not prevalent. Low concentrations continue to be detected in P-2, and no detectable concentrations of VOCs are present in MW-3. Except for the upgradient bedrock well (MW-1B), no target VOCs or VOC TICs were detected in the bedrock wells. One target VOC (2-butanone) was detected in MW-1B at 9 23 µg/l, which is below the NYSDEC water quality standard of 50 µg/l. Because 2-butanone is a common laboratory contaminant, the detection of it in MW-1B is unlikely to be due to environmental contamination.

Three SVOCs (1,2-dichlorobenzene, 2,4,5-trichlorophenol, and bis(2-ethylhexyl)phthalate) were detected in the groundwater samples at total concentrations of non-detect in 8 wells, 1 µg/l in MW-2B, and 3 µg/l in MW-2S. Each of the above target SVOCs were detected at an estimated concentration of 1 µg/l, and none exceeded the applicable groundwater quality standards. SVOC TICs were present in 4 groundwater samples collected from MW-1SA (2 µg/l), MW-1B (13 µg/l), MW-2S (383 µg/l), and MW-2 (45 µg/l).

No target pesticides or PCBs were detected in any of the groundwater samples collected during Round 6.

Twenty-two of the 23 TAL metals were detected in the groundwater samples. The only metal not detected was selenium. Metals detected at concentrations exceeding the groundwater quality standards include antimony, iron, manganese, nickel, sodium, and thallium. Antimony was only detected at a concentration above the groundwater quality standard in the duplicate sample of MW-2B at 3.1 µg/l (NYSDEC water quality standard is 3 µg/l and the EPA MCL is 6 µg/l). The concentration of antimony in MW-2B was 2.5 µg/l, and it was not detected in the Round 7 groundwater sample. Thus, the significance of this exceedance relative to human health and the environment is questionable. Exceedences of the standards for iron, manganese, and sodium (commonly occurring metals) occurred in 6 or more of the 10 samples collected during Round 6, including the upgradient samples (MW-1SA, MW-1, and MW-1B). The concentrations of these commonly occurring metals are attributable to background conditions. Nickel was only detected at a concentration above the groundwater quality standard in MW-2S at 120 µg/l (NYSDEC water quality standard is 100 µg/l). The groundwater quality standard for thallium is 2 µg/l. This standard was slightly exceeded in 5 wells (MW-1 at 2.5 µg/l, MW-1B at 3 µg/l, MW-2S at 3.2 µg/l, P-2 at 2.1 µg/l, and MW-14 at 3 µg/l). Because the turbidity of select wells (MW-1 and MW-2S) exceeded 50 NTUs during sampling, samples from MW-1 and MW-2S were filtered in the field and analyzed for dissolved metal concentrations. The concentrations of dissolved metals were similar to or less than the total metal concentrations recorded for the unfiltered samples. Thirteen of the 23 TAL metals were detected in the filtered samples, and 5 metals (iron, manganese, nickel, sodium, and thallium) were detected at concentrations exceeding groundwater quality standards. The concentrations of iron, manganese and sodium are attributable to background conditions. Nickel was only detected in MW-2S at 120 µg/l (same concentrations as the total analysis). Thallium was also detected in MW-2S at 2.7 µg/l (3.2 µg/l in the unfiltered sample) which slightly exceeds the groundwater quality standard of 2 µg/l.

4.2.4.3 Round 7 Sampling Results

During Round 7, groundwater samples were collected from the same 10 monitoring wells that were sampled during Round 6. Twelve VOCs were detected in the groundwater samples at total concentrations ranging from non-detected in 6 wells to 281.3 µg/l detected in MW-2S. The four wells containing detectable concentrations of target VOCs included MW-2S, MW-2, P-2, and MW-14B. Seven of the 12 VOCs detected in the groundwater samples were present at concentrations above the applicable ARARs. These VOCs include vinyl chloride, choroethane, 1,1-dichloroethane, cis-1,2-dichloroethene, 1,1,1-trichloroethane, trichloroethene, and tetrachloroethene (same VOCs as Round 6). It is notable that the concentrations of cis-1,2-dichloroethene and 1,1,1-trichloroethane exceed the NYSDEC water quality standards but are below the EPA MCLs. Consistent with previous sampling events, the concentrations of VOCs are greatest in MW-2S and the concentrations decrease in MW-2 indicating that vertical migration is not prevalent. Consistent with Round 6, low concentrations continue to be detected in P-2, and no target VOCs were detected in MW-3. Except for MW-14B, no target VOCs or VOC TICs were detected in the bedrock wells. One target VOC (1,1-dichloroethane) was detected in MW-14B at 0.9 µg/l, which is below the NYSDEC water quality standard of 5 µg/l.

Three SVOCs (1,2-dichlorobenzene, di-n-butylphthalate, and bis(2-ethylhexyl)phthalate) were detected in the groundwater samples at total concentrations of non-detect in 8 wells, 5 µg/l in MW-14, and 2 µg/l in MW-2S. None of the constituents were detected at concentrations that exceeded the applicable groundwater quality standards. SVOC TICs were present in 7 groundwater samples at total concentrations ranging from 2 µg/l in MW-1, MW-1B, and P-2 to 455 µg/l in MW-2S.

No target pesticides or PCBs were detected in any of the groundwater samples collected during Round 7.

Twenty-one of the 23 TAL metals were detected in the groundwater samples. The only metals not detected were cadmium and selenium. Metals detected at concentrations exceeding the groundwater quality standards include iron, manganese, mercury, sodium, and thallium. Exceedences of the standards for iron, manganese, and sodium (commonly occurring metals) occurred in all 10 of the samples collected during Round 7, including the upgradient samples (MW-1SA, MW-1, and MW-1B). The concentrations of these commonly occurring metals are believed to be attributable to background conditions. Mercury was only detected in MW-14B and was present at a concentration (2.3 µg/l) which exceeds both the NYSDEC water quality standard and the EPA MCL. During Round 6, the concentration of mercury in MW-14B was not detected at a detection limit of 0.12 µg/l. The groundwater quality standard for Thallium (2 µg/l) was slightly exceeded in 2 wells (MW-1 at 4 µg/l and MW-14B at 2.4 µg/l). Because the turbidity of select wells (MW-1, MW-3 and P-2) exceeded 50 NTUs during sampling, samples from MW-1, MW-3, and P-2 were filtered in the field and analyzed for dissolved metal concentrations. The concentrations of dissolved metals were similar to or less than the total metal concentrations recorded for the unfiltered samples. Twelve of the 23 TAL metals were detected in the filtered samples, and 2 metals (manganese and sodium) were detected at concentrations exceeding groundwater quality standards. The concentrations of manganese and sodium are believed to be due to background conditions.

4.2.5 NYSDOH Domestic Well Sampling

The June 1986 Phase II investigation report prepared for the NYSDEC reports that five residential water supply wells located near the site were sampled and analyzed for organic and inorganic priority pollutants in 1985. The well at the Stahl residence, located east of the site on Osborne Hollow Road, was the only well tested which contained detectable concentrations of organic compounds. Ethylbenzene was detected at 6 µg/l and xylenes were detected at 17 µg/l. The Stahl residence is located side gradient of the Tri-Cities Barrel site and presumably downgradient of the abandoned Don Snow Trucking Company. It is notable that repeated sampling did not reproduce the results, and the source of these constituents is unknown. However, because of the residence is side gradient of the site and because ethylbenzene and xylenes are not constituents of concern in the bedrock groundwater at the site, it is highly unlikely that the Tri-Cities Barrel site is the source for the organic compounds detected in the Stahl's water supply well.

In May 1990, the domestic water supply wells of the following seven residences were sampled for VOCs by the NYSDOH: Lance, Lee, Vail, Stahl, Smith, McGonnigal, and Duval. The Lance and Stahl residences are located to the east of the former operating site on Osborne Hollow Road. The Lee, Vail, Smith, McGonnigal, and Duval residences are located south of the site along Old Route 7. All seven residences are located hydraulically upgradient or cross-gradient of the site. There are no downgradient groundwater users. In addition, the well located at the Don Snow Trucking Company property, located approximately 500 feet southeast of the site was sampled for VOCs. Based on a review of the files at the

Broome County Health Department, no VOCs were detected in any of the wells. In October 1992, the same seven residential wells were sampled and the samples analyzed for VOCs, ketones, and metals. According to the files reviewed by ESC at the Broome County Health Department, no VOCs or ketones were detected. Metals were detected but none were reportedly detected at concentrations of concern. In October 1995, the NYSDOH again sampled the wells at the Lance residence and the Stahl residence for VOCs. Total xylenes were detected at 1 µg/l in the groundwater sample collected from the Lance residence. No VOCs were reportedly detected in the groundwater sample collected from the Stahl residence.

Thus, the results of the offsite bedrock groundwater supply wells and the results for the onsite out-of-service production well (MW-4) and the newly installed bedrock monitoring wells indicate that the bedrock aquifer underlying the site has not been adversely impacted by the former operations at the site. Additionally, for the following reasons the offsite residential water supply wells have not been affected to date by the residual contamination present in the soils and unconsolidated groundwater at the site.

- The bedrock water-bearing zone beneath the site has not been adversely impacted by former site activities.
- The residential water supply wells are either upgradient or sidegradient of the site.
- The site data suggest that the groundwater contamination present in the unconsolidated water-bearing zone is primarily in the source area (former lagoons) and is not appreciably migrating horizontally or vertically.

4.3 Surface Water

A total of seven surface water samples (SW2 and SW4 through SW9) were collected during the RI activities and analyzed for VOCs, SVOCs, pesticides, PCBs, total metals, and hardness. Two samples were collected from the tributaries to Osborne Creek (SW7 and SW8), one sample from the manmade pond north of I-88 (SW4), and four samples from Osborne Creek (SW2, SW5, SW6, and SW9). The sampling locations were selected to assess if surface waters were affected by onsite activities or past releases.

The field parameter measurements (pH, specific conductance, temperature, and dissolved oxygen) collected from each surface water location before sampling are provided in Table 4-31. The analytical results from the surface water sampling event are presented in Table 4-32. All surface water analytical results were compared to the NYSDEC ambient water quality standards and guidance values for surface waters (6 NYCRR Parts 700-705). Where applicable, the standards have been adjusted for the hardness of the water at each sampling location. Figure 4-28 shows the surface water sampling results that exceed the standards.

The pH readings indicate that the surface waters in the site vicinity are nearly neutral ranging from a pH of 6.7 at SW9 to a pH of 8.2 at SED1 (surface water at this sediment sampling location). The pH of the 4 sampling locations in Osborne Creek ranges from a pH of 6.7 at SW9/SED10 to a pH of 7.8 at SW6/SED9. The specific conductance of waters from both tributaries and Osborne Creek were similar and averaged 251 µmhos (range - 155 µmhos to 355 µmhos). The temperature of the surface water is largely a function of the time of year that the samples were collected (October). The temperature ranged from 9.8° C to 15.8° C. The dissolved oxygen content ranged from 2.70 mg/l near the confluence of the western tributary and Osborne Creek (SED6) to 8.04 mg/l in Osborne Creek (SW5/SED8). The dissolved oxygen content of the main channel of Osborne Creek ranged from 6.13 mg/l to 8.04 mg/l.

One VOC, carbon disulfide, was detected in two of the surface water samples, SW5 at 7 µg/l and SW9 at 13µg/l, both of which were collected from Osborne Creek. A surface water quality standard has not been established for carbon disulfide. No other VOCs and no VOC TICs were detected in the surface water samples.

No target SVOCs were detected in the surface water samples. The concentrations of SVOC TICs ranged from 20 µg/l in SW4 to 48 µg/l in SW7.

Only two pesticides (alpha-chlordane and gamma-chlordane) were detected in the surface water samples SW8 and its duplicate sample (SW61) which were collected from the western tributary near I-88. Alpha-chlordane was detected at an estimated concentration of 0.034 µg/l, and gamma-chlordane was detected at an estimated concentration of 0.043 µg/l. The ambient water quality standard for chlordane is 0.00002 µg/l for a Class C stream. No other pesticides were detected in the surface water samples, and no PCBs were detected in any samples.

The metals detected in the surface water samples and their corresponding maximum concentrations include aluminum (1,710 µg/l), barium (33.3 µg/l), calcium (21,600 µg/l), iron (2,870 µg/l), lead (3.2 µg/l), magnesium (5,230 µg/l), manganese (58 µg/l), potassium (2,080 µg/l), sodium (53,700 µg/l), vanadium (3.8 µg/l), mercury (0.31 µg/l), and zinc (65.2 µg/l). It is notable that the results for antimony and copper were rejected during data validation because the contract required detection limit recovery was less than 50 percent or because the results for preparation blanks were outside of EPA Region II QC limits. Ambient water quality standards do not exist for calcium and potassium. The standard for sodium (20,000 µg/l) was exceeded at all sampling locations. With the exception of SW4, the concentrations of sodium were similar at all sampling locations, ranging from 27,700 µg/l at SW7 (eastern tributary) to 38,500 µg/l at SW8 (western tributary). The concentration of sodium detected in SW6 (upstream sample of Osborne Creek -- background) was 34,900 µg/l. Thus, the concentrations of sodium detected in the tributaries and Osborne Creek are believed to be representative of background conditions of the area. The Class C standard for aluminum (100 µg/l) was exceeded only at locations SW4 (1,710 µg/l) and SW8 (302 µg/l). However, the man-made pond (SW4) and the western tributary (SW8) are classified as Class D streams and a standard does not exist for aluminum for Class D streams. The standard for iron (300 µg/l) was exceeded only at SW4 (2,870 µg/l) and SW8 (408 µg/l), and the standard for mercury was exceeded at SW2.

The hardness of the surface water ranged from 20 mg/l at SW4 to 110 mg/l at SW8.

4.3.1 East Tributary

One sample, SW7, was collected from the eastern tributary to Osborne Creek. No VOCs, VOC TICs, SVOCs, pesticides, or PCBs were detected in SW7, and the concentration of SVOC TICs was tentatively identified at 48 µg/l. Nine metals were positively identified in SW7; sodium was the only metal detected in exceedence of the NYSDEC water quality standard. Based on these results, surface water in the eastern tributary has not been adversely affected by constituents at the subject site. The concentrations of sodium is similar to the background concentration for Osborne Creek and is likely due to use of deicing agents.

4.3.2 West Tributary

One sample, SW8, and one duplicate sample (SW61) were collected from the western tributary to Osborne Creek. No VOCs, VOC TICs, SVOCs, or PCBs were detected in SW8 or SW61. The concentration of SVOC TICs was tentatively identified at 45 µg/l. Two pesticides (alpha-chlordane and gamma-chlordane) and nine metals were positively identified in SW8. The chlordane concentrations exceeded the ambient water quality standard. It is important to note that the western tributary is an intermittent stream that does not support aquatic species (e.g., fish); however, other organisms, including benthic invertebrates and amphibians may be present in the tributary. In addition, SW8 was collected in the same general vicinity as SED5 which, based on the Phase I, II, and III sediment sampling results, contains chlordane at concentrations up to 10,600 µg/kg. Aluminum, sodium, and iron, common in earth materials, were the only metals detected in exceedence of the NYSDEC water quality standards. It is notable that the constituents of potential concern (chlordane and aluminum) identified in SW8 and SW61 are not detected in the receiving stream (Osborne Creek).

4.3.3 Osborne Creek

SW2, SW5, SW6, and SW9 were collected from Osborne Creek. SW6 was collected upstream of the site and eastern tributary confluence point, and SW9 was collected downstream of the site and the western tributary confluence point. SW5 was collected between SW6 and SW9, and SW-2 was collected from a branch of the Osborne Creek braided stream system. Carbon disulfide, the only VOC detected, was detected in SW5 and SW9 at concentrations of 7 µg/l and 13 µg/l. No VOC TICs, SVOCs, pesticides, or

PCBs were detected in the Osborne Creek surface water samples. Ten metals were positively identified in the Osborne Creek samples; sodium was the only metal detected in exceedence of the ambient water quality standards and the concentrations are believed to be representative of background water quality. Additionally, the concentration of mercury detected in SW2 is less than the standard for protection of sources of drinking water but greater than the standard for protection of human consumers of fish.

Based on the surface water sampling results for Osborne Creek, the qualitative ecological survey performed by EDR in 1994, and the abundance of aquatic life (e.g., minnows) and water-related species (e.g., beavers) present in the creek, the primary surface water body in the vicinity of the site has been minimally affected by the former site operations. This is not surprising given that no wastewater discharges from the site have entered Osborne Creek for almost 20 years and the flow rate of Osborne Creek has diluted any residual contamination that may have been present in the past.

4.3.4 Pond

One surface water sample, SW4, was collected from the manmade pond (former lagoon) located north of I-88. No VOCs, VOC TICs, SVOCs, pesticides, or PCBs were detected in the samples. The concentration of SVOC TICs was estimated at 20 μg/l. Eleven metals were positively identified in the sample. Of all the surface water samples collected during the RI, the maximum concentrations of aluminum, iron, lead, manganese. sodium, vanadium, and zinc were detected in SW4. However, aluminum, sodium, and iron, common in earth materials, were the only metals detected in exceedence of the ambient water quality standards. Based on our knowledge of past use of the pond and the results for the sediment samples collected from the pond, the pond has been affected by former site operations. However, the surface water sampling results indicate that the water held in the manmade pond has only been minimally impacted, if at all, by past operations at the site. Thus, the constituents detected in the sediment samples collected from the pond are not appreciably partitioning into the overlying surface water, when present.

4.4 Sediments

During the RI, 21 sediment samples were collected from the two tributaries and Osborne Creek. Six samples were collected from the eastern tributary (SED1 through SED3 and SED20 through SED22); 9 samples were collected from the western tributary (SED4, SED5-1, SED5-2, SED5-3(a), SED5-3(b), SED6, SED23, SED24, and SED25); and 6 samples were collected from Osborne Creek (SED8 through SED10 and SED26 through SED28). The Phase I sediment sampling locations were selected to identify potential constituents of concern in the sediments of the tributaries and Osborne Creek. Following review of the Phase I data, the Phase II sampling locations were selected to further delineate the identified constituents of potential concern (SVOCs, pesticides, PCBs, and metals). To complete delineation of SVOCs, pesticides, and PCBs, the two Phase III samples (SED5-3(a) and SED5-3(b)) were selected. The analytical results are presented in Table 4-33 (eastern tributary), Table 4-34 (western tributary), and Table 4-35 (Osborne Creek).

The sediment sampling results were compared to sediment screening criteria (ARARs for Sediments are presented with each of the sediment sampling result data tables; Tables 4-33 through 4-35). The ARARs for the site sediments were developed using the NYSDEC Technical Guidance for Screening Contaminated Sediments (NYSDEC 1994). To develop the sediment ARARs, the lowest value for the various sediment screening pathways, except the human health bioaccumulation pathway, was used. The human health bioaccumulation pathway was excluded because the risk assessment did not recognize human health bioaccumulation as a complete pathway because no game fish were present at or near the site. It is important to note that these ARARs are not necessarily levels which require remedial action. According to the guidance, the screening criteria are "for identifying areas of sediment contamination, and providing an initial assessment of potential adverse impacts. While attainment of the EP-based sediment criteria will provide the maximum assurance of environmental protection, it is not necessary in all cases and at all times to achieve these criteria through remediation efforts." Figure 4-29 illustrates the distribution of all compounds that were detected in the sediment samples at concentrations in exceedence of the ARARs.

4.4.1 East Tributary

One VOC (2-butanone at 32 µg/kg) was detected in the upstream (background) sediment sample (SED1) collected from the eastern tributary. Because no ARAR for sediments exists for this compound, the constituent concentration was compared to the soil ARAR of 300 µg/kg and was found to be lower. Total VOC TICs ranged from not detected to 77 µg/kg. Based on these results, VOCs are not constituents of potential concern in the eastern tributary sediments.

Twelve SVOCs were detected in the 6 eastern tributary sediment samples. The highest concentration of total SVOCs and total SVOC TICs were detected in the upstream sample SED20. SED20 was collected from the portion of the eastern tributary that traverses through the parcel of land that was formerly an offsite junkyard. Based on the aerial photographs reviewed for the site, the parcel of land located southeast of the site, and from which SED20 was collected, was used as a junkyard from at least 1958 to 1973. Review of the analytical data shows that the concentration of every individual SVOC, except phenanthrene, was higher in this upstream sample than in the other eastern tributary samples. While six SVOCs detected in the eastern tributary samples exceeded the sediment screening criteria, the source of the SVOCs detected in the samples is largely due to offsite areas (e.g., former junk yard and railroad tracks) and not the site. Thus, the SVOCs in the eastern tributary do not require further remedial consideration.

Seven pesticides (alpha- and gamma-chlordane, heptachlor, aldrin, dieldrin, endrin aldehyde, and 4,4'-DDE) were detected in the 6 sediment samples. Five of the 7 pesticides (alpha-chlordane, gamma-chlordane, heptachlor, endrin aldehyde, and 4,4'-DDE) were detected at concentrations that exceeded the screening criteria. Five of the 6 eastern tributary samples contained two or more pesticides at concentrations that exceeded the sediment ARARs. The only sample not to contain elevated levels of pesticides was SED1, which was collected south of Route 7. 4,4'-DDE (270 µg/kg) was only detected in SED20 (upstream, offsite, background sample), and the highest concentration of heptachlor was detected in SED20. The concentration of endrin aldehyde (5.8 µg/kg) was only exceeded in SED21. The concentrations of alpha- and gamma-chlordane in samples SED2, SED3, SED21, and SED 22 exceeded the criteria. These samples were collected along the portion of the eastern tributary that potentially could have received runoff (albeit minor) from the site. Chlordane was detected in the site soils and thus may be site related. However, while the concentrations of the chlordanes in SED2, SED3, and SED22 (downstream eastern tributary samples of SED21) exceed the screening criteria, the concentrations decline in the downstream direction.

		alpha-Chlordane (µg/kg)		gamma-Chlordane (µg/kg)	
Upstream	SED21	33	NJD	8.7	NJ
	SED 2	7.3	J	7.9	J
	SED22	13		4.2	NJ
Downstream	SED3	2	J	1.7	J

PCBs were detected in 5 of the 6 sediment samples, and the concentrations of Aroclor-1248 in all five samples exceeded the TOC adjusted screening criterium. However, the concentration of Aroclor-1248 detected in SED20 (offsite, upstream, background sample) was significantly higher than the concentrations detected in the other 4 samples (84,000 µg/kg in SED20 versus 34 µg/kg to 1,100 µg/kg detected in the other 4 downstream samples). Because SED20 was collected from the parcel of land that was formerly a junkyard, the source of the PCBs appears to be the former junkyard and is not site related.

Similarly, only the concentrations of lead (132,000 µg/kg) and zinc (275,000 µg/kg) detected in SED20 exceeded the upper range of the screening criteria for metals. The concentrations of other metals detected in the eastern tributary samples did not exceed the upper range levels.

These results indicate that VOCs, SVOCs, select pesticides (4,4'-DDE and heptachlor), PCBs, and metals are either not constituents of concern or were detected at significantly higher concentrations in the upstream, offsite samples and thus are not attributable to the former site operations. The concentrations of alpha- and gamma-chlordane exceed the screening criteria in four samples and may be site related, and the concentration of endrin aldehyde slightly exceeds the screening criterium in only one sample.

It is important to note that while a potential pathway (albeit unlikely) does exist from the site to the eastern tributary, few constituents of concern (only PAHs at concentrations similar to background concentrations and seven metals) were identified in the soils within the eastern portion of the site and the elevation of the ground surface in the eastern portion of the site generally slopes toward the site and not the eastern tributary. In fact, approximately 98.3 percent of the land located south of I-88 slopes toward the site and only approximately 1.7 percent (extreme eastern portion of the site) slopes toward the eastern tributary. The topographic map with 2-foot contour intervals, presented in Appendix E, depicts the above information. Thus, while a potential pathway from the site to the eastern tributary exists, a defined pathway from a portion of the site which is contaminated (i.e., former lagoon area, drum processing area, and incoming drum storage area) does not exist. A more likely source area for most of the constituents detected in the eastern tributary is the former junkyard.

4.4.2 West Tributary

One VOC (2-butanone) was detected at 29 µg/kg in the upstream (background) sediment sample (SED4) collected from the western tributary at an offsite location south of Old Route 7. Because no sediment ARAR exists for this compound, the constituent concentration was compared to the soil ARAR of 300 µg/kg and was found to be an order of magnitude lower than the soil ARAR. Total VOC TICs ranged from non-detect to 20 µg/kg. Based on these results, VOCs are not constituents of potential concern in the western tributary sediments.

Each of the shallow (collected from a depth of 1 foot or less) western tributary sediment samples contained at least one of 20 target SVOCs. Of the 20 SVOCs detected, 16 are PAHs. The two deep samples (SED5-3(A) and SED5-3(B), collected at depths of 2-3 feet and 5-6 feet, did not contain any target SVOCs, and 14 of the 20 target SVOCs were present in the background sample, SED4. Except for the duplicate sample collected from SED5-1, SED4 also exhibits the highest concentration of total SVOCs (111,800 µg/kg). Interestingly, the downstream samples (SED6 and SED25), collected from the portion of the stream north of I-88, contained only two SVOCs (bis(2-ethylhexyl)phthalate and bi-n-butyl phthalate) with total SVOC concentrations of 171 µg/kg and 280 µg/kg, which are below the screening criteria concentrations. Of the 9 sediment samples collected from the western tributary, 4 samples (SED4-1, SED5-1, SED5-2 (resampling of SED5-1), and SED24-2) contained concentrations of PAHs that exceed the sediment screening criteria. Thus, only 3 locations (SED4 (offsite, upstream, background), SED5, and SED24) contain concentrations of PAHs that exceed the sediment screening criteria, and all of these sample locations are south of I-88.The SVOCs detected in the western tributary may be related to the former site operations, but may also be attributable to upstream, offsite sources (e.g., runoff from the roadways that bisect the site and railroad tracks).

Each of the 9 samples collected from the western tributary contained at least one of the 10 pesticides (alpha-chlordane, gamma-chlordane, beta-BHC, heptachlor, dieldrin, 4,4'-DDE, 4,4'-DDD, 4,4'-DDT, endrin aldehyde, and toxaphene) detected in the samples, and all of the 9 samples contained at least one pesticide at a concentration that exceeded the ARARs. Seven pesticides (alpha-chlordane, gamma-chlordane, heptachlor, dieldrin, 4,4'-DDD, 4, 4'-DDE, and toxaphene) were detected at concentrations exceeding the ARARs for sediments. Alpha- and gamma-Chlordane were the most prevalent pesticides detected in the western tributary sediment samples. The concentrations of alpha-Chlordane exceeded the screening criteria in all samples, except SED23, and the concentrations of gamma-Chlordane exceeded the screening criteria in all samples. It is notable that the highest concentrations of alpha- and gamma-chlordane were detected in the "deep" samples collected from SED5 (SED5-3(A) and SED5-3(B)) which were collected from depths of 2-3 feet and 5-6 feet. SED5 is located adjacent to and south of I-88. Furthermore, the concentrations of the chlordanes detected in SED25 and SED6 (the most downstream samples) are significantly lower than those concentrations detected at SED5 (south of I-88). Chlordane was detected in the site soils and thus the concentrations detected in the sediment sample are probably site related. Heptachlor, dieldrin, toxaphene, and 4,4'-DDD were only a potential concern in the samples collected from SED5, and 4,4'-DDE was only a potential concern in the samples collected from SED5 and SED25. The concentration of 4,4'-DDE in SED25 was 26 µg/kg, which is significantly lower than the concentrations detected in the upstream samples (SED5; 890 µg/kg). Thus, the sediments in the vicinity of SED5 are the most severely impacted sediments in the western tributary.

PCBs were detected in 5 of the 9 samples. The concentrations of Aroclor-1254 in SED5-3(A) (1,700 µg/kg) and SED5-3(B) (10,000 µg/kg) and the concentrations of Aroclor-1248 in SED23 (44 µg/kg) and SED24 (µg/kg) exceeded the TOC adjusted screening criteria. Like the concentrations of chlordane, the highest concentrations of PCBs were detected in the deeper samples collected from SED5. It is notable that the highest concentrations of PCBs are restricted to the SED5 sampling location.

Only three metals (iron, manganese, and mercury) were detected at concentrations exceeding the upper range of the screening criteria for metals. The concentrations of iron and mercury (42,500,000 µg/kg and 1,900 µg/kg) detected in SED5-2, and the concentrations of manganese detected in SED4, SED23, and SED24 were the only locations with levels exceeding the upper range of the screening criteria. Because manganese was detected in SED4 at elevated levels, the concentrations detected in SED23 and SED24 are likely related to background rather than the site.

The sediment sampling results indicate that VOCs, select SVOCs, and most metals are either not constituents of concern or were detected at similar concentrations in the upstream, offsite sample. The concentrations of several pesticides, PCBs, iron, and mercury exceed screening criteria and may be site related. In summary, the concentrations of manganese detected in the upstream, offsite sample (SED4) are likely attributable to an offsite source (e.g., railroad tracks or soils in vicinity of SS-8). The concentrations of PAHs, pesticides, PCBs, iron, and mercury are likely a result of former site operations with contribution from the offsite source(s), especially the PAHs.

4.4.3 Osborne Creek

No VOCs, VOC TICs, pesticides, or PCBs were detected in any of the sediment samples collected from Osborne Creek, indicating that these constituents are not of potential concern in the sediments. Low concentrations (less than 1 part per billion) of pesticides were detected in the Phase I sediment samples but were rejected during data validation. As a result, the Osborne Creek sediment samples were resampled during the Phase II and analyzed for pesticides and PCBs. No pesticides or PCBs were detected in the Phase II samples.

Only two SVOCs were detected in the sediment samples (bis(2-ethylhexyl)phthalate and di-n-butyl phthalate). The concentrations of bis(2-ethylhexyl)phthalate (42 µg/kg and 43 µg/kg) are well below the sediment ARAR. No ARAR exists for di-n-butyl phthalate, but like bis(2-ethylhexyl)phthalate, the concentrations detected in the samples were low ranging from 42 µg/kg to 48 µg/kg. For comparative purposes, the concentrations of di-n-butyl phthalate were compared to the ARAR for soils and found to be over two orders of magnitude lower than this ARAR. The concentrations of SVOC TICs ranged from 4,600 µg/kg to 6,500 µg/kg. Based on these results, SVOCs are not constituents of concern in the Osborne Creek sediments.

None of the 16 metals detected in the Osborne Creek sediment samples were detected at concentrations that exceeded the upper range of the screening criteria for metals. In addition, the concentrations of metals detected in the upstream (background) sample (SED9) were, in all cases, higher than the concentrations detected in at least one of the two downstream samples. Thus, the concentrations of metals detected in Osborne Creek reflect background conditions for that stream. Overall, the data indicate that no potential constituents of concern are present in the sediments of Osborne Creek. While remedial action is not necessary for the sediments in Osborne Creek, further sampling of the floodplain area where the western tributary discharges to Osborne Creek will be conducted as a pre-design activity of the Remedial Design.

4.5 Air

Air monitoring for VOCs was conducted during the Phase I RI trenching activities to ensure that these site activities did not result in any airborne constituents that might pose a threat to onsite workers or the

general public. PID readings of the excavated soils were obtained by monitoring soils in the trackhoe bucket as the soils were removed from depths of 2-feet, 5-feet, and from the bottom of the excavation. Oxygen/explosimeter measurements were collected from the open excavations. The PID does not quantitatively measure concentrations of specific constituents, but provides qualitative measurements that correspond to a relative concentration as compared to isobutylene. The field headspace results collected during the trenching activities are provided in Appendix P.

During the excavation activities no explosive or oxygen deficient atmospheres were encountered in any of the trenches.

The results of the perimeter air sampling conducted during the trenching activities are presented in Table 4-36. Three air samples and a field blank were collected during each of the 12 days of trenching and analyzed for VOCs. Ten VOCs were detected in the air samples. The detected compounds are methylene chloride, 1,1,1-trichloroethane, benzene, 1,2-dichloroethane, n-heptane, 1-heptane, trichloroethene, toluene, ethylbenzene, and total xylenes. The occurrence of methylene chloride, n-heptane, and toluene in the samples may be attributable to blank contamination because these compounds were detected with significant frequency in the field blanks. The detectable quantities of benzene, n-heptane, 1-heptane, toluene, ethylbenzene, and total xylenes may be attributable to vehicle exhausts based on their potential as a byproduct of gasoline combustion and the site's proximity to I-88. Finally, the highest detected concentration of 1,1,1-trichloroethane, 1,2-dichloroethane, and trichloroethene is approximately 1,000 times less than background outdoor concentrations of the same compounds in the Kanawha Valley region of West Virginia (Cohen, et al, 1989). As indicated in Section 4.1 of this report, the concentrations of VOCs detected in the soil samples collected from the trenches were generally low indicating that a concentrated source of VOCs in these soils is lacking. Thus, the air sampling results along with the soil sampling results indicate that little potential exists for airborne constituents to be released from the site. Also, the results indicate a negligible potential for exposure to future onsite workers or the general public.

The results of the PID ambient air quality survey conducted at the site, which primarily focussed on the former onsite buildings, indicate that VOCs were detected in the immediate vicinity of the former gasoline tank vents and the former aboveground fuel tank located north of the process building. The levels of total VOCs at the gasoline tank vents and the aboveground fuel tank located north of the pole barn were greater than 20 ppm. These were the only locations outside of the former buildings where levels above background were detected. The only location inside the former process buildings where levels of organic vapors greater than background were detected was near a small, aboveground stainless steel container in the northwest corner of the boiler room. The level of organic vapors at this location was 8 ppm. It is important to note that all waste materials, drums, tanks, debris, and structures were removed from the site in 1996, as part of the time critical removal action. Thus, these isolated sources of VOCs to the atmosphere are no longer present at the site and consequently are no longer an issue for the site.

4.6 Building

This section presents the results of the building samples and building-related samples (e.g., aqueous samples from the septic tank) that were collected during the RI. However, it is important to note that all sumps, tanks, and structures were decontaminated and then either abandoned in place or demolished and disposed of offsite. The septic tank, located west of the former onsite buildings, was pumped out, pressure washed, breached in-place, and then backfilled with clean fill material. The two sumps (smoke washing sump and blaster unit sump) located in the former onsite buildings were pumped out, pressure washed, backfilled with sand, and topped with 6-inches of concrete. In addition, for the blaster unit sump, the solidified mass of steel shot was removed from the sump and properly disposed of offsite before the sump was backfilled with sand and capped. The structures formerly present at the site were decontaminated, demolished and properly disposed of offsite. Following decontamination activities, confirmatory samples were collected to ensure that the structures were adequately cleaned and achieved the performance requirements specified in the Removal Action Site Operations Plan (ESC 1996). A detailed summary of the removal action and the findings and results of all samples collected during the removal action are presented in the Removal Action Final Report (ESC 1997).

Because the units and structures sampled during the RI have since been addressed (clean closed or disposed of offsite), the building sampling results presented below have little significance. Nonetheless, the RI building sampling results are presented below.

4.6.1 <u>Building Surfaces</u>

A total of 13 samples (BS1 through BS13) were collected from building surfaces and analyzed for SVOCs, pesticides, PCBs, metals, and cyanide. The locations of the building samples are summarized on Table 2-6 and presented on Figure 1-5. The building sampling analytical results are presented in Table 4-37.

Seven SVOCs (phenol, 4-chloro-3-methylphenol, fluorene, di-n-butyl phthalate, butyl benzyl phthalate, bis(2-ethylhexyl)phthalate, and benzo(a)pyrene) were detected in eleven of the building samples. No target SVOCs were detected in samples BS7 or BS12 which were collected from the floor in the smoke washing room and the outer surface of the incinerator, respectively. The highest concentrations of SVOCs were detected in the three samples collected from the floor near the drum washing tanks and drum chain tank.

Each sample contained at least one of 10 pesticides that were detected in the building samples. The detected pesticides included beta-BHC, endosulfan I, dieldrin, 4,4'-DDE, endosulfan II, 4,4'-DDD, methoxychlor, endrin aldehyde, alpha-chlordane, and gamma-chlordane. Five additional pesticides (alpha-BHC, gamma-BHC, heptachlor, endrin, and 4,4-DDT) were detected in the samples, but the results were rejected during data validation. The estimated concentrations of total pesticides detected in the samples ranged from 2.4 μg/kg in BS12 to 5,170 μg/kg in BS10. The most commonly occurring pesticide was gamma-chlordane which was present in 12 of the samples and in the duplicate sample. Of the 10 pesticides detected in the samples, four compounds (4,4'-DDE, methoxychlor, alpha-chlordane, and gamma-chlordane) were present in more than half of the 13 building samples.

Four PCB isomers (Aroclor-1242, 1248, 1254, and 1260) were detected in 9 of the 13 building samples; no PCBs were detected in four of the samples (BS3, BS4, BS12, and BS13). The concentration of total PCBs ranged from none detected to 72,000 μg/kg in BS8.

Metals were detected in all 13 building samples. The 21 metals detected included aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, silver, sodium, vanadium, and zinc. Selenium was detected in the samples but was rejected during data validation. The only metal not detected was thallium. Two of the 13 samples (BS12 and BS13) were collected from exterior building surfaces. The concentrations of target SVOCs, pesticides, PCBs, and metals were considerably lower than the concentrations detected in the samples collected from interior building surfaces.

In summary, because all buildings and building materials have been removed, the building materials and associated constituents of potential concern detected in the building samples, no longer present any potential hazard or risk at the site.

4.6.2 Sumps

The two sumps were formerly used as part of the site operations. One sump was located beneath the blaster unit in the southwestern portion of the process building and the other sump was located beneath the smoke washing unit in the northwestern portion of the building. During the Phase I RI, a surface water sample and a sediment sample were collected from the sump beneath the smoke washing unit. In addition, as part of the Phase II field activities, both sumps were emptied to the extent practicable, power washed, and visually inspected for cracks, leaks, and signs of seepage.

During the blaster unit sump inspection, it was noted that all four walls of the blaster unit sump were pitted and cracked. A visual inspection of the sump bottom was not possible due to the presence of steel shot and hardened solids. The wall cracks were oriented vertically, horizontally, and at angles on the sump walls. At approximately 1 foot below grade, water was observed trickling into the sump from one vertical crack located on the western wall of the sump and over a 2-day period, approximately 5-10 gallons leaked into the sump. No water was observed leaking or seeping into the sump from any of the other cracks.

All four walls and the bottom of the smoke washing unit sump were visible for inspection. The sump walls and floor were observed to be pitted. One hole approximately 4 inches in diameter and 6 inches deep was observed in the southwestern corner of the bottom of the sump and one large vertical crack in the center of the eastern wall of the sump was noted. Several horizontal cracks were noted on all sump walls. While no water was observed leaking into the sump from any of the cracks, approximately 0.5 inch of water accumulated on the sump floor within several hours of emptying and cleaning the sump.

One water sample (SW1) and a duplicate water sample (SW60-1) were collected from the sump below the smoke washing unit and analyzed for VOCs, SVOCs, pesticides, PCBs, metals, and hardness (Table 4-38).

Only one VOC (chloromethane) was detected in the duplicate water sample. The concentration of VOC TICs detected was 20 μg/l in SW1 and 27 μg/l in SW60-1.

Eight SVOCs (bis(2-ethylhexyl)phthalate, anthracene, pyrene, fluoranthene, phenanthrene, butyl benzyl phthalate, fluorene, and 2-methylnaphthalene) were detected at similar concentrations in both the water sample and the duplicate. The estimated total SVOC concentration in SW1 was 494 μg/l. The concentration of total SVOC TICs detected in SW1 was 14,000 μg/l.

Three pesticides (alpha-chlordane, gamma-chlordane, and dieldrin) were detected in the water samples, with the total concentration of pesticides of 1.4 μg/l in SW1 and 10.32 μg/l in SW60-1. Endrin ketone was also detected, but the results were rejected during data validation. One PCB (Aroclor-1242) was detected in the sample and the duplicate sample at a maximum concentration of 6.7 μg/l; however, the result for SW1 was rejected during data validation.

Fifteen metals were detected in the water sample and duplicate sample, and the water hardness was 9.2 mg/l.

One sediment sample (SED11) was collected from the sump below the smoke washing unit and analyzed for VOCs, SVOCs, pesticides, PCBs, and metals (Table 4-39).

Five VOCs (ethylbenzene, toluene, total xylenes, 1,1,1-trichloroethane, and 2-butanone) were detected in the sediment sample. The total concentration of VOCs was 42,000 µg/kg, and the total concentration of VOC TICs was 30,700 µg/kg. These results indicate the former presence of VOCs in the sediments below the smoke washing unit.

A total of 13 SVOCs (bis(2-ethylhexyl)phthalate, anthracene, pyrene, benzo(b)fluoranthene, fluoranthene, chrysene, benzo(a)anthracene, acenaphthene, phenanthrene, butyl benzyl phthalate, fluorene, naphthalene, and 2-methylnaphthalene) were detected in the sediment sample, and the concentration of total SVOCs was 1,307,800 µg/kg. The total concentration of SVOC TICs was 7,400,000 µg/kg. These results indicate the former presence of SVOCs in the sediments below the smoke washing unit.

Two pesticides were positively detected in the sediment sample and the concentration of total pesticides was 78 µg/kg. One PCB Aroclor was positively detected in the sample at a concentration of 52 µg/kg.

All 23 TAL metals were detected in the sediment sample.

4.6.3 Septic Tank

During the Phase I investigation, a water sample was collected from the septic tank (SW3) formerly situated west of the building and analyzed for VOCs, SVOCs, pesticides, PCBs, metals, and hardness (Table 4-38).

Only one VOC, 2-butanone, was detected in the sample, and no VOC TICs were detected. Two SVOCs (bis(2-ethylhexylphthalate and 2-methylnaphthalene) were detected in the sample with a total SVOCs concentration of 195 µg/l. The concentration of total SVOC TICs was 5,000 µg/l.

Three pesticides (alpha-chlordane, gamma-chlordane, and beta-BHC) were detected in the sample; however, the results were rejected during data validation. No PCBs were detected.

Fourteen metals (aluminum, barium, calcium, chromium, copper, iron, lead, magnesium, manganese, nickel, potassium, sodium, vanadium, and zinc) were detected in the septic tank water samples. The septic tank water hardness was 180 mg/l.

Based on these results, it is does not appear that industrial wastewaters were routinely disposed of through the septic system, and the septic tank is not a significant source of contaminants at the site.

4.7 Ecological Receptors

During the Phase II RI, plant and earthworm samples were collected and analyzed for SVOCs, pesticides, and PCBs.

4.7.1 Plants

The plant sampling results are provided in Table 4-40, and a pictorial presentation of the distribution of constituents detected in the plant samples is provided on Figure 4-30.

2-Methylphenol was the only target SVOC detected in the plant samples and was detected in samples collected from three locations at concentrations ranging from 450 µg/kg to 610 µg/kg. Because it was detected in the duplicate sample collected from the background location south of Old Route 7, its presence in the plant samples is not believed to be site related.

Two pesticides (beta-BHC and 4,4'-DDT) were detected in only one sample (ESP3). The concentration of total pesticides in this sample was 40 µg/kg. Two PCBs (Aroclor-1248 and -1254) were detected in four samples collected from south of I-88 (former incoming drum storage area and former lagoons) and north of I-88 (near former lagoon and within the 1958 discharge area). The concentrations of total PCBs ranged from 120 µg/kg to 250 µg/kg. No SVOCs, pesticides, or PCBs were detected in two of the samples (ESP6 and ESP8).

Based on these results, the distribution of constituents detected within plant material at the site are primarily associated with the samples collected from former operating portions of the site (e.g., former lagoons, drum storage areas, and discharge area). Thus, those areas with constituents present in the soils have the potential to have plant material with non-naturally occurring compounds (e.g., PCBs).

4.7.2 Earthworms

The earthworm sampling results are provided in Table 4-41, and a pictorial presentation of the distribution of constituents detected in the earthworm samples is provided on Figure 4-31. Because the sampling location for ESW5 was located near the floodplain of Osborne Creek and the moisture content of these soils was high, no earthworms were found and it was not possible to collect a sample at this location.

SVOCs, pesticides, and PCBs were detected in the earthworm samples collected at the site. Nine SVOCs (phenol, naphthalene, pentachlorophenol, phenanthrene, anthracene, pyrene, butylbenzylphthalate, chrysene, and benzo(b)fluoranthene) were detected with the total SVOC concentrations ranging from 81 µg/kg in the background sample collected from south of Osborne Hollow Road (ESW7) to 3,132 µg/kg in the sample collected from the former incoming drum storage area (ESW1).

Six pesticides (gamma-BHC, endosulfan I, dieldrin, 4,4'-DDE, alpha-chlordane, and gamma-chlordane) were detected in 5 of the 7 earthworm samples with the total concentrations ranging from none detected in the two background samples (ESW7 and ESW8) to 1,095 µg/kg in ESW1. At least one of three PCBs (Aroclor-1248, -1254, and -1260) were detected in all 7 samples at concentrations ranging from 260 µg/kg in the background sample (ESW7) to 22,600 µg/kg in the sample collected from the vicinity of the former lagoon north of I-88 (ESW4).

A comparison of the earthworm sampling results to the soil sampling results indicates a general correlation exists between the constituent concentrations detected in the soils and the concentrations detected in the earthworm samples. For example, the earthworm samples with the highest concentrations include ESW1 which was collected from the former incoming drum storage area, ESW2 which was collected near the former lagoons, ESW4 which was collected from the vicinity of the former lagoon north of I-88, and ESW6 which was collected north of I-88 in the area of the former surficial discharge area (as seen in the historical aerial photographs). This correlation between constituent concentrations in soils and that in the earthworms is consistent with anticipated trends, because earthworms ingest soil as their food source. Because it was not possible to ensure that the worms had depurated before preparation and analysis, the constituent concentrations detected in the samples represents the concentration present in the earthworms body mass combined with their digestive tracts. Thus, it does not reflect or represent only those contaminants that have bioaccumulated in the flesh of the worms. It is also notable that because earthworms are somewhat mobile, it is not surprising to find earthworms containing detectable concentrations of PCBs in background portions of the site.

5.0 Contaminant Fate and Transport

The purpose of this section is to discuss the current extent of the site in terms of the transport and fate of the constituents since their introduction to the environment and to predict the future fate of the constituents given current conditions. Fate and transport parameters, such as the octanol-water coefficient (Kow) and organic carbon coefficient (Koc), are presented in the following discussions. Kow is a measure of the extent to which a chemical partitions between water (aqueous phase) and octanol (organic phase). It is determined experimentally in the laboratory as defined under the Toxic Substances Control Act (TSCA - 40 CFR 796). The higher the Kow, the more likely the compound will partition to the organic phase rather than stay in water. Kow is often used to predict the potential for bioconcentration in aquatic organisms. Koc is a measure of chemical partitioning between organic carbon and water. The higher the Koc, the more likely the compound will bind to the organic content in the soil or sediment rather than remain dissolved in water.

5.1 Soils North of I-88 and Former Lagoon

Until the summer of 1967, wastewater discharges to the land surface and the use of lagoons affected the soils north of I-88. The construction of I-88 during the 1967 construction season eliminated use of the land north of I-88 as part of site operations. Consequently, the constituents of potential concern in the soils north of I-88 are aged (i.e., deposited before 1968) and were limited to constituents present in the wastewater discharges. Recent research indicates that aged chemicals in the environment are sorbed more strongly to soil and are less mobile compared to freshly released chemicals (Pignatello and Xing 1996, Alexander 1995, Lyman 1996). Chemicals that remain in contact with particulate matter become more and more resistant with time to desorption and leaching.

Long-term sorption and aging of chemicals in soil appears to involve not only the surface of particles, but also a slow and continuing diffusion of molecules to sites within the particles. The internal and more remote binding sites continue to sorb more of the compound with time. Suggested sequestration mechanisms include solid-phase diffusion into non-organic materials, diffusion through micropores into a soil particle aggregate, penetration into porous organic materials, and oxidized coats and films (Pignatello and Xing 1996). The cumulative effect of the long-term aging of chemicals in the environment is a dramatic decrease in bioavailability and decreased ability to leach the sorbed compound from soil.

An additional practical consideration is that a chemical Koc is typically derived from laboratory studies of spiked soils. The behavior of aged chemicals in the environment indicate that chemical-specific

Kocs are likely to underestimate the long-term tendency of a compound to bind to soil. Therefore, the chemicals of potential concern at the site are likely to have even less potential to migrate than would be predicted by an evaluation of their chemical and physical properties.

5.1.1 Constituents of Potential Concern

Based on the comparison of the soil data to the ARAR levels and background concentrations and the results of the baseline risk assessments, the following constituents of potential concern were identified in the soils north of I-88: SVOCs (2-methylphenol and benzo(a)pyrene), PCBs, pesticides (dieldrin, heptachlor, heptachlor epoxide, alpha-chlordane, and gamma-chlordane), and metals (arsenic, beryllium, lead, manganese, mercury, silver, sodium, thallium, and zinc).

5.1.2 Persistence and Migration

The constituents of potential concern were deposited in the soils 30 years ago and were a result of surficial releases via overland flow and within the former lagoon. The data indicate that the constituents of potential concern in soils are largely restricted to the top 3 feet or less. For example, only mercury in the subsurface soil sample collected from MW9S was present at a concentration exceeding the ARAR level. A comparison of the shallow surficial soil samples (samples collected from 1 foot or less) to the deeper surficial soil samples (samples collected from 2-3 feet) indicate that the concentrations of the constituents of potential concern markedly decrease with depth.

The chemicals detected in soil have not displayed a tendency to leach to groundwater. No organic compounds were identified in the groundwater samples collected from the two well pairs (MW6S/MW6 and MW7S/MW7) located within the area historically affected by the surficial discharges and immediately downgradient of the former lagoon. These data indicate that the constituents of potential concern are restricted to the surficial soils and are not migrating though the clay-rich till soils. Overall, the data are consistent with the model of historical, surficial releases of wastewater to the soils north of I-88. The only metals identified in the soil as constituents of potential concern and also detected in these well pairs above ARAR levels include arsenic, lead, manganese, sodium, and thallium.

The observed site conditions are consistent with the expected fate and transport characteristics of the constituents of potential concern. For example, high molecular weight PAHs (i.e., PAHs with 4 to 7 carbon rings; benzo(a)pyrene) have high Kow and Koc, low water solubility, and biodegrade slowly (i.e., persistent). Kow and Koc increase as the molecular weight of the PAH increases. Lower molecular weight PAHs including acenaphthene and phenanthrene have lower Kow and Koc and would be less bound to soils than the heavier molecular weight PAHs including benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene. High Kocs for the heavier PAHs indicate that these compounds will be strongly adsorbed to organic matter in soil and will not migrate to groundwater. However, PAHs strongly adsorb sunlight; therefore, PAHs on the soil surface will undergo photochemical degradation. PAHs are ubiquitous in the environment particularly next to roadways. PAHs are found in automobile exhaust bound to particulate matter and become deposited in soils. PAH concentrations were found in soils near highway interchanges ranging from 4,000 µg/kg - 8,000 µg/kg (Toxicological Profile for PAHs, Agency for Toxic Substances and Disease Registry, 1990).

Similarly, chlorinated pesticides (e.g., dieldrin and alpha-chlordane) and PCBs also have high Kow and Koc, low water solubility, high tendency to adsorb to soils, and biodegrade slowly. Chlorinated pesticides and PCBs are highly resistant to degradation in the environment because chlorine atoms attached to organic compounds stabilize the molecules. Organochlorine pesticides are generally resistant to leaching to groundwater.

PCBs are mixtures of congeners of 1 to 10 chlorines attached to the biphenyl rings (total of 209 chlorobiphenyl congener combinations). Based on their Kow, Koc, and water solubilities, PCBs adsorb strongly to soil and sediment particles. PCB adsorption to soil increases with the number of chlorines. The higher the chlorine content, the less mobile the PCBs are (i.e., unlikely to leach to groundwater) and the less likely they are to degrade. PCBs degrade by a combination of anaerobic and aerobic processes. The chlorines are removed anaerobically in a slow process first. Highly chlorinated PCB congeners are highly stable, and therefore, are resistant to degradation.

Under neutral pHs, metals tend to adsorb to the soil and are generally non-mobile. Thus, based on the fate and transport characteristics of the constituents of potential concern detected in the soils north of I-88, it is highly likely that the constituents will continue to adsorb to the surficial soils and will not migrate. Based on the data, minimal leaching of metals to groundwater appears to have occurred. In addition, the grass and vegetative cover on these soils significantly reduces the potential for the constituents of potential concern to become eroded and entrained in surface water runoff during heavy precipitation events.

In summary, the observed distribution of the chemicals of potential concern in soil and groundwater north of I-88 indicates a minimal potential to migrate in the environment. During the 30 to 40 years that have lapsed since the original releases of chemicals in facility wastewater to the environment, the site-related chemicals are still detected only in the upper soil horizons, and are not detected in shallow groundwater. Therefore, there is negligible risk that the chemicals of concern north of I-88 will migrate horizontally or vertically, or will contaminate the shallow groundwater.

5.2 Soils South of I-88

From 1955 through 1992, south of I-88 was the primary operating portion of the site used by the Tri-Cities Barrel Company. Historically, incoming drums were stored west and north of the former process buildings. The reconditioning process began by removing the tops of drums, if necessary, at the drum decapitation shed and then burning any residual materials present in the drums in the barrel burner (drum processing area). The remainder of the reconditioning process (e.g., shot blasting, washing, reforming, and repainting) were conducted inside the former process buildings. The reconditioned drums and empty polyethylene drums were generally stored east of the former process buildings. During the 1950s, wastewater was discharged north of the former process building and allowed to flow downslope to the portion of the site referred to as north of I-88. From the 1960s until 1980, wastewater was treated using a lagoon system that trended north-south (before the construction of I-88) and then east-west (following the construction of I-88). Some of these lagoons were located between the former process buildings and I-88.

Based on this summary of historical site operations alone, it is evident that south of I-88 was the primary area affected by former site operations. The RI sampling data confirm this observation. In fact, the constituents of potential concern in the soils south of I-88 include a diverse range of constituents with varied concentrations dependent on their location relative to the former operations.

5.2.1 Incoming Drum Storage Area

The former incoming drum storage area was located west of the former processing buildings and was the primary staging area for used drums arriving at the site for reconditioning.

5.2.1.1 Constituents of Potential Concern

Based on the comparison of the soil data to the ARAR levels and background concentrations, and the results of the baseline risk assessments, the following constituents of potential concern were identified in the soils of the former incoming drum storage area: VOCs (ethylbenzene, toluene, xylenes, acetone, 4-methyl-2-pentanone, tetrachloroethene, and trichloroethene), SVOCs (phenol, 2-methylphenol, 4-methylphenol, and 4 PAHs), pesticides (delta-BHC, dieldrin, endrin, heptachlor, heptachlor epoxide, alpha-chlordane, and gamma-chlordane), PCBs, and metals (antimony, barium, beryllium, chromium, cobalt, copper, iron, lead, mercury, nickel, silver, sodium, thallium, and zinc).

5.2.1.2 Persistence and Migration

The data indicate that the constituents of potential concern are present both in the surficial and subsurface soils to a depth of approximately 6 feet. The presence of site-related chemicals in the subsurface soils in the southwestern portion of this area may be due to possible leveling of this area using fill from the construction of I-88. According to Mr. Warner, the fill was placed to expand the storage capacity of the site. Thus, the vertical distribution of constituents detected in the subsurface soils is probably due to historical soil moving activities and may not be due to their mobility and fate and transport characteristics. The groundwater monitoring results for MW-5S, which is located at the downgradient edge of the former incoming drum storage area, indicate that Aroclor-1242 at 1.6 µg/l is the only organic compound that exceeds the groundwater ARARs. Iron and thallium have been detected in MW-5S at concentrations exceeding ARARs but at concentrations similar to background levels. Thus, negligible leaching of constituents of potential concern in the soils to groundwater is occurring. These data further indicate that site-related chemicals are restricted to the top 6 feet of soil and are not migrating appreciably though the clay-rich till. Overall, the monitoring data are consistent with the known historical, intensive use of this area as a storage area for incoming drums.

The observed conditions in the former drum storage area are generally consistent with the expected fate and transport characteristics of the constituents of potential concern. In general, the aromatic VOCs (toluene, ethylbenzene, and xylenes) have low Kow and Koc, are more soluble than SVOCs, and easily degrade by aerobic processes. Compared to aromatic hydrocarbons, chlorinated VOCs (tetrachloroethene and trichloroethene) have higher Kow and Koc, lower water solubilities, and tend to degrade slower and by more complex anaerobic and aerobic processes. Acetone and 4-methyl-2-pentanone are highly soluble in water, have a relatively low Kow and Koc, and biodegrade aerobically. These compounds are more soluble in water than the VOCs, and thus, are not expected to be retarded by adsorption to soil and are subject to leaching to the water table. Phenol, 2-methylphenol, and 4-methylphenol are slightly acidic SVOCs that are relatively soluble in water with low Kow and Koc. These phenolic compounds leach more readily than PAHs, organochlorine pesticides, and PCBs, but not as readily as aromatic and chlorinated hydrocarbons.

The site monitoring data show that while the aromatic and chlorinated hydrocarbons, acetone, 4-methyl-2-pentanone, and phenolic compounds are present in the surficial and subsurface soils, they are not present in MW5. This suggests that the clay-rich till soils are significantly minimizing the ability for these VOCs and SVOCs to migrate through the vadose zone and to be transported in the slowly moving groundwater flow system. PAHs, chlorinated pesticides (e.g., dieldrin and chlordanes), and PCBs have high Kow and Koc, low water solubility, high tendency to adsorb to soils, and biograde slowly. Given the fate and transport characteristic of PCBs, the detection of PCBs in the groundwater at MW5 is somewhat surprising, but may be a function of the concentration of PCBs in the subsurface soils near the water table (up to 150,000 µg/kg) and the presence of VOCs which may mobilize the PCBs. Additionally, given that only one PCB is present in the groundwater at a very low concentration (approximately one-half of a part per billion), negligible transport to groundwater has occurred which is consistent with expectation. Under neutral to slightly basic pHs, metals tend to adsorb to the soil and are generally immobile. The lack of metals as constituents of potential concern in the groundwater at MW5 supports this position.

Thus, based on the fate and transport characteristics of the constituents of potential concern detected in the soils within the former incoming drum storage area, it is highly likely that the site-related chemicals south of I-88 will continue to adsorb to the soils and will not migrate. In addition, the grass and vegetative cover on these soils significantly reduces the potential for the constituents of potential concern to become eroded and entrained in surface water runoff during heavy precipitation events.

5.2.2 Drum Processing Area

The former drum processing area was located west of and adjacent to the former processing building. This area included the drum decapitation shed and the barrel burner. A wide variety of constituents were detected in these samples at a wide range of concentrations. Given the former use of the area, the RI sampling results are not unexpected. The drum processing area was not subjected to fill activities and the soil profiles are relatively undisturbed.

5.2.2.1 Constituents of Potential Concern

Based on the comparison of the soil data to the ARAR levels and background concentrations and the results of the baseline risk assessments, the following constituents of potential concern were identified in the soils of the former drum processing area: VOCs (toluene, ethylbenzene, xylenes, acetone, 2-butanone, 4-methyl-2-pentanone, carbon tetrachloride, 1,1,1-trichloroethane, 1,1-dichloroethane, and trichloroethene), SVOCs (phenol, 2-methylphenol, 4-methylphenol, naphthalene, 2-methylnapthalene, dibenzofuran, bis(2-ethylhexyl)phthalate, diethylphthalate, and di-n-butylphthalate, and 13 PAHs), pesticides (heptachlor, aldrin, endosulfan II, dieldrin, endrin, alpha-chlordane, gamma-chlordane, 4,4'-DDD, and 4,4'-DDT), PCBs, and metals (antimony, barium, beryllium, calcium, chromium, cobalt, copper, lead, mercury, nickel, silver, sodium, thallium, and zinc).

5.2.2.2 Persistence and Migration

The data indicate that a myriad of constituents of potential concern are present in the surficial soils at high concentrations but are generally absent in the subsurface soils. Thus, negligible vertical transport of constituents of potential concern in the surficial soils to the subsurface soils is occurring. The lack of constituents of potential concern in the subsurface soils indicates that little potential exists for contaminant migration to the water table. Overall, the data are consistent with the known historical intensive use of this area for drum processing with surficial releases of chemicals.

The observed conditions are consistent with the expected fate and transport characteristics of the constituents of potential concern. Aromatic VOCs (toluene, ethylbenzene, and xylenes) have low Kow and

Koc, are more soluble than SVOCs, and easily degrade by aerobic processes. Compared to aromatic hydrocarbons, chlorinated VOCs (carbon tetrachloride, 1,1,1-trichloroethane, 1,1-dichloroethane, and trichloroethene) have higher Kow and Koc, lower water solubilities, and tend to degrade slower and by complex anaerobic and aerobic processes. Acetone, 2-butanone, and 4-methyl-2-pentanone are highly soluble in water, have a relatively low Kow and Koc, and biodegrade aerobically. These compounds are more soluble in water than the VOCs, and thus, are not expected to be retarded by adsorption to soil and are subject to leaching to the water table. Phenol, 2-methylphenol, and 4-methylphenol are slightly acidic SVOCs that are relatively soluble in water with low Kow and Koc. These phenolic compounds leach more readily than high molecular weight PAHs, organochlorine pesticides, and PCBs, but not as readily as aromatic and chlorinated hydrocarbons. The low molecular weight PAHs (naphthalene and 2-methylnapthalene) identified as constituents of potential concern in the former drum processing behave similar to phenols (relatively soluble in water with low Kow and Koc).

It is notable that while the aromatic and chlorinated hydrocarbons, acetone, 2-butanone, 4-methyl-2-pentanone, phenolic compounds, and low molecular weight PAHs are present in the surficial soils, they are not present in the subsurface soils. This suggests that the tight, clay-rich till soils are significantly minimizing the ability for these VOCs and SVOCs to migrate through the vadose zone.

Phthalates (bis(2-ethylhexyl)phthalate, diethylphthalate, and di-n-butylphthalate) are used primarily as plasticizers in the polymers industry to give plastics flexibility and are ubiquitous in the environment. In general, they have low solubility in water, high Kow and Koc. Thus, they have a tendency to strongly adsorb to soils and do not leach to groundwater. Similarly, PAHs, chlorinated pesticides (heptachlor, aldrin, endosulfan II, dieldrin, endrin, alpha-chlordane, gamma-chlordane, 4,4'-DDD, and 4,4'-DDT), and PCBs have high Kow and Koc, low water solubility, high tendency to adsorb to soils, and biograde slowly. Under neutral to slightly basic pHs, metals tend to adsorb to the soil and are generally immobile. The lack of phthalates, pesticides, PCBs, and metals as constituents of potential concern in the subsurface soils is consistent with their fate and transport characteristics.

In summary, based on the fate and transport characteristics of the constituents of potential concern detected in the soils within the former processing area and the low permeability of the surficial soils, it is highly likely that the constituents will continue to adsorb to the soils and will not migrate vertically. It is notable that this portion of the site lacks any appreciable vegetative cover; thus, the potential exists for erosion of the contaminated surficial soils during heavy precipitation events given the current condition of the site. Based on field observations, erosion does not appear to be occurring in this portion of the site.

5.2.3 Process Building Area

The former process building area included both the original concrete building and the pole barn. The main portion of the concrete block building was constructed in approximately 1955 and included the washing tanks, blaster unit, and paint booth. The office to the east and the smoke washing room to the west were added later as additions to the original concrete block building. The pole barn was constructed in approximately 1980 and was located north of the original building. Soil samples were collected within and around the former buildings.

5.2.3.1 Constituents of Potential Concern

Based on the comparison of the soil data to the ARAR levels and background concentrations and the results of the baseline risk assessments, the following constituents of potential concern were identified in the soils of the former process building area: VOCs (toluene, ethylbenzene, xylenes, acetone, 2-butanone, 1,2-dichloroethene, 1,1-dichloroethane, 1,1,1-trichloroethane, trichloroethene, tetrachloroethene, and vinyl chloride), SVOCs (phenol and 3 PAHs), pesticides (dieldrin, alpha-chlordane, and gamma-chlordane), PCBs, and metals (antimony, barium, beryllium, chromium, copper, lead, mercury, nickel, silver, sodium, thallium, and zinc).

5.2.3.2 Persistence and Migration

The data indicate that the constituents of potential concern are present in the surficial and subsurface soils, but that higher concentrations and more constituents are present in the surficial soils. Overall, the data are consistent with the model of historical, intensive use of this area as part of the drum reconditioning process.

The observed conditions are generally consistent with the expected fate and transport characteristics of the constituents of potential concern. Aromatic VOCs (toluene, ethylbenzene, and xylenes) have low Kow and Koc, are more soluble than SVOCs, and easily degrade by aerobic processes. Compared to aromatic hydrocarbons, chlorinated VOCs (1,2-dichloroethene, 1,1-dichloroethane, 1,1,1-trichloroethane, trichloroethene, tetrachloroethene, and vinyl chloride) have higher Kow and Koc, lower water solubilities, and tend to degrade slower and by complex anaerobic and aerobic processes. Acetone and 2-butanone are highly soluble in water, have a relatively low Kow and Koc, and biodegrade aerobically. These compounds are more soluble in water than the VOCs, and thus, are not expected to be retarded by adsorption to soil and are subject to leaching to the water table. Phenol is relatively soluble in water with low Kow and Koc. The presence of acetone, 2-butanone, 1,2-dichloroethene, and xylenes in the subsurface soils is consistent with the fate and transport characteristics of these compounds.

PAHs, chlorinated pesticides (dieldrin, alpha-chlordane, and gamma-chlordane), and PCBs have high Kow and Koc, low water solubility, high tendency to adsorb to soils, and biograde slowly. Under neutral to slightly basic pHs, metals tend to adsorb to the soil and are generally immobile. The lack of PCBs and metals as constituents of potential concern in the subsurface soils is consistent with their fate and transport characteristics. However, the presence of chlordanes at concentrations up to 1,300 μg/kg in the subsurface soils collected from a depth of 8-10 feet is somewhat surprising and contradicts the expectation based on their fate and transport characteristics.

In summary, based on the fate and transport characteristics of the constituents of potential concern detected in the soils within the former process building area and the low permeability of the surficial soils, it is highly likely that the constituents will continue to adsorb to the soils and will not migrate appreciably. Additionally, much of the soils in this portion of the site are covered by the concrete foundations of the former buildings. As a result, leaching of constituents in this area via infiltrating precipitation is minimized. The remaining soils not covered by the foundations are either covered with gravel or vegetation. Thus, the potential for the constituents of potential concern to become eroded and entrained in surface water runoff during heavy precipitation events is minimal.

5.2.4 Lagoon Area

The former lagoon area was located between the former pole barn and I-88 and included 3 lagoons that trended east-west across the site. These lagoons were closed (filled with clean fill) in 1980. The wastewater in the lagoons mixed with the fill as it was placed in each lagoon. Thus, constituents of potential concern are present both at the surface and in the subsurface soils. Furthermore, while the lagoons were closed in 1980, facility operations continued until approximately 1992. Thus, the manner in which the lagoons were closed and the operation of the site for over 10 years following closure of the lagoons are the likely explanations for the constituent concentrations detected in the surficial soils of the former lagoon area.

5.2.4.1 Constituents of Potential Concern

Based on the comparison of soil data to the ARAR levels and background concentrations, and the results of the baseline risk assessments, the following constituents of potential concern were identified in the soils of the former lagoon area: VOCs (toluene, ethylbenzene, xylenes, 4-methyl-2-pentanone, 1,1-dichloroethane, 1,1,1-trichloroethane, trichloroethene, tetrachloroethene, carbon tetrachloride, and methylene chloride), SVOCs (phenol, 4-methylphenol, 2-methylphenol, 2,4,5-trichlorophenol, 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, bis(2-ethylhexyl)phthalate, and diethylphthalate), pesticides (dieldrin, endrin, endosulfan I, heptachlor, heptachlor epoxide, 4,4'-DDD, 4,4'-DDE, alpha-chlordane, and gamma-chlordane), PCBs, and metals (antimony, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, mercury, nickel, selenium, silver, sodium, thallium, and zinc).

5.2.4.2 Persistence and Migration

The data indicate that the constituents of potential concern are present both in the surficial and subsurface soils. The presence of constituents of potential concern in these subsurface soils is likely a result of closing and filling the lagoons which were over 4 feet deep. Thus, any material in the bottom of the lagoon at the time of closure would now be positioned within the subsurface soils without any migration. The groundwater monitoring results for MW2S and MW3S, which are located within and along the downgradient edge of the former lagoons, indicate that transport of VOCs, phenolic compounds, naphthalene, heptachlor, and select metals to the shallow groundwater has occurred. Overall, the monitoring data are consistent with the known historical, intensive use of this area as lagoons that were later closed by filling with clean soil.

The observed conditions are consistent with the expected fate and transport characteristics of the constituents of potential concern. Aromatic VOCs (toluene, ethylbenzene, and xylenes) have low Kow and Koc, are more soluble than SVOCs, and easily degrade by aerobic processes. Compared to aromatic hydrocarbons, chlorinated VOCs (1,1-dichloroethane, 1,1,1-trichloroethane, trichloroethene, tetrachloroethene, carbon tetrachloride, and methylene chloride) have higher Kow and Koc, lower water solubilities, and tend to degrade slower and by complex anaerobic and aerobic processes. 4-methyl-2-pentanone is highly soluble in water, has a relatively low Kow and Koc, and biodegrades aerobically. This compound is more soluble in water than the other VOCs, and thus, is not expected to be retarded by adsorption to soil and is subject to leaching to the water table. Phenol, 4-methylphenol and 2-methylphenol are relatively soluble in water with low Kow and Koc. 2,4,5-Trichlorophenol is moderately soluble in water, but less soluble and has a higher Kow and Koc than 2-methylphenol. It will biodegrade aerobically in soil depending upon conditions (i.e., temperature, oxygen, micro-organisms). It will moderately adsorb to soil especially soils with high organic content (Howard, 1989).

Most of the phenolic compounds leach more readily than high molecular weight PAHs, organochlorine pesticides, and PCBs, but not as readily as aromatic and chlorinated hydrocarbons. 1,2,4-Trichlorobenzene is slightly soluble with moderate Kow and Koc values. It adsorbs readily to soils with organic carbon contents of 1 to 2 percent.

Phthalates (bis(2-ethylhexyl)phthalate and diethylphthalate) are ubiquitous in the environment. In general, they have low solubility in water, and high Kow and Koc. Thus, they have a tendency to strongly adsorb to soils and do not leach to groundwater. Similarly, chlorinated pesticides (dieldrin, endrin, endosulfan I, heptachlor, heptachlor epoxide, 4,4'-DDD, 4,4'-DDE, alpha-chlordane, and gamma-chlordane) and PCBs have high Kow and Koc, low water solubility, high tendency to adsorb to soils, and biograde slowly. Under neutral to slightly basic pHs, metals tend to adsorb to the soil and are generally immobile.

In comparing the soil data to the groundwater data, it is notable that the constituents present in the groundwater at MW2S and MW3S (aromatic hydrocarbons, chlorinated hydrocarbons, 2-butanone, and phenolic compounds) are expected based on their fate and transport characteristics. The presence of heptachlor in MW3S at a concentration of 0.089 μg/l contradicts expectation based on its fate and transport characteristics. However, given that it is present in the groundwater at a very low concentration (less than one-tenth of a part per billion), negligible transport to groundwater has occurred which is consistent with expectation. Furthermore, it is important to recognize that MW2S and MW3S were installed through (or immediately adjacent to) the former lagoons and the top of the well screens in these wells is within approximately 4 to 9 feet of the bottom of the former lagoons.

In summary, based on the fate and transport characteristics of the constituents of potential concern detected in the soils within the former lagoon area, some vertical migration of the VOCs and select SVOCs may continue to occur but the other constituents (phthalates, pesticides, PCBs, and metals) will largely continue to adsorb to the soils and will migrate little, if at all. It is notable that this portion of the site is vegetated; thus, little potential exists for erosion of the contaminated surficial soils during heavy precipitation events.

5.2.5 Downslope of Former Incoming Drum Storage and Lagoon Areas

The portion of the site located topographically downslope of the former incoming drum storage and lagoon areas includes the northwest portion of the site located south of I-88.

5.2.5.1 Constituents of Potential Concern

Based on the comparison of the soil data to the ARAR levels and background concentrations, and the results of the baseline risk assessments, the following constituents of potential concern were identified in the soils of the downslope area: 5 PAHs, one pesticide (dieldrin), PCBs, and metals (antimony, beryllium, lead, mercury, potassium, thallium, and zinc).

5.2.5.2 Persistence and Migration

The data indicate that the constituents of potential concern are present in the surficial soils but are generally absent in the subsurface soils. Thus, negligible transport of the limited constituents of potential concern identified in the surficial soils to the subsurface soils is occurring. The lack of constituents of potential concern in the subsurface soils indicates that little potential exists for contaminant migration to the water table. Overall, the data are consistent with the model for this area which is: it was not used as part of the site operations and had limited potential to be affected by runoff.

The observed conditions are generally consistent with the expected fate and transport characteristics of the constituents of potential concern. PAHs, dieldrin, and PCBs have high Kow and Koc, low water solubility, high tendency to adsorb to soils, and biodegrade slowly. Under neutral to slightly basic pHs, metals tend to adsorb to the soil and are generally immobile. The presence of dieldrin and PCBs as constituents of potential concern in the surficial soils and their absence in the subsurface soils is consistent with their fate and transport characteristics.

In summary, based on the fate and transport characteristics of the constituents of potential concern detected in the soils within the downslope area and the low permeability of the surficial soils, it is highly likely that the constituents will continue to adsorb to the soils and will not migrate appreciably. In addition, the grass and vegetative cover on these soils significantly reduces the potential for the constituents of potential concern to become eroded and entrained in surface water runoff during heavy precipitation events.

5.2.6 Reconditioned Drum Storage Area

The former reconditioned drum storage area was located east of the former processing buildings and was the primary staging area for reconditioned drums and empty polyethylene drums.

5.2.6.1 Constituents of Potential Concern

Based on the comparison of the soil data to the ARAR levels and background concentrations, and the results of the baseline risk assessments, the following constituents of potential concern were identified in the soils of the reconditioned drum storage area: 2 PAHs (benzo(a)anthracene and benzo(a)pyrene) and metals (beryllium, copper, lead, mercury, potassium, silver, and zinc).

5.2.6.2 Persistence and Migration

The data indicate that this portion of the site is significantly less impacted when compared to other portions of the site and that the constituents of potential concern are limited to the surficial soils. Thus, negligible, if any, transport of the limited constituents of potential concern identified in the surficial soils to the subsurface soils is occurring. The lack of constituents of potential concern in the subsurface soils indicates that little potential exists for contaminant migration to the water table. Overall, the data are consistent with the model for this area of it being used primarily for the storage of reconditioned drums.

The observed conditions are consistent with the expected fate and transport characteristics of the constituents of potential concern. PAHs generally have high Kow and Koc, low water solubility, high tendency to adsorb to soil, and biodegrade slowly. Under neutral to slightly basic pHs, metals tend to adsorb to the soil and are generally immobile. The presence of metals as constituents of potential concern in the surficial soils and their absence in the subsurface soils is consistent with their fate and transport characteristics. Based on the fate and transport characteristics of the constituents of potential concern detected in the soils within the reconditioned drum storage area and the low permeability of the surficial soils, it is highly likely that the constituents will continue to adsorb to the soils and will not migrate appreciably. It is notable that this portion of the site has sparse vegetative cover; thus, the potential exists, albeit minor, during heavy precipitation events for erosion of the surficial, metals-containing soils.

5.3 Soils South of Osborne Hollow Road

Based on a review of aerial photographs and discussions with Mr. Warner, the portion of the site south of Osborne Hollow Road was not part of the primary site operations and had limited use. The use of this approximately 1-acre parcel included the storage of approximately 100 empty drums and the storage of empty fiber drums and drum lids in the shed formerly located on this parcel. The empty drums, drum lids, and shed were removed from the site as part of the 1996 removal action.

5.3.1 Constituents of Potential Concern

Based on the comparison of the soil data to the ARAR levels and background concentrations, and the results of the baseline risk assessments, the following constituents of potential concern were identified in the soils south of Osborne Hollow Road: SVOCs (benzo(a)pyrene, benzo(a)anthracene, and benzo(b)fluoranthene), one pesticide (endrin), and metals (antimony, cadmium, lead, manganese, mercury, silver, and zinc). However, the concentrations of benzo(a)pyrene, benzo(a)anthracene, lead, and manganese detected in the samples are likely representative of background conditions for the area. It is also notable that the risk assessment concluded that the risk to future residents and current and future workers and visitors from exposure from the soil south of Osborne Hollow Road was negligible.

5.3.2 Persistence and Migration

The data indicate that the constituents of potential concern are largely restricted to the top 1 foot. For example, 8 compounds exceeded ARAR or background concentrations in the samples collected from a depth of 0-0.5 foot. Conversely, only 2 compounds (silver and mercury) exceeded ARAR or background concentrations in the samples collected from a depth of 2.5-3.0 feet. Antimony, cadmium, lead, mercury, silver, and zinc were not detected at concentrations exceeding ARARs in monitoring wells located south of Osborne Hollow Road which indicates leaching is unlikely.

In addition, except for a one time detection of 4,4'-DDE (0.031 µg/l), no organic compounds were identified in the groundwater samples collected from the wells located on this parcel (MW1, MW1SA, MW1B, MW8S, and MW8). The only metals identified in these wells above ARAR levels include iron, manganese, sodium, and thallium. However, these three metals are believed to be attributable to background conditions and not the former site operations. These data further indicate that the constituents of potential concern are restricted to the surficial soils and are not migrating though the clay-rich till soils. Overall, the data are consistent with the known limited use of this area for the storage of empty drums.

Furthermore, the observed conditions are consistent with the expected fate and transport characteristics of the constituents of potential concern. For example, high molecular weight PAHs (i.e., PAHs with 4 to 7 carbon rings; benzo(a)pyrene and benzo(a)anthracene) have high Kow and Koc, low water solubility, and biodegrade slowly (i.e., persistent). Similarly, chlorinated pesticides (e.g., endrin) have high Kow and Koc, low water solubility, high tendency to adsorb to soils, and biodegrade slowly. Under neutral to slightly basic pHs, metals tend to adsorb to the soil and are generally immobile. In summary, based on the fate and transport characteristics of the constituents of potential concern detected in the soils south of Osborne Hollow Road, it is highly likely that the constituents will continue to adsorb to the surficial soils and will not migrate. In addition, the grass and vegetative cover on these soils significantly reduces the potential for the constituents of potential concern to erode and become entrained in surface water runoff during heavy precipitation events.

5.4 Groundwater

Groundwater at the site is present in two distinct horizons, the unconsolidated, low permeability till deposits and the fractured bedrock. The unconsolidated water bearing zone consists of low permeability till with sand and gravel lenses. The prevalence of the sand and gravel lenses increases to the north, closer to Osborne Creek which was a former glaciated valley. Based on observations and data collected during the RI, the unconsolidated till deposits are dense, well compacted, have low permeability, and do not yield sufficient water to be used as a water supply. The thickness of the unconsolidated deposits ranges from 25 feet at the southern end of the site to more than 70 feet at the northern end of the site. The fractured bedrock serves as the water supply for the adjacent homes and formerly as the water supply for the operations at the site.

5.4.1 Constituents of Potential Concern

Based on the comparison of the groundwater data to the ARAR levels and background concentrations and the results of the baseline risk assessments, the following constituents of potential concern were identified in the groundwater: VOCs (benzene, toluene, ethylbenzene, xylenes, 2-butanone, chloroethene, 1,1-dichloroethane, cis-1,2-dichloroethene, 1,2-dichloroethane, 1,1,1-trichloroethane, trichloroethene, tetrachloroethane, methylene chloride, and vinyl chloride), SVOCs (phenol, 2-methylphenol, 4-methylphenol, 2,4-dichlorophenol, 2,4,5-trichlorophenol, 1,2-dichlorobenzene, 1,2-dichloropropane, naphthelene, and bis(2-ethylhexylphthalate), PCBs, pesticides (alpha-chlordane, 4,4'-DDE, and heptachlor), and metals (antimony, arsenic, cadmium, chromium, iron, lead, manganese, nickel, sodium, and thallium). However, iron, manganese, and sodium were detected in the upgradient wells at concentrations similar to those at the site and downgradient of former site operations (Table 5-1). In addition, these three constituents are present throughout the site. Thus, iron, manganese, and sodium are largely representative of background conditions.

Constituents of potential concern detected in the bedrock aquifer include 7 metals (antimony, arsenic, iron, mercury, manganese, sodium, and thallium). As indicated above, iron, manganese, and sodium are similar to background concentrations. The concentrations of the metals were based on total metal results. The dissolved concentrations of antimony, arsenic, mercury, and thallium are less than the total results and, as a result, may not be a concern.

5.4.2 Persistence and Migration

An evaluation of the site data indicates the following findings.

- Exceedences of organic ARARs were only detected in monitoring wells: MW-1, MW2S, MW2, MW3S, MW5S, MW12S, MW13S, P2, and P3.

- The detected concentrations of iron, manganese, and sodium are attributable to background conditions.

- Excluding iron, manganese, and sodium; antimony, arsenic, cadmium, chromium, lead, nickel, and thallium are the only metals detected in the groundwater above ARAR levels.

- Monitoring wells in which water quality standards have not been exceeded for organic compounds include: MW1S, MW1SA, MW1B, MW2B, MW6S, MW6, MW7S, MW7, MW8S, MW8, MW9S, MW9, MW10, MW10S, MW11S, MW14, MW14B, and P1.

- Only one constituent of potential concern (1,1,1-trichloroethane) was detected in P2. Other isolated areas containing only one organic constituent of potential concern include MW3 (phenol), MW5S (PCBs), MW12S and P3 (bis(2-ethylhexyl)phthalate), and MW13S (alpha-chlordane). It is notable that while the concentration of 1,1,1-trichloroethane exceeds the NYSDEC water quality criteria, it is less than the toxicology-based EPA MCL.

- Two monitoring locations that contain more than one constituent of potential concern include MW2S/MW2 and MW3S. A comparison of the data for the shallow wells (MW2S and MW3S) to the deeper monitoring wells (MW2 and MW3) indicates that the constituents of potential concern have not migrated appreciably in the vertical direction.

- No organic constituents of potential concern were detected in the out-of-service bedrock production well (MW4), in the adjacent homeowner water supply wells, or in the bedrock monitoring wells (MW1B, MW2B, and MW14B). These data further support the lack of vertical movement of constituents of potential concern. It is notable that MW4 was located in the center of the former site operations and very close to portions of the site with some of the highest concentrations of constituents in the soils, yet remains free of contamination. Furthermore, MW14B and MW2B are located adjacent to the former lagoons and on the downgradient edge of the former operational area.

- No constituents of potential concern were detected in the wells installed within the median of I-88 (MW9S/MW9 and MW10S/MW10) or in the wells located north of I-88 (MW6S/MW6 and MW7S/MW7). These well pairs are downgradient of MW2 and MW3 well pairs which contained the majority of the constituents of potential concern in the groundwater at the site. Thus, the data indicate that little horizontal migration of the constituents of potential concern has occurred over the past 40 years in the unconsolidated water bearing zone.

- Many of the VOC constituents of potential concern are breakdown products of primary chlorinated VOCs. These data suggest, but do not conclusively indicate, that degradation of the VOCs in the groundwater is occurring naturally.

The fate and transport characteristics of the constituents of potential concern are provided below. Aromatic VOCs (benzene, toluene, ethylbenzene, and xylenes; BTEX) have low Kow and Koc, are more soluble than SVOCs, and easily degrade by aerobic processes. Compared to aromatic hydrocarbons chlorinated VOCs (1,1-dichloroethane, cis-1,2-dichloroethene, 1,1,1-trichloroethane, trichloroethene, methylene chloride, and vinyl chloride), have higher Kow and Koc, lower water solubilities, and tend to degrade slower and by complex anaerobic and aerobic processes. 1,1,1-Trichloroethane (TCA), cis-1,2-dichloroethene (DCE), 1,1,-dichloroethane (DCA), and vinyl chloride are degradation products of TCE indicting that degradation by natural attenuation may be occurring at the site. The chlorines are removed by anaerobic microbes to final products of ethylene, ethane, and methane which are further degraded by aerobic processes to carbon dioxide and water. 2-Butanone is highly soluble in water, has relatively low Kow and Koc, and biodegrades aerobically. It is more soluble in water than the volatile aromatic hydrocarbons (BTEX compounds) and chlorinated VOCs (i.e., TCE and cis-1,2-DCE). As such, 2-butanone is not expected to be retarded by adsorption to soils and is subject to leaching into groundwater which is consistent with the data for this site. 2-Butanone is also not expected to bioconcentrate in aquatic organisms (U.S. EPA 1994).

In general, compared to other constituents of potential concern, VOCs have a higher tendency to migrate. However, the site data indicate that the VOCs either are not migrating because of the physical characteristics of the water bearing zone (e.g., low hydraulic conductivity) or the concentrations are attenuating by the time they reach the wells in the median of I-88 (approximately 100 feet downgradient).

Phenol, 2-methylphenol, and 4-methylphenol are slightly acidic SVOCs that are relatively soluble in water. Phenol is more soluble than 2-methylphenol and 4-methylphenol. Thus, phenol, 2-methylphenol, and 4-methylphenol would be expected to leach from soil to groundwater. In contrast, these phenolic compounds leach more readily than PAHs, organochlorine pesticides, and PCBs, but not as readily as the volatile BTEX compounds and chlorinated hydrocarbons. Bis(2-ethylhexyl)phthalate is part of the class of compounds known as phthalate esters, which are used primarily as plasticizers in the polymers industry to give plastics flexibility. They are ubiquitous in the environment. The greatest source of phthalate esters is from the degradation of PVC plastics. Bis(2-ethylhexyl)phthalate has low solubility in water, high Kow and Koc. Bis(2-ethylhexyl)phthalate in soil does not tend to leach to groundwater and when released to waters, biodegrades quickly after a period of accumulation, given its high Kow. Bis(2-ethylhexyl)phthalate has a tendency to strongly adsorb to soils and strongly partitions to clays. Howard (1989) reports a Koc value for bis(2-ethylhexyl)phthalate in soil from Broome County, New York, of greater than 87,000 mg/l. (Howard, 1989).

There is also a possibility that bis(2-ethylhexyl)phthalate is an artifact of the soil and groundwater sampling procedures. PVC gloves were worn by field personnel during the sampling events and isopropyl alcohol (IPA) was used as an equipment decontamination fluid. PVC gloves have high concentrations of phthalate esters, and bis(2-ethylhexyl)phthalate is extremely soluble in IPA. It is possible that during field sampling procedures this compound leached from the gloves. It is notable that the equipment blank collected on the same day as the groundwater sample from MW-12S also contained a detectable concentration of bis(2-ethylhexyl)phthalate supporting the hypothesis that its detection is an artifact of the sampling procedures.

Chlorinated pesticides (alpha-chlordane and heptachlor) and PCBs have high Kow and Koc, low water solubility, high tendency to adsorb to soils, and biodegrade slowly. Each of these constituents of potential concern were each only detected at one or two monitoring locations, and the concentrations of each were less than 0.6 µg/l (less than 1 part per billion). These data are consistent with the fate and transport characteristics for pesticides and PCBs.

Lastly, under neutral pHs, metals tend to adsorb to the soil and are generally immobile. Thus, the RI data are consistent with the general fate and transport characteristics for metals.

In summary, based on the physical characteristics of the water bearing zone, the RI data, and the fate and transport characteristics of the constituents of potential concern; the isolated areas of shallow groundwater contamination are not expected to migrate appreciably horizontally or vertically, and biodegradation of the VOCs in the groundwater may be occurring. In addition, given that the removal action is completed and the constituents of potential concern in soil will be addressed during the remedial action, improvement of the affected groundwater is expected over time. It is notable that only one primary area of affected groundwater exists -- MW2S and MW3S which are located within the former lagoons.

5.5 East Tributary

The entire length of the intermittent eastern tributary is outside the boundaries of the Tri-Cities Barrel site. The headwaters of the tributary originate in the vicinity of the D&H railroad tracks and flow through property that was formerly a junkyard, and under Osborne Hollow Road and I-88. No historical evidence exists indicating any discharge of site wastewaters to this tributary. It is important to note that the eastern tributary is located proximate to the former reconditioned drum storage area, which is generally free of organic constituents in the surficial soils. Furthermore, based on the topography of the site (Appendix E; topographic map with 2-foot contour intervals and site drainage depicted), the majority of the site (approximately 98.3 percent) drains toward the site and away from the eastern tributary. As indicated above, the portion of the site that falls within the drainage basin of the eastern tributary is essentially free of organic compounds.

5.5.1 Constituents of Potential Concern

Based on the comparison of the sediment data to the ARAR levels and background concentrations, and the results of the baseline risk assessments, the following constituents of potential concern were identified in the eastern tributary sediments: PAHs, PCBs, pesticides (alpha-chlordane, gamma-chlordane, heptachlor, and endrin aldehyde), and metals (lead and zinc). However, the concentrations of the PAHs, PCBs, heptachlor, lead, and zinc were detected at elevated concentrations in the upstream sample, SED20, which was collected from the parcel of land that was formerly a junkyard and is topographically upgradient of the site. The source of these constituents appears to be the former junkyard or possibly another offsite source (e.g., railroad), and is not likely to be the site. Thus, only the concentrations of alpha-chlordane, gamma-chlordane, and endrin aldehyde may be site related. It is notable that the concentrations of chlordane decrease downstream of the site. One surface water sample (SW7) was collected from the eastern tributary, and only the concentrations of barium and sodium exceeded the ambient water quality criteria. However, it is important to note that SW7 was located immediately adjacent to I-88; as a result, the sodium is likely related to the use of deicing agents during the winter months and is not site-related.

It is also notable that the risk assessment concluded that the total excess cancer risk estimated for the current and future visitor does not exceed 1E-04 for exposure to the surface water and sediment in

Osborne Creek and its tributaries. However, according to the ecological risk assessment, potential impacts to ecological receptors were identified. Specifically, ecological risks related to contaminated sediments in the eastern tributary are presented by pesticides (primarily chlordane), PCBs, and select PAHs. The ecological risk assessment also concludes that potential ecological risks associated with contaminated sediments were identified upstream of the site due to several metals, PAHs, PCBs and 4,4'-DDE, but these risks appear to be unrelated to past onsite activities.

5.5.2 Persistence and Migration

The eastern tributary is an intermittent stream, is located outside the boundaries of the site, never received wastewater discharges from the site, and appears to have been affected by upstream sources (i.e., railroad and former junkyard). The data indicate that the only possible, site-related constituents of potential concern in the sediments are the chlordanes and endrin aldehyde, and the concentrations decrease downstream of the site. Overall, the data are consistent with our understanding that this tributary did not receive wastewater discharges from the site.

The observed conditions are consistent with the expected fate and transport characteristics of the constituents of potential concern. For example, chlorinated pesticides (e.g., alpha-chlordane and gamma-chlordane) have high Kow and Koc, low water solubility, high tendency to adsorb to soils/sediment, and biodegrade slowly. Thus, based on the fate and transport characteristics of the constituents of potential concern detected in the sediments of the eastern tributary, it is highly likely that the constituents will continue to adsorb to the sediments. Because future releases to the eastern tributary will not occur, the ultimate fate of the residual chlordane in these sediments is erosion and dilution with downstream sediments during periods of heavy stream flow when sediment particles will be more likely to mix with the water column.

5.6 West Tributary

The intermittent western tributary is largely within the boundaries of the Tri-Cities Barrel site. The headwaters of the tributary originate in the vicinity of the D&H railroad tracks and flow through the Vail property and under Old Route 7 and I-88. It appears that wastewater from the lagoons was discharged to the western tributary.

5.6.1 Constituents of Potential Concern

Based on the comparison of the sediment data to the ARAR levels and background concentrations and the results of the baseline risk assessments, the following constituents of potential concern were identified in the western tributary sediments: PAHs, PCBs, pesticides (alpha-chlordane, gamma-chlordane, heptachlor, dieldrin, 4,4′-DDD, 4,4′-DDE, and toxaphene), and metals (manganese, iron, and mercury). However, the concentrations of the PAHs and manganese were detected at elevated concentrations in the upstream sample (SED4), and the concentrations of these constituents decrease dramatically downstream passing through the portion of the site south of I-88. As a result, manganese and PAHs (in part) appear to be from an offsite source(s) (e.g., house fire on Vail property, railroad, and Old Route 7/Osborne Hollow Road). The concentrations of PCBs, alpha-chlordane, gamma-chlordane, heptachlor, dieldrin, 4,4′-DDD, 4,4′-DDE, toxaphene, iron, and mercury in the western tributary sediments may be site related. It is notable that the constituents of potential concern are concentrated in the portion of the tributary south of I-88 (SED5), and that the concentrations of pesticides decrease downstream of this area. The concentrations of PAHs in the vicinity of SED5 may be attributable to both offsite source(s) and possibly onsite areas. One surface water sample (SW8) was collected from the western tributary at the same location as SED5. The concentrations of chlordane, aluminum, barium, iron, and sodium exceeded the ambient water quality criteria. It is important to note that SW8 was located immediately adjacent to I-88; as a result, the sodium is likely related to the use of deicing agents during the winter months and not the site.

It is also notable that the risk assessment concluded that the total excess cancer risk estimated for the current and future visitor does not exceed 1E-04 for exposure to the surface water and sediment in Osborne Creek and its tributaries. However, the ecological risk assessment identified potential impacts to ecological receptors. Ecological risks related to contaminated sediments in the western tributary were presented by chlordane, dieldrin, and PCBs, and to a lesser extent, by mercury. Ecological risks resulting from the presence in sediments of other metals plus PAHs also were identified in the ecological risk assessment; however, contribution to the ecological risks from these constituents was attributed primarily to offsite sources (i.e., many of the metals and PAHs were identified in the background sediment sample for the western tributary.

5.6.2 Persistence and Migration

The western tributary is an intermittent stream, reportedly received wastewater discharges from the site, and appears to have been affected, in part, by upstream sources (i.e., Vail house fire, railroad, and runoff from adjacent road surfaces). The data indicate that the site-related constituents of potential concern in the sediments are PAHs, PCBs, alpha-chlordane, gamma-chlordane, dieldrin, 4,4′-DDD, 4,4′-DDE, toxaphene, iron, and mercury and in the intermittent surface water are chlordane, aluminum, barium, and iron. Overall, the data are consistent with our understanding that the portion of the tributary south of I-88 received wastewater from the former lagoons and the concentrations attenuate downstream.

The observed conditions are consistent with the expected fate and transport characteristics of the constituents of potential concern. For example, PCBs and chlorinated pesticides (e.g., alpha-chlordane and gamma-chlordane) have high Kow and Koc, low water solubility, high tendency to adsorb to soils/sediment, and biodegrade slowly. The data indicate that these constituents are primarily present in the portion of the stream where the original release occurred. Much lower concentrations are present in the downstream samples, which may be the result of erosion of affected sediments. Under neutral to slightly basic pHs, metals tend to adsorb to the soil/sediment and are generally immobile. The data indicate that the pH of the surface water in the western tributary is 7.5, and the metals of potential concern, iron and mercury, are only present in SED5.

The concentrations of chlordane detected in the samples collected from SED5 at 2-3 feet and 5-6 feet are likely a result of the construction of I-88, which required the movement (cut and fill) of significant volumes of earthen material. SED5 is located near the point where the tributary enters the corrugated piping which extends under I-88. Based on the fate and transport characteristics of chlordane, it is likely that the chlordane concentrations were "buried" during the construction of I-88 rather than due to unaided constituent transport in the environment.

Given the concentrations of chlordanes and iron in SED5, the partitioning of 0.077 µg/l of chlordane and 408 µg/l of iron to the surface water is not unexpected.

In summary, based on the fate and transport characteristics of the constituents of potential concern detected in the surface water and sediments of the western tributary, it is highly likely that the constituents will continue to adsorb to the sediments. Furthermore, because future releases to the western tributary will not occur, the ultimate fate of the residual PCBs, pesticides, and metals in these sediments is erosion and dilution with downstream sediments.

5.7 Osborne Creek

During the time of direct discharges to the ground surface (i.e., 1950s), it is possible that wastewaters were discharged to Osborne Creek. In addition, both the eastern and western tributaries discharge to Osborne Creek which forms the northern boundary of the site. Osborne Creek is a gaining stream, flows all year, has flooded on several occasions, and supports aquatic life including beaver and fish.

5.7.1 Constituents of Potential Concern

Based on the comparison of the sediment data to the ARAR levels and background concentrations, and the results of the baseline risk assessments, the following constituents of potential concern were identified in Osborne Creek: manganese and nickel. However, the concentration of manganese in a background, upstream sample was slightly higher than the downstream concentration, indicating that elevated manganese concentrations are not site related.

Barium, sodium, and mercury were the only constituents identified as a potential concern in the surface water of Osborne Creek. It is important to note that Osborne Creek receives runoff from I-88; as a result, sodium is likely related to the use of deicing agents during the winter months and is not site-related. Mercury was only detected above the ARAR concentration in one sample collected from Osborne Creek.

Thus, the only constituents of potential concern for human exposure that may possibly be site-related are barium, mercury, and nickel. However, nickel was not identified as a constituent of potential concern in the tributary samples. It is also notable that the risk assessment concluded that the total excess cancer risk estimated for the current and future visitor does not exceed 1E-04 for exposure to the surface water and sediment in Osborne Creek and its tributaries. In addition, the ecological risk assessment did not conclude that potential ecological risks were attributed to site-related constituents in Osborne Creek.

5.7.2 Persistence and Migration

While it is possible that affected sediments from the tributaries may have been eroded and been deposited in Osborne Creek and that historical (1950s) discharges to Osborne Creek may have occurred, the past flooding of Osborne Creek and the high flow volume of Osborne Creek as compared to the tributaries would have caused significant downstream transport of any affected sediments and dilution of the residual concentrations. The data (no organic compounds detected at concentrations of concern) and the field observations (vital wildlife in the Creek) are consistent with the belief that if constituents of potential concern were discharged to the creek, they have since been diluted and transported downstream. Furthermore, the tributary sediment data indicate that significant attenuation of the concentrations has occurred in the downstream reaches (approximately 500 feet) of the tributary channels. Specifically, the concentrations of PCBs, pesticides, and metals detected in the tributaries near the site attenuate to low concentrations in the downstream tributary samples collected near the confluences with Osborne Creek. Thus, if constituents of potential concern were to have reached Osborne Creek, the concentrations would very likely have attenuated further than those in the downstream portions of the tributaries.

In summary, monitoring of Osborne Creek has not demonstrated the presence of predominant site-related chemicals (organic compounds). Given the 30 to 40 years that have lapsed since the site operations were begun, it appears that Osborne Creek is unaffected by site conditions.

5.8 Building

As indicated in Section 4.0 of this report, the buildings, equipment, and waste materials present in drums and within the buildings were removed from the site in the fall of 1996, as part of the time-critical removal action. Because all buildings and building materials have been removed, the building materials and associated constituents of potential concern detected in the building samples collected during the RI are no longer present. Thus, no current or future hazards to human health and the environment exist related to the former buildings.

6.0 Summary of Site Risks

A Baseline Human Health Risk Assessment Addendum to the Baseline Risk Assessment, and a Baseline Ecological Risk Assessment were prepared by Life Systems, Inc., an EPA contractor, to estimate the probability and magnitude of risks to human health and the environment from exposure to site contaminants. The human health and ecological risk assessments are summarized below.

6.1 Baseline Human Health Risk Assessment

The Baseline Human Health Risk Assessment (HHRA) and the Addendum to the HHRA estimate the magnitude of adverse human health effects from hypothetical exposure to contaminants associated with the site. The public health risk assessment followed a four step process.

- Contaminant identification summarized the hazardous substances of significant concern
- Exposure assessment evaluated actual or potential exposure pathways, characterized the potential exposed receptors, and determined the magnitude of possible exposure
- Toxicity assessment characterized the adverse health effects associated with high levels of exposure to hazardous substances
- Risk characterization integrated the three earlier steps to summarize the upperbound risks posed by the hazardous substances at the site

The institutional controls on future land use that have been implemented were not considered in the exposure assessment. As a result, the risk assessment is a conservative evaluation of hypothetical receptors and exposure pathways.

6.1.1 Contaminant Identification

A total of 46 compounds, found in Section 2.0 of the HHRA and Addendum reports, were identified as contaminants of potential concern and were evaluated in the HHRA. Table 2-4 of the Addendum report is provided in Appendix S of this report. Additional chemicals were eliminated as compounds of concern based on their low frequency of detection, risk-based screening, nutritional essentiality, and a comparison with background concentrations. Following EPA guidance, two exposure point concentrations of each contaminant of potential concern for each environmental medium were estimated, the average concentration and the lower of the 95 percent upper confidence interval on the arithmetic average, or the maximum concentration. Separate exposure point concentrations were estimated for the areas of concern north of I-88, south of I-88, and south of Osborne Hollow Road.

6.1.2. Exposure Pathways

Potential human exposures to the contaminants of potential concern were evaluated quantitatively or qualitatively through the development of several hypothetical exposure scenarios and pathways. The pathways involve hypothetical future industrial and residential uses of the site. The existing deed restriction forbidding future residential development of the site was not considered during the evaluation of plausible exposure scenarios. The following is a brief summary of the human exposure pathways evaluated. A more detailed description can be found in Section 3.0 of the HHRA and Addendum reports, and is summarized in Table 3-1 of the Addendum. A summary of the default human exposure parameters at the site is provided in Table 3-4 of the HHRA. The individual exposure pathways are described in the following sections.

6.1.2.1 Exposure to Contaminants in Soil

Direct contact with and inhalation of chemicals in surface soils were evaluated for hypothetical future workers, visitors, and residents at the site. The inhalation exposure pathway was evaluated for the area south of I-88 only and was not considered appropriate for the areas north of I-88 and south of Osborne Hollow Road (see Section 6.1.2.4). Although future construction workers can also be expected to contact soil during work activities, the construction worker exposure pathway was not evaluated because the short duration of exposure (several weeks or months) was judged to be minor when compared to other pathways with longer exposure duration.

6.1.2.2 Exposure to Contaminants in Groundwater

There is no municipal water supply at the site. Therefore, exposure to chemicals of potential concern in bedrock groundwater was evaluated. Current offsite residential populations use bedrock groundwater from private wells for household purposes (drinking, bathing, toilets, and laundry), and it was assumed in the HHRA that hypothetical future onsite residents could also install wells for household use.

Exposure to chemicals in bedrock groundwater was evaluated for hypothetical future onsite residents by the oral, dermal, and inhalation (off-gassing of volatiles to indoor air) routes. Exposure of hypothetical future onsite workers was evaluated for the oral route only.

6.1.2.3 Exposure to Contaminants in Surface Water and Sediments

Surface waters at the site include two intermittent streams on the east and west sides of the site, a man-made pond (former lagoon) north of I-88, and Osborne Creek. Site visitors and hypothetical future resident children were assumed to have sporadic contact with sediment and surface water during playing, wading, or similar activities. Exposure to chemicals through ingestion and dermal contact with surface water and sediments were evaluated.

6.1.2.4 Exposure to Contaminants in Outdoor Air

Based on available sampling data, the levels of volatile organics compounds in air are generally low, except in the portion of the site south of I-88. Emissions of volatiles from surface soil to ambient air were considered to be trivial north of I-88 and south of Osborne Hollow Road. Exposure to volatiles released from soil in outdoor air was modeled and evaluated quantitatively only for potential onsite populations south of I-88, which include current and future site visitors, hypothetical resident populations, and future workers.

6.1.2.5 Exposure to Contaminants in Fish and Game

Osborne Creek is shallow near the site and does not support an extensive sport fish population. Therefore, exposure to contaminants via frequent ingestion of fish caught in Osborne Creek is not plausible and was not evaluated in the HHRA. Ingestion of meat from game animals that forage on the site was also considered a minor part of the human diet and also was not evaluated in the risk assessment.

6.1.2.6 Exposure to Contaminants in Homegrown Vegetables

Chemical-specific uptake of contaminants into vegetables assumed to be grown under the future residential exposure scenario was evaluated. Default bioconcentration factors reported in the literature were used to conservatively estimate the concentrations of chemicals of potential concern in vegetables that would be grown in onsite surface soil. The homegrown vegetable exposure pathway is a conservative evaluation, as it does not incorporate the deed restriction on future residential use of the site, and does not use the site-specific data collected during the RI that demonstrated only minor uptake of chemicals of potential concern by onsite vegetation.

6.1.2.7 Exposure to Indoor Contaminants

Future site workers could be exposed to indoor contaminants by the inhalation and incidental ingestion pathways. However, these exposures are also part of the known occupational exposures of a worker in the workplace, and were not addressed in the HHRA. Furthermore, the buildings, drums, and waste materials have been removed from the site. Thus, this exposure scenario is no longer applicable.

6.1.3 Toxicity Assessment

A summary of health effects of each of the contaminants of potential concern for which quantitative toxicity information is available (i.e., reference dose or cancer potency factor) can be found in Section 4.0, Tables 4-1 through 4-3, and Appendix 5 of the HHRA report. Toxicity criteria for the chemicals of potential concern are obtained from the Integrated Risk Information System, (IRIS), the Health Effects Assessment Summary Tables (HEAST), and the EPA National Center for Environmental Assessment . For chemicals exhibiting noncarcinogenic effects, the EPA recommends using critical toxicity values based on verified RfDs and reference concentrations (RfCs). The RfD and RfC are estimates of the average daily exposure to a chemical that is likely to pose a negligible risk of adverse effects, even after a lifetime exposure by sensitive receptors. RfDs and RfCs have uncertainties that span at least an order of magnitude and are likely to overestimate potential risks to human health.

For the quantitative assessment of carcinogenic potential, the relevant toxicity criterion is the cancer slope factor. Cancer slope factors are derived from the results of animal bioassays or human epidemiological studies. Mathematical models are used to derive a conservative estimate of the upper limits on lifetime cancer risks. This means that the actual risks of contracting cancer from exposure to contaminants in environmental media at the site are unlikely to be higher than the risks estimated in this assessment, and may be considerably lower.

6.1.4 Risk Characterization

Excess lifetime cancer risks were determined for each exposure pathway by multiplying the average daily intake of carcinogenic chemicals of potential concern with the chemical specific cancer slope factor. The resulting risk estimates are expressed in scientific notation as a probability (e.g., 1E-06) and indicate (using this example) that an average individual is not likely to have greater than a one in a million chance of developing excess cases of cancer over 70 years as a result of site-related exposures. Current EPA practice considers carcinogenic risks from individual chemicals to be additive when assessing exposure to a mixture of hazardous substances.

The hazard index was also calculated for each pathway as EPA's measure of the potential for non-carcinogenic health effects. A hazard quotient is calculated by dividing the average daily intake by the RfD for an individual compound. The hazard quotient is often expressed as a single value (e.g. 0.3) indicating the ratio of the site-specific exposure to the RfD. In this example, the characterized exposure is approximately one third of the target exposure level for the given compound. The hazard quotient is only considered additive for compounds that have similar toxic endpoints and the sum of hazard quotients is referred to as the hazard index (HI). (For example: the hazard quotient for a compound known to produce liver damage should not be added to a second whose toxic endpoint is kidney damage).

6.1.4.1 Evaluation of Carcinogenic Risks

The following sections discuss the risk estimates with respect to the EPA's target regulatory risk range (excess cancer risks of 1E-04 to 1E-06). For carcinogenic risks, the EPA considers the lower bound (1E-06) to be the threshold of regulatory concern, and the upper bound (1E-04) is where remedial action is necessary. Specific compounds contributing significantly to the overall risk are also noted. A detailed discussion of risks characterized for the site is provided in Section 5.0 of the HHRA and Addendum reports and selected tables are included in Appendix S.

For all the exposure pathways that were evaluated south of Osborne Hollow Road, the estimated upperbound cancer risks to human health are less than 1E-04. Because the estimated excess risks are relatively low and below the regulatory threshold for remedial action, the portion of the site south of Osborne Hollow Road will not be discussed further.

6.1.4.1.1 Hypothetical Site Residents Total excess cancer risks for future site residents in the Processing Area south of I-88 were estimated to range from 3E-03 (average exposure concentration) to 2E-02 (upperbound exposure concentrations) (Section 5.0, Table 5-1 of the Addendum). Risks associated with the hypothetical ingestion of vegetables grown in the soil portion of the Processing Area south of I-88 contribute the major portion of the total pathway risks for this population. The individual chemicals in soil that are predicted to bioconcentrate in vegetables and contribute to excess cancer risks include polychlorinated biphenyls (PCBs), isomers of chlordane, polycyclic aromatic hydrocarbons (PAHs), and 2,3,7,8-tetrachchlorodibenzo-dioxin (TCDD). Potential upperbound risks presented by the bedrock groundwater pathways (oral, dermal, and indoor air inhalation) do not exceed the upper regulatory target of 1E-04.

Total excess cancer risks for future residents north of I-88 (North Area) from all exposure pathways (average and upperbound) are estimated to range from 3E-03 to 2E-02 (Table 5-1 of the Addendum). Consumption of homegrown vegetables containing PCBs, PAHs, and chlordane contribute the bulk of the risk (Table 5-1 of the Addendum). Exposure to bedrock groundwater is estimated to present excess cancer risks that do not exceed the regulation target of 1E-04.

The surface water and sediment exposure pathways were evaluated for site visitors only, and not for hypothetical future residents (Table 5-2 of the HHRA). However, the average and upperbound risks associated with exposure of site visitors to surface water and sediments (less than the upper regulatory target of 1E-04) could also be predictive of future exposures and risks for site residents.

6.1.4.1.2 Current and Future Workers and Visitors Total excess cancer risk was estimated for the future worker population in the area north of I-88, the Processing Area south of I-88, and south of Osborne Hollow Road. Average and upperbound exposures of workers to environmental media south of I-88 present excess cancer risks of 2E-05 to 8E-05 (Table 5-1 of the Addendum). North of I-88, workers exposed by all pathways (average and upperbound) presented maximum risks of 7E-05. In all cases, potential risks to occupational receptors did not exceed the upper regulatory target of 1E-04.

Total excess cancer risks for the future visitor populations in the areas north of I-88, south of I-88, and south of Osborne Hollow Road via the soil, outdoor air, surface water and sediment exposure pathways did not exceed the upper regulatory target of 1E-04 (Table 5-2 of the HHRA).

Total excess cancer risk estimated for the current and future visitor did not exceed the upper regulatory target of 1E-04 for surface water or sediment in Osborne Creek and the tributaries.

6.1.4.2 Evaluation of Noncancer Effects

The potential for noncancer effects from exposure to a chemical is evaluated by comparing the estimated average intake of the chemical with the RfD (Intake/RfD), which results in a noncancer hazard quotient (HQ). Individual HQs for each pathway are summed to derive the hazard index (HI). If the total HI for an exposure pathway is equal to or less than one, it is believed there is no appreciable risk that adverse noncancer health effects will occur. If an HI exceeds one, there is some possibility, but no certainty, that adverse noncancer effects could occur even for sensitive receptors. HI values for subchronic and chronic exposures were calculated for each exposure scenario evaluated at the site. A detailed discussion of noncarcinogenic effects is presented in Section 5.2 of the HHRA and Addendum reports.

6.1.4.2.1 Hypothetical Site Residents The chronic HI values were greater than one for hypothetical onsite residential receptors in the areas north and south of I-88 (Table 5-3 of the Addendum). The individual exposure pathways that exceeded an HI of 1 include ingestion of soil and homegrown vegetables and direct contact with soil. The major or contributing chemicals in soil include bis(2-ethylhexyl)phthalate, chlordanes, dieldrin, and PCBs. For child residents exposed to bedrock groundwater (antimony, arsenic, manganese, and mercury), the HI ranges from 2 (average) to 3 (upperbound), slightly exceeding the target of 1 (Table 5-2 of the Addendum).

6.1.4.2.2 Current and Future Workers and Visitors For hypothetical future workers, the HI values equal 1 for the areas north and south of I-88 (Table 5-3 of the Addendum). Contact with surface soil is the individual pathway that contributes significantly to the total pathway HI.

6.1.4.2.3 Noncancer Risks from Exposure to Lead Modeling performed for the HHRA to predict blood levels in children (0 to 6 years) suggested that hypothetical, onsite residential exposures to lead in soil could be a future concern if residences were established on the site. The predicted geometric mean blood lead level for a population of children exposed to surface soils in the Processing Area is 7.9 μg/dL, with 30 percent of the population predicted to have blood lead levels greater than 10 μg/dL (Table 5-6 of the Addendum). For a population of children exposed to surface and subsurface soil in the Processing Area, the predicted blood lead level is 6.6 ug/dL, with 18 percent of the population predicted to have levels greater than 10 ug/dL. 10 ug/dL of blood lead in 5% of the child population is the level of concern for blood lead in children under the EPA Superfund program.

6.1.4.3 Uncertainties

Each step of the risk assessment process has some associated uncertainty. Some of the uncertainties can result in overestimated or underestimated risk at the site. However, because conservative assumptions were generally made, it can be assumed that the site-specific risks are overestimated and the true risk is likely to be lower than the risks presented in the HHRA. For example, the primary potential risk associated with the site is based on hypothetical residential exposure, even though the site is a former industrial property and a deed restriction is in place to prevent future use of the site for residential purposes. Detailed descriptions of specific methodological uncertainties are presented in Section 6.0, Assessment of Uncertainties in the HHRA and Addendum reports.

6.1.4.4 Summary of HHRA

The EPA typically considers excess cancer risks within the range of 1E-04 and 1E-06 and noncancer HI values less than 1 to be acceptable. Section 7 of the Addendum summarizes the critical potential receptors and risks associated with the Tri-Cities Barrel site. Under the conditions and assumptions of the exposure scenarios selected for the site, upperbound, excess cancer risks exceed 1E-04 for the following receptors and pathways:

- Former Processing Area between I-88 and Osborne Hollow Road
    - hypothetical future resident: oral and dermal exposure to chemicals in soil; ingestion of vegetables grown in soil; oral, dermal, and inhalation exposure to till groundwater

- North of I-88
    - hypothetical future resident: oral and dermal exposure to chemicals in soil; ingestion of vegetables grown in soil; oral, dermal, and inhalation exposure to till groundwater

Exposure to bedrock groundwater does not present excess cancer risks exceeding the upper regulatory target. The chemicals in soil contributing to excess cancer risks exceeding the target of 1E-04 are lipophilic chemical that are assumed to bioconcentrate in vegetables; alpha- and gamma-chlordane, PCBs, PAHs, and 2,3,7,8-TCDD.

Under the conditions and assumptions of the exposure scenarios selected for the site, upperbound noncancer risks exceed 1 for the following receptors and pathways:

- Former Processing Area between I-88 and Osborne Hollow Road
    - hypothetical future resident: oral and dermal exposure to chemicals in soil, ingestion of vegetables grown in soil; oral, dermal, and inhalation exposure to till groundwater; and, ingestion of bedrock groundwater

- North of I-88
    - hypothetical future resident: oral and dermal exposure to chemicals in soil; ingestion of vegetables grown in soil; oral, dermal, and inhalation exposure to till groundwater; and ingestion of bedrock groundwater
    - hypothetical current and future visitor: oral and dermal exposures to soil and sediment

- South of Osborne Hollow Road
    - hypothetical future child resident: ingestion of soil and vegetables

None of the HQs for the chemicals in bedrock groundwater exceeded 1; however, the sum of the HQs for antimony, arsenic, manganese, and mercury resulted in an HI of 2 to 3, which slightly exceeds the regulatory target of 1. A comparison of the background and onsite concentrations of these compounds (Table A1-1 of the Addendum, presented in Appendix S) indicates that only manganese (0.19 to 0.29 mg/l) appreciably exceeded its maximum background concentration (0.079 mg/l). The low frequencies of detection for antimony, arsenic, and mercury in both the onsite and background samples indicate their presence may not be related to historical practices at the site.

The chemicals in soil that contributed to an elevated total pathway hazard index are bis(2-ethylhexyl)phthalate, alpha-chlordane, gamma-chlordane, and PCBs.

In summary, the hypothetical risks associated with the Tri-Cities Barrel site are primarily associated with direct contact with soil by residential receptors and uptake through the terrestrial food chain. Bedrock groundwater is not associated with appreciable risks. The small exceedance of the noncancer HI for groundwater is associated only with compounds that have a low frequency of detection and may not be site-related. Additionally, the HQ of individual constituents do not pose a concern; only the sum of the HQs indicates potential for risk. Furthermore, the analytical results are for total metals (dissolved plus metals adsorbed to solid particles) which overestimates the concentration that would likely be ingested from consumption of the bedrock groundwater. Future industrial use of the site is not identified with risks exceeding the regulatory targets.

6.2 Baseline Ecological Risk Assessment

A separate baseline ecological risk assessment (ERA) was performed to estimate the magnitude of potential adverse effects to ecological receptors from exposure to contaminants associated with the site. The ERA followed a four step process similar to the HHRA of contaminant identification, exposure assessment, toxicity assessment, and risk characterization.

6.2.1 Habitats

A vegetation and wildlife survey was conducted by Environmental Design & Research in 1994. The survey identified five plant communities that exist at the site that include deciduous forest, conifer plantation, shrub upland/old field, stream and floodplain, and wetlands. A detailed discussion of each of these five areas is provided in Section 2.5 and Appendix 2 of the ERA and in Section 3.8 of this report.

The area north of I-88 is heavily vegetated with trees and shrubs, and grasses and weed species are present in the area of the seasonal man-made pond (former lagoon). The area south of Osborne Hollow Road is also vegetated with stands of weed species and woody shrubs. In contrast, the portion of the site south of I-88 is physically disturbed by historical industrial activities and site cleanup, and contains several unvegetated areas covered with gravel, coarse dirt, and foundations of former structures. The eastern and western borders of the area south of I-88 are dominated by large weed growth and stands of secondary growth trees near the seasonal tributaries.

Seasonal tributaries are present along the eastern and western borders of the site. Wetland vegetation is associated with both tributaries and the man-made pond. Osborne Creek is the only major water feature near the site, and flows in a westerly direction along the north border of the site. The creek flows into the Chenango River approximately 1 mile downstream.

6.2.2 Evaluation of Site Stressors (Chemicals of Concern)

A stressor is defined as any physical, chemical, or biological entity that can induce an adverse effect. Adverse effects can encompass a range of disturbances from morbidity and mortality in an individual or population, to a loss of ecosystem function. For an adverse ecological effect to occur, there must be a stressor capable of inducing an adverse effect and that stressor must co-occur with an ecological receptor long enough and at a sufficient level to result in a response.

A total of 123 chemicals were detected in at least one sample collected from site media, as described in Appendix 1 of the ERA. Sample results from several different media at the site, including soil, groundwater, surface water and sediment, plants, and earthworms, are summarized in this RI. Contaminants of potential concern were evaluated either quantitatively (chemicals that have benchmarks) or qualitatively (chemicals for which no benchmarks are available). A list of contaminants of potential concern is provided in Tables 2-2 and 2-3 of the ERA. These tables are provided as Appendix T of this report. Individual compounds were eliminated as chemicals of potential concern if they were not detected in any sample or if they were present at levels below a risk-based screening concentration (RBSC), as described below:

- RBSC values for chemicals in soil were calculated based on a shrew food chain exposure model (Appendix 4 of the ERA)

- Chemicals in surface water were evaluated using the EPA chronic ambient water quality criteria or were compared to values calculated using the Great Lakes Water Quality Initiative Tier II methodology (Section 2.3 of the ERA). These surface water criteria are protective of a wide variety of aquatic organisms.

- Chemicals detected in sediments were evaluated using the EPA Sediment Quality Criteria or effects ranges published in the literature (Section 2.3 of the ERA).

The dominant chemical fate and transport processes involve adsorption to soil, sediments, and aquifer materials. Chemicals detected in both surface and subsurface soil appear to be relatively immobile. Contaminants detected in stream sediments were likely deposited by overland flow or runoff containing soil particulates or via former discharges of wastewater to the streams. Dissolved chemicals in surface water were generally not detected, with the exception of chlordane in one surface water sample. The presence of multiple chemicals with high Kow (octanol/water coefficient) values in soil and sediments and the presence of constituents in plants and earthworms suggest that food chain transfer is theoretically possible.

In addition to the chemical stressors at the site, there are also physical stressors that were not fully evaluated in the ERA. The habitats at the site have been modified due to past farming, former industrial operations, and the construction of I-88. In addition, the intermittent nature of the two tributaries and the man-made pond (former lagoon) prevent the sustainment of aquatic populations. The impacts of these physical stressors were not evaluated in the ERA, but it should be recognized that habitat disturbance can contribute to adverse effects in individual receptors and populations. These physical stressors can have as much or more impact on ecological receptors as do chemical stressors, and are associated with all forms of development.

6.2.3 Exposure Assessment

The maximum concentrations of the chemicals of potential concern detected in shallow soils were conservatively used to represent each exposure point.

Organisms present at the site that could be potentially exposed to contaminated media include:

- plants growing in contaminated soil
- soil and aquatic invertebrates
- transient and resident wildlife (amphibians, reptiles, mammals, and birds)
- fish in Osborne Creek

Terrestrial populations were evaluated in the ERA for exposure to surface soil and foraging of onsite vegetation. Aquatic populations can come in contact with surface water and sediments in the tributaries, Osborne Creek, and in the man-made pond; however, Osborne Creek is the only viable surface water feature at the site. The exposure routes that were evaluated included the following:

- direct contact with and absorption of contaminants in surface water, sediment, and soil
- uptake of contaminants from soil (plants, invertebrates)
- ingestion of contaminated surface water, sediment, and soil
- ingestion of contaminated organisms, both plants and animals (food chain accumulation)

An evaluation of chemicals of potential concern, their concentration in different media, and their likely fate and transport determined that the pathways of major importance are those involving exposure to contaminants in soil and from food chain transfer and accumulation. Inhalation of volatiles and dermal contact with soil were considered minor pathways for terrestrial receptors by comparison to food chain accumulation. It was determined that the surface water exposure pathways were also relatively minor based on the intermittent nature of the tributaries and the lack of detected constituents in Osborne Creek.

6.2.4 Evaluation of Adverse Ecological Effects

Adverse impacts to organisms exposed to chemicals of potential concern include direct toxicity (reduced survival, increased mortality); sublethal effects such as physiological changes, reduced growth and reproduction, tissue anomalies; changes in behavior due to presence of contaminants; and increased susceptibility to predation and disease as a result of sublethal effects. Chemicals of potential concern can also be transferred to higher trophic levels by bioaccumulation and biomagnification, causing toxic effects in organisms that do not have direct contact with environmental media at the site. Indirect effects presented to higher trophic level organisms may include adverse changes in population characteristics or resident species (e.g., changes in species composition, diversity, and food web complexity) and reduced biomass and productivity.

Appendix 3 of the ERA provides chemical-specific hazard assessments for onsite organisms. Where specific data were not available, toxicity data for surrogate test species were evaluated. Because species-specific toxicity information and chronic studies are often lacking, it is typically necessary to develop toxicity reference values by extrapolating from available information. The methodology used to develop toxicity reference values is discussed in detail in Section 3.0 of the ERA. Critical toxicity data are summarized in Tables 3-5 through 3-8 of the ERA and are presented in Appendix T.

6.2.5 Screening Level Risk Characterization

The hazard quotient (HQ) methodology was used to interpret the results of most of the approaches presented in the ERA. An HQ is the ratio of a potential exposure level to an ecotoxicity value or benchmark. An HQ greater than 1 indicates an increasing potential for contaminants to cause adverse effects in exposed receptors.

6.2.5.1 Soil Toxicity to Terrestrial Plants

The potential for soil toxicity to terrestrial plants was evaluated by comparing monitored soil concentrations to values reported in the literature as being toxic to plants (Table 4-1 of ERA, Appendix T). If the concentration of a chemical in a site soil sample was less than a literature phytotoxic concentration, no adverse impacts related to phytotoxicity were expected to occur at that location. Due to a lack of relevant information concerning phytotoxic levels for most organic compounds, screening-level estimates could not be developed for organic chemicals of potential concern. There was a potential for plants growing at the site to exhibit signs of phytotoxicity for each metal evaluated except selenium, nickel, and vanadium. Most exceedances occurred in the area south of I-88 and were not widespread. South of Osborne Hollow Road, antimony, cadmium, lead, manganese, mercury, silver, and zinc were determined to be of ecological concern. In the soils north of I-88, only manganese, mercury, thallium, and zinc were reported at levels considered to be phytotoxic.

In contrast to the literature-reported phytotoxic concentrations, the ecological survey performed for the site and summarized in the ERA did not document any observed areas of chemically-stressed vegetation. With the exception of the physically-disturbed areas near the former process buildings, vegetative cover appeared to be healthy. The physical disturbances associated with the former industrial/commercial activities south of I-88 were identified in the ERA as a more likely significant stressor than the chemical soil contamination.

6.2.5.2 Invertebrate Toxicity

Although there was limited site-specific data characterizing soil invertebrates, data for some of the chemicals of potential ecological concern (metals and dioxin) were evaluated for soil invertebrates considered likely to be present (Table 4-2 of ERA, Appendix T). A comparison of invertebrate toxicity values found in the literature to the soil monitoring data revealed that seven metals, chlordane, and dioxin could be toxic to soil invertebrates. No information was available on other chemicals of potential concern.

6.2.5.3 Sediment Toxicity

For the west tributary, HQs for sediments are summarized in Table 4-3 of the ERA (Appendix T). Exceedances of arsenic, manganese, mercury, zinc, several PAHs, and chlordane were estimated for sediment benchmarks at the background sediment sample location (SED-4). The ERA concluded that this sample point appears to be impacted by offsite sources because the levels of PAHs drop dramatically downstream passing through the portion of the site south of I-88. The potential for toxicity to aquatic organisms was determined to increase downstream, however, due to the presence of pesticides, mercury, and PCBs.

For the east tributary, HQs are summarized in Table 4-4 of the ERA (Appendix T). Background sediment samples from this tributary indicated that offsite sources may be affecting sediment quality because concentrations of all chemicals of potential concern detected in sediment generally decrease downstream of the background sampling location. HQ values for samples collected from the east tributary indicated cadmium, copper, lead, zinc, 4,4'-DDE, dieldrin, endrin aldehyde, chlordane, some PAHs, and total PCBs with HQ values greater than 1.

In the former lagoon north of I-88, the highest estimated HQ values were for PCBs and chlordane, as shown in Table 4-5 of the ERA (Appendix T). DDE/DDD were present in levels of potential concern for potential resident aquatic species and terrestrial receptors that feed on them. HQ values estimated for some metals and bis(2-ethylhexyl)phthalate were also slightly elevated in some sediment samples taken from this former lagoon.

In Osborne Creek, HQ values for manganese and nickel slightly exceeded an HQ of 1 for one sample collected downstream of the site. However, the concentration of manganese in a background, upstream sample was higher than the downstream sample concentration (Table 4-35 of RI), indicating that elevated manganese concentrations are not site-related.

6.2.5.4 Surface Water Toxicity

Alpha and gamma-chlordane were detected in one sample from the west tributary just south of I-88. The HQ for chlordane in the west tributary was estimated to be approximately 15. Carbon disulfide was detected in two locations in Osborne Creek; however, no verified surface water benchmark exists for carbon disulfide. Barium is the only inorganic chemical that exceeded its surface water benchmark in all surface water samples (Table 4-32 of RI).

6.2.5.5 Soil Ingestion and Food Chain Toxicity

Exposure of terrestrial wildlife by soil ingestion and food chain uptake was considered to be a complete exposure pathway. The herbivore food chain was evaluated using the Eastern cottontail rabbit (Sylvilagus floridanus) consuming plant material and associated soils while feeding in areas where shallow soils were sampled during the RI. The screening level calculations indicated that HQs for herbivorous mammals exceed 1 for several metals, PAHs, pesticides, and PCBs (Table 4-7 of the ERA, Appendix T).

South of I-88, all metals evaluated had HQ values greater than 1, and the HQ for lead (including the background samples) was significantly higher than any other chemicals of potential concern. Organic compounds appear to be a potential concern both south of I-88 and north of I-88. South of I-88, several PAHs, PCBs, and pesticides were evaluated at exposure point concentrations that resulted in an HQ above 1. North of I-88, PCBs and dieldrin were found to be a potential concern. The extent to which contaminants of potential concern transfer to trophic levels higher than a primary herbivore was not determined in the ERA.

The omnivore food chain was determined through the evaluation of an American robin (Turdus migratorius) eating a mixed diet of fruits and invertebrates. The ERA (Appendix T) used site-specific sample data from the plant and earthworm samples collected during the Phase II of the RI. Table 4-8 of the ERA summarizes the HQ values. Based on the evaluation, the ERA determined that food chain transfer of PCBs, chlordane, and dieldrin could affect bird populations that forage onsite.

The ERA also qualitatively addressed the uptake of chemicals by aquatic organisms from sediment and surface water contaminants. Of the chemicals detected in sediment and surface water samples, pesticides and PCBs were qualitatively determined to have the potential to bioaccumulate in aquatic species. The potential magnitude of uptake of contaminants by aquatic organisms and the potential for adverse impacts was not quantified in the ERA.

6.2.5.6 Uncertainties

Uncertainties in the ERA primarily include the selection (and elimination) of chemicals of potential ecological concern, inability to evaluate some chemicals due to lack of data regarding ecotoxicity for specific chemicals, conservative estimates of exposure, and conservative estimates of toxicity to wildlife.

The extent to which exposure of receptors actually occurs at the site is likely to be one of the larger uncertainties. Assumptions regarding onsite foraging were very conservative and likely overestimated exposures due to the assumption that receptors restricted their range only to the areas of concern and obtained food only from onsite sources. The assumed bioavailability of soil contaminants (100%) at the site also overestimates risks posed by contaminants to the ecological receptors. A discussion of uncertainties is also presented in Section 4.7 of the ERA.

6.2.5.7 Summary of ERA

Under the conditions and assumptions of the ERA, worst-case screening evaluations of chemicals detected in environmental media at the site indicate that a potential for adverse impacts could occur for exposed ecological receptors. As summarized in Tables 5-1 and 5-2 of the ERA (included in Appendix T), the following chemicals are a potential concern:

- lead, pesticides (primarily chlordane), and PCBs in soil south of I-88
- PCBs in soil north of I-88
- pesticides (primarily chlordane), PAHs, and PCBs in sediments in the west and east tributaries and the former lagoon north of I-88

The chemicals and environmental media of concern for ecological receptors are similar to those identified for human receptors. Conservative screening level evaluations of chemicals in environmental media present evidence that chemically exposed ecological receptors could be at risk for adverse health effects and deserve remedial consideration.

7.0 RI Summary and Conclusions

The RI was conducted in 4 phases from July 1993 through December 1997, and included the installation of 22 monitoring wells and 3 piezometers and the collection of groundwater, soil, surface water, sediment, ecological, air, and building material samples. The data objectives established for this RI were accomplished including:

- the constituents of concern were identified
- source areas were identified and characterized
- the extent of constituents of concern in the various environmental media (soil, sediment, surface water, groundwater, plants, and wildlife) were characterized
- the depth to bedrock beneath the site and groundwater quality of the bedrock aquifer were determined
- the hydrogeology (direction and rate of groundwater flow) of the unconsolidated water bearing zone was characterized
- potential exposure pathways and potential receptors were identified for the constituents detected in the site media

The investigation of the site was divided into 3 primary spatial areas: north of I-88, south of I-88 (between Osborne Hollow Road and I-88), and south of Osborne Hollow Road. Because the majority of the former operations were conducted on the parcel south of I-88, this area was further subdivided for discussion purposes into the former incoming drum storage area, the former drum processing area, the former process building area, the former lagoon area, the land downslope of the former incoming drum storage and lagoon areas, and the former reconditioned drum storage area.

7.1 Summary

This section summarizes the constituents of potential concern and their extent within each media at the site. This information is also presented in tabular form on Table 7-1. The approximate extent of soils affected by site-related organic compounds are presented on Figure 7-1. The horizontal and vertical extent of organics in groundwater are presented on cross sections A-A' and D-D' (Figure 7-2). Cross section A-A' trends north-south, and cross section D-D' trends east-west.

7.1.1 Soils North of I-88

The constituents of potential concern in the soils north of I-88 include: SVOCs (2-methylphenol and benzo(a)pyrene), PCBs, pesticides (dieldrin and alpha-chlordane), and metals (arsenic, beryllium, lead, manganese, mercury, silver, sodium, thallium, and zinc). However, the concentrations of benzo(a)pyrene, lead, and sodium detected in the samples are representative of background conditions for the area. The sampling locations containing constituent concentrations above ARARs are either within the former lagoon or the former surficial discharge drainage pattern. A comparison of the samples collected in and near the former lagoon to the generic sediment criteria indicates the following additional constituents may pose a concern: heptachlor epoxide, heptachlor, gamma-chlordane, dieldrin, PCBs, and manganese. It is notable that no organic constituents were detected at concentrations of potential concern in the right-of-way of I-88. Furthermore, in general, the concentrations are higher in the shallow surficial soils (less than 1 foot) compared to the deeper surficial soils (2-3 feet). Based on these results, it is evident that the concentrations of pesticides and PCBs that may potentially pose a concern are generally restricted to the top 2 feet or less.

For the subsurface soil samples collected north of I-88, only the concentration of mercury in one sample (MW-9) exceeds the NYSDEC ARAR. Based on these results, it is evident that the former lagoon and the former surficial discharge drainage pattern have not affected the subsurface soils north of I-88. Thus, the constituents of potential concern are restricted to the surficial soils and are not migrating though the clay-rich till soils. Overall, the data are consistent with the known historical (30 to 40 years ago), surficial releases of wastewater to the soils north of I-88.

7.1.2 Soils South of I-88

7.1.2.1 Former Incoming Drum Storage Area

The constituents of potential concern in the soils of the former incoming drum storage area include: VOCs (ethylbenzene, toluene, xylenes, acetone, 4-methyl-2-pentanone, tetrachloroethene, and trichloroethene), SVOCs (4 PAHs, phenol, 2-methylphenol, and 4-methylphenol), pesticides (delta-BHC, dieldrin, endrin, heptachlor, heptachlor epoxide, alpha-chlordane, and gamma-chlordane), PCBs, and metals (antimony, barium, beryllium, chromium, cobalt, copper, iron, lead, mercury, nickel, silver, sodium, thallium, and zinc). It is notable that VOCs were not present at concentrations of potential concern in the surficial soil samples; they were only present in the shallow subsurface samples (5 feet and less). Furthermore, of the 12 subsurface soil samples collected within the former incoming drum storage area, the affected samples were collected from the southwestern portion of the incoming drum storage area, and except for one, all were collected from a depth of 6 feet or less.

The data indicate that the constituents of potential concern are present both in the surficial and subsurface soils to a depth of approximately 6 feet. The presence of constituents of potential concern in the subsurface soils in this portion of the site may be due to leveling of this area using fill from the construction of I-88. The groundwater monitoring results for MW5, which is located at the downgradient edge of the former incoming drum storage area, indicate that negligible transport of constituents of potential concern in the soils to groundwater is occurring. These data further indicate that the constituents of potential concern are restricted to the top 6 feet and are not migrating appreciably though the clay-rich till soils. Overall, the data are consistent with the known historical, intensive use of this area as a storage area for incoming drums.

7.1.2.2 Former Drum Processing Area

The constituents of potential concern in the soils of the former drum processing area include: VOCs (toluene, ethylbenzene, xylenes, acetone, 2-butanone, 4-methyl-2-pentanone, carbon tetrachloride, 1,1,1-trichloroethane, 1,1-dichloroethane, and trichloroethene), SVOCs (13 PAHs, phenol, 2-methylphenol, 4-methylphenol, naphthalene, 2-methylnapthalene, dibenzofuran, bis(2-ethylhexyl)phthalate, diethylphthalate, and di-n-butylphthalate), pesticides (heptachlor, aldrin, endosulfan II, dieldrin, endrin, alpha-chlordane, gamma-chlordane, 4,4'-DDD, and 4,4'-DDT), PCBs, and metals (antimony, barium, beryllium, calcium, chromium, cobalt, copper, lead, mercury, nickel, silver, sodium, thallium, and zinc). In general, the most affected samples were those collected within the center of the area. The samples collected along the edge of the area contained lower concentrations and only had ARAR exceedences for pesticides, PCBs, and metals. Thus, the surficial soils in the former drum processing area, especially those in the center of the area and adjacent to the former barrel burner and drum decapitation shed, have been affected by former site operations.

No VOCs, SVOCs, pesticides, or PCBs were detected at concentrations above ARAR levels in the subsurface soil samples collected from the former drum processing area. Only the concentrations of 5 metals (beryllium, lead, mercury, thallium, and zinc) were detected above the background concentrations. It is notable that the 6 subsurface soil samples were all collected from the center portion of the former drum processing area which, based on the surficial soil sampling results, was the most impacted part of this area. Thus, the data indicate that a myriad of constituents of potential concern are present in the surficial soils at high concentrations, but are generally absent in the subsurface soils indicating negligible transport of constituents of potential concern in the surficial soils to the subsurface soils. The lack of constituents of potential concern in the subsurface soils also indicates that little potential exists for contaminant migration to the water table. Additionally, the data indicate that the tight, clay-rich till soils are significantly minimizing the ability for constituents of potential concern to migrate through the vadose zone. Overall, the data are consistent with the known historical, intensive use of this area as a drum processing area with surficial releases in this work area.

7.1.2.3 Former Process Building Area

The constituents of potential concern in the soils of the former process building area include: VOCs (toluene, ethylbenzene, xylenes, acetone, 2-butanone, 1,2-dichloroethene, 1,1-dichloroethane, 1,1,1-trichloroethane, trichloroethene, tetrachloroethene, and vinyl chloride), SVOCs (3 PAHs and phenol), pesticides (dieldrin, alpha-chlordane, and gamma-chlordane), PCBs, and metals (antimony, barium, beryllium, chromium, copper, lead, mercury, nickel, silver, sodium, thallium, and zinc). The results of the surficial soil samples collected from this area indicate that 9 of the 11 VOCs were detected at concentrations exceeding ARARs in only 1 sample which is located below the concrete floor of the pole barn. None of the concentrations of VOCs detected in the other process building surficial samples exceeded the ARAR concentrations. The PAHs and phenol detected in the surficial soils may be attributable to former site operations. The pesticides and PCBs detected in the surficial soils were present in one of the two samples collected adjacent to the former drum processing area. The concentrations of metals above the background concentrations were detected in eight samples. Based on the surficial sampling results, the primary areas of potential concern within the former process building area include below the pole barn and near the former drum processing area.

Four VOCs and 2 pesticides were detected at concentrations exceeding ARARs in the subsurface soils samples. The samples with concentrations of VOCs or pesticides exceeding ARARs were located north and east of the exterior walls of the former pole barn, and below the concrete floor of the former pole barn. Silver, thallium, and sodium were the only metals detected in the subsurface soil samples that exceeded the background levels. Furthermore, it is notable that except for silver, the samples collected near the bottom of the unconsolidated deposits (depths of 40 to 42 feet and 46 to 47.3 feet) contained no constituents above ARAR or background levels. In summary, the data indicate that the constituents of potential concern are present in the surficial and subsurface soils but that higher concentrations and more constituents are present in the surficial soils. Additionally, much of the soils in this portion of the site are covered by the concrete foundations of the former buildings. As a result, leaching of constituents in this area via infiltrating precipitation is minimized. Overall, the data are consistent with the known historical, intensive use of this area as part of the drum reconditioning process.

7.1.2.4 Former Lagoon Area

The constituents of potential concern in the soils of the former lagoon area include: VOCs (toluene, ethylbenzene, xylenes, 4-methyl-2-pentanone, 1,1-dichloroethane, 1,1,1-trichloroethane, trichloroethene, tetrachloroethene, carbon tetrachloride, and methylene chloride), SVOCs (phenol, 4-methylphenol, 2-methylphenol, 2,4,5-trichlorophenol, 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, bis(2-ethylhexyl)phthalate, and diethylphthalate), pesticides (dieldrin, endrin, endosulfan I, heptachlor, heptachlor epoxide, 4,4'-DDD, 4,4'-DDE, alpha-chlordane, and gamma-chlordane), PCBs, and metals (antimony, barium, beryllium, cadmium, chromium, calcium, cobalt, copper, iron, lead, mercury, nickel, selenium, silver, sodium, thallium, and zinc). In the surficial soils samples, 2 VOCs, 2 SVOCs, 6 pesticides, PCBs, and metals were detected at concentrations above ARAR levels or background concentrations. The sampling locations with concentrations of organic compounds exceeding ARAR levels were from the central lagoon area. In general, the samples collected from the far eastern and western portions of this area are generally unaffected. Thus, based on these data, the surficial soils in the former lagoon area have been affected by former site operations, particularly those soils due north of the former process buildings.

In the subsurface soil samples, 10 VOCs, 8 SVOCs, 6 pesticides, PCBs, and metals were detected at concentrations above ARAR levels or background concentrations. The samples with concentrations of organic compounds exceeding ARAR levels were collected from the portion of the former lagoon area that is located east of trench no. 3, except for one sample which was collected from trench no. 3. In addition, except for two samples, all samples with concentrations exceeding ARARs were collected from depths of 4.5-7 feet. It is not surprising that concentrations of constituents above ARARs were largely encountered in the samples collected from depths of 4.5-7 feet, given that the bottoms of the lagoons prior to closure were likely 4-6 feet below the current ground surface.

The data indicate that the constituents of potential concern are present both in the surficial and subsurface soils. Overall, the data are consistent with the known historical, intensive use of this area as lagoons that were later closed by filling with soil. During closure, the wastewater in the lagoons mixed with the fill as it was placed in each lagoon. Thus, constituents of potential concern are present both at the surface and in the subsurface soils. Furthermore, while the lagoons were closed in 1980, facility operations continued until approximately 1992. Thus, the manner in which the lagoons were closed and the operation of the site for over 10 years following closure of the lagoons are the likely explanations for the constituent concentrations detected in the surficial soils of the former lagoon area.

7.1.2.5 Downslope of Former Incoming Drum Storage and Lagoon Areas

The constituents of potential concern in the soils of the downslope area include: 5 PAHs, pesticides (dieldrin), PCBs, and metals (antimony, beryllium, lead, mercury, potassium, thallium, and zinc). Dieldrin and PCBs were only detected at elevated concentrations in the surficial soils and only at one sampling location, MW13S. Furthermore, neither constituent was detected in the subsurface sample collected from

MW13S which suggest that these constituents are not elevated below a depth of 8 feet. It is also notable that this location (MW13S) is within approximately 25 feet of the western tributary sediment sampling location (SED5) that contains elevated concentrations of pesticides. PAHs were identified as constituents of potential concern in the surficial soils in the western portion of the downslope area and near the western tributary.

The data indicate that the constituents of potential concern are present in the surficial soils but are generally absent in the subsurface soils. Thus, negligible transport of the limited constituents of potential concern identified in the surficial soils to the subsurface soils is occurring. Overall, the data are consistent with the known use of this area which is that it was not used as part of the site operations but it did have the potential to be affected by runoff. As a result, fewer constituents of potential concern are present in this area and the concentrations are generally much lower than the former active areas of the site (e.g., former drum processing area).

7.1.2.6 Former Reconditioned Drum Storage Area

The constituents of potential concern in the soils of the former reconditioned drum storage area include: 2 PAHs, beryllium, copper, lead, mercury, potassium, silver, and zinc. VOCs, pesticides, and PCBs are not a concern in this portion of the site in either the surficial or subsurface soils. The PAHs are present at this portion of the site at concentrations that are similar to the offsite background concentration. The metals were primarily detected at concentrations above the background levels in the surficial samples. The ecological risk assessment indicated that lead was the primary potential concern to exposed ecological receptors.

The data indicate that this portion of the site is significantly less impacted compared to other portions of the site and that the constituents of potential concern (metals) are generally limited to the surficial soils. The lack of constituents of potential concern in the subsurface soils indicates that little potential exists for contaminant migration to the water table. Overall, the data are consistent with the known use of this area as a storage location for reconditioned drums.

7.1.3 Soils South of Osborne Hollow Road

During operation of the site, south of Osborne Hollow Road had limited use and was used primarily for storage of empty drums. The constituents of potential concern in the soils south of Osborne Hollow Road include: 3 PAHs, a pesticide (endrin) and metals (antimony, cadmium, lead, manganese, mercury, silver, and zinc); select PAHs and lead were detected in these soils but at concentrations similar to background concentrations for the area. It is notable that endrin only slightly exceeded the ARAR, and that the HHRA concluded that total excess cancer risks to future residents and current and future workers and visitors from exposure to the soil south of Osborne Hollow Road are less than 1E-05. Furthermore, a comparison of the constituents and concentrations detected in the shallow surficial soils (0-0.5 foot) to the deeper surficial samples (2.5-3.0 feet) indicate that the number and concentrations of the constituents of potential concern markedly decrease. Thus, the data indicate that the constituents of potential concern are largely restricted to the top 1 foot of soil in a discrete area. Overall, the data are consistent with the known limited use of this parcel for the storage of empty drums.

7.1.4 Groundwater

Based on the stratigraphy in the southern portion of the site (dense, clay-rich till) and the observed conditions, minimal transport of constituents in the soils to the groundwater and minimal transport of constituents within the low conductivity water bearing zone are occurring. Water elevation measurements collected at the site indicate that groundwater flows at an average rate of 3.2×10^{-4} cm/sec to the north, discharging to Osborne Creek. The thickness of the unconsolidated till deposits ranges from approximately 25 feet to more than 60 feet with the thickness increasing toward the valley of Osborne Creek. The unconsolidated deposits are underlain by bedrock.

The constituents of potential concern in the shallow groundwater (unconsolidated deposits) at the site include: VOCs (benzene, toluene, ethylbenzene, xylenes, 2-butanone, chloroethane, 1,1-dichloroethane, cis-1,2-dichloroethene, 1,2-dichloroethane, 1,1,1-trichloroethane, trichloroethene, tetrachloroethane, methylene chloride, and vinyl chloride), SVOCs (phenol, 2,4-dichlorophenol, 2,4,5-trichlorophenol, naphthalene, 2-methylphenol, 4-methylphenol, 1,2-dichlorobenzene, 1,2-dichloropropane, and bis(2-ethylhexylphthalate), PCBs, pesticides (alpha-chlordane, 4,4'-DDE, and heptachlor), and metals (antimony, arsenic, cadmium, chromium, iron, manganese, nickel, sodium, and thallium). The concentrations of iron, manganese, and sodium were generally detected in the upgradient wells at concentrations similar to those at the site and downgradient of former site operations. In addition, these three constituents are present across the site. Thus, across most of the site, iron, manganese, and sodium are likely representative of background conditions and are not related to environmental contamination at the site.

Excluding metals, exceedences of ARARs were only detected in monitoring wells: MW1, MW2S, MW2, MW3S, MW5S, MW12S, MW13S, P2 and P3, and only the concentration of one compound was exceeded in each of the following wells: MW5S, MW12S, P2, and P3. Excluding iron, manganese, and sodium; antimony, arsenic, cadmium, chromium, mercury, nickel, and thallium are the only metals detected in the groundwater above ARAR levels. Given the pH of the groundwater at the site, these metals are not expected to be dissolved in the groundwater but rather are likely adsorbed to the solid particles. Constituents detected in the groundwater at isolated locations include PCBs in MW1 and MW5S, alpha-chlordane in

MW13S, and bis(2-ethylhexyl)phthalate in MW12S and P3. PCBs were only detected at concentrations above groundwater quality standards in MW1 during Phase I (0.37 ug/l), and since 1994 (Phases II through IV), PCBs have not been detected in the groundwater at MW1. Additionally, during Phase IV, MW12S was resampled and bis(2-ethylhexyl)phthalate was not present in MW12S at a concentration of potential concern. Based on the fate and transport characteristics, migration of PCBs, alpha-chlordane, and bis(2-ethylhexyl)phthalate away from the isolated areas where they were detected is not anticipated. Furthermore, it is unlikely that these constituents are dissolved in the groundwater; they are more than likely adsorbed to the suspended solids in the groundwater. Additionally, only one constituent of potential concern (1,1,1-trichloroethane) was detected in P2. It is notable that while the concentration of 1,1,1-trichloroethane exceeds the NYSDEC water quality criteria, it is less than the toxicology-based EPA MCL.

The only monitoring locations that contain several organic constituents of potential concern include MW2S/MW2 and MW3S, which were installed through (or immediately adjacent to) the former lagoons. Many of the VOC constituents of potential concern are potential breakdown products of primary chlorinated VOCs. These data suggest that degradation of the VOCs in the groundwater may be occurring. Alternatively, suspected breakdown products may also be present because they were possibly disposed of at the site. A comparison of the data for the shallow wells (MW2S and MW3S) to the deeper monitoring wells (MW2 and MW3) indicates that the constituents of potential concern have migrated minimally in the vertical direction within the unconsolidated water bearing zone. In addition, no organic constituents of potential concern were detected in the wells installed within the median of I-88 (MW9S/MW9 and MW10S/MW10) or in the wells located north of I-88 (MW6S/MW6 and MW7S/MW7). These well pairs are downgradient of MW2 and MW3 well pairs, which contained the majority of the organic constituents of potential concern in the groundwater at the site. These data indicate that little horizontal migration of the organic constituents of potential concern has occurred over the past 40 years in the unconsolidated water-bearing zone.

No organic constituents of potential concern were detected in the out-of-service bedrock production well (MW4) during Phases I, II, and III or in the 3 bedrock monitoring wells installed at the site. In addition, the low concentrations of xylenes detected in the adjacent homeowner water supply wells is not believed to have originated at the site but is more likely to have a source that is upgradient of the residences (e.g., former Don Snow trucking facility). These data support the lack of vertical movement of constituents of potential concern from the unconsolidated water-bearing zone to the bedrock aquifer. It is notable that MW4 was located in the center the former site operations and very close to portions of the site with some of the highest concentrations of constituents in the soils, and MW2B and MW14B are located along the downgradient portion of the site which is south of I-88 and in the vicinity of the former lagoons. The bedrock monitoring wells were installed in the portion of the site which was most heavily impacted from former site operations, and they are free of organic contamination.

The contaminated groundwater, may not be restricted to the area south of I-88. The contaminated groundwater may extend under a portion of I-88. There is no evidence of contaminated groundwater north of I-88. The lack of VOCs and SVOCs in the wells downgradient of MW2S and MW3S indicate that these constituents are not migrating horizontally. This may be due to the physical characteristics of the water-bearing zone (e.g., low hydraulic conductivity) or due to attenuation of the concentrations by the time they reach the wells in the median of I-88 (approximately 100 feet downgradient). The lack of constituents of potential concern in the bedrock monitoring wells, former production well, and the offsite domestic wells indicates that vertical migration of constituents detected in the onsite soils and the unconsolidated water-bearing zone is not occurring at an appreciable rate.

In summary, the RI data indicate that the constituents of potential concern are generally restricted to the surficial soils and shallow subsurface soils, are not migrating appreciably through the vadose zone due to the site-specific soil characteristics (e.g., tight soils), and once reaching the water table have migrated to a very limited extent both horizontally and vertically. Because no sources remain (except the soils) and because no further releases will occur, further impact or migration of constituents of potential concern in the groundwater, beyond what has already occurred, is highly unlikely.

7.1.5 Surface Water

A total of seven surface water samples were collected during the RI. One VOC, carbon disulfide, was detected in two surface water samples at 7 μg/l and 13μg/l, collected from Osborne Creek. A surface water quality standard has not been established for carbon disulfide. No other VOCs were detected in the surface water samples, and no SVOCs or PCBs were detected in any of the surface water samples. Two pesticides (alpha-chlordane and gamma-chlordane) were detected in the surface water sample collected from the western tributary near I-88. Alpha-chlordane was detected at an estimated concentration of 0.034 μg/l, and gamma-chlordane was detected at an estimated concentration of 0.043 μg/l. The ambient water quality standard for chlordane is 0.00002 μg/l. It is notable that this sample was collected from the same general vicinity as SED5 which contained elevated concentrations of chlordane and that the western tributary is an intermittent stream that does not support aquatic species (e.g., fish); however, other organisms, including benthic invertebrates and amphibians may be present in the tributary. With the exception of the results for one sample collected from the former lagoon located north of I-88, the concentrations of sodium were similar at all sampling points. The standard for aluminum (100 μg/l) was exceeded in the former lagoon

(SW4 at 1,710 µg/l) and in the western tributary (SW8 at 302 µg/l), and the standard for iron (300 µg/l) was also exceeded at these same locations (2,870 µg/l and 408 µg/l). The standard for zinc was only exceeded in SW4 (65.2 µg/l). It is notable that aluminum, iron, and sodium are common in earth materials. Mercury exceeded the ambient water quality standard in only one sample (SW2).

Based on the RI surface water sampling results, surface water in the eastern tributary and Osborne Creek have not been adversely affected by the former site operations, but the surface water in the western tributary may have been slightly impacted by constituents originating at the subject site. However, these constituents are not detected in the receiving stream (Osborne Creek) indicating that the concentrations are either diluted or are not transported to the downstream sampling locations. In addition, based on our knowledge of past use of the pond (i.e., former lagoon) and the results for the sediment samples collected from the pond, the pond has been affected by former site operations. However, the surface water sampling results indicate that the water held in the former lagoon has only been minimally impacted, if at all, by past operations at the site.

7.1.6 Sediments

During the RI, 21 sediment samples were collected from the two tributaries and Osborne Creek. Six samples were collected from the eastern tributary (SED1 through SED3 and SED20 through SED22); 9 samples were collected from the western tributary (SED4, SED5-1, SED5-2, SED5-3(a), SED5-3(b), SED6, SED23, SED24, and SED25); and 6 samples were collected from Osborne Creek (SED8 through SED10 and SED26 through SED28). The ARARs for the site sediments were developed using the NYSDEC Technical Guidance for Screening Contaminated Sediments (NYSDEC 1994). It is important to note that these ARARs are not necessarily levels which require remedial action. Furthermore, it is also notable that the risk assessment concluded that the total excess cancer risk estimated for the current and future visitor does not exceed 1E-04 for exposure to the surface water and sediment in Osborne Creek and its tributaries.

7.1.6.1 Eastern Tributary

One VOC (2-butanone) was detected in the upstream (background) sediment sample collected from the eastern tributary. Twelve SVOCs were detected in the eastern tributary sediment samples, and seven were detected at concentrations that exceeded the screening criteria. Additionally, the highest concentration of total SVOCs were detected in the upstream sample collected from the portion of the eastern tributary that traverses through the parcel of land that was formerly an offsite junkyard. Five of the 7 pesticides (alpha-chlordane, gamma-chlordane, 4,4'-DDE, heptachlor, and endrin aldehyde) detected in the sediment samples were present at concentrations that exceeded the screening criteria. The concentration of 4,4'-DDE only exceeded the screening criteria in the upstream, background sample, and the concentration of heptachlor in the background sample was more than an order of magnitude higher than in the downstream samples. Alpha- and gamma-chlordane exceeded the criteria along the portion of the eastern tributary that potentially could have received runoff from the site (SED-21). It is important to note that the concentrations of the chlordanes in the samples collected downstream of SED-21 decrease with distance from SED-21. PCBs were detected in 5 of the 6 sediment samples, and the concentration of Aroclor-1248 in these five samples exceeded the screening criteria. However, the concentration of PCBs in the background sample (84,000 µg/kg) was almost an order of magnitude higher that the downstream samples. Because the highest exceedance was from the parcel of land that was formerly a junkyard, the source of the PCBs appears to be the former junkyard and is unlikely to be site related. Similarly, only the concentrations of lead (132,000 µg/kg) and zinc (275,000 µg/kg) detected in the upstream background sample exceeded the upper range of the screening criteria for metals. Based on these results, only alpha- and gamma-chlordane and endrin aldehyde detected in the eastern tributary sediment samples may be site related and will be considered for remedial action in the FS.

While few details are known about the operations of the former junkyard, the VOCs, SVOCs, PCBs, metals, and select pesticides detected in the portion of the eastern tributary that flows through the junkyard are unlikely to be related to the site and are most likely due to the former use of the property. The site can not be a source for the constituents detected in SED20 because the site is hydraulically downgradient of the former junkyard and the junkyard is topographically higher than the site.

7.1.6.2 Western Tributary

One VOC (2-butanone) was detected at 29 µg/kg in the upstream (background) sediment sample collected from the western tributary. Each of the shallow (collected from a depth of 1 foot or less) western tributary sediment samples contained at least one of 20 target SVOCs, and of the 20 SVOCs detected, 16 are PAHs. It is notable that 14 of the 20 target SVOCs were present in the background sample and, except for one duplicate sample, the background sample (SED4)exhibits the highest concentration of total SVOCs (111,800 µg/kg). Nine PAHs exceed the screening criteria at three sampling locations. These PAHs were present in the background sample and in two sediment samples located adjacent to the portion of the site that is south of I-88. Thus, PAHs in the western tributary may be related to former site operations, but may also be attributable to upstream, offsite sources. All of the nine sediment samples collected from the western tributary contained at least one pesticide at concentrations that exceed the ARARs, and 7 pesticides are present in the tributary at concentrations higher than the screening criteria It is notable that the highest concentrations of alpha- and gamma-chlordane were detected in the "deep" samples collected from one location adjacent to and south of I-88 at depths of 2-3 feet and 5-6 feet. Additionally, the concentrations of the chlordanes detected in the most downstream samples are significantly lower than those concentrations detected just south of I-88. PCBs were detected in 5 of the 9 samples, and the ARAR for PCBs was exceeded in four samples.. Chlordane and PCBs were detected in the site soils, and thus, the concentrations detected in the sediment samples are probably site related. Only three metals (iron, manganese, and mercury) were detected at concentrations exceeding the upper range of the screening criteria for metals. Because manganese was detected in the background sample at elevated levels, the concentrations detected in the downstream samples are likely related to background rather than the site. Based on these results, the concentrations of selected SVOCs, alpha- and gamma-chlordane, iron, and mercury may be of potential concern and are likely site related. The sediments in the western tributary will be considered for remedial action in the FS.

7.1.6.3 Osborne Creek

No VOCs, pesticides, or PCBs were positively detected in any of the sediment samples collected from Osborne Creek, and none of the 16 metals detected in the Osborne Creek sediment samples were detected at concentrations that exceeded the upper range of the screening criteria for metals. Thus, these constituents are not of potential concern in the sediments. Only two SVOCs (bis(2-ethylhexyl)phthalate and di-n-butyl phthalate) were detected in the sediment samples. The concentrations of bis(2-ethylhexyl)phthalate (42 µg/kg and 43 µg/kg) are well below the sediment ARAR. No ARAR exists for di-n-butyl phthalate, but like bis(2-ethylhexyl)phthalate, the concentrations detected in the samples were low ranging from 42 µg/kg to 48 µg/kg. Based on these results, SVOCs are not constituents of concern in the Osborne Creek sediments. Overall, the data indicate that no potential constituents of concern are present in the sediments of Osborne Creek.

7.1.7 Building

Because waste materials were removed from the site and all sumps, tanks, and structures were decontaminated and then either abandoned in place or demolished and disposed of offsite as part of the 1996, time-critical removal action; the results of the building material samples are no longer a relevant site issue. However, it is important to note that during the extensive removal action all liquids were removed from the site and the mobility and toxicity of hazardous constituents were significantly reduced. Approximately 470,000 pounds of hazardous constituents were removed from the site. As a result, principle threats at the site were eliminated through the removal action.

7.1.8 Ecological (Plants and Earthworms)

During the RI, plant and earthworm samples were collected from across the site. 2-Methylphenol was the only target SVOC detected in the plant samples and was detected in samples collected from three locations at concentrations ranging from 450 µg/kg to 610 µg/kg. Because it was detected in the duplicate sample collected from the background location south of Old Route 7, its presence in the plant samples is not believed to be site related. Two pesticides (beta-BHC and 4,4'-DDT) were detected in only one sample at a total concentration of 40 µg/kg. Two PCBs (Aroclor-1248 and -1254) were detected in four samples at concentrations ranging from 120 µg/kg to 250 µg/kg. Based on these results, the distribution of constituents detected within plant material at the site are primarily associated with the samples collected from former operating portions of the site (e.g., former lagoons, drum storage areas, and discharge area). Thus, those areas with constituents present in the soils have the potential to have plant material with non-naturally occurring compounds (e.g., PCBs).

SVOCs, pesticides, and PCBs were detected in the earthworm samples collected at the site. Nine SVOCs were detected with the total SVOCs concentration ranging from 81 µg/kg in the background sample collected from south of Osborne Hollow Road to 3,132 µg/kg in the sample collected from the former incoming drum storage area. Six pesticides were detected in 5 of the 7 earthworm samples with the total concentrations ranging from not detected in the two background samples to 1,095 µg/kg. At least one of three PCBs (Aroclor-1248, -1254, and -1260) were detected in all 7 samples at concentrations ranging from 260 µg/kg in the background sample to 22,600 µg/kg in the sample collected from the vicinity of the former lagoon north of I-88. A comparison of the earthworm sampling results to the soil sampling results indicates a general correlation exists between the constituent concentrations detected in the soils and the concentrations detected in the earthworm samples. This correlation is consistent with anticipated trends given that earthworms ingest soil as their food source.

7.2 Conclusions

The conclusions of the RI include the following:

- The constituents of potential concern were identified as VOCs, SVOCs, pesticides, PCBs, and metals; the concentrations and areal extent of specific chemicals and metals within these broad groups of compounds were determined for the various environmental media.
- The onsite sources of these constituents of potential concern were the storage and processing of drums and the discharge of wastewater to the land surface and lagoons.
- The depth to bedrock varies across the site from a depth of approximately 25 feet in the southern portion of the site to greater than 70 feet in the northern portion of the site.
- The unconsolidated deposits overlie the predominantly shale bedrock and largely consists of clay-rich till with lenses of sand and gravel; the abundance of sand and gravel increases to the north toward the valley of Osborne Creek.

- Fractured siltstone units approximately 2.5 feet thick are present within the shale bedrock; the siltstone unit is the predominant water bearing unit of the bedrock and the unit in which the bedrock wells are screened.

- Groundwater flows to the north in the unconsolidated deposits and to the northeast in the bedrock; the rate of groundwater flow in the unconsolidated deposits is believed to be controlled by the pervasive low permeability till deposits resulting in a groundwater flow rate of 2.6×10^{-4} foot per day; the average groundwater flow rate for the site using all conductivity data was calculated to be 0.9 foot per day.

- Groundwater contamination is confined to an isolated portion of the unconsolidated water bearing zone and for the most part to the upper portion of these deposits; the water bearing siltstone within the bedrock aquifer has not been affected (Figure 7-2).

- There are no users of the shallow groundwater; users of the bedrock groundwater are located sidegradient and upgradient of the site and have not been affected by site-related constituents of potential concern.

- The primary portion of the site south of I-88 is surrounded by a chain link fence, and a Grant of Easement and Declaration of Restrictive Covenants was executed between the PRPs and the Tri-Cities Barrel Company which restricts the future use of the property and specifically prohibits the development of the site for residential uses.

- Soils in the portions of the site used for drum storage and discharge of wastewater to the ground surface and lagoons are affected (Figure 7-1).

- Surface waters in Osborne Creek and the eastern tributary are not being impacted by the site; surface waters in the western tributary and the former lagoon located north of I-88 are impacted.

- Sediments in specific portions of the eastern and western tributaries and the former lagoon north of I-88 appear to have been impacted by the site.

- As part of a remedial action pre-design study, the sediments in the flood plain area where the western tributary discharges into Osborne Creek will be sampled for chemical analyses.

- The ecological sampling results indicate that the affected soils at the site have the potential to affect the plants that grow in these soils and the earthworms that live in these soils.

- The site-specific conditions identified above (no downgradient groundwater users, fence, and Grant of Easement and Declaration of Restrictive Covenants), while not evaluated in the baseline risk assessments, will modify the default human exposure pathways identified in the risk assessments and will alter the actual risks to potential onsite and offsite human receptors, but will not reduce risks to ecological receptors; these conditions and institutional controls will be evaluated in detail in the FS to determine the appropriate remedial objectives and technologies to adequately protect human health and the environment.

The primary areas of the site that have been affected by historical operations and will need to be addressed in the FS include:

- Surficial soils north of I-88 (top 3 feet) associated with the former wastewater discharge pattern and lagoon.
- Surficial and subsurface soils in the former incoming drum storage area, former process building area, and lagoon area.
- Surficial soils in the former drum processing area, and portions of the parcel downslope of the former incoming drum storage and lagoon areas and the former reconditioned drum storage area.
- An isolated area of the surficial soils south of Osborne Hollow Road (top 1 foot).
- Groundwater south of and partially under I-88 (former lagoon area) and within the unconsolidated water bearing zone; there is no evidence of contaminated groundwater north of I-88.
- Surface waters in the western tributary (portion of tributary south of I-88) and the former lagoon located north of I-88.
- Sediments in the western tributary.
- Sediments in the eastern tributary affected by alpha-chlordane, gamma-chlordane, and endrin aldehyde.

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