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ACRONYMS AND ABBREVIATIONS

ARAR	Applicable or Relevant and Appropriate Requirements
ASTM	American Society of Testing Materials
ATSDR	Agency for Toxic Substances and Disease Registry
ATV	All-terrain Vehicle
Bgs	Below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CH ₄	Methane
CO	Carbon Monoxide
COC	Chain-of-Custody
DCE	Dichloroethene
DERA	Defense Environmental Restoration Act
DoD	Department of Defense
EFS	Environmental Field Services
EM	Electromagnetic
ERA	Ecological Risk Assessment (screening)
ESI	Expanded Site Investigation
ESERE	Expanded Site Ecological Risk Assessment
ESRE	Expanded Site Risk Evaluation
FBA	Floyd Browne Associates, Inc.
FDA	Food and Drug Administration
FS	Feasibility Study
Ft	Feet
FUDS	Formerly Used Defense Sites
Gpm	Gallons Per Minute
H ₂ S	Hydrogen Sulfide
HAS	Hollow Stem Augers
ID	Inside Diameter
LTA	Local Training Area
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCL	Maximum Contaminant Levels
MDL	Method Detection Limit
MED	Marion Engineer Depot
Mg/kg	Milligrams per Kilogram
MW	Montgomery Watson
µg/kg	Micrograms per Kilogram
µg/l	Micrograms per Liter
MID	Marion Industrial Depot
MI	Milliliter
MOU	Memorandum of Understanding
Msl	Mean Sea Level
NCP	National Contingency Plan
O ₂	Oxygen

ACRONYMS AND ABBREVIATIONS (CONTINUED)

ODH	Ohio Department of Health
ODNR	Ohio Department of Natural Resources
Ohio EPA	Ohio Environmental Protection Agency
OSHA	Occupational Safety and Health Administration
OU1	Operable Unit 1
PA	Preliminary Assessment
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyls
PCDD	Polychlorinated dibenzo-p-dioxin
PCDF	Polychlorinated dibenzofuran
PCE	Tetrachloroethene
PE	Physical Education
PID	Photo-Ionization Detector
PQL	Practical Quantitation Limit
PRG	Preliminary Remediation Goal
PUF	Polyurethane Filter
PVC	Polyvinyl Chloride
QAPP	Quality Assurance Project Plan
RI	Remedial Investigation
RVLSD	River Valley Local School District
RVS	River Valley Schools
SEC	Safety and Ecological Corporation
SES	Soil Exploration Services
SOP	Scioto Ordnance Plant
SVOCs	Semi-Volatile Organic Compounds
TAL	Target Analyte List
TCDD	Tetrachlorodibenzo-p-dioxin
TCE	Trichloroethene
TEF	Toxicity Equivalent Factor
TERC	Total Environmental Restoration Contract
TVH	Total Volatile Hydrocarbons
USACE	United States Army Corps of Engineers
USAR LTA	U.S. Army Reserve Local Training Area
USCS	Unified Soil Classification System
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
VF	Volatilization Factor
VOCs	Volatile Organic Compounds

1.0 INTRODUCTION

In 1998 the United States Army Corps of Engineers – Louisville District (USACE) contracted Montgomery Watson (MW) to conduct environmental investigation and restoration activities at the former Marion Engineer Depot (MED) under the Total Environmental Restoration Contract (TERC) DACW27-97-D-0015, Task Order No. 0005. The MED, located in Marion, Ohio, is a formerly used defense site (FUDS) that is being evaluated through the USACE FUDS program.

A portion of the former MED was obtained by the River Valley Local School District (RVLSD) in 1961 for the construction and operation of a middle school and high school, and associated educational and sports facilities. This area is collectively referred to as the River Valley Schools (RVS), and currently occupies approximately 78 acres of the former MED property. The location of the RVS area relative to the former MED is shown on Figure 1-1.

The environmental investigations performed on behalf of the USACE since March 1998 have encompassed the entire 78 acres of the RVS area. The results of the initial RVS investigative efforts, coupled with available historical information and findings of previous investigations performed by others, identified an area within the RVS area that was used for the disposal of construction debris and waste materials during operation of the former MED. This former disposal area is referred to as Operable Unit 1 (OU1) and is the subject of a report entitled *Operable Unit 1-Former Disposal Area Draft Remedial Investigation Report, Marion, Ohio* (OU1 RI Report) released in February 2000 by MW. Detailed information regarding the OU1 area specifically is provided in the OU1 RI Report (Montgomery Watson, 2000b).

In contrast to the OU1 RI Report, the activities and findings described in this Expanded Site Inspection (ESI) Report are specific to the remainder of the property, outside OU1,

herein referred to as the RVS Property, or “the Property.” The RVS Property ESI boundary is shown as the highlighted area on Figure 1-2.

The USACE is currently involved in additional investigations within the former MED area, including:

- Assisting the United States Army Reserve (USAR) with the implementation of a Preliminary Assessment and Site Inspection (PA/SI) of the 127-acre Local Training Area (LTA) that borders the RVS Property to the southwest. In March 1999, the USACE implemented a removal action at the USAR LTA that resulted in the removal of approximately 50 rusted and crushed drums and approximately 10 cubic yards of contaminated soil and waste materials.
- Planning additional site investigations within the existing Marion Industrial Depot (MID), which is located west of the RVS Property, to address specific areas of the MID for environmental impacts associated with past military use of the Property.

The RVS Property comprises the 78 acres described above, excluding the area of OU1, leaving an area of approximately 58 acres that is the focus of this report. While historical information indicates that operations of the former MED were not restricted to the RVS Property area and the activities did cross property boundaries, the investigations performed to date have identified only small discrete areas of contamination within the 58 acres.

The data set of analytical information used to evaluate the RVS Property was established to sufficiently address the extent of potential surface and subsurface contamination in both soil and groundwater. This ESI Report documents the investigation and evaluation of contamination outside the OU1 area on the Property. In addition, an expanded site risk evaluation (Section 6.0) was performed, which explores human health risks resulting from potential exposures to chemicals detected during the ESI activities.

1.1 PROJECT PURPOSE AND OBJECTIVES

USACE is the lead agency for executing Department of Defense (DoD) investigations of FUDS under the Defense Environmental Restoration Act (DERA). DERA identifies the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as the mechanism by which USACE is to execute its authority. CERCLA, commonly known as Superfund, was enacted to respond to threats posed by uncontrolled releases of hazardous substances into the environment. The USACE follows the CERCLA process and associated National Contingency Plan (NCP).

The former MED, as part of the FUDS program, is being evaluated to determine if past DoD contamination exists that could potentially affect human health, safety, and the environment. The RVS Property, as part of the former MED, is being investigated to identify any past DoD contamination that requires remediation to comply with CERCLA, and Federal and State applicable or relevant and appropriate requirements (ARARs).

The objectives of the ESI were to collect environmental data necessary to assess the nature and extent of past DoD environmental contamination and to evaluate potential health risks as a function of the identified contamination. This ESI Report pertains to the area of the former MED that lies outside OU1, specifically known as the RVS Property. The report summarizes the available information for the Property, including a description of the field activities conducted at the site and an assessment of the nature and extent of contamination that has been identified to date. The expanded site risk evaluation, which is included as an integral part of the ESI, focuses on the potential health risks associated with the Property.

1.2 BACKGROUND INFORMATION

This section describes the location, history, and previous investigations performed at the RVS Property. The information in this section was obtained from various sources, including:

- *Report on the Environmental Assessment of Former Marion Engineer Depot.* ERM-Midwest, Inc., June 1990.
- *Environmental Investigation at the River Valley School Property.* Floyd Browne Associates, Inc, September 1997.
- *Quick Response Radiological Removal Action Final Report, River Valley High School.* U.S. Army Corps of Engineers, Tulsa District, September 1997.
- *Radiological Removal Action Report, River Valley School Property.* U.S. Army Corps of Engineers, Kansas City District, December 1997.
- *Interim Report for River Valley Local Schools, Marion.* Lawhon & Associates, Inc. for the Ohio Environmental Protection Agency, December 1997.
- *Field Investigation Report for River Valley Local Schools, Marion, Ohio.* Ohio EPA, Division of Emergency and Remedial Response, October 1998.
- *Archives Search Report for the Former Marion Engineer Depot.* USACE, August 1998.
- *Marion Air Toxics Study.* Ohio EPA, September 1988, March 1999, and September 1999.

1.2.1 Site Location And Description

The former MED is located approximately one mile northeast of Marion, Ohio at 2565 Harding Highway East (State Route 309). The former MED originally consisted of 640 acres. The River Valley Middle and High School are located at 1239 Columbus-Sandusky Road (State Route 98), and occupy the eastern 78 acres of the former MED. Within the 78 acres, the approximately 58-acre area located outside OU1 (i.e., the Property) is located in the north, east, and southeastern portion of the Property (Figure 1-2).

1.2.2 Site History

In 1942, the Ohio River Division of the USACE received authorization to construct an engineer equipment, maintenance, and storage depot near Marion, Ohio. Property for the depot was acquired, construction began in June 1942, and the depot was completed in November 1942. The former MED operated for approximately 19 years thereafter as the largest depot of its type in the United States. The depot had various names during that time period, including the War Aid Depot, the Marion Quartermaster Depot, the Marion Holding and Reconsignment Depot, and finally the Marion Engineer Depot.

The depot was used primarily for the storage and renovation of heavy construction machinery for the United States Army. During World War II, prisoners of war were encamped at the depot and performed various tasks. Following the war, the former MED continued to operate until 1961. Land on the east end of the depot was acquired by the River Valley School District (RVSLD) in 1961.

Interviews conducted by the USACE and Ohio EPA historical documents summarized in the *Marion Engineer Depot Archives Search Report* (USACE 1998), and aerial photographs compiled by the regulatory agencies, local citizens, USACE, and MW (included with the OU1 RI Report), indicate that the RVS Property had many uses during the operation of the former MED. At a minimum, the entire RVS area, including OU1, was used for heavy equipment use and training, storage of materials, disposal/burial of

construction debris and depot waste materials, burning of waste materials and fuels, and as a prisoner of war camp.

An aerial photograph from 1944 (Appendix A of the OU1 RI Report) depicts the location of this prisoner of war camp in the general area of the current high school on the RVS grounds. Prisoners were reportedly brought in by rail car on the north end of the property. The rail line has since been removed from the property, but the shallow soils in the drainage ditches on either side of the former rail line were found to contain elevated levels of arsenic. These soils have been remediated by the USACE and MW, in accordance with a Remedial Investigation Final Work Plan (Montgomery Watson, 1998a).

Historical aerial photographs depict large areas of the RVS Property as being void of vegetative cover. Typically, these photographs show the area of OU1 as disturbed by activities associated with the former MED operations, including the excavation and mounding of soils. Personal accounts of past MED activities have indicated that the OU1 portion of the property was frequently used for the disposal of construction debris and other waste materials. Disposal activities are said to have included, but may not have been limited to, trenching, burning, and burial of refuse and waste, including fuels, paints, spent solvents, and solid materials.

Since 1961, the parcel has been owned by the RVLSD and operated as a school campus with associated educational and sports facilities. The Property currently contains a middle and high school; temporary classroom and administrative buildings; football, track, baseball and softball facilities; practice ball fields; a nature preserve area; and parking lots (Figure 1-3). The current RVS population exceeds over 800 students and faculty.

1.2.3 Previous Investigations

Previous limited environmental investigations helped to direct subsequent USACE investigations of the RVS Property. The activities performed during these previous investigations are summarized below. All analytical data generated as a result of previous investigations (not conducted by USACE) have been considered as screening-level data and used to focus subsequent detailed investigations discussed in this report. Details of the work performed can be found in the published reports from each contractor or agency.

1.2.3.1 Floyd Browne Associates, Inc.

On behalf of the Marion CAN-DO organization, Floyd Browne Associates, Inc. (FBA) conducted an environmental assessment of the RVS Property that included a screening-level radiation survey and soil and groundwater sampling at RVS in August 1997. The non-intrusive radiation screening was performed by FBA to provide a rapid scan for high concentrations of radiological constituents on the school grounds. The screening-level survey, which consisted of walking the school property, was conducted using a Victoreen, Thyac V Survey Meter, Model 190. The site walk revealed no anomalies and no elevated radiation on the site.

Geoprobe[®] borings were advanced by FBA at selected locations, and soil and groundwater samples were collected. Thirty-eight soil samples, five groundwater samples, and one drinking water sample were collected. The drinking water sample was collected from the drinking fountain in the main hall of the middle school. Selected soil and groundwater samples were screened in the field for total volatile hydrocarbons (TVH) using a gas chromatograph. In addition, seven samples were sent to a fixed laboratory for analysis.

The results of the limited FBA investigation identified no anomalous environmental contaminants on the school grounds. The published FBA report concluded that the "...investigation found no evidence of contamination that would present an immediate or chronic health hazard to the students, teachers or staff of River Valley Schools" (FBA, 1997).

1.2.3.2 Ohio Department of Health

A screening-level radiological survey of the RVS area was conducted by the Ohio Department of Health (ODH) in the summer of 1997 (ODH 1997a). The survey detected a radium source (radium-painted, dime-sized aluminum disc) buried just below the surface of the soils in front of the High School. Two other small radioactive sources were also found inside the high school science lab. It appeared that the radioactive sources detected inside the school were procured from an educational company, whereas the radium source found in the soils in front of the High School appeared to have originated from past MED activities. These sources were removed by the USACE in September 1997, as documented in the USACE report titled "Quick Response Radiological Removal Action Final Report, River Valley High School" (USACE, 1997a).

In addition, several epidemiology studies and public health assessments have been performed by the ODH and the Agency for Toxic Substances and Disease Registry (ATSDR) for the RVS student population and Marion County, Ohio (ODH 1997b; ODH 1998; and ATSDR 1998).

1.2.3.3 Lawhon & Associates, Inc.

Lawhon & Associates, Inc. (Lawhon), under contract to the Ohio EPA, conducted preliminary field investigations and a site evaluation of the RVS area in late 1997. A non-intrusive geophysical investigation was performed to detect and map buried debris, objects, and subsurface changes in electromagnetic conductance at the RVS area, and on an adjacent parcel of land to the west of the RVS Property. Nearly all of the outdoor areas of the RVS grounds were surveyed using electromagnetic (EM) methods, which are capable of sensing significant changes in electromagnetic conductance of subsurface materials up to a depth of approximately 6 feet (ft) (EM61 instrument) or 18 ft (EM31 instrument). The EM data were gridded and contoured to produce geophysical maps. Detailed results of the

survey are presented in the Lawhon report (Lawhon 1997). Appendix B of the Draft Remedial Investigation (RI) Report contains the EM-31 in-phase geophysical map that was prepared from the Lawhon investigation.

The results of the geophysical survey indicated the presence of at least eight significant anomalies representative of probable underground features. Six of the eight anomalies were identified in the Lawhon report as most likely indicative of subsurface utilities located at the site. Two of the anomalies (identified as anomalies 1 and 2), however, were interpreted in the Lawhon report as not suggestive of any type of utility, based on their shape, and have since been identified as former disposal areas of waste materials.

Investigative activities related to the anomalies completed by Montgomery Watson during the RI and SI field events have indicated that four of the eight anomalies are utilities. The Utility and Cultural Features Map (Figure 3-1) depicts the locations of the on-site utility lines.

Geoprobe[®] borings completed on the site by Lawhon, based on historical aerial photograph analysis, were located around the Middle School building, the southwestern corner of the nature preserve area, and adjacent to geophysical anomalies (Figure 1-4). Soil boring samples were identified by an "A", "B", or "H" prefix. Sediment (surface soil) samples were collected from roadside drainage ditches along the perimeter of the RVS Property. Surface water runoff samples could not be collected at that time due to dry conditions. Groundwater and perched water samples were collected from temporary piezometers installed at the site.

The results of the Lawhon sampling indicated the presence of volatile organic compounds (VOCs) in both soil and perched groundwater within the RVS Property. The majority of the sampling was performed in the area currently described as OU1. The Lawhon report concluded "Data gathered from this investigation partially characterizes and identifies

contaminants detected at the site. Based on the information obtained from the analytical results, many of the detected chemicals were present in the low parts per billion range. However, several areas exist on the site where the concentrations of chemicals are above background and risk-based screening levels” (Ohio EPA, 1998b).

1.2.3.4 Ohio EPA

Since 1998, the Ohio EPA has conducted ambient air monitoring at the RVS area to address community concerns regarding air quality at the site. The procedures, results, and evaluation of these data have been published by the Ohio EPA (Ohio EPA 1998a, 1999a, and 1999b). The Ohio EPA ambient air studies consisted primarily of the collection and analysis of numerous 24-hour, time-integrated, whole air samples collected from an air monitoring station situated on the roof top of the Middle School building. These samples were analyzed for volatile organic compounds (VOCs). In addition, several air grab samples were collected from a height of less than two meters above the ground surface by Ohio EPA for comparison with the rooftop samples.

The results and evaluation of the ambient air data collected by the Ohio EPA are summarized in the following discussion quoted from their *Marion Air Toxics Study – River Valley School Campus Air Quality 1999 Summary* report (Ohio EPA 1999b):

“The collection of this data by Ohio EPA summarizes a long-term ambient air quality collection analysis for the RVS campus area. Data of this type presents an accurate description of long-term air quality in the school. These results do not detect any ambient air concentration of any VOC that merits concern.”

The Ohio EPA further concludes in their summary report (Ohio EPA 1999b):

“This study continues to support the hypothesis that the ambient air is not a current pathway of exposure to pollutants discovered in the school area. This summary of the

results collected in 1999 continues to indicate that the school population is not being exposed to uncommonly high concentrations of VOCs from existing sites of contamination.”

The Ohio EPA also performed surface soil sampling at the RVS campus before and during the course of the USACE investigation of the site. These samples have included both surficially composited and individual, or discrete, samples that have been analyzed as a screening-level review of surface soil conditions. These data have been published at various times by the Ohio EPA and can be found in the Information Repository in the Marion County Library.

1.3 REPORT ORGANIZATION

In addition to this Introduction Section, the ESI Report is organized into the following sections:

- Section 2 describes the study area investigation and the field activities conducted during the ESI.
- Section 3 describes the physical characteristics of the Property, including a discussion on the surface features of the site, local meteorological information, surface-water hydrology, geology, soils, hydrogeology, demography, and land use.
- Section 4 presents the investigative findings, and describes the nature and extent of contamination identified within the Property.

- Section 5 presents a discussion on contaminant fate and transport at the site, including information on contaminant persistence and potential contaminant migration conditions.
- Section 6 presents an expanded site risk evaluation developed for the conditions and contaminants identified within the Property.
- Section 7 summarizes the results and findings of the ESI.
- Section 8 presents the references cited in this report.

Supporting tables, figures, and appendices are provided for each section of this report. In addition, a Data Validation Report, provided in Appendix A, documents the quality control measures, review, and validation of the analytical data compiled from the RVS Property.

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2.0 STUDY AREA INVESTIGATION

In March 1998, USACE directed MW to initiate field investigative activities at the 78-acre RVS site under the FUDS program. The area investigated included the OU1 area, in addition to the RVS Property outside OU1, which is the subject of this report. The RVS investigation consisted of an initial screening and survey program, followed by more detailed and specific sampling and monitoring of various environmental media. The ESI activities performed by USACE, or its contractors on the RVS Property, and the approximate time periods in which they occurred, can generally be described as follows:

Site Screening, Removal Action, and Surveys:

- Radiation survey (June 1998)
- Soil gas survey (July 1998)
- Arsenic ditch program (November 1998 through August 1999)
- Ambient air monitoring (July through November 1999)
- Expedited soil sampling (July 1999)
- Ecological assessment (September 1999)

Soil Investigation:

- Surface soil sampling (July and December 1998, July 1999, August 1999, and August 2000)
- Soil boring sampling (July 1998, July 1999, August 1999, and August 2000)

- Geoprobe[®] sampling (August and October 1999)
- Surface water runoff sampling (July 1998)

Groundwater Investigation:

- Groundwater monitoring well installation (July and December 1998 and August 2000)
- Quarterly groundwater monitoring (startup in August 1998)
- Formation hydraulic conductivity testing (November 1999, inside OU1)

Development of Background Concentrations in Soil and Groundwater:

- Groundwater background conditions (startup in August 1998)
- Soil background conditions (August 1998 and August 1999)

Because information on the site was limited prior to conducting the ESI activities, field investigations were performed in several iterations as sampling efforts became increasingly focused. With each successive field effort, additional information was compiled that assisted in the understanding of the physical and chemical characteristics of the site.

Details on the approach, procedures, and protocols used to develop and implement the screening, sampling, and monitoring programs can be found in the following referenced documents:

- *Radiation Survey Workplan*. Safety and Ecology, Corporation, dated May 1998.

- *MED/SOP Remedial Investigation Final Workplan*. Montgomery Watson, dated June 1998.
- *MED/SOP Remedial Investigation/Feasibility Study Quality Assurance Project Plan (QAPP)*. Montgomery Watson, dated July 1998.
- *Remedial Action Plan, River Valley School Ditch Remediation, Marion, Ohio*. Montgomery Watson, dated November 1998.
- *Remedial Investigation Workplan Addendum of December 1998*. Montgomery Watson, dated December 1998.
- *Remedial Investigation Workplan Addendum*. Montgomery Watson, dated July 1999.

Table 2-1 summarizes the types and nomenclature of samples collected for this investigation. The following subsections describe the various field activities performed as part of the study area investigation.

2.1 SITE SCREENING REMOVAL ACTIONS AND SURVEYS

Since the onset of the USACE investigation of the RVS area in early 1998, screening and survey programs have helped to focus subsequent investigative activities on specific areas and issues at the site.

The following discussions summarize the performance and findings of the screening removal actions and survey programs conducted at the RVS Property. Details on these activities can be found in previously published reports, specifically:

- *Soil Vapor Survey Report, River Valley School, Marion Ohio.* Soil Exploration Services, Inc., (SES) dated September 1998.
- *Radiological Survey for the River Valley School District Property, Marion, Ohio.* Safety and Ecology Corporation, (SEC) dated September 1998.
- *Arsenic Ditch Remediation Closure Report, River Valley School Property, Marion, Ohio.* Montgomery Watson, dated April 2000.
- *Draft Ambient Air Survey of the River Valley School Property, Marion, Ohio.* Montgomery Watson, dated February 2000.

2.1.1 Soil Gas Survey

To assess the potential extent of VOCs at depth and to help target subsequent sampling activities, 123 soil gas survey points (RVS-SG001 through RVS-SG123) were completed on the RVS site by SES under the supervision of MW personnel. Of these 123 soil gas points, approximately 43 were completed near the school buildings and elsewhere outside the OU1 area. The soil gas sampling locations are shown on Figure 2-1. A copy of the Soil Gas Survey Report will be provided in the Final OU1 RI Report and is also provided in Appendix A of the Preliminary Remedial Investigation Report (Montgomery Watson, 1998e).

Soil gas sampling used a direct push method for sample collection. A Geoprobe[®] apparatus was used to push a stainless steel rod to a predetermined depth of five ft. below grade. The soil vapor sample was collected from a section of replaceable polyethylene tubing using a factory-clean, graduated syringe and needle, provided by the subcontracted laboratory. Soil vapor samples were delivered to Microseeps (the SES subcontracted on-site mobile

laboratory) using chain-of-custody (COC) procedures outlined in the project specific QAPP (Montgomery Watson, 1998b) dated July 1998. Soil gas survey data was screening level only.

The areas outside OU1 that were chosen for the soil gas investigation were primarily based on the results of previous investigations and assessments at the RVS. VOCs were detected in and around OU1; no VOCs were detected at sample locations around the Middle and High School buildings.

2.1.2 Radiation Survey

SEC of Knoxville, Tennessee performed a detailed radiological survey of the RVS site. The Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), (DoD 1997) process was used to design, implement, and evaluate the radiological survey data. This survey was designed to detect a source of similar size, depth, and intensity as the radium-painted dime-sized disc found by the ODH which was removed by the USACE in 1997. Radiation survey activities consisted of the following:

- 100% surface gamma scans to identify locations of any elevated radiation levels.
- Measurements of gamma radiation levels at one meter above the surface for comparison with the derived criterion for unrestricted site use.
- Collection of composite soil samples to correlate Ra-226 concentrations with gamma exposure levels and demonstrate compliance with the soil contamination criterion.

A detailed description and summary of the setup, performance, and findings of the radiological survey were documented in the by in the report entitled “*Radiological Survey for the River Valley School District Property, Marion Ohio*”, dated September 1998 (SEC, 1998b). Based on the design objective of the survey, all data indicated that direct radiation levels and radionuclide concentrations in the surface soil were well below State and Federal limits, and that no significant radiological contamination existed above background levels at a depth between ground surface and 18 inches below ground surface (bgs). If significant radiological contamination were present at depth, the survey would have detected the radiological contamination.

2.1.3 Arsenic Ditch Program

A portion of the former MED acquired by the RVLSD had previously been used by the Army during the Second World War for the prisoner of war camp. Prisoners arrived via a rail spur (now gone from the site) on the north end of the property. Records indicate the prisoners were sprayed with an arsenic-laden delousing agent upon exiting the rail cars. In addition, railcars may also have been treated with arsenic-bearing fumigants. As a result of these activities, soils in the drainage ditches on both sides of the former rail spur, now a road, contained elevated levels of arsenic.

The RVS drainage ditches were initially investigated by the Ohio EPA through their subcontractor, Lawhon and Associates, Inc., in 1997. The preliminary investigation, conducted by Lawhon, identified arsenic as a chemical of concern in the shallow soils within the drainage ditches (also referred to as arsenic ditches) located on the north and east sides of the RVS property (Figure 2-2). Further investigation on the extent of impacted soil in the RVS drainage ditches was completed by MW in 1998, under contract to the USACE as part of the RI for the RVS area. The results of this investigation were used to assess the extent of arsenic in the shallow soils within the drainage ditches. Based on past investigation efforts, remedial action activities were initiated.

The remedial efforts in the arsenic ditches involved excavating soils containing arsenic at levels exceeding background concentrations, off-site disposal of excavated soils, collection of confirmatory soil samples, air monitoring, backfilling of the excavations with clean fill, and site restoration. Remedial activities were continued until confirmation samples indicated levels of arsenic below the pre-determined background values.

2.1.4 Ecological Assessment

As part of a screening-level ecological risk assessment conducted under the OU1 RI activities, a habitat assessment of the 78-acre RVS area was conducted on September 30, 1999 by Anne Profilet, a Montgomery Watson field biologist. The assessment was performed to identify dominant vegetation communities and potential ecological receptors on the site. The approximately 15-acre nature preserve area was the focus of the field investigation since the other undeveloped areas on the site are primarily athletic facilities or agricultural fields.

Based on the habitat assessment, the nature preserve on the RVS area does not contain sensitive ecological receptors or habitats. Potential ecological receptors on the site are typical of disturbed areas with ruderal (i.e. growing in disturbed ground) vegetation communities. The habitat value of this community is diminished by mowing, which limits its ability to provide food and cover for wildlife. No rare plant or animal species or suitable habitat for these species was seen during the field investigation. According to the Ohio Department of Natural Resources (ODNR), Division of Natural Areas and Preserves, no rare or endangered species or unique ecological features are known to occur within a one-half mile radius of the Former MED.

2.1.5 Ambient Air and Particulate Monitoring

In 1999, a screening-level ambient air and particulate monitoring program was initiated at the RVS site at the request of the Ohio EPA. This program aimed to collect ambient data for an evaluation of air quality per Ohio EPA guidance and recommendations. This program was performed to assist the Ohio EPA with responding to community questions about air quality at the site. The data was used in an evaluation of the risk for the RVS site and is presented in the OU1 RI Report.

The ambient air monitoring program was conducted from July to November, 1999. During this period, eight separate sampling runs were completed at six VOC sampling stations. In addition, nine separate sampling runs were completed at five particulate sampling stations. The ambient air monitoring program is summarized as follows:

- VOC air sampling was initiated on July 23, 1999 with the first round of sample collection, and repeated on a 12-day cycle until October 15, 1999 for a total of eight rounds. VOC air samples were collected over a 24-hour time period using a whole-air sampling system that pumps captured air into an evacuated stainless steel canister. The canister acts as a storage container that allows the air sample to be maintained virtually unchanged until it is analyzed. The procedures for this type of sampling and the analysis performed on each sample can be found in the U.S. Environmental Protection Agency (EPA) document (1997a) "Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air (Section TO-14A)."
- Ohio EPA recommended that in addition to VOC monitoring, particulate samples should also be collected and analyzed for polynuclear aromatic hydrocarbons (PAHs). Particulate sampling was performed on the same schedule as the VOC air monitoring but was not initiated until August 17, 1999 due to the need for installation of a power supply for the sampling equipment. Nine rounds of PAH sampling were performed,

ending on November 20, 1999. Particulate samples were collected over a 24-hour period using Anderson samplers with polyurethane filters (PUF) as the sampling media. All samples were analyzed following the USEPA (1997b) Compendium Method TO-13 for PAHs.

The ambient air evaluation process recommended by the Ohio EPA utilizes an approach that is different than the approach used in the air pathway evaluation performed in the OU1 Baseline Risk Assessment. The two investigative processes are different, as one uses actual real-time measured air information, while the other uses conservative fate and transport predictive modeling. For this reason, the ambient air monitoring results have been compiled in a separate report from the OU1 RI Report or this ESI Report. An evaluation of the ambient air monitoring results, in accordance with direct recommendations and guidance provided by the Ohio EPA Division of Air Toxics, is included in the draft report titled "*Draft Ambient Air Monitoring Program, River Valley School, Marion, Ohio*", by Montgomery Watson dated February 2000 (Montgomery Watson, 2000c).

2.1.6 Expedited Soil Sampling

At the request of the RVSD and the Ohio EPA, several surface and subsurface soil samples were collected throughout the RVS site in July and August 1999. Subsurface samples were either collected during the completion of angle borings or Geoprobe[®] borings. These samples were sent to DLZ Laboratories for expedited analysis. The primary purpose of this sampling effort was to provide information to the State of Ohio and the RVSD for their interpretation and evaluation. Most of the soil samples were collected from outside the boundaries of OU1. Nine of the soil samples were collected within the OU1 area boundaries, including eight surface soil samples and one subsurface soil sample. Sample locations are presented on Plate 1 (surface soil) and Plate 2 (subsurface soil).

All soil samples collected under this activity were delivered to DLZ Laboratories for analysis. The samples were analyzed for the presence of volatile organic compounds (VOCs), semi-organic compounds (SVOC), target analyte list (TAL) metals, and polychlorinated biphenyls (PCBs). A discussion of the sample collection procedures and analytical results is presented below. Tables 2-2 and 2-3 present a summary of analytes detected in these samples.

Surface soil samples were collected at 11 sampling sector areas across the site. Up to four samples were collected from each of the sectors sampled. A total of 40 surface soil samples were collected. These samples are identified with the nomenclature "RVS-01-SUR01", etc. The "01" suffix designation represents the sampling sector, and the nomenclature "SUR01" through "SUR04" indicates the sequenced sample collected from within the identified sampling sector. In addition, duplicate samples were collected at six of the sector areas, and analyzed for quality assurance purposes. The suffix for the duplicate samples is "SUR05".

The surface soil samples were collected from the interval immediately beneath the root zone, at approximately six inches bgs. A decontaminated stainless steel shovel was used to expose the root zone, and then a decontaminated stainless steel trowel was used to collect the soil samples.

The results for the surface soil samples indicated detections above reporting limits of benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, pentachlorophenol, phenanthrene, pyrene, bis(2-ethylhexyl)phthalate, xylenes, and the PCB isomer Aroclor 1260. TAL metals detected above site-specific background levels (see Table 2-6) include chromium, iron, lead, manganese, mercury and zinc.

A total of six subsurface soil samples were collected from the angled borings, at a depth of 28 to 30 ft. bgs. The angled boring soil samples were collected from beneath the Middle

and High School buildings. The borings were conducted using a hollow stem auger rig equipped with a split-barrel sampling device. VOCs, SVOCs, and PCBs were not detected above reporting limits in any of these six samples. TAL metals detected above site-specific background levels (see Table 2-6) include cobalt, copper, iron, mercury, and zinc.

A total of nine subsurface soil samples were also collected at the site using a Geoprobe® direct push sampling technique at depths varying between 1 to 4 ft. bgs, 8 to 12 ft. bgs, and 12 to 16 ft. bgs. Neither VOCs or SVOCs were detected in any of the nine samples. The PCB isomer Aroclor 1260 was detected in the RVS-GP54 sample collected at the 1-4 ft. bgs depth. TAL metals detected above site-specific background levels (see Table 2-6) include aluminum, chromium, copper, iron, lead, nickel, and vanadium.

2.2 SOIL INVESTIGATION

Detailed sampling of the soil on the RVS Property outside OU1 included the collection of surface soil (ground surface to one foot bgs) and subsurface soil (1 to 20 feet bgs) during the course of the field work. All samples were collected in general accordance with the procedures and protocols defined for media sampling in the RVS RI Final Work Plan (Montgomery Watson, 1998a), RI Work Plan Addendum dated, December 1998 (Montgomery Watson, 1998d), and the RI Work Plan Addendum, dated July 1999 (Montgomery Watson, 1999).

A summary of the samples collected and interpreted as part of this ESI Report is shown in Table 2-1. Samples shown in this summary table are organized by sample type, nomenclature (i.e. sample point identification), and number of samples submitted for laboratory analysis. This table references only those samples collected on the RVS Property, outside OU1. A detailed summary of RVS Property samples collected and analyzed is presented in Appendix A, Data Validation Report. Copies of the soil boring logs are included in Appendix B.

To assist in the optimization of sampling locations used to assess the nature and extent of potential contamination, a review of historical aerial photographs was performed for both the OU1 area and the remainder of the RVS Property. Aerial photographs of the former MED, and in particular that portion of the Property occupied by the RVS, were obtained for the time periods 1939, 1944, 1951, 1953, 1957, 1959, 1960, 1961, 1964, 1966, and 1997. Copies of these aerial photographs are provided in the OU1 RI Report. As part of this review, observed disturbed areas and patterns of disturbance were noted. Sampling methods and locations were partially based on observed disturbed areas and patterns, which were interpreted to suggest possible historical disposal or trenching areas.

The following sections describe the activities performed to collect information on surface soils and subsurface soils within the RVS Property. Analytical test methods, method detection limits (MDLs), and practical quantitation limits (PQLs) used to evaluate and report contaminant concentrations in the media sampled as part of this investigation, were originally described in the Remedial Investigation/Feasibility Study (RI/FS) QAPP (Montgomery Watson 1998b), and are summarized in Appendix A, Data Validation Report.

In addition to the samples collected as part of this investigation, the Ohio EPA collected random split samples from approximately 10% of the samples collected by the USACE. USACE will contract with an independent third party contractor to review chemical quality by comparing 10% of the total number of samples USACE collected with the split samples that Ohio EPA collected. USACE will also contract with a third party contractor to perform additional data validation and to evaluate data completeness on ten percent (10%) of the total number of samples collected by the USACE.

Stults and Associates, Inc., under contract to MW, surveyed the horizontal position and elevations of all sampling locations as part of this investigation at the RVS. These data are summarized in Appendix C. Survey data was established by electronic measuring methods and was referenced to the existing survey grid established at the site by Lawhon and

Associates during the performance of the geophysical survey. The elevations are tied into a site benchmark which is located on a chiseled square on the concrete base of the sign for the River Valley Junior High School. The benchmark is located 0.20 feet west of the west end of the brick sign on the west side of State Route 98 at the south end of the school complex at grid location 4619.52N, 5660.04E. The benchmark elevation is 992.09 feet mean sea level (msl).

2.2.1 Surface Soil Sampling

Surface soil samples were collected during the field investigation activities in July 1998, December 1998, August 1999, October 1999, and August 2000. Surface soil samples were generally collected from ground surface to one foot bgs, and below the vegetative root zone, using several sampling techniques. Both discrete surface soil samples and composite surface soil samples were collected and delivered to a laboratory for analysis. All soil samples were forwarded on ice using COC procedures. Samples were submitted to various labs depending on the analytes being evaluated or the time frame in which results were required. The analytical labs used during the investigation included Specialized Assays, Inc., Quantera, Trace Analytical Laboratories, and Southwest Laboratories.

The August 2000 surface soil sampling effort on the RVS Property (outside of OU1) consisted of discrete sampling in selected areas to fill data gaps and to augment information gathered in areas where historical sampling had revealed concentrations of SVOCs greater than US EPA Region IX residential preliminary remediation goals (PRGs). The scope of this work was outlined in MW's April 11, 2000 letter work plan that was subsequently revised per the request of Ohio EPA. The August 2000 sampling effort consisted of sampling near previously completed angle borings located at the perimeter of the middle and high school buildings; sampling in Area 17 south of the middle school and along the historical road southwest of the middle school; and sampling in Area 23 near a former Metcalf & Eddy sampling location (see Plate 1).

A total of 156 surface soil samples (sum of discrete and composite samples) were collected using either a stainless steel trowel, split-barrel sampler (during soil boring completion), or direct push sampling techniques (at selected Geoprobe[®] sampling locations). Twenty-four of the 156 surface soil samples were composite surface soil samples. Surface soil sample locations are presented in Plate 1.

Based on sample location and previous sample results, samples were analyzed for VOCs, SVOCs, TAL metals, and/or PCBs. Starting in July 1999, if significant SVOC or PCB concentrations were detected in a sample submitted for laboratory analysis, the same sample was also analyzed for dioxins/furans. Table 2-4 presents the general list of analytes associated with the VOC, SVOC, PCB, TAL metals, and dioxins/furans testing procedures used for this investigation.

As discussed earlier, 24 of the 156 surface samples were composite surface soil samples. The composite samples were collected from 24 areas located throughout the RVS Property. Each composite area sample was created by combining samples from six discrete locations within an area. Each composite sample was analyzed for SVOCs, TAL metals and PCBs. Each of the six discrete locations within a sampling area was also screened for potential VOCs using a photoionization detector (PID). A sample was then collected and analyzed for VOCs at one of the six discrete locations. The VOC sample location was based on PID readings and visual observations with the sample location suspected of containing the highest level of VOCs being used. If elevated VOCs or PCBs were detected in the sample, based on the seven-day verbal results from the testing laboratory, then an additional analysis for dioxins/furans was performed.

2.2.2 Subsurface Soil Sampling

Subsurface soil samples were collected during field investigation activities in July 1998, December 1998, August 1999, October 1999, and August 2000. Subsurface soil samples were collected from varying depths during Geoprobe[®] and soil boring (including angle boring) completion. Samples were collected using a split-barrel sampling device while advancing soil borings, and using a direct push sampling technique during Geoprobe[®] soil sampling. Both discrete subsurface soil samples and vertical composite subsurface soil samples were collected within the RVS Property. Subsurface soil sample locations are presented on Plate 2.

2.2.2.1 Soil Boring Sampling

TolTest, Inc. (TolTest), under MW supervision, drilled nineteen soil borings (including eight angle borings) with truck-mounted and all-terrain vehicle (ATV) drilling rigs, using both 2.25-inch and 4.25-inch inside diameter (ID) hollow stem augers (HSA). All vertical soil borings were completed to a depth of 20 feet bgs. Soil boring placement was based on the results of previous sampling and the results of the soil gas survey. Soil boring locations are shown on Plate 2.

Soil samples were collected at the surface, as previously discussed, and at five-foot intervals to the terminus of each borehole. Soil samples were collected using a split-barrel sampling device. Sampling equipment was decontaminated between each sampling event using procedures and materials outlined in the MED/SOP RI Final Work Plan (Montgomery Watson, 1998a). Soil samples were classified in the field in general accordance with the Unified Soil Classification System (USCS) (American Society of Testing Materials (ASTM) D2488). Soil boring logs are included in Appendix B. Investigation derived waste materials (soil cuttings, decontamination fluids, personal protective equipment, and disposable sampling materials) were containerized and disposed of off-site with appropriate waste manifest documentation based on analytical results.

Soil samples collected through HSAs were screened for VOCs with a PID and for radiation at the time of collection (July 1998 sampling period only). The work area was also monitored for VOCs, hydrogen sulfide (H₂S), carbon monoxide (CO), oxygen (O₂), and methane (CH₄) during drilling activities in accordance with worker safety procedures described in the site-specific health and safety plan. Following termination of drilling activities, each borehole was plugged with 3/8-inch diameter chipped bentonite from the terminus of the borehole to approximately one-foot bgs. The borehole was backfilled to final grade using native soils.

All vertical soil boring samples were submitted to Specialized Assays, Inc. for analysis. Soil boring soil samples (except August 2000 soil boring samples) from the ground surface, 5 and 10-foot depths were analyzed directly by the testing laboratory. The remaining soil samples from 15- and 20-foot depths were held by the testing laboratory until preliminary verbal results of the shallower samples were available. The laboratory generally provided a verbal report of the preliminary analytical results from the shallow samples within seven days. If significant concentrations of target analytes were identified in the sample from the 10-foot depth, the deeper (15 and 20 ft) soil samples from the same boring were then analyzed. All samples were analyzed for VOCs, SVOCs, TAL metals, and PCBs. If PCBs were detected in the sample based on the seven-day verbal results from the testing laboratory, then an additional analysis for dioxins/furans was performed.

In August 2000, two vertical soil borings were drilled with an HSA adjacent to sampling locations GP99 and GP194 (Plate 2). Each boring was drilled to 20 feet bgs. Soil samples were collected for laboratory analysis from each boring, beginning with a surface soil sample, then at the following depths: 2-4, 6-8, 10-12, 14-16, and 18-20 feet bgs. Samples were screened with a PID for indications of VOC contamination and submitted to a laboratory for analyses for VOCs only. Following completion of drilling activities, each borehole was plugged with 3/8-inch diameter chipped bentonite from the terminus of the

borehole to approximately one-foot bgs. The borehole was backfilled to final grade using native soils.

In July and August 1999, eight angle soil borings were drilled around the Middle and High School buildings to obtain soil samples from beneath the buildings footprints. Five soil borings (SB30 through SB34) were drilled around the Middle School, and three soil borings (SB35 through SB37) were drilled around the High School. The soil borings were drilled with a CME 550 ATV at angles ranging from 30 to 34 degrees off horizontal. Each boring was drilled 50 linear feet. Soil samples were collected at ten foot intervals (8-10 linear ft, 18-20 linear ft, 28-30 linear ft, 38-40 linear ft, and 48-50 linear ft). In addition, a surface sample was collected for laboratory analysis at each boring location. On completion, each boring was grouted to six inches bgs. Soil boring locations are shown on Plate 2.

2.2.2.2 Geoprobe[®] Sampling

Environmental Field Services (EFS), under MW supervision, completed 151 Geoprobe[®] borings with a van-mounted Geoprobe[®] direct push rig and/or a truck-mounted Hurricane direct push rig using nominal two-inch diameter by four foot-long sampling tubes. Geoprobe[®] borings were completed to 20 feet bgs, or until refusal occurred. Boring placement was based on aerial photography, results of previous sampling, and the results of the soil gas survey. Geoprobe[®] boring locations are shown on Plate 2.

Soil samples were continuously collected from ground surface in four-foot intervals to the boring terminus depth, excluding the interval of the ground surface to one-foot bgs. Soil samples were classified in the field in general accordance with the USCS. Samples were screened for VOCs with a PID. Breathing space in the work area was also monitored for VOCs with a PID during sampling activities. Boring logs are included in Appendix B for each of the Geoprobe[®] boring locations on the RVS Property.

Soil samples obtained from the Geoprobe[®] borings (254 samples) were either vertical composite or discrete samples, based on the specific location or observed contamination within the boring. When a boring was used for composite sampling, the individual vertical samples within a single Geoprobe[®] borehole were combined over the length of the hole and submitted for analysis of SVOCs, TAL metals, and PCBs. A discrete VOC sample was retained from each four-foot interval within the length of the Geoprobe[®] borehole. Based on either the highest PID reading or field-apparent contamination within the soil column, one of the retained VOC samples was submitted for VOC analysis. If elevated readings were not encountered, then the sample interval that was judged most likely to be contaminated (e.g. the interval above the first water-bearing zone, or a sample with more coarse grained soil than other retained samples) was submitted for VOC analysis. Oftentimes, the Ohio EPA field personnel assisted in the VOC sample selection. If the Geoprobe[®] location was targeted for discrete sampling, all intervals were sampled and submitted for analysis of VOCs, SVOCs, PCBs, and TAL metals (Table 2-4). All soil samples were forwarded to an analytical laboratory using COC procedures.

Following completion of Geoprobe[®] boring activities, each borehole was plugged with 3/8-inch diameter chipped bentonite from the terminus of the hole to approximately one-foot bgs. The borehole was backfilled to final grade using native soils.

2.3 SURFACE WATER RUNOFF SAMPLING

Surface water runoff samples were collected as part of the ESI activities. Seven surface water runoff samples were collected within ditch locations along State Route 98 and the agricultural field ditch on the RVS Property in July 1998. Each of these samples was collected after a recent precipitation event. Samples were collected directly into laboratory provided sample jars without filtering. The samples were submitted for analysis of VOCs, SVOC, TAL metals, and PCBs.

2.4 GROUNDWATER INVESTIGATION

To assess whether groundwater had been impacted by past military operations at the RVS site, a network of 23 groundwater monitoring wells was installed. Twelve monitoring wells are located within OU1; 11 wells are located outside OU1 on the RVS Property. Eight rounds of groundwater samples were collected and analyzed from 20 of the 23 wells (MW02D, MW15, and MW16 were installed after the quarterly groundwater sampling effort) under the RVS investigation activities. In addition to the on-site wells, seven shallow and seven deep groundwater monitoring wells were installed at off-site locations to assist in the evaluation of background groundwater quality conditions. Results of sample analyses for samples collected from the wells located on the RVS Property outside OU1 (well MW02D excepted) are included in this report (Section 4.0). Results of sample analyses for samples collected from the wells located within OU1 are included in the OU1 RI Report.

The monitoring well network was designed to assess the physical and chemical characteristics of groundwater within the glacial till (shallow wells, completed in the shallow water-bearing zone) and groundwater in the transition zone between the glacial till and the underlying shale bedrock (deep wells, completed in the deep water-bearing zone).

2.4.1 Monitoring Well Installation

Monitoring well locations were targeted to assess the quality of groundwater throughout the RVS site, including the areas presumed to be upgradient and downgradient of the Lawhon-identified geophysical anomalies 1 and 2. Initially, the locations of the geophysical anomalies were avoided for well installation until more information was available on the content and characteristics of these areas.

Originally, 17 wells were placed in locations that would provide the most coverage of the RVS site. Following the initial investigation and well installation efforts in July and August 1998, three additional monitoring wells (MW12, MW13, and MW14) were installed in the vicinity of geophysical anomalies 1 and 2, in December 1998. Finally, wells MW02D, MW15, and MW16 were constructed in August 2000 (the latter three wells were not sampled under the ESI effort).

Of the 23 wells on the RVS site, 16 are shallow (completed into the glacial till): MW01, MW02, MW03S, MW04S, MW05, MW06, MW07S, MW08, MW09S, MW10S, MW11S, MW12, MW13, MW14, MW15, and MW16. The shallow wells range in depth from approximately 15 to 22 ft bgs. Seven deep (glacial till-bedrock interface) monitoring wells (MW02D, MW03D, MW04D, MW07D, MW09D, MW10D, and MW11D) were also installed, ranging in depth from approximately 56 to 70 ft bgs. Monitoring well locations across the RVS site are shown on Figure 2-4. In this report, the monitoring well identification label is used with or without the "RVS" prefix interchangeably, i.e. MW05 is the same well as RVS-MW05. Well construction details are summarized in Table 2-5.

As mentioned above, 11 of the 23 monitoring wells are located outside the OU1 area on the RVS Property (Table 2-1): MW02, MW02D, MW05, MW06, MW07S, MW07D, MW08, MW09S, MW09D, MW10S, and MW10D. However, since well MW02D was not constructed until after the quarterly sampling program was completed, it has not been sampled under the ESI effort. Thus, only results from ten of the wells on the Property are included in this report (Section 4.0).

In addition to the on-site wells, seven shallow and seven deep groundwater monitoring wells were installed at off-site locations to assist in the evaluation of background groundwater quality conditions. These background wells were installed with the same methods and procedures as described herein. The locations and designation of these wells are presented in the OU1 RI Report.

Monitoring wells were constructed in accordance with Ohio EPA guidance (Ohio EPA Technical Guidance Manual, 1995) using two-inch nominal ID Schedule 40 polyvinyl chloride (PVC) riser pipe and factory slotted five ft or ten ft-long PVC screens with a slot width of 0.010 inch. A quartz sand filter pack was placed around each well screen. The filter packs extend approximately two to three ft above the top of the well screen. Filter pack materials consist of either No. 5 Global Silica Sand (20-40 U.S. standard sieve size) or No. 7 Global Silica Sand (40-60 U.S. standard sieve size).

Monitoring wells MW01, MW02, and MW05 were constructed with No. 5 Global sand pack. Following installation of the aforementioned wells and consultation with Ohio EPA, No. 7 Global sand (finer gradation) was used as the preferred filter pack material for monitoring wells installed in the glacial till. The change in filter pack material size was based on the grain size of the till (clay and silts) and the increased ability of the No. 7 Global sand to filter fine-grained particles as compared to the No. 5 Global sand. In the shallow monitoring wells, an annular space seal of 3/8-inch chipped bentonite was placed above the filter pack to approximately 1.5 ft bgs. In the deep wells, a three-foot bentonite pellet seal was placed above the filter pack followed by an annular space seal of bentonite-cement slurry. Monitoring well construction reports are included in Appendix D.

Monitoring wells were completed at the surface with steel aboveground locking protective casing or a flushmount protective box. All monitoring wells were completed with a concrete surface seal installed around the protective casing. Aboveground protective casings were drilled to create “weep holes” above the surface seal for drainage.

Monitoring wells were developed in accordance with Ohio EPA guidance on groundwater investigation procedures and protocols (Ohio EPA, 1995). The volume of water in each well casing and filter pack was calculated. The well was then surged for approximately 30 minutes. The well was considered developed following the removal of water equal to ten

well volumes bailed or pumped from the well, or if the temperature, specific conductance, and pH readings stabilized (within 10%) for three consecutive readings. Following Ohio EPA approved well development methods, groundwater from many of the wells remained turbid, and this turbidity has likely contributed to elevated totals concentrations observed in the analytical results. Monitoring well development forms are presented in Appendix D.

Monitoring wells were surveyed by level circuit to determine vertical elevation of the ground surface, PVC casing, and steel protective casing. An accuracy of ± 0.01 feet for the top of PVC casing and ground surface was obtained. The location and elevation of each well are included on the well construction forms in Appendix D. The elevations of the top of PVC at each well were used in determining groundwater elevations at each well.

2.4.2 Groundwater Sampling Procedures

Eight rounds (quarterly sampling from September 1998 through May 2000) of groundwater samples were collected from ten wells on the RVS Property outside of the OU1 area. Prior to the collection of a groundwater sample from each well, the static water level was measured and recorded on all wells prior to any purging and sampling the wells. The well volume was then calculated using the total depth of the constructed well. If possible, three well volumes were purged from each well using a disposable bailer. Otherwise, wells were purged until dry. After three well volumes were removed, a representative sample was collected. In cases where a well went dry, it was not possible to sample immediately following purging. Such wells were either sampled later the same day or the next day. Wells were sampled within 72 hours of purging. The field pH, conductivity, and temperature of the sample were measured during sample collection and recorded. Groundwater samples were shipped on ice following COC procedures and analyzed by Specialized Assays. Groundwater sampling data forms are included in Appendix E, which contains sampling information for each well.

Groundwater samples were analyzed for VOCs, SVOCs, TAL metals, and PCBs. The list of analytes associated with each of these groups of compounds is presented in Table 2-4. In accordance with Ohio EPA recommendations, all groundwater samples were unfiltered during collection efforts.

2.4.3 Hydraulic Conductivity Testing

In November 1999, MW personnel conducted hydraulic conductivity (or “slug”) tests on seven monitoring wells located within the OU1 area. The slug tests were performed to provide estimates of the hydraulic conductivity of the water-bearing zones. Five wells (MW01, MW04S, MW11S, MW12, and MW14) used to conduct slug tests were completed into the shallow water-bearing zone. Two wells (MW04D and MW11D) used for testing purposes were completed in the deeper water-bearing zone (till/bedrock interface).

To conduct the tests, water in each well was displaced by introducing a solid “slug” into the well. Following this perturbation, water levels in each well were recorded with an In Situ Hermit data logger until the well was at least 90% recovered (pre-test static level). Two tests were conducted at each location: a falling head test, and a rising head test. Test results were interpreted using appropriate methods (i.e. Bower-Rice and Cooper-Bredehoeft-Papadopoulos) to estimate the hydraulic conductivity of the water-bearing zones in the immediate vicinity of each well.

The estimates of hydraulic conductivity are included in Section 3.0 of this report. More details about the slug testing and slug test data plots are found in the OU1 RI Report. It should be noted that the monitoring wells are constructed of small diameter (two inch) PVC with a surrounding filter pack. Therefore, the volume of water displaced during a slug test is relatively small, hence the assessment of the saturated zone hydraulic conductivity using this method is subject to a certain degree of variability. Nevertheless, the results provide a reasonable estimate of the permeability of the glacial till in both the shallow and deep water-bearing zones.

2.5 DEVELOPMENT OF BACKGROUND CONCENTRATIONS

Background sampling was completed from both on-site locations as well as off-site locations to provide information on naturally occurring compounds in the soil and groundwater. Tables 2-6 and 2-7 present a summary of developed background values for soil and groundwater constituents, respectively. These values were developed as part of the OU1 RI Report. A specific discussion of the development of these background values is included in the OU1 RI Report.

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3.0 PHYSICAL CHARACTERISTICS OF STUDY AREA

The following sub-sections describe the physical characteristics of the RVS Property. The information in this section was developed from the various field investigations performed at the site since March 1998, and augmented with information gathered from the following referenced reports:

- *Report on the Environmental Assessment of Former Marion Engineer Depot.* ERM-Midwest, Inc., June 1990.
- *Interim Report for River Valley Local Schools, Marion.* Lawhon & Associates, Inc., for the Ohio EPA, December 1997.
- *Environmental Investigation at the River Valley School Property.* Floyd Browne Associates, Inc., September 1997.
- *Archives Search Report for the Former Marion Engineer Depot.* USACE, August 1998.
- *Soil Survey of Marion County, Ohio.* United States Department of Agriculture, 1989.
- *Ground Water Resources of Marion County Map,* Katie Schafer Crowell. Ohio Department of Natural Resources, 1979.
- *Drift Thickness Map of Marion County Ohio,* Vormelker, Joel. Ohio Department of Natural Resources, 1985.

3.1 SURFACE FEATURES

Marion County lies within the Scioto Lobe of the Indiana-Ohio Till Plain. The surface features include nearly level plains and basins, gently sloping hills, and a few moderately steep valley sides. The topographic features are generally uniform. Local topography is generally flat, with elevations in the range of 986 to 994 ft above MSL.

3.2 METEOROLOGY

The climate of Marion County is classified as continental. The average temperature during the winter is 27 degrees Fahrenheit, and the average temperature in the summer is 71 degrees Fahrenheit. The most extreme temperatures for this area have ranged from minus 23 degrees to 101 degrees Fahrenheit.

The total annual precipitation for Marion County is approximately 34 inches. Nearly 60% of the annual rainfall occurs between the months of April and September. The local record for rainfall during one 24-hour period is 3.94 inches. The average annual snowfall is approximately 26 inches. On average, snow is on the ground (at least one inch) for an average of 25 days each year. The most snow measured at one time in Marion County is 18 inches.

The average relative humidity in mid-afternoon is about 70%. The humidity generally is higher at night with an average humidity at dawn of approximately 80%.

The sun shines 60% of the time possible in the summer and 40% in the winter. The prevailing wind is from the south-southwest with an average wind speed of 13 miles per hour (winter).

3.3 SURFACE WATER HYDROLOGY

Surface drainage on the RVS Property is controlled by a series of perimeter drainage ditches and a west-draining storm sewer that discharges into the southern-flowing Clendenan Ditch. Figure 3-1 presents a regional surface water map. Site drainage features are shown on Figure 3-2. The Clendenan Ditch discharges into Riffle Creek approximately three miles south of RVS. Riffle Creek, which is located west of RVS, flows to the south approximately two miles, before gradually bending to the southwest for an additional two miles. At this point, Riffle Creek converges with the southeastern flowing Grave Creek. The convergent flow of Grave Creek and Riffle Creek travels an additional 0.2 miles south, where it discharges into the Olentangy River, near the intersection of State Route 98 and Wheatstone River Road.

There are no surface water bodies present within the RVS Property. Any water that occurs in the drainage ditches along the adjacent highways accumulates as a result of precipitation and runoff. Surface water is occasionally found in the low-lying areas of the RVS Property area near the practice ball fields and nature preserve. This surface water is most likely the result of precipitation ponding on clayey soils, or the occurrence of saturated shallow soils that retain precipitation in a perched condition. This area drains to the south-southwest toward the adjacent USAR LTA.

3.4 GEOLOGY

The RVS site was covered by a series of continental glaciers during the Pleistocene Epoch of the Cenozoic Era. The bedrock in contact with the Pleistocene glacial till deposits includes both Devonian aged limestone and shale in the eastern portion of the Marion County. The Devonian Limestone includes the Delaware and Columbus formations. According to the ODNR records, the eastern portion of the former MED (including the RVS Property) is located on top of the Olentangy and Ohio shales.

Based on the findings of this investigation, a generalized stratigraphic column (Figure 3-3) was prepared depicting the subsurface materials encountered beneath the RVS Property to a depth of approximately 80 feet.

3.4.1 Unconsolidated Deposits

Soils beneath RVS are generally comprised of clayey and silty glacial till deposits. Several sand, silty sand, and clayey sand layers and lenses were also encountered during drilling investigations. Most sandy zones are thin (less than one foot thick) and laterally discontinuous, although some sandy horizons reach five feet in thickness. Because of the relatively thin and/or discontinuous nature of the sandy layers, it is not practical to discuss each as a distinct stratigraphic unit. Based on the subsurface data collected at the locality, both inside and outside OU1, the total thickness of unconsolidated materials ranges from 49.5 ft (RVS-MW02D) to 59 ft (RVS-MW07D).

The silt/clay glacial deposits are the predominant materials encountered beneath the site. The upper 10 to 20 ft. of the till is generally comprised of brown silts or clays with interbedded thin horizons of sand and gravel within a fine-grained matrix. The till generally changes to a gray, stiff, silty clay to clayey silt below 10 ft, with thin, interbedded horizons of coarser-grained material present at various depths down to the base of the till deposits.

The predominance of the silt/clay deposits and the comparatively thin, laterally discontinuous nature of the more permeable, sandy zones are shown graphically in a series of cross-sections constructed for various locations across the RVS Property (Figure 3-4). The cross-sections are included as Figures 3-5 through 3-11.

Soil samples of the till deposits were submitted for grain size analysis (sieve and hydrometer) during the course of the investigation. Based on these analyses, till samples ranged from SP-SM (poorly graded sand-silty sand) to CL (clay or silty clay) in the USCS.

3.4.2 Bedrock Geology

The bedrock underlying the Pleistocene glacial deposits varies from Silurian limestone and dolomites in the western portion of the county to younger Devonian limestone and shale in the eastern portion of the county. Regionally, the bedrock dips approximately 19 ft per mile toward the southeast. The eastern area of the former MED lies on top of the Olentangy and Ohio shales, as shown in Figure 3-12.

The oldest bedrock unit in the area is the Columbus Limestone, which consists of brown dolomite (lower 1/3 of formation) and gray fossiliferous limestone (upper 2/3 of formation). Local thicknesses range from 0-105 feet. Overlying the Columbus Limestone is the Delaware Limestone, which consists of gray to brown argillaceous, cherty, carbonaceous limestone. Thicknesses range from 0-45 feet. The Olentangy Shale overlies the Delaware Limestone. It consists of a greenish gray to medium gray, clayey shale with limestone nodules (lower 1/3) and thin beds of brownish gray shale (upper 2/3). Thicknesses range from 20-55 feet. Local thickness is reportedly around 28 feet. Overlying the Olentangy Shale is the Ohio Shale, which consists of brownish black to greenish gray carbonaceous shale with carbonate/siderite concentrations in the lowermost 50 feet. Thicknesses range from 250-500 feet.

Bedrock was encountered during drilling at each deep monitoring well site on the RVS Property. Based on these drilling logs, unconsolidated deposits are underlain by a dark gray to black shale (Ohio Shale) at depths ranging from 49.5 to 59 feet bgs. Bedrock topography of the Ohio Shale beneath the RVS site appears to slope gently toward the north (Figure 3-13), suggesting a bedrock high south of the site. The RVS investigation findings, with respect to the nature of the bedrock underlying the site, are consistent with published regional geologic information. The Ohio Shale is hard, and it is fractured at the contact with the overlying glacial till.

At most locations a hydrogen-sulfide odor was detected when the shale was encountered during drilling. Sources indicate that the Ohio Shale frequently contains pyrite (iron sulfide) and its pseudomorph marcasite (a less stable form of iron sulfide) as disseminated grains or nodules. It is likely that the gas is a byproduct of bacterial metabolism of the iron sulfide. The bacteria utilize similar minerals and naturally occurring organic matter as a food source, and release hydrogen sulfide gas as a byproduct of their microbial respiration. It is also suspected that impurities in the pyrite are a potential source of anomalous background concentrations of arsenic and other heavy metals observed in groundwater collected from deep (bedrock-glacial till interface) monitoring wells (Botoman and Stieglitz 1978, Hoover 1960, Struble, et. al 1982).

The shale beneath the RVS site is overlain by a thin (one to several ft) gravelly transitional zone (possibly weathered shale) that contains subangular shale fragments. The shale bedrock was not penetrated more than 11 ft by any boring, thus the actual thickness of the Ohio Shale at the site cannot be determined from the subsurface investigations conducted to date.

3.5 SOILS

According to the United States Department of Agriculture (USDA), soils that originally developed in the area are part of three different soil associations: the Blount-Pewamo, Pewamo-Elliot, and Milford-Centerburg units (USDA 1989). Since most of the site has been regraded to accommodate construction of school facilities, the distribution and occurrence of the documented original soil types are not as previously mapped.

The Blount Soil unit is described as a silt loam and consists of somewhat poorly drained soils occurring on slight rises (end and ground moraines). The Pewamo soil unit is described as a silty clay loam and consists of very poorly drained soil occurring on broad flats, in depressions, and along drainageways on ground moraines and end moraines. The

Elliot unit is described as a silty clay loam and consists of somewhat poorly drained soil occurring on slight rises and ground moraines. The Milford unit is described as a silty clay loam and consists of very poorly drained soil on broad flats, in shallow depressions, and along drainageways on lake plains. The Centerburg unit is described as a silt loam and consists of moderately well drained soil occurring in hummocky areas on ground moraines and end moraines. Underlying material down to a depth of about 60 inches bgs, is brown to yellowish brown, mottled, calcareous, firm to very firm, clay to silty clay loam glacial till and silty clay loam of lacustrine origin.

3.6 HYDROGEOLOGY

Marion County can generally be divided into two areas according to groundwater availability. The western two-thirds of the county obtains readily available groundwater supplies from the underlying Silurian and Devonian-aged limestones and dolomites. The remainder of the county contains minimal amounts of potable water as this is where the Devonian-aged shales are present beneath the clay-rich glacial till. The area where the limestone and dolomite are in direct contact with the overlying glacial sediments exhibits well yields of approximately 10 to 50 gallons per minute (gpm) from depths of less than 80 ft. The clayey till above the shale yields less than four gpm, and dry wells are not uncommon. Wells completed in the limestone below the shale can produce more than 400 gpm.

The ODNR Division of Groundwater completed a water well survey at the request of Montgomery Watson. The survey was completed for an area within a one-mile radius of the RVS Property to provide information on the number of wells, well locations, well depths, and the source of supply for the wells. Based on the results of the ODNR survey, eight residential water wells were identified within a one-mile radius of the property. Of these eight wells, seven are located north of the site, and the eighth is south of the site. Well depths range from 19 to 151 ft, and well completions are in sand and gravel horizons

in the till, or in underlying limestone. A reference map showing well locations and well logs for these wells is presented in the OU1 RI Report.

A large portion of Marion County residents obtain their drinking water from public water supplies originating from groundwater and surface water sources, including the Little Scioto River. Water supplies at RVS are provided by the Ohio American Water Company potable water supply system. Groundwater resources at the site are not used by the RVS.

During the drilling of borings on RVS site, shallow, saturated soil horizons were encountered from 2 to 12 ft bgs. The presence of these saturated horizons appears to be dependent on the occurrence of permeable horizons in the otherwise low-permeability clays that comprise the glacial till. Small, localized occurrences of (perched) groundwater may be present in sandy stringers that are not hydraulically connected with other saturated horizons, due to their limited lateral extent and/or small saturated thickness (Figures 3-5 through 3-11).

Water levels measured in the shallow groundwater monitoring well network suggest an apparent, but non-uniform, groundwater flow direction to the southwest. Variable and inconsistent water levels measured in shallow wells over the duration of the monitoring period, coupled with the lack of homogeneity in the till deposits, suggest that the saturated horizons may not be continuous across the site. Seasonal variations in perched water levels may contribute to the inconsistencies observed in the shallow well network as increases and decreases in precipitation and recharge occur.

To exhibit a potentiometric surface and apparent or potential flow directions within the shallow glacial till, a Shallow Groundwater Contour Map (Figure 3-14) was prepared. In addition, Table 3-1 presents a summary of groundwater elevations derived from eight quarters of monitoring plus an additional monitoring event that occurred in January 2001. The inferred contours in Figure 3-14 reflect the water levels measured in the shallow well

network during the January 2001 monitoring event. Additionally, each contour is dashed to reflect the indeterminate nature of the hydraulic potential within the shallow, permeable horizons in the glacial till.

Water levels measured in the deep well network suggest groundwater flows generally in a southeastern direction. Similar to the assessment of shallow groundwater flow directions, a Deep Groundwater Contour Map (Figure 3-15) was developed using water levels measured in deep wells during the aforementioned January 2001 monitoring period.

The water levels measured in the deep wells represent a potentiometric surface that appears to be hydraulically distinct from that in the shallow water-bearing zone. Deep wells are screened at depths ranging from 44 to 70 feet, yet the water levels measured in these wells range from 10 to 14 feet bgs for the month of January 2001 (excluding well MW03D), implying the deep water-bearing zone is under confined conditions. Confined conditions are representative of a saturated horizon that is bound (confined) by aquitards (less permeable beds in a stratigraphic sequence). Under confined conditions, the static water level in a well is present above the top of the saturated horizon.

The saturated materials that occur at the till-bedrock interface are variable in grain size, content and thickness. This variability also appears to impact the hydraulic characteristics of this horizon. As an example, deep well RVS-MW03D is typically bailed dry during sampling, and the depth to water at this location is significantly lower (48 ft bgs) than in the other deep wells. As a result, this well is not included in the assessment of the flow direction for deep water-bearing zone, as shown on Figure 3-15.

The results of the slug testing (slug test data are representative of horizontal hydraulic conductivity) are summarized in Table 3-2. It should be noted that all the wells listed in this table are contained within the OU1 area. However, the results obtained from the slug

tests are also relevant and applicable to a description of the hydraulic characteristics of the deep and shallow water-bearing zones beneath the Property outside of OU1.

As indicated in Table 3-2, the range in estimated hydraulic conductivity for the shallow water-bearing zone is 3.4 to 31 ft/day. The high end of this range is the average of a falling head and a rising head test conducted at well MW01. This well is screened across a more permeable sandy horizon in the till, and the test results reflect its presence. It is apparent that the heterogeneity of the glacial till deposits (horizons of sand within an otherwise clay-rich deposit) results in a range of relative permeability values.

The estimated hydraulic conductivity of the deeper water-bearing zone ranges from 0.2 to 11 ft/day. Literature values for hydraulic conductivity in glacial tills range from 0.001 to 10 ft/day. The slug test results for the saturated horizons may only be representative of the individual lenses or coarse-grained horizons within the otherwise low-permeability clay. The horizontal hydraulic gradient in the deep water-bearing zone in January 2001 was approximately 0.003 ft/foot. The horizontal hydraulic gradient for the shallow zone was not estimated due to the indeterminate nature of flow in the glacial till.

As shown in Table 3-1, the water elevations in each deep well of the deep/shallow monitoring well pairs was lower than the respective shallow well, suggesting that a downward vertical hydraulic gradient exists. However, the magnitude of this vertical gradient is unclear, based on the existing well network at the site and the variability in the water levels measured. Due to the manner in which the till was deposited, it is likely that the vertical hydraulic conductivity of the till is significantly lower than the values derived from the slug test analysis.

3.7 DEMOGRAPHY AND LAND USE

The RVS is situated on approximately 78 acres in a generally rural area, and consists of several school buildings, modular classrooms, athletic fields, and support structures associated with the RVS facility. Land use surrounding RVS consists of commercial and light industry to the west (Marion Industrial Depot), north (commercial facilities along State Route 309) and east (GTE facility). Sparsely populated farmland and residential properties are also present to the north, southeast, and south of the RVS. The USAR LTA borders the RVS property to the southwest.

3.8 FLORA AND FAUNA

In general, outside of the OU1 area, grasses are kept short by periodic mowing of ball fields and other green belts. The dominant vegetation type in the unmowed grass area on the RVS Property is a ruderal-field community that supports grasses and weedy herbaceous species typical of disturbed areas. Wild carrot (*Daucus carota*), tall goldenrod (*Solidago stricta*), thistle (*Cirsium* sp.), plantain (*Plantago lanceolata*), rye grass (*Lolium perenne*), and Kentucky bluegrass (*Poa pratensis*) form the predominant vegetation. In general, outside of the OU1 area, grasses are kept short by periodic mowing of ball fields and other green belts.

A few shrubs and trees, such as smooth sumac (*Rhus glabra*), rough-leaf dogwood (*Cornus drummondii*), and apple (*Malus slyvestris*), grow along the fence line. The grasses and flowering plants in the ruderal-field community could provide habitat for potential ecological receptors such as insects, birds, and small mammals. A cottontail rabbit (*Sylvilagus floridanus*), butterflies, and birds, including killdeer (*Charadrius vociferus*), red-winged blackbirds (*Agelaius phoeniceus*), and goldfinch (*Carduelis tristis*) are present in the area. Praying mantis (*Tenodera aridifolia*) egg cases have also been identified in the area.

3.8.1 Threatened and Endangered Species

Based on field inspection and the ODNR, no rare or endangered species or unique ecological features are known to occur within a one-half mile radius of the former MED (Ohio Department of Natural Resources, 1998).

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4.0 NATURE AND EXTENT OF CONTAMINATION

The following sub-sections describe the nature and extent of contamination as identified by the ESI field activities on the RVS Property. The results of the laboratory analysis of subsurface and surface soils are discussed in 4.1. Groundwater sample results are discussed in 4.2, while surface water laboratory results are discussed in 4.3. The discussion of the nature of organic and inorganic compounds identified within the RVS Property is based on samples with detectable concentrations of contaminants. Tabulated data associated with these discussions are provided in this report. For a complete summary of all analytical results for samples collected and analyzed as part of the RVS Property investigation (including non-detects), the reader is directed to the Data Validation Report (Appendix A).

Several types of screening criteria were utilized in order to evaluate the extent of elevated organic and inorganic contaminant concentrations on the RVS Property. These screening criteria include site-specific industrial worker preliminary remediation goals (used to screen all soil samples), site-specific recreational user (ballplayer) preliminary remediation goals (used to screen all soil samples), USEPA Region IX tap water preliminary remediation goals (PRGs) as published in November 2000 (used to screen organics in groundwater samples), natural background concentrations (see Section 2.5) (used to screen TAL metals in soil and groundwater samples), and the Ohio EPA drinking water maximum contaminant levels (MCLs) (used to screen organics and TAL metals in groundwater samples) (Appendix F). Should other criteria be deemed applicable for addressing and/or determining the extent of contamination, then the estimates made in this report, as to the extent of an impacted medium, may be partially or wholly revised.

The site-specific industrial worker preliminary remediation goals and the site-specific ballplayer preliminary remediation goals (presented above) were developed in the Draft Industrial Worker Addendum to the River Valley School Property, Operable Unit 1 – Former Disposal Area, Draft Remedial Investigation Report (April 2001). The Industrial

Worker Addendum address potential health risks from future exposure to hazardous constituents at OU1 under the industrial/commercial land use. In addition, the addendum reiterates the risks associated with the use of the property as a school (based on the use of the property as a school until the Fall of 2003). The OU1 Addendum's risk characterization includes an estimate of risk and develops both site-specific industrial worker preliminary remediation goals and site-specific ballplayer preliminary remediation goals. As discussed above, these preliminary remediation goals were used to screen the RVS Property data.

4.1 SOIL RESULTS

Soil samples collected on the RVS Property were analyzed for VOCs, SVOCs, TAL metals, and PCBs. Selected samples were also analyzed for dioxins/furans. Results of the analytical tests are presented in two general categories: surface soils, which are defined as those soils at the ground surface to a depth of one foot bgs; and subsurface soils, defined as those soils at depths greater than one foot bgs. Four hundred and eighty-five individual soil samples were collected from the RVS Property and tested for the above analytes. Approximately 27% of these samples were collected as discrete surface samples, while approximately 5% of the samples were collected as composite surface samples. The remainder (approximately 68%) were collected as subsurface samples.

4.1.1 Surface Soil Sample Results

RVS Property surface soil samples were collected from the ground surface to 1 foot bgs using several sampling techniques. Both discrete surface soil samples (132 total) and composite surface soil samples (24) were collected and submitted for laboratory analysis. Tables 4-1 through 4-5 summarize the detected VOCs (Table 4-1), SVOCs (Table 4-2), TAL metals (Table 4-3), PCBs (Table 4-4), and dioxins/furans (Table 4-5) in RVS Property

surface soil samples. As mentioned in Section 2.0, Plate 1 presents surface sample locations.

Table 4-1 presents the VOCs detected in surface soils on the RVS Property. The VOCs detected in surface soils were primarily solvent-related compounds, including 1,1,2-trichloroethane and tetrachloroethene. The compound 1,1,2-trichloroethane was detected predominantly along State Route 98, State Route 309, and within and east of the agricultural field ditch (See Figure 2-2 and Plate 1). Tetrachloroethene was detected predominantly in the agricultural field ditch as well as in the southeast corner of the RVS Property. None of the samples containing VOCs exceeded the screening criteria.

Table 4-2 presents the SVOC compounds detected in surface soils on the RVS Property. Elevated concentrations of SVOC compounds were found in twenty-four samples. These included acenaphthene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenzo(a,h)anthracene, which are polynuclear aromatic hydrocarbons (PAHs). Plate 3 presents surface sample locations which exceeded the screening criteria.

PAHs can enter soil through various methods, including deposition from vehicle exhaust, oil spills and leaks, and runoff from paved roads and parking lots. PAHs, such as benzo(a)pyrene, are also found in petroleum-based tars used for road and roofing repair. The contaminants were primarily found along State Route 98, State Route 309, and in the areas near SB34, SB35, SB36, and SB37, which are near parking lots or buildings (See Plate 1). Due to the proximity of these locations to roads and buildings, the possibility exists that anthropogenic effects (such as vehicle exhaust and runoff from roads, parking lots and roofs), unrelated to historical waste disposal activities at the RVS site, may have contributed to PAH contamination in the samples. A further discussion of anthropogenic sources of contamination can be found in Section 6.

Table 4-3 presents detected concentrations of TAL metals in surface soils on the RVS Property that were greater than the screening criteria (background level and site-specific preliminary remediation goal). In all instances except arsenic, the background concentration for a given metal was less than the respective site-specific preliminary remediation goal. Thus, if a concentration exceeds the site-specific preliminary remediation goal, it will also most likely exceed the background value for that metal. For arsenic, the background concentration is 18 mg/kg and the site-specific ballplayer and industrial worker preliminary remediation goals are 5.5 mg/kg and 3.1 mg/kg, respectively. Therefore, if the arsenic concentration exceeds the site-specific preliminary remediation goals, it may not exceed the background level. Arsenic background sample locations and values are presented in Appendix E of the Remedial Action Plan dated November 1998 (Montgomery Watson). Only samples that exceed both screening criteria are highlighted.

Among the TAL metals for which samples were analyzed, only lead and arsenic exceeded both background levels and the site-specific preliminary remediation goals. Elevated lead levels were only detected in two locations (SB31 and SB36 at the middle and high school buildings, respectively). Elevated arsenic levels were found along State Route 98, State Route 309, and the area adjacent to the agricultural field ditch. Plate 3 presents surface sample locations that exceeded both the site-specific preliminary remediation goals and background levels. Many of these locations were remediated during the arsenic ditch removal action described previously. A detailed report of the arsenic ditch remediation can be found in the previously published report "River Valley School Property, Arsenic Ditch Remediation Closure Report" (Montgomery Watson, 2000). Plate 3 also indicates sample locations which have been remediated as part of the arsenic ditch remediation.

Table 4-4 presents the PCBs that were detected in two surface soil samples. Aroclor 1260 was detected in both surface soil samples (SD09 and SD14). Neither sample exceeded the screening criteria.

In addition to VOCs, SVOCs, metals, and PCBs, dioxins/furans analysis was completed on discrete and composite surface soil samples. As shown in Table 4-5, several samples had several low-level dioxins/furans detections. These are further addressed relative to their toxicity equivalent factors in Section 6.0 – Expanded Site Risk Evaluation.

4.1.2 Subsurface Soil Sample Results

Approximately 329 subsurface soil samples were collected on the RVS Property from depths of 1 to 20 ft bgs during Geoprobe[®] soil sampling, soil boring completions, and hand augering. Both discrete subsurface soil samples and composite subsurface soil samples were collected and submitted for laboratory analysis. Soil samples were analyzed for VOCs, SVOCs, TAL metals, and PCBs. Starting in July 1999, if significant SVOC or PCB concentrations were detected in a sample submitted for laboratory analysis, the same sample was also analyzed for dioxins/furans.

Tables 4-6 through 4-10 present summaries of detected VOCs, SVOCs, TAL metals, PCBs, and dioxins/furans in RVS subsurface soil samples, respectively. Plate 2 presents a plan view of the subsurface sample locations.

Table 4-6 summarizes the VOCs detected in RVS Property subsurface soil samples, including the maximum, minimum, and average concentrations of each VOC detected. None of the samples collected exceeded the screening criteria.

Table 4-7 presents the SVOCs detected in RVS Property subsurface soils. Table 4-7 also summarizes the maximum, minimum, and average concentration of each SVOC detected. Detectable concentrations of SVOCs were discovered in samples collected at only six locations. None of the concentrations exceeded the screening criteria.

Table 4-8 summarizes TAL metal concentrations detected in subsurface soils, including those metals that were detected above the screening criteria (background levels and site-specific preliminary remediation goals) in subsurface soil samples. As discussed above, in all instances except arsenic, the background concentration for a given metal was less than the respective site-specific preliminary remediation goal. Thus, if a concentration exceeds the site-specific preliminary remediation goal, it will also most likely exceed the

background value for that metal. Only samples that exceed both screening criteria are highlighted.

Arsenic was the only TAL metal detected above the screening criteria. Sample locations where concentrations of arsenic in soils exceeded the screening criteria are scattered throughout RVS. However, those sites tend to be clustered primarily along the agricultural field ditch and around the River Valley Middle School and High School buildings. Plate 4 presents subsurface sample locations which exceeded both the site-specific preliminary remediation goals and background levels. The possibility exists that anthropogenic sources including arsenical pesticides, unrelated to historical waste activities at the RVS site, may have contributed to the arsenic contamination in the area of the school buildings.

Table 4-9 summarizes the PCBs detected in subsurface soil samples. PCBs were detected in one subsurface soil sample (RVS-SB33(8-10 ft. bgs)). This sample is located on the west side of the River Valley Middle School building. However, the concentration of PCBs in this sample did not exceed the screening criteria.

In addition to soil analysis for VOCs, SVOCs, metals, and PCBs, dioxins/furans analysis was completed on five discrete subsurface samples on the RVS Property. Table 4-10 presents the dioxins/furans detected for all subsurface soil samples on the RVS Property. As shown in Table 4-10, one sample had several low-level dioxins/furans detections. These are further addressed relative to their toxicity equivalent factors in Section 6.0.

4.2 GROUNDWATER RESULTS

As part of the RVS remedial investigation, the monitoring well network described in Section 2.4 was sampled eight times on a quarterly basis since August 1998, with the previously noted exceptions (refer to Section 2.4.1).

Groundwater samples collected from the monitoring wells were analyzed for VOCs, SVOCs, TAL metals, and PCBs. Analytical groundwater results for VOCs, SVOCs, and PCBs were compared to the Ohio EPA Maximum Contaminant Levels (MCL) and USEPA Region IX Tap Water PRGs (screening criteria) (Appendix F). The analytical groundwater results for TAL metals were compared to Ohio EPA MCLs and background concentrations (screening criteria) (Table 2-7 and Appendix F). It should be noted that the shallow groundwater sampled from shallow monitoring wells at the RVS site is potentially perched groundwater that resides in discontinuous, permeable horizons in the glacial till. These water-bearing horizons are likely incapable of yielding sustained flows to wells and do not generally yield water of a potable nature.

In order to quantify total metals concentrations, groundwater samples collected from monitoring wells were not filtered at the time of collection, per the Ohio EPA directive for groundwater sampling procedures. This aspect of the sampling procedures may have had a significant effect on the resultant water quality concentrations identified by the analytical testing. While all wells were developed following construction and then purged prior to sampling, collected samples displayed varying levels of turbidity, which may have affected (increased) the metals concentrations reported by the laboratory.

No VOCs were detected in the groundwater at any monitoring well outside OU1 during the eight rounds of sampling. In addition, no PCBs were detected in samples collected from the RVS Property wells over the eight rounds of sampling.

Table 4-11 presents a summary of SVOCs detected in the groundwater at RVS monitoring wells over eight rounds of sampling. As shown, SVOCs were detected at MW02 and MW06 during the February 1999 round of sampling. Both detections were below both the screening criteria (Ohio EPA MCL and USEPA Region IX Tap Water PRGs). Lab contamination cannot be ruled out as the source of this one-time detection of bis(2-ethylhexyl)phthalate. In addition, bis(2-ethylhexyl)phthalate is also a common field

sampling artifact most likely the result of sampling personal protective equipment (i.e. sampling gloves).

Table 4-12 presents a summary of TAL metals detected in samples collected from the monitoring wells on the RVS Property. The TAL metals concentrations were compared with Ohio EPA MCL values and with background levels for both shallow and deep groundwater, as appropriate.

As shown, both criteria were exceeded more than once for aluminum, cobalt, iron, nickel, and zinc. Background criteria for arsenic, cadmium, chromium, and lead were exceeded most notably during the later rounds of sampling. Highest exceedances occurred for the metals arsenic, chromium, and lead. The Ohio EPA MCLs for arsenic and lead were typically exceeded in at least one well during most rounds of sampling.

4.3 SURFACE WATER RUNOFF RESULTS

Seven surface water runoff samples were collected within the RVS Property from low-lying areas after a precipitation event in the summer of 1998. Surface water runoff samples were analyzed for VOCs, SVOCs, TAL metals, and PCBs.

VOCs and PCBs were not detected in any of the surface water runoff samples. SVOCs, in particular bis(2-ethylhexyl)phthalate, was detected in one surface water runoff sample. TAL metals were detected in all of the surface water runoff water samples, as expected, as the samples were not filtered (Table 4-14). While noted, the occurrence of TAL metals in surface water runoff does not directly constitute contamination, nor does it necessarily imply an abnormal condition in terms of surface-water runoff quality.

4.4 EXTENT OF CONTAMINATION

This section describes the extent of elevated concentrations of VOCs, SVOCs, TAL metals, and PCBs identified in soils and groundwater within RVS, as identified by the investigation results compiled to date. Samples with detected concentrations were compared to several screening criteria. These screening criteria include site-specific industrial worker preliminary remediation goals (used to screen all soil samples), site-specific ballplayer preliminary remediation goals (used to screen all soil samples), USEPA Region IX tap water preliminary remediation goals (PRGs) as published in November 2000 (used to screen organics in groundwater samples), natural background concentrations (see Section 2.5) (used to screen TAL metals in soil and groundwater samples), and the Ohio EPA drinking water maximum contaminant levels (MCLs) (used to screen organics and TAL metals in groundwater samples) (Appendix F).

As previously described, these screening criteria are used in order to focus on chemicals and areas of potential concern. Should other criteria be deemed applicable for addressing and/or determining the extent of contamination, then the estimates made in this report as to contaminant extent may be partially or wholly revised.

The sources of contaminants on the RVS site are presumed to be related to the past disposal practices associated with the former military use of the property prior to 1961. Due to the proximity of identified contaminants to roads and buildings, one cannot rule out the possibility that anthropogenic effects (such as vehicle exhaust and runoff from roads, parking lots and roofs) unrelated to historical waste disposal activities at the RVS site, may have contributed to the contamination. This is discussed in detail in Section 6.3.2.4. Uncertainties of this report.

4.4.1 Surface Soils

Although VOCs were detected in surface samples within RVS, all of the detected VOCs were below the screening criteria. This investigation has not identified areas of elevated concentrations of VOC contaminants in surface soils above the screening criteria.

As previously presented, SVOCs were detected above the screening criteria in surface soils on the RVS site. SVOCs in surface samples in exceedance of the screening criteria were predominantly found along State Route 98, State Route 309, and in the areas near borings SB34, SB35, SB36, and SB37. The SVOCs detected are acenaphthene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenzo(a,h)anthracene, which are PAHs. As stated earlier, PAHs can enter the surrounding soil through vehicle exhaust, oil spills and leaks, and runoff from paved areas. PAHs, such as benzo(a)pyrene, are also found in petroleum-based tars used for road and roofing repair. The following summarizes the observed extent of elevated SVOC levels compared to the screening criteria:

- SVOCs detected above the screening criteria at SD03, SD04, SD05 and SD11 were remediated during the arsenic ditch removal action.
- SVOC levels detected above the screening criteria exist in surface soil samples behind and just east of the River Valley Middle and High School buildings (at boring locations SB35, SB36, and SB37). Each of these locations is bounded by areas of low level (below screening criteria) and non-detect SVOC concentrations, which suggests a limited spatial extent of contamination in this area.
- SVOC detections greater than the screening criteria were also found at SD17 and SD18, which are located along State Route 309 and at SD01 and SD02 which are located along State Route 98. The areas bounding of SD17, SD18, SD01 and SD02 are areas of low level (below screening criteria) and non-detect levels of SVOCs, suggesting a limited spatial extent to contamination. Also, SVOC detections would be expected in these areas due to their proximity to pavement and vehicle use.

- SVOC levels detected above the screening criteria were also detected at 17SUR05S (benzo(a)pyrene at 0.491 mg/kg) and at SUR68 (benzo(a)pyrene at 0.413 mg/kg), which are both located in the same general area. Other than these two locations, no other sample locations in the area yielded detections of SVOCs greater than the screening criteria. Screening criteria for SVOCs were not exceeded at location 17SUR05N. Given the fact that surface water runoff from the middle school roof and the adjacent parking lot flows in a southwest direction away from the building, the presence of benzo(a)pyrene and other PAH compounds at the locations in question is likely attributable to surface water drainage away from the middle school and parking lot. There are several PAH detections in surface soil at each of the sampling points between the middle school and sample locations SUR68 and 17SUR05S; however, these detections are slightly below PAH screening levels. Therefore, it is likely that sheet flow during precipitation events has deposited suspended matter from these areas on surface soil. Consequently, the soil detections of benzo(a)pyrene (as well as other PAH compounds) at this location are likely attributable to eroded material from the middle school roof and the asphalt parking lot.
- One other SVOC detection above the screening criteria was found at the location of sample 17SUR01S. This is located off the southwest corner of the middle school building. There were no other SVOC detections above the screening criteria found near this location, suggesting a limited area of contamination.

TAL metals were detected greater than the screening criteria (background levels and site-specific preliminary remediation goals) in the surface soil throughout the RVS Property. Lead and arsenic were the only two metals detected at levels exceeding the screening criteria (both the respective site-specific preliminary remediation goals and the background concentrations) in the surface soil at RVS. However, lead was only detected at levels

above screening criteria at two sample locations. The following summarizes the observed extent of elevated TAL metal concentrations detected exceeding background:

- A number of sample locations with arsenic detections above the screening criteria (SUR01, SUR02, SUR03, SUR04, SUR05, SUR06, SUR07, SUR08, SUR09, SUR10, SD04, SD07, SD08, SD09, SD10, SD11, and SD13) were remediated during the arsenic ditch removal action.
- Arsenic levels above the screening criteria (both site-specific preliminary remediation goals and background concentration)(excluding sample locations that have previously been remediated) were only detected in two surface soil samples along State Route 309 (SD17 and SD18). Surface soil samples east, south, and west did not detected arsenic above screening criteria.
- Detections of lead greater than the screening criteria were located at SB31 (at the south side of the middle school building) and at SB36 (behind the high school building).

PCBs were detected in two surface soil samples (SD09 and SD14). Neither sample exceeded the screening criteria.

Dioxins/furans analysis was performed on surface soil samples and composite surface soil samples. As shown on Table 4-5, several samples had several low level dioxin/furan detections.

4.4.2 Subsurface Soils

As previously discussed, Plate 2 presents subsurface soil sample locations on the RVS Property. Summaries of actual detected concentrations of VOCs, SVOCs, TAL metals, PCBs, and dioxins/furans are presented in Tables 4-6 through 4-10.

Table 4-6 presents the VOCs detected in RVS subsurface soils. Although VOCs were detected in a number of subsurface samples on the RVS Property, all of the detected VOCs were less than the site-specific remediation goals. This investigation has not identified areas of elevated concentrations of VOC contaminants in subsurface soils exceeding the screening criteria.

Table 4-7 presents the SVOCs detected in RVS Property subsurface soils. Of the 145 locations sampled for SVOCs, only six locations yielded any detectable concentration of SVOCs. None of these locations yielded samples in which concentrations exceeded screening criteria.

TAL metals were detected at levels exceeding the screening criteria at approximately 20 locations. The following summarizes the observed extent of elevated TAL metal concentrations:

- Only arsenic was detected in the subsurface soils within RVS at elevated levels. The extent of arsenic in subsurface soil greater than the screening criteria is predominantly in the area of the agricultural field ditch (GP88, GP192, GP216, and SB25-05) and the River Valley Middle and High School buildings (GP151, SB30, SB31, SB32, SB33, SB34, SB36, and SB37).
- Arsenic was also detected greater than the screening criteria southwest of the tennis courts (GP81), the southern end of RVS (GP112 and GP233), in Area 24 (GP154), south of the Middle School (GP246, GP232, and GP234) and at the southeast corner of RVS (SB26-20).

PCBs were detected at one subsurface sample location (RVS-SB33 (8-10 ft. bgs)). This detection was not greater than the screening criteria.

Dioxins/furans analysis was performed on five discrete subsurface soil samples within RVS. Only one sample location yielded detectable dioxins/furans compounds at low-level concentrations.

4.4.3 Groundwater

Eight rounds of groundwater samples were collected from the ten monitoring well network on the RVS Property. No VOCs or PCBs were detected in any of the samples during any of the rounds. Only two wells yielded samples with detectable SVOCs in the groundwater. These detections were observed during the February 1999 sampling event. Neither of the SVOC detections were greater than the screening criteria (Ohio EPA MCLs or USEPA Region IX tap water PRGs). Due to the fact that no SVOCs were detected during the other rounds of sampling, lab contamination for the February 1999 sampling event cannot be ruled out as a possible source of the detections.

Well sampling also indicated levels of TAL metals that exceed the screening criteria (both Ohio EPA MCLs and background concentrations). Since groundwater samples were not filtered, it is difficult to determine whether the analytical results are truly representative of the actual groundwater quality conditions at the site.

Table 4-12 summarizes the TAL metal detections observed in the monitoring wells at the RVS Property. The detection exceeding the screening criteria were spread throughout RVS at MW5, MW7S, MW8, MW9S, MW10S and MW10D during different sampling events. As shown, both the Ohio EPA MCLs and the background levels were exceeded more than once for cobalt, iron, nickel, thallium and zinc.

During the August 1998 round of sampling, detections of aluminum, arsenic, cadmium, chromium, cobalt, iron, lead, nickel, thallium, vanadium and zinc were observed at MW10S. In subsequent groundwater monitoring rounds, many of these contaminants were

not identified. It is possible that the elevated metals concentration in the August 1998 round was due to excessive silt content in the groundwater sample.

Elevated TAL metals were predominantly detected in later rounds of sampling with the exception of MW10S in August 1998. In later rounds, cobalt, iron, nickel, thallium, vanadium, and zinc were detected above background levels and Ohio EPA MCLs.

5.0 CONTAMINANT FATE AND TRANSPORT

This section identifies the probable fate and migration potential of contaminants identified as part of this ESI. The release of hazardous substances from sources at the site and the subsequent transport and transformation in the surrounding environment are dependent on properties of the transporting media, specific properties of the chemical contaminants, climatic conditions, and site-specific features.

5.1 FATE AND TRANSPORT OF SITE CONTAMINANTS

As previously described in Section 4.0, limited contamination was identified at discrete locations throughout the RVS Property (outside of OU1). The limited contamination may be related to the past activities associated with the former military use of the property prior to 1961.

Contaminants were identified in both surface and subsurface soil samples. VOCs, SVOCs (PAHs), TAL metals (arsenic and lead), and dioxins/furans were all identified in surface soil samples, although only various PAHs, arsenic and lead exceeded screening criteria (See Section 4.0). VOCs, SVOCs, metals, and dioxins/furans were also identified in subsurface soil samples, although only arsenic exceeded screening criteria (refer to Section 4.0).

One SVOC contaminant (bis(2-ethylhexyl)thalate) and various TAL metals above screening criteria were identified in site groundwater samples. Because bis(2-ethylhexyl)thalate was not identified in later samples, it is believed that bis(2-ethylhexyl)thalate is a relic of laboratory contamination or a field sampling artifact and not present in representative samples of groundwater. In addition, the elevated metals concentrations are likely due to

excessive solids (clay/silt) content in turbid groundwater samples and, therefore, are not representative of the actual groundwater conditions.

Arsenic contamination identified in surface soils was primarily located along the drainage ditches on the north and east side of the Property and has since been remediated as part of a removal action conducted in 1998 and 1999 (Montgomery Watson, 2000d).

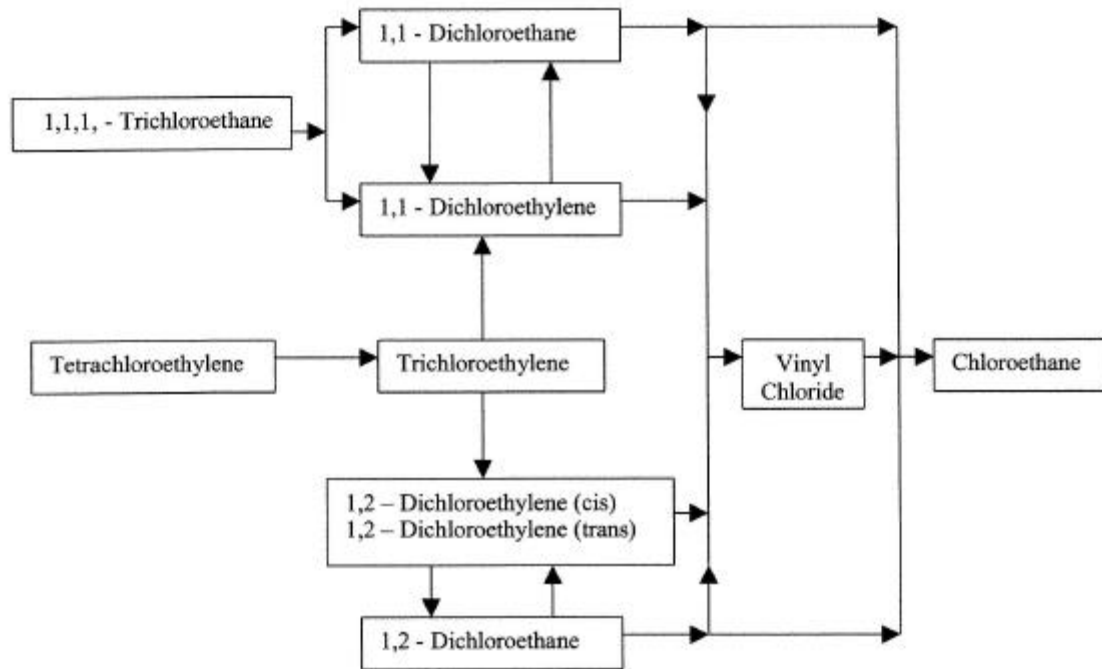
Sources for the site contaminants were likely introduced to the site over 40 years ago although more recent anthropogenic sources may also have contributed. Several VOCs were detected in soil samples collected from the RVS Property but were not detected within the OU1 – Former Disposal Area. These analytes include n-propylbenzene, styrene, 1,1,2,2-tetrachloroethane, 1,2,3-trichloropropane, dimethylphthalate, and 2,4,5-trichlorophenol. The lack of detections for these compounds within OU1 suggest the possibility that these compounds are not related to past military activities and may likely be from more recent sources.

Empirical evidence (i.e. analytical results) verify the persistence of these contaminants in the environment at the RVS site. Processes that affect the fate and persistence of site contaminants include physical, chemical, and biological properties of the impacted medium, and the types of contaminants present. Within the soil column, processes such as adsorption, biodegradation, volatilization, and leaching have the potential to impact the mobility and the physical and chemical characteristics of the contaminants present.

Retention of organic chemicals by soils is typically attributed to sorption of these chemicals to soil particles composed of organic matter. Retention of inorganic chemicals by soils is typically attributed to sorption exchange, or precipitation of these chemicals onto the soil matter. Carbonates and oxides of iron, aluminum, and manganese have the capacity to retain contaminants through sorption and ion exchange reactions (due to an electrostatic attraction to ion-charged mineral surfaces). Because these reactions typically take place at

the surface of soil particles, particle size influences adsorption capacity. Silts, clays, and organic matter have larger effective surface areas, thus greater sorption capacities than sands and gravels. Also, compounds with high organic carbon partition coefficient (as represented by a compound's soil sorption coefficient K_{oc}) values (e.g., SVOCs, PCBs, etc.) tend to be adsorbed to a greater extent than compounds with lower K_{oc} values (e.g., VOCs). Metals may be complexed with organic matter, adsorbed by metal oxides, and/or retained by ion exchange reactions. Specifically, lead can bind to soil humus or be adsorbed by the hydrous oxides of aluminum, iron, and manganese found naturally in the soil (both contributing to the persistence of lead in a soil matrix).

Biodegradation is an important attenuation process under the proper conditions. In general, chlorinated parent compounds, such as tetrachloroethene (PCE) and trichloroethene (TCE), can be converted sequentially through the loss of a chlorine atom to tri-, di-, or mono-chlorinated species through reductive dehalogenation. However, the degradation of vinyl chloride and potentially cis-1,2-dichloroethene (DCE) can occur either anaerobically or aerobically. The typical degradation pathway is:



This reaction appears to be microbially mediated, although the precise reaction mechanisms are not well understood. The degradation of PCE and TCE are favored under anaerobic conditions, with a nonhalogenated carbon source present for sustaining the bacterial community. However, the degradation of vinyl chloride and potentially cis-1,2 DCE can occur either anaerobically or aerobically.

Because of the limited amount of low level (below screening criteria) VOCs identified at the RVS Property (outside of OU1), biodegradation of contaminants cannot be confirmed.

The continued presence of PAH compounds, such as benzo(a)pyrene, in surface and subsurface soils indicates the relative persistence of these contaminants in the environmental setting of this site. While some minor biological or chemical degradation may have occurred over the years (assuming the contaminants were a result of past military activities conducted more than 40 years ago), the stability of these contaminants is evident

from their persistence in surface soils under current climatic and land use conditions. While the past use of the property during the operation of the former MED has most likely contributed to the origin of these compounds, activities associated with the operations of the RVS over the past 35 years (such as outdoor and indoor burning, road and building maintenance, and use and maintenance of vehicular or power equipment) cannot be discounted as potential sources for these types of contaminants.

Volatilization may be or have been a significant process for reducing some contaminant levels in soils. Because of the limited number of low level (below screening criteria) VOC contaminants identified, volatilization is not considered a current primary pathway for migration. This is confirmed by the relatively low levels of VOCs identified in the soil gas samples (Appendix A) in addition to the ambient air samples collected outside of OU1 (Appendix A) as part of the study completed by the Ohio EPA and the USACE. Still, factors controlling volatilization include soil porosity, soil moisture content, surface wind speed, temperature, surface characteristics (e.g., hard packed, vegetative cover, paved, tilled, etc.) and contaminant properties, including Henry's Law constant and diffusivity. Volatilization involves several steps, including desorption from soils, diffusion in water, interphase mass transfer, and diffusion in air.

5.2 POTENTIAL MIGRATION PATHWAYS

Migration pathways define the route and method by which a chemical moves from the source to the potential receptor. Potential migration pathways for contaminants detected include both vertical and horizontal migration through soil, air, and groundwater.

As discussed earlier, contaminants that exceeded screening criteria were PAHs, arsenic and lead in surface soil samples, in addition to various metals in subsurface soil samples.

Surface soil contaminants have the potential to migrate through the ambient air. Low level (below screening criteria) VOCs detected in surface soil could volatilize as vapors into the ambient air. Although because these VOCs are at such low levels a very limited source of VOCs would be available for volatilization. In addition, while dust generation is minimized by the typical abundance of vegetation, there is a potential for fugitive dust to transport contaminants. Low-permeability surface soils may restrict vapor migration and thus limit the migration potential of subsurface contaminants to the ambient air. Contaminants in shallow soils, therefore, have relatively low potential for release to the air as particulates due to wind erosion because of the vegetative cover and relatively flat slope. Ambient air sample results indicate that the potential for contaminant migration through the air pathway is limited.

Arsenic was the only identified contaminants in subsurface soils that exceeded screening criteria. As discussed in Section 3.0 of this report, the predominant unconsolidated soil type at the site is clayey and silty till deposits, which limits the migration potential of subsurface contaminants. Limited migration potential does exist through thin sand, silty sand, and clayey sand seams interbedded with the clayey and silty till deposits. In addition to these higher permeable lenses, broken clay field tiles were observed on the school property during the field investigation activities. Although these tiles were not observed to be intact, and all clay field tiles have likely since been destroyed, potentially intact clay field tile could transport contaminants laterally.

The unconsolidated deposits at the RVS site are underlain by a dark gray to black shale (Ohio Shale) at approximately 50 to 60 ft. bgs. The shale is hard with some horizontal fracturing and trace angular fractures. The thickness of the till overlying the bedrock material suggests a significant impediment to vertical migration from the surface to the bedrock.

6.0 EXPANDED SITE RISK EVALUATION

6.1 INTRODUCTION

This section of the ESI presents the findings of the Expanded Site Risk Evaluation (ESRE) for the RVS Property. The ESRE is a risk-based screening of the analytical data for the RVS Property to evaluate potential risks to human health and the environment resulting from potential exposures to chemicals detected during the ESI activities.

The RVS property is currently used as a middle school and high school, and associated educational and sports facilities. However, a Memorandum of Understanding (MOU) between the Ohio EPA, the Department of the Army, and RVLSD, indicates that the RVS property will be used for different purposes in the future. The MOU stated that the three parties agreed “that future use of the property will be limited to industrial/commercial use,” and that “clean up criteria will be risk based consistent with the industrial/commercial future use restriction” (MOU, 2000). In addition, RVLSD agreed to relocate all of its operations, including the schools and related facilities, by fall of 2003.

Consequently, this ESRE addresses potential human health risks from future exposure to hazardous constituents at the RVS property under industrial/commercial land use. In addition, it evaluates the risks associated with the use of the property as a school, based on the use of the property as a school until the fall of 2003. This risk evaluation compares maximum site concentrations to site-specific preliminary remediation goals based on the industrial/commercial worker exposure scenario presented in *the Draft Industrial Worker Risk Scenario Addendum River Valley School Property, Operable Unit 1 – Former Disposal Area, Draft Remedial Investigation Report* (Montgomery Watson, 2001a) and the ballplayer exposure scenario presented in *the Draft Revision to the River Valley School Property, Operable Unit 1 – Former Disposal Area, Draft Remedial Investigation Report* (Montgomery Watson, 2001b). The site-specific preliminary remediation goals developed

in the OU1 addendum (Montgomery Watson, 2001a) represent the screening criteria used in this ESRE. Both of these exposure scenarios are conservative and health protective for the RVS students until relocation occurs and for the intended future land reuse as an industrial/commercial operation. The results of the ESRE are intended to assist in making risk management decisions concerning the necessity for remediation, the nature and extent of remediation, and selection of remedial alternatives.

The ESRE process was recommended by the Ohio EPA and is appropriate and consistent with the MOU as agreed to by the Army, the State of Ohio, and the RVLSD. The process is considered conservative because the maximum concentrations detected on the remainder of the RVS property and a 10⁻⁶ risk level are used in the screening. The exposure scenarios for the industrial/commercial worker and the ballplayer have been approved by the Ohio EPA.

6.2 DATA EVALUATION

6.2.1 Data Used for Expanded Site Risk Evaluation

The ESRE for the RVS Property relies on the findings of the ESI investigation to evaluate risks associated with potentially contaminated media within the Property (e.g., soil and groundwater). Prior to comparing data to site-specific preliminary remediation goals, the relevant ESI data was grouped and summarized. This included segregating the applicable data from the RVS OU1 data set, and then summarizing the data by medium (e.g., soil and groundwater). The data summary is contained in Section 4 of this document.

Data summarization and grouping were performed using procedures in accordance with USEPA guidance (1989a, 1998b). These summary procedures are described below:

- Only discrete (individual) ESI data collected and analyzed in accordance with the QAPP, and validated according to the USEPA's validation procedures were used as the basis for this evaluation. The Data Validation Report provides a thorough summary of the data quality (refer to Appendix A).
- The site ESI data were divided into groups by media, which describe environmental conditions relevant to the ESRE (e.g., surface soils, subsurface soils, and groundwater). Grouping of the data by media type allows for the characterization of different areas of concern within the RVS Property.

Surface and subsurface soil data groups are the primary focus of the remainder of this subsection because these data were used to determine maximum concentrations for use in the risk evaluation. Groundwater sample results are discussed briefly; however, these data are not used in the risk evaluation because as discussed in Section 6.3.1.2, exposure to groundwater below the RVS Property is not considered a potentially complete exposure pathway.

The soil samples that were used in the ESRE are presented in Tables 6-1 and 6-2 for surface and subsurface soil, respectively. Analytical results for the samples listed in these tables were used to determine maximum detected concentrations for use in the risk evaluation. The following is a summary of the methods used to segregate soil data for purposes of the human health and ecological risk evaluations.

Surface Soil Data for Human Health Risk Evaluation – For the human health evaluation, all of the surface soil samples collected from 0 to 1 foot below ground surface (bgs) within the boundary of the RVS Property outside of OU1, with the exception of composite soil results, were used in the risk evaluation. Composite soil sample results are not normally used for risk assessment purposes, and as agreed to with the Ohio EPA, were

eliminated from the risk evaluation database. The surface soil sample locations used in the risk evaluation are listed in Table 6-1, and shown on Plate 1.

Subsurface Soil Data for Human Health Risk Evaluation – For the human health evaluation, all of the subsurface soil samples collected from 0 to 13 ft bgs within the boundary of the RVS Property outside of OU1 were used in the risk evaluation. During possible future soil intrusive activities surface and subsurface soils may become commingled once these activities are complete (e.g., construction activities). The 0 to 13 ft soil samples account for possible future contact with any portion of the total soil column. Contact with soils greater than 13 ft during construction activities is considered unlikely. As with surface soils, composite sample results were excluded from the ESRE. The subsurface soil sample locations used in the risk evaluation are listed in Table 6-2, and shown on Plate 2.

Surface Soil Data for the Ecological Risk Evaluation – With the exception of an area of unmowed grass behind the middle school, along the southern boundary of the school property, all other areas of the ESI have been disturbed by human activities, such as school buildings, ball fields, roads, parking lots, and outdoor common areas where students congregate before, during, and after school. This unmowed area is the focus of the ecological risk evaluation. Several surface soil samples were collected from this area. The sampling locations for this area are as follows: (1) discrete sampling for VOCs, SVOCs, TAL Metals, and PCBs, SD022 (2) discrete sampling for SVOCs only, SUR63, SUR64, SUR65, and SUR66; (3) discrete sampling for VOCs only, AREA18-VOC, AREA19-VOC, AREA20-VOC, AREA21-VOC, 21-SUR-01N, and 21-SUR-01S.

All of the data collected during the ESI was based on specific Data Quality Objectives (DQOs), one of them being that the data must be of sufficient quality for use in the risk evaluation. This means that the PQLs must be low enough, such that chemicals not

detected can not be present in concentrations high enough to pose a health concern. This is discussed in more detail for the soil data within Section 6.2.2.1.

6.2.2 Soil Data Summary

During the ESI soil investigation, over 485 soil samples were collected to characterize the site conditions. An overall summary of the surface and subsurface soil data collected within the RVS Property are provided by chemical groupings (VOCs, SVOCs, TAL metals, PCBs, and Dioxins) in Tables 4-1 through 4-5, and 4-6 through 4-10, respectively. It should be noted that the tables in Section 4 represent the complete ESI data set, while the data used in the ESRE is summarized in the screening tables in Section 6.3.2.

6.2.2.1 Evaluation of Practical Quantitation Limits for Soil Data

Tables 6-3 and 6-4 provide summaries of the minimum and maximum PQLs for soil samples for analytes that were not detected, frequencies of detection, the Region IX residential PRGs (USEPA, 2000), and listings identifying the analytes where the minimum PQL exceeded the Region IX PRG. Based on a review of the sample PQLs for surface and subsurface soil data, the data were considered sufficient for the risk assessment. Although some samples had minimum PQLs above health based guidelines (Region IX PRGs), the minimum PQLs were below the Region IX PRGs for almost all compounds that were not detected in any sample. For surface soils, 4 analytes had minimum PQLs above their respective Region IX PRG (refer to Table 6-3). These analytes include 1,2,3-trichloropropane, bis(2-chloroethyl)ether, hexachlorobenzene, and n-nitroso-di-n-dipropylamine, which would not likely be present based on the nature of the site contamination and historical use of the site.

For subsurface soils, 3 analytes had minimum PQLs above their respective Region IX PRG (refer to Table 6-4). These analytes include bis(2-chloroethyl)ether, hexachlorobenzene, and n-nitroso-di-n-dipropylamine, which would not likely be present based on the nature of

the site contamination and historical use of the site. In most cases where the minimum PQL was above the Region IX PRG, the difference between the Region IX PRG and minimum PQL was slight (less than a factor of 3).

6.2.2.2 Comparison of Site Data to Blank Contamination

Site data was compared to available blank (laboratory, field, and trip) data as recommended in USEPA guidance (1989a and 1992). If the maximum detected concentration of a common laboratory contaminant (acetone, 2-butanone, methylene chloride, toluene, and the phthalate esters) in a site sample grouping was less than 10 times the maximum concentration detected in the blanks, the chemical was not selected in that grouping for evaluation in the ESRE. For those organic or inorganic chemicals that were not considered by USEPA to be common laboratory contaminants, the chemicals were not selected in grouping for evaluation in the ESRE if the maximum detected concentration was less than 5 times the maximum detected concentration in the blanks. Those sample results were eliminated because of blank contamination. This evaluation is presented in the Data Validation Report (Appendix A).

6.2.2.3 Comparison of Soils Data to Site Background Data

For soils, the mean plus two times the standard deviation of the background data is the calculated background criteria. (Montgomery Watson, 1998c). Table 6-5 presents a comparison of site data for inorganic chemicals to the background criteria. As shown in Table 6-5, the maximum concentrations of antimony and selenium in surface soil and antimony in subsurface soil were below the background criteria. In addition, beryllium and thallium were not detected in any site soil samples.

6.2.3 Groundwater Data Summary

Groundwater monitoring wells were sampled for VOCs, SVOCs, TAL metals, and PCBs within the RVS Property. No VOCs or PCBs were detected. The analytical results for SVOCs and TAL metals are summarized in Tables 4-11 and 4-12.

6.3 HUMAN HEALTH EXPANDED SITE RISK EVALUATION

6.3.1 Methodology

The following subsections describe the methodology used to evaluate potential human health risk at the RVS Property.

6.3.1.1 Soil

For the purposes of this risk-based screening, maximum concentrations of chemicals detected in soil are compared to Site-Specific Preliminary Remediation Goals for the industrial worker and recreational user (ballplayer), as agreed to with Ohio EPA. The Site-Specific Preliminary Remediation Goals represent human health-based concentrations in soil derived from the combination of EPA toxicity values and exposure assumptions corresponding to a lifetime cancer risk of 10^{-6} risk for carcinogens and/or a hazard index of 1 for noncarcinogens, and were developed in the Draft Industrial Worker Risk Scenario Addendum to OU1 (Montgomery Watson, 2001a) and the ballplayer exposure scenario presented in the Draft Final Remedial Investigation Report for OU1 (Montgomery Watson, 2001b). These site-specific preliminary remediation goals represent the screening criteria used in the ESRE. Six compounds, n-propylbenzene, styrene, 1,1,2,2-tetrachloroethane, 1,2,3-trichloropropane, dimethylphthalate, and 2,4,5-trichlorophenol, were detected outside of OU1 but not within OU1 so remediation goals for these compounds were not included in the Addendum to OU1. For all of these compounds except dimethylphthalate, remediation goals were calculated for the industrial worker and recreational user (ballplayer) following the methodology presented in the Draft Industrial Worker Risk

Scenario Addendum to OU1 (Montgomery Watson, 2001a) and Draft Final Remedial Investigation Report for OU1 (Montgomery Watson, 2001b), respectively, and are presented in the screening tables included in Section 6.3.2. Remediation goals could not be calculated for dimethylphthalate because no toxicity values were available for this compound.

Soil data are screened against industrial and recreational user (ballplayer) preliminary remediation goals for surface and subsurface soil. The exposure assumptions used to calculate the preliminary remediation goals for each receptor are presented in Table 6-6. The maximum concentrations of chemicals detected in soil are presented in the screening tables, along with the appropriate industrial and recreational user (ballplayer) remediation goals. All of the remediation goals were calculated using equations that are conservative and protective of human health; therefore, if site concentrations are below the remediation goals, potential public health risks would not be considered significant.

Essential Nutrients - Based on USEPA guidance (1989a), chemicals that are essential human nutrients, and toxic only at very high doses, were not considered for evaluation. These chemicals include calcium, iron, magnesium, potassium, and sodium. Each of these chemicals lack USEPA-approved toxicity criteria except for iron.

Lead – For lead, the maximum concentrations detected in soil are compared to screening values based on the USEPA blood-lead models (IEUBK and TRW, 1996), as cited in the USEPA Region IX PRG Table (USEPA, 2000). Depending upon the exposure conditions, higher soil lead concentrations may also be considered to pose no public health concerns. The industrial/commercial screening value for lead of 750 mg/kg is used for the commercial/industrial worker and the residential screening value of 400 mg/kg is used for the recreational user (ballplayer).

Toxicity Equivalency Factors for Dioxins/Dibenzofurans - For the toxicity evaluation of polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans, the toxicity equivalency factor (TEF) approach for 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) was used. The chlorine substitutions at positions 1-4 and 6-9 on either of the benzene rings of TCDD yield compounds commonly referred to as “polychlorinated dibenzo-p-dioxins” (PCDDs). Polychlorinated dibenzofurans (PCDFs) are a closely related family of compounds. There have been efforts from the scientific community to relate the toxic potency of PCDDs and PCDFs to TCDD. The most recent effort is the "I-TEF/89" method developed by USEPA in conjunction with scientists under the auspices of the North Atlantic Treaty Organization's Committee on Challenges in Modern Society (USEPA, 1989b).

The “I-TEF/89” approach was used in evaluating risks associated with dioxins and furans. TEFs were assigned to each dioxin or furan congener, based on their potencies relative to 2,3,7,8-TCDD. The TEFs for specific congeners can be found within Table 6-6. The TEF was used to modify the congener concentration measured in soil by multiplying the soil concentration by the applicable TEF. Then the toxicity equivalent concentrations for each congener were summed resulting in a total 2,3,7,8-TCDD equivalent concentration. For laboratory results reported only as total pentachloro-, hexachloro-, heptachloro-, or octachlorodibenzo-p-dioxins or furans, toxicity equivalent concentrations were not assigned. These results were not evaluated quantitatively in this risk evaluation. This is because chlorination in the 2,3,7,8-positions is required for the carcinogenic effects of PCDDs and PCDFs (USEPA, 1989b). Total 2,3,7,8-TCDD equivalent (TCDD equivalent) concentrations were used in the comparison to site-specific preliminary remediation goals.

6.3.1.2 Groundwater

Based on the analytical results, no VOCs or PCBs were detected in groundwater samples. One SVOC (bis(2-ethylhexyl)phthalate) was detected in samples from two monitoring wells at concentrations less than Ohio EPA MCL and Region IX tap water PRG levels (see

Section 4.2). Lab contamination cannot be ruled out as the source of this one-time detection of bis(2-ethylhexyl)phthalate. A number of metals were also detected in the monitoring well water at the RVS Property, but this is to be expected since metals are naturally occurring in groundwater. The metals in groundwater that exceed Ohio primary or secondary MCLs and/or EPA Region IX PRGs, and are above background groundwater concentrations are presented in Table 6-8. These metals include aluminium, antimony, cadmium, chromium, lead, iron, nickel, and thallium. Chemicals that do not exceed either Ohio MCLs or EPA Region IX PRGs and background are not included in Table 6-8.

Currently, the RVS is supplied with municipal water, and the municipality draws water from wells that are not located near the RVS. Shallow groundwater of the site is present in glacial till soils, which consist primarily of silt and clay with interbedded horizons and lenses of sand and gravel. Glacial till is typically not a viable drinking water resource due to the low production capacity of the permeable horizons and the naturally occurring poor water quality conditions. Under current and likely future land use conditions, therefore, groundwater at the RVS Property would not be expected to be used for drinking water purposes. For this reason, exposure to RVS groundwater is not expected to occur now or in the future, and is not evaluated further.

6.3.1.3 Surface Water

Surface water runoff samples were collected as part of the ESI activities. Seven surface water runoff samples were collected within ditch locations along State Route 98 and the Agricultural Field ditch on the RVS Property in July 1998. Each of these samples was collected after a recent precipitation event. Analytical results for surface water are discussed in Section 4.3. The potential for exposure to the surface water is very low since water is only present in these ditches intermittently. Exposure to surface water is not considered to be of significant public health concern. Rather it was assumed that any substantive exposure and risk would be associated with the surficial soil exposure and not intermittent surface water. For this reason, surface water is not evaluated further.

6.3.2 Human Health Risk Evaluation Screening Results

The results of the risk-based screening for the industrial/commercial land use scenario are provided in Tables 6-9 and 6-10 for surface and subsurface soil, respectively. The results of the risk-based screening for the recreational user (ballplayer) land use scenario are provided in Tables 6-11 and 6-12 for surface and subsurface soil, respectively. These tables present the following information for each compound: frequency of detection, minimum and maximum practical quantitation limits, minimum and maximum detected concentrations, and the appropriate site-specific preliminary remediation goal. This information is shown for all compounds detected in soil.

6.3.2.1 Industrial/Commercial Land Use Scenario

A review of the Tables 6-9 and 6-10 indicates that compounds in exceedance of commercial/industrial worker site-specific preliminary remediation goals for surface and subsurface soil exposure include benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, arsenic, and lead. Plates 3 and 4 present the sampling locations for surface and subsurface soil, respectively, where the concentrations of PAHs exceeded site-specific preliminary remediation goals, and the concentrations of metals exceeded both the site-specific preliminary remediation goals and the background levels.

PAHs - Benzo(a)anthracene was detected above the site-specific preliminary remediation goal in 4 samples, benzo(a)pyrene in 22 samples, benzo(b)fluoranthene in 7 samples, and dibenz(a,h)anthracene in 9 samples. All of the samples with PAH concentrations exceeding remediation goals were collected from 0 to 1 foot bgs. Although PAHs were detected in surface soil at concentrations higher than the site-specific preliminary commercial/industrial worker remediation goals, they are still within the range of PAHs

typically detected in urban soils (0.06 to 5.8 mg/kg) and road dust (8 to 336 mg/kg) from anthropogenic sources such as automobile exhaust (Menzie, et. al., 1992).

It should be noted that PAHs were detected in surface soil samples collected from areas outside OU1, for example, along Highway 309, Highway 98, and Pole Lane (in the vicinity of the Marion Engineer Depot). Several samples (33 in all) from these locations contained individual PAH compounds that exceeded USEPA Region IX PRGs. . Because these 33 surface soil samples were collected from areas along paved roads and industrial structures, one cannot rule out the possibility that anthropogenic effects (such as vehicle exhaust and runoff from roads, parking lots, and industrial structures) unrelated to historical waste disposal activities at RVS may have contributed to PAH contamination in the samples. The locations of these off site background surface sampling locations and the individual sampling results for each PAH detected in these samples are included in Appendix G.

Table 6-13 presents the SVOC samples with detections above the site-specific preliminary remediation goals for PAHs in the areas outside OU1. The first column shows the sample location. The second column presents the individual PAH detected in that sample and the concentration (in units of mg/kg) in parentheses following the chemical. The final column indicates the probable anthropogenic source that is likely associated with the detection of the PAH compound. Plate 3 presents the surface soil sampling locations where detected concentrations exceeded site-specific preliminary remediation goals.

An examination of the sample locations where the remediation goals were exceeded and their association with a likely anthropogenic source would indicate that these PAH exceedances are not significant. This is further supported by a selected literature review of the range of PAHs detected in the environment from anthropogenic sources and the site-specific preliminary background sampling for PAHs along roadsides near the River Valley School property. A discussion of PAH data associated with soil samples collected near

roadways is presented in the uncertainty section of this risk assessment (*see* Section 6.3.2.4).

Arsenic - Arsenic was detected above the calculated background criteria of 18 mg/kg in 7 soil samples at concentrations ranging from 18.1 to 22.7 mg/kg. Two of these samples were collected from 0 to 1 foot bgs and five were collected from depths ranging from 5 to 10 feet bgs. Although arsenic was detected at concentrations slightly above the background criteria in a small number of samples (7 out of 131 surface and subsurface soil [0 to 13 feet] samples), most of the arsenic detections fall within the background concentration range of 3.47 to 20.9 mg/kg (Montgomery Watson, 1998c). In addition, the two arsenic detections (22.3 and 22.7 mg/kg) that exceed the background concentration range are not likely statistically different from the maximum background concentration of 20.9 mg/kg. Furthermore, a receptor would not be exposed to soil solely from the small areas of the site where the background criteria are exceeded. Therefore, these exceedences are not considered of public health concern.

Lead - Lead was detected above the USEPA industrial/commercial screening level of 750 mg/kg (USEPA, 2000) in RVS-SB31-SUR at a concentration of 1,090 mg/kg. Lead was only detected above the screening level in 1 out of 131 surface and subsurface soil [0 to 13 feet] samples. Lead concentrations at the site range from 6.91 mg/kg to 1090 mg/kg. The average soil-lead concentration is 62 mg/kg (Montgomery Watson, 2001b). This concentration is below the USEPA industrial/commercial screening level of 750 mg/kg. The significance of this single exceedance is further diminished as a receptor would not be exposed to soil solely from this one small area of the site for all of his exposure duration. Therefore, lead in soils is not expected to pose a public health concern.

6.3.2.2 Recreational User (Ballplayer) Land Use Scenario

A review of the Tables 6-11 and 6-12 indicates that compounds in exceedance of recreational user (ballplayer) site-specific preliminary remediation goals for surface and

subsurface soil exposure include benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, arsenic, and lead.

PAHs - Benzo(a)pyrene was detected above the site-specific preliminary remediation goal in 13 samples, benzo(b)fluoranthene in 1 sample, and dibenz(a,h)anthracene in 2 samples. All of the samples with PAH concentrations exceeding remediation goals were collected from 0 to 1 foot bgs.

As with the industrial/commercial land use scenario, an examination of the sample locations where the remediation goals were exceeded and their association with a likely anthropogenic source would indicate that these PAH exceedances are not significant. This is further supported by a selected literature review of the range of PAHs detected in the environment from anthropogenic sources and the site-specific background sampling for PAHs along roadsides near the River Valley School property.

Arsenic - Arsenic was detected above the background criteria of 18 mg/kg in 7 soil samples at concentrations ranging from 18.1 to 22.7 mg/kg. Two of these samples were collected from 0 to 1 foot bgs and five were collected from depths ranging from 5 to 10 feet bgs. Although arsenic was detected at concentrations slightly above the background criteria in a small number of samples (7 out of 131 surface and subsurface soil [0 to 13 feet] samples), most of the arsenic detections fall within the background concentration range of 3.47 to 20.9 mg/kg (Montgomery Watson, 1998c). In addition, the two arsenic detections (22.3 and 22.7 mg/kg) that exceed the background concentration range are not likely statistically different from the maximum background concentration of 20.9 mg/kg. Furthermore, a receptor would not be exposed to soil solely from the small areas of the site where the background criteria are exceeded. Therefore, no public health concerns are expected.

Lead - Lead was detected above the USEPA residential screening level of 400 mg/kg (USEPA, 2000) in RVS-SB31-SUR and RVS-SB36-SUR at concentrations of 1,090 mg/kg and 419 mg/kg, respectively. Lead was only detected above the screening value in 2 out of 131 surface and subsurface soil [0 to 13 ft] samples. Lead concentrations at the site range from 6.91 mg/kg to 1090 mg/kg. The average soil-lead concentration is 62 mg/kg (Montgomery Watson, 2001b). This concentration is below the USEPA residential screening level of 400 mg/kg. The significance of these two exceedances is further diminished as a receptor would not be exposed to soil solely from these two small areas of the site for all of his exposure duration. Therefore, lead in soils is not expected to pose a public health concern.

6.3.2.3 Summary of Human Health Risks

Based on the results of the comparison of the maximum detected site concentrations to site-specific preliminary remediation goals, adverse effects to human health are not expected from exposure to chemicals detected during the ESI activities. As discussed previously, most of the compounds detected in surface and subsurface soil samples collected from the RVS Property outside of OUI are present at concentrations less than both the industrial/commercial worker site-specific preliminary remediation goals and the recreational user (ballplayer) site-specific preliminary remediation goals. For the four PAHs that exceeded site-specific preliminary remediation goals, an examination of the sample locations where the remediation goals were exceeded and their association with a likely anthropogenic source would indicate that these PAH exceedances are not significant. This is further supported by a PAH literature review and the site-specific background sampling for PAHs along roadsides near the River Valley School. The significance of the exceedance of site-specific preliminary remediation goals and the background criteria for arsenic is diminished by the fact that arsenic was detected at concentrations only slightly greater than the background criteria in a small number of samples. The significance of the exceedance of site-specific preliminary remediation goals and background criteria for lead is diminished by the fact that lead was detected above remediation goals in only two of 131

samples. Lead concentrations at the site range from 6.91 mg/kg to 1090 mg/kg. The average soil-lead concentration is 62 mg/kg (Montgomery Watson, 2001b). This average soil-lead concentration (62 mg/kg) is below both the industrial/commercial and residential USEPA screening levels of 750 mg/kg and 400 mg/kg, respectively. For this reason, current and possible future exposures to lead in soils are not expected to pose a public health concern for the ballplayer nor the industrial worker.

6.3.2.4 Uncertainties

The following is a summary of some of the general assumptions and uncertainty factors applied in the ESRE, as well as indications of their resulting biases. Following this summary is a specific discussion of the uncertainties associated with the source of PAHs detected within surface soils of the ESI area.

- It was assumed that the ESI area is adequately characterized. The presence of areas of contamination not identified may result in an underestimation of area risks. However, the ESI area has been well characterized with regard to the nature and extent of contamination.
- It was assumed that the identified chemicals with toxicity values are those that may be of concern in the ESI area. The presence of highly toxic compounds not analyzed for, or compounds for which little toxicity information exists, may result in an underestimation of risks. Site-specific preliminary remediation goals could not be calculated for compounds without any USEPA identified toxicity values. The compounds that were detected in ESI soil samples that do not have any USEPA identified toxicity values or, therefore, site-specific preliminary remediation goals are acenaphthylene, benzo(g,h,i)perylene, dimethylphthalate, 4,6-dinitro-2-methylphenol, and phenanthrene. Because site-specific preliminary remediation goals were calculated for all of the other compounds detected in the ESI soil samples, uncertainties associated with not addressing the toxicity of each compound have been minimized within the ESRE.

- Locations where site-specific PRGs were exceeded are covered by vegetation; therefore, the potential for direct contact with surface soil is reduced and risks attributable to surface soil contaminants may be overstated.
- The human toxicity values used to calculate the site-specific preliminary remediation goals may overestimate risk. Reference doses incorporate maximum levels of conservative uncertainty factors, and cancer slope factors estimate upper bound 95th percentile values.
- Several VOCs were detected in soil samples collected from the RVS property, but were not detected within the OU1-former disposal area. These analytes include n-propylbenzene, styrene, 1,1,2,2-tetrachloroethane, 1,2,3-trichloropropane, dimethylphthalate, and 2,4,5-trichlorophenol. The lack of detections for these compounds within OU1 suggest the possibility that these compounds are not related to past military activities and may likely be related to more recent sources.
- A site specific background value was calculated for Arsenic from soil samples collected on the RVS site. Elevated levels of arsenic were detected on the RVS site and attributed to the delousing prisoners of war by the Army. Uncertainties do exist with respect to other sources of arsenic on the RVS site. Other sources of arsenic could be related to agricultural materials, wood preservatives, soil parent materials (such as shales and limestones), and industry.
- It is not clear what was the source of the PAH contamination in surface soil in the ESI area. If the source of the PAHs was due to other than Army related activities, inclusion of PAH risks may overestimate the risk related to past Army activities. This is discussed in further detail below.

Uncertainties Associated with the Source of PAH Detections in Soils

It is believed that PAHs detected in surface soil within the ESI area may be attributable to anthropogenic sources other than past Army related activities. Several studies from the vast literature on PAHs in the environment indicate a range of PAH concentrations detected in the environment from various anthropogenic sources; this information is summarized in Table 6-14. PAHs are ubiquitous in soils, and can reach elevated concentrations as a result of prolonged industrial activities, release of PAH-containing materials, individual activities, or natural emissions. Emissions associated with an individual's activities may include automobile and other exhausts, furnaces, fireplaces and woodstoves, and cigarette smoking. Industrial emissions would include coal and oil-fired power plants, waste incinerators, coke and asphalt production, petroleum refining, aluminum smelting, carbon black production, and wood preservation. Emissions of PAHs from natural phenomenon include forest and brush fires, volcanic eruptions, and decaying organic matter. As indicated below, PAHs can enter the surrounding soil environments through vehicle exhaust, oil spills and leaks, and runoff from paved roads and parking lots. PAHs, such as benzo(a)pyrene, are also found in petroleum-based tars used for road repair and roofing.

Based on literature reviews, the largest anthropogenic sources of PAHs are vehicular emissions from both gasoline and diesel powered vehicles, coal and oil combustion, petroleum refining, natural gas consumption, and municipal and industrial incinerators (Yang et al., 1991). Once they enter the atmosphere, PAHs redistribute between gas and gas and particle phases and are subject to wet and dry deposition (Gigliotti et al., 2000; Simcik et al., 1997; Spitzer and Kuwatsuka, 1993). Most of these activities have occurred in the vicinity of the former MED; therefore, these activities may be anthropogenic sources of PAHs in surface soils. Moreover, while loads of PAHs from some sources may have decreased in recent years, PAH loads from vehicle use have increased (Van Metre et al., 2000).

On the other hand, historical records indicate the Army likely used the RVS Property (including OU1) for heavy equipment use and training, storage of materials, disposal/burial of construction debris and depot waste materials, burning of waste materials and fuels, and as a prisoner of war camp. Since the Army turned over this property for civilian activities in 1961, ball fields, parking lots, and school buildings have been constructed. Surface soil grading for construction of these structures may have re-distributed contaminants associated with the Army's activities, and additional anthropogenic contaminants may have been added to the site surface soil. Therefore, the use of this site for civilian activities has added uncertainty to the degree and extent of site contamination associated with Army activities.

Since there have been no site-specific studies to quantify the PAH contributions from anthropogenic sources, this remains an area of uncertainty in this report. Due to the fact that detections of all chemicals were compared to risk-based screening criteria, no differentiation is made between anthropogenic and non-anthropogenic contributions to contaminant concentrations. Therefore, the presence of chemicals that are attributable to anthropogenic sources may cause an overestimation of risks associated with past site activities. For example, Appendix G provides PAH data for PAH surface soil samples collected near roadways. The observed median concentrations from this data set is generally consistent with modeled vehicle emissions contributions to soil concentrations in the Los Angeles Basin (Yaffe et al., 2001). In conclusion, cancer risk estimates from PAHs may over- or under estimate risk contributions from former MED-related activities.

In addition, USEPA recognizes the potential for the presence of PAHs from anthropogenic sources. For example, some EPA regions are considering an exemption of PAHs located next to roads or parking lots or other obvious anthropogenic sources of PAHs. At one site closure, the exclusion of PAHs is stated as follows, "As a matter of definition of a release under CERCLA 101(22), to which CERCLA 104 gives authority to respond, as well as a common sense issue that an exemption to PAHs adjacent to roads exist in the CERCLA

program” (communication with USEPA Region IV, Key West BRAC, NAS Key West, 2000a).

In another closure, the same logic was applied. The language used to exempt PAHs detected at the site is as follows, "However, once removal activities commenced, it became apparent that the low level PAH contamination was so prevalent and far afield from the original areas of concern that it could not have been caused by a "release", and should thus be considered an "exclusion" to the definition. A CERCLA exclusion in this instance is defined as "(B) emissions from the engine exhaust of a motor vehicle, rolling stock, aircraft, vessel, or pipeline pumping station engine (42 USC §9601, 22(B))." CERCLA defines the term "release" as any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment (including the abandonment or discarding of barrels, containers, and other closed receptacles containing any hazardous substance or pollutant or contaminant) (42 USC §9601, 22), (communication with USEPA Region IV, Homestead Air Force Base, 2000b).

In conclusion, while this report provides an evaluation of potential risks associated with PAHs in soils for the RVS Property (excluding OU1), there is uncertainty with respect to the actual sources of the PAHs in soils. In some areas, the presence of PAHs may be attributable only to anthropogenic sources. Therefore, the risks derived from PAHs in soils may not be solely attributable to past Army activities.

6.4 EXPANDED SITE ECOLOGICAL RISK EVALUATION

This section of the ESI presents the findings of the Expanded Site Ecological Risk Evaluation (ESERE). This section evaluates the potential impacts to ecological receptors associated with exposures to the chemicals of potential concern for the remainder of the River Valley School property. The format of this ESERE is consistent with Recommended Procedures for Level 1 Ecological Assessment (Ohio EPA, 2000). The overall objective of

this recommended procedure is to determine if an ecological risk assessment is warranted at a site. There are three tasks associated with this procedure as follows: (1) to assess existing data, (2) to gather site information and identification of important ecological resources, and (3) identify potential chemical and non-chemical stressors. A Level 1 assessment makes an estimate, based on the information gathered in the three tasks noted above and best professional judgement, as to whether important ecological resources are, or potentially could be impacted by site related ecological stressors (Ohio EPA, 2000).

A Screening Level Ecological Risk Assessment (including a site walk-over by a MW biologist) was performed for the Operable Unit 1 portion of the River Valley School property and is presented in Section 6.7 and Appendix U of the Draft Final Remedial Investigation Report for OU1 (Montgomery Watson, 2001b). The ESI presents the findings for the remainder of the school property outside OU1.

It should be noted that normal operating activities at the River Valley School place certain restrictions on the existing ecosystem. This does not imply that the ecosystem is stressed or unhealthy, however, the ecosystem that exists on site and along with the operation of the school is not expected to be the natural ecosystem for this region of Ohio. For example, little vegetation is available for food or cover within the nature preserve. Frequent human activity at the site will likely inhibit activities of animals. In the future, the site is restricted to industrial/commercial land reuse; therefore, soil ecosystems are limited by present and future human disturbance activities at the site. Endangered, threatened or special species of plants or animals have not been identified within a one-half mile radius of the MED/SOP (Montgomery Watson, 2001b).

6.4.1 Existing Data

With the exception of an area of unmowed grass behind the middle school, along the southern boundary of the school property, all other areas of the ESI have been disturbed by

human activities, such as school buildings, ball fields, roads, parking lots, and outdoor common areas where students congregate before, during and after school. This unmowed area is the focus of the ESERE presented below. Plate 1 and 2 show all of the surface and subsurface sampling locations and the developments of the River Valley School property. There is no completed exposure pathway for groundwater. There are no natural surface water sources on the property. Therefore, only soils are considered in the ESERE.

No rare plant or animal species or suitable habitat for these species were seen during the field investigation. According to the Ohio Department of Natural Resources, no rare or endangered species or unique ecological features are known to occur within a one-half mile radius of the Former Marion Engineer Depot (Letter from Ohio Department of Natural Resources, Division of Natural Areas and Preserves, dated March 30, 1998, Montgomery Watson, 2001b). Therefore, an additional ecological risk assessment is not warranted for the remainder of the River Valley School property because this area provides little food or cover for wildlife, no rare plant or animal species or suitable habitat for these species have been observed during field investigations, and the detected concentrations of lead, PAHs, and VOCs are below ecological benchmarks.

In general, outside the OU1 area, grasses are kept short by periodic mowing of ball fields, other green belts, including parts of the nature preserve. The dominant vegetation type in the unmowed grass portion of the ESI site is a ruderal-field community (i.e., disturbed in nature) that supports grasses and weedy herbaceous species typical of disturbed areas. Wild carrot (*Daucus carota*), tall goldenrod (*Solidago stricta*), thistle (*Cirsium* sp.), plantain (*Plantago lanceolata*), rye grass (*Lolium perenne*), Kentucky bluegrass (*Poa pratensis*) form the predominant vegetation. (see Appendix U of the Draft Final Remedial Investigation Report for OU1 (Montgomery Watson, 2001b). A few shrubs and trees such as smooth sumac (*Rhus glabra*), rough-leaf dogwood (*Cornus drummondii*), and apple (*Malus slyvestris*) grow along the fence line.

The grasses and flowering plants in the ruderal-field community could provide habitat for potential ecological receptors such as insects, birds, and small mammals. A cottontail rabbit (*Sylvilagus floridanus*), butterflies, and birds including killdeer (*Charadrius vociferus*), red-winged blackbirds (*Agelaius phoeniceus*) and goldfinch (*Carduelis tristis*) were observed during the field survey. Praying mantis (*Tenodera aridifolia*) egg cases were also found. However, the unmowed portion is relatively small and surrounding areas have been disturbed for human use, i.e., manicured school grounds, parking lots, school building, etc. and future industrial/commercial land use will continue use of the property by humans. Therefore, the ecological value of this area to ecological receptors is considered low.

The RVS Property does not contain sensitive ecological receptors or habitats. Potential ecological receptors on the site are typical of disturbed areas with ruderal vegetation communities. The unmowed portion of ESI area and surrounding school grounds provide little food or cover for wildlife further diminishing the habitat value of this community. No rare plant or animal species or suitable habitats for these species were seen during the field investigation. As this unmowed portion is characterized by disturbed or artificial conditions and surrounded by areas maintained for human uses (eg., manicured school grounds, mowed areas of the nature preserve), it is unlikely that this unmowed grass portion of the site would be considered an ecologically important resource.

6.4.2 Potential Chemical and Non-chemical Stressors

Several samples were collected from the unmowed grass area behind the middle school, along the southern boundary of the school property. All other sampling locations are within areas severely disturbed by human activities. The sampling locations for the unmowed area along the southern boundary of the property are as follows: (1) discrete sampling for VOCs, SVOCs, TAL Metals, and PCBs, SD022 (2) discrete sampling for SVOCs only, SUR63, SUR64, SUR65, and SUR66; (3) discrete sampling for VOCs only,

AREA18-VOC, AREA19-VOC, AREA20-VOC, AREA21-VOC, 21-SUR-01N, and 21-SUR-01S. The analytical results for these sampling locations can be found in Tables 4-1 through 4-5.

No VOCs, SVOCs, PCBs, or metals above background were detected in the discrete sample SD022. For the SVOC only samples, SUR66 had two detections of PAHs, fluorene at 0.074 mg/kg and indeno(1,2,3-cd)pyrene at 0.082 mg/kg. It is expected that these detections are related to a former road that cut through this portion of the property. No other SVOCs were detected.

For the discrete VOC only samples, low level hits of several volatiles were detected as follows: ethylbenzene (0.0123 mg/kg), methylene chloride (0.0034 mg/kg), n-propylbenzene (0.0123 mg/kg), naphthalene (0.0041 mg/kg), xylene (0.0405 mg/kg), TCE (0.0024 mg/kg), 1,2,4-trimethylbenzene (0.0922 mg/kg), and 1,3,5-trimethylbenzene (0.0264 mg/kg).

The detections within this unmowed grass portion of the River Valley School property are low and not considered ecologically significant. A comparison of maximum soil analyte concentrations with available terrestrial toxicity benchmarks is presented in Table 6-15. The list of analytes presented in this table represents those that were detected above their respective detection limit within surface soil samples collected in the unmowed area. Metals are not included because none were detected above site-specific background concentrations, with the exception of single lead detection of 31.9 mg/kg (background for lead is 28 mg/kg).

Toxicity benchmark concentrations for plant toxicity were obtained from Table 1 of Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision. (ORNL 1997; ES/ER/TM-85/R3). It should be noted that for PAHs there was only a plant toxicity benchmark for acenaphthene, but it was

applied as a surrogate benchmark for the other PAHs. Toxicity benchmark concentrations for soil associated invertebrates were obtained from Table 3 of Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision. (ORNL 1997; ES/ER/TM-126/R2). An "I" to right of the benchmark indicates it is based on earthworm toxicity information, while an "m" to the right of the benchmark indicates it is based on microbial toxicity information.

Soil Ecological Data Quality Levels (EDQLs) were obtained from USEPA Region V Final Technical Approach for Developing EDQLs for RCRA Appendix IX Constituents and Other Significant Contaminants of Ecological Concern, April 1998. The hazard quotient (HQ) represents the maximum analyte concentration divided by the appropriate toxicity benchmark (i.e., soil invertebrate or plant). HQs that are greater than 1 are indicative of a potential for adverse health effects to ecological receptors.

Based on the comparisons made in Table 6-15, the concentrations of VOCs and SVOCs detected in the unmowed area would not be expected to pose an ecological health concern. All analyte concentrations were lower than available toxicity benchmarks (i.e., HQs were less than one). For several volatile organic compounds detected at the site, no toxicity benchmarks were available. However, these compounds are not expected to pose a problem for ecological receptors as the compounds tend to have a low residence time in the surface soil environments and there is little potential for these chemicals to accumulate in terrestrial biota.

Further, this area serves as only minimal habitat for potential ecological receptors. The destruction of habitat for human development and the high activity use of the remainder of the River Valley School property are the primary non-chemical stressors for ecological life at this site. In the future, this property is to be limited to industrial/commercial use. A Memorandum of Understanding (MOU) between the Ohio Environmental Protection

Agency, the Army, and River Valley Local School District states that the three parties agree “that future use of the property will be limited to industrial/commercial use,” and that “clean up criteria will be risk-based and consistent with the industrial/commercial future use restriction.” (MOU, 2000). Therefore, present and future land use for the River Valley School property is for human activities.

6.4.3 Summary of Potential Ecological Risks

Normal operating activities at the River Valley School place certain restrictions on the existing ecosystem. This does not imply that the ecosystem is stressed or unhealthy, however, the ecosystem that exists on site and along with the operation of the school is not expected to be the natural ecosystem for this region of Ohio. For example, little vegetation is available for food or cover within the school campus. Frequent human activity at the site will likely inhibit activities of animals. In the future, the site is restricted to industrial/commercial land reuse; therefore, soil ecosystems are limited by present and future human disturbance activities at the site. Endangered, threatened or special species of plants or animals have not been identified within a one-half mile radius of the MED/SOP (Refer to letter from Ohio Department of Natural Resources, letter dated March 30,1998, Montgomery Watson, 2001b).

As this unmowed portion is characterized by disturbed or artificial conditions and surrounded by areas maintained for human uses (eg., manicured school grounds, mowed areas of the nature preserve), it is doubtful that this unmowed grass portion of the site would be considered an ecologically important resource. Further, the low concentrations of VOCs, PAHs, and lead detected in the unmowed area would not be expected to pose an ecological health concern. All analyte concentrations were lower than available toxicity benchmarks (i.e., HQs were less than one).

In summary, based on the results of this ESERE, Level 1 Assessment, important ecological resources are, or potentially could not be impacted by site related ecological stressors. Therefore, an additional ecological risk assessment is not warranted for the remainder of the River Valley School property.

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7.0 SUMMARY AND CONCLUSIONS

As discussed earlier, a portion of the former MED was obtained by the River Valley Local School District (RVLSD) in 1961 for the construction and operation of a middle school and high school, and associated educational and sports facilities. RVS currently occupies approximately 78 acres of the former MED property. For investigative purposes, this 78 acre is divided into 2 areas, OU1 and the remaining 58 acres which is referred to as the RVS Property. OU1, which is the former disposal area of the former MED, is the subject of a report entitled Operable Unit 1-Former Disposal Area Draft Remedial Investigation Report, Marion, Ohio released in February 2000 by Montgomery Watson.

The RVS Property is the focus of the activities and findings described in this ESI Report.

7.1 NATURE AND EXTEND OF CONTAMINATION

Samples with detected concentrations were compared to several screening criteria. These screening criteria include site-specific industrial worker preliminary remediation goals (used to screen all soil samples), site-specific ballplayer preliminary remediation goals (used to screen all soil samples), USEPA Region IX tap water preliminary remediation goals (PRGs) as published in November 2000 (used to screen organics in groundwater samples), natural background concentrations (see Section 2.5) (used to screen TAL metals in soil and groundwater samples), and the Ohio EPA drinking water maximum contaminant levels (MCLs) (used to screen organics and TAL metals in groundwater samples) (Appendix F).

7.1.1 Surface Soils

SVOCs and TAL metals were detected above screening criteria in surface soils on the RVS Property. VOCs, PCBs, and dioxins/furans were not detected above screening criteria. The SVOCs detected above screening levels in the surface soils were PAHs. PAHs were identified in exceedance of the screening criteria along State Route 98, State Route 309, and in the areas near borings SB34, SB35, SB36, and SB37. Due to the proximity of identified contaminants to roads and buildings, one cannot rule out the possibility that anthropogenic effects (such as vehicle exhaust and runoff from roads, parking lots and roofs) unrelated to historical waste disposal activities at the RVS site, may have contributed to the contamination.

Of the TAL metals, lead and arsenic were the only two metals detected above the screening criteria in the surface soil. However, lead was only detected at elevated levels in two locations. In addition, a number of sample locations with arsenic detections (SUR01, SUR02, SUR03, SUR04, SUR05, SUR06, SUR07, SUR08, SUR09, SUR10, SD04, SD07, SD08, SD09, SD10, SD11, and SD13) were remediated during the arsenic ditch removal action.

7.1.2 Subsurface Soils

Arsenic was the only contaminant identified above screening criteria in subsurface soil samples. Organic contaminants (VOCs, SVOCs, PCBs, and dioxins/furans) were not detected above screening criteria. Arsenic was detected above screening criteria at approximately 20 locations. Sample locations where concentrations of arsenic in soils exceeded screening criteria are scattered throughout RVS. However, those sites tend to be clustered primarily along the agricultural field ditch and around the River Valley Middle School and High School buildings. The possibility exists that anthropogenic sources including arsenical pesticides, unrelated to historical waste activities at the RVS site, may have contributed to the arsenic contamination in the area of the school buildings.

7.1.3 Groundwater

Eight rounds of groundwater samples have been collected from the network of 10 monitoring wells on the RVS Property. No VOCs or PCBs were detected in any of the samples in any of the rounds. Only two wells, during one sampling event, yielded samples with detectable SVOCs in the groundwater. Neither of the SVOC detections were above screening criteria (Ohio EPA MCLs or USEPA Region IX Tap Water PRGs). Due to the fact that no SVOCs were detected during the other rounds of sampling, lab contamination for the February 1999 sampling event cannot be ruled out as a possible source of the detections.

TAL metals were detected above both the screening criteria (Ohio EPA MCLs and background concentrations). Because groundwater samples were not filtered before analysis, it is difficult to determine whether the analytical results are truly representative of the actual groundwater quality conditions at the site.

7.2 CONTAMINANT FATE AND TRANSPORT

Limited contamination was identified at discrete locations throughout the RVS Property (outside of OU1). The limited contamination may be related to the past activities associated with the former military use of the property prior to 1961.

Sources for the site contaminants were introduced to the site over 40 years ago although more recent anthropogenic sources may also have contributed. Empirical evidence (i.e. analytical results) verify the persistence of these contaminants in the environment at the RVS Property. Processes that affect the fate and persistence of site contaminants include physical, chemical, and biological properties of the impacted medium, and the types of contaminants present. Within the soil column, processes such as adsorption,

biodegradation, volatilization, and leaching have the potential to impact the mobility and the physical and chemical characteristics of the contaminants present.

The continued presence of PAH compounds, such as benzo(a)pyrene, in surface and subsurface soils indicates the relative persistence of these contaminants in the environmental setting of this site. While some minor biological or chemical degradation may have occurred over the years (assuming the contaminants were a result of past military activities conducted more than 40 years ago), the stability of these contaminants is evident from their persistence in surface soils under current climatic and land use conditions. While the past use of the property during the operation of the former MED has most likely contributed to the origin of these compounds, activities associated with the operations of the RVS over the past 35 years (such as outdoor and indoor burning, road and building maintenance, and use and maintenance of vehicular or power equipment) cannot be discounted as potential sources for these types of contaminants.

Transportation of surface soil and subsurface soil contaminants at the RVS Property appears to be limited. Despite this fact, surface soil contaminants do have the potential to migrate through the ambient air. Low level (below screening criteria) VOCs detected in surface soil could volatilize as vapors into the ambient air. Because these VOCs are at such low levels in the soil, a very limited source of VOCs would be available for volatilization. Dust generation may be minimized by the typical abundance of vegetation on site. However, there is a potential for fugitive dust to transport contaminants. Low permeable surface soils may restrict vapor migration and thus limit the migration potential of subsurface contaminants to the ambient air. Therefore, contaminants in surface soils have relatively low potential for release to the air as particulates due to wind erosion because of the vegetative cover and relatively flat slope. Ambient air test conducted by the Ohio EPA and the USACE indicate that the potential for contaminant migration through the air pathway is limited.

Arsenic was the only identified contaminants in subsurface soils that exceeded screening criteria. The predominant unconsolidated soil type at the site is clayey and silty till deposits, which limits the migration potential of subsurface contaminants. Limited migration potential does exist through thin sand, silty sand, and clayey sand seams interbedded with the clayey and silty till deposits. In addition to these higher permeable lenses, broken clay field tiles were observed on the school property during the field investigation activities. Although these tiles were not observed to be intact, and all clay field tiles have likely since been destroyed, potentially intact clay field tile could transport contaminants laterally.

7.3 EXPANDED SITE RISK EVALUATION

The ESRE addresses potential human health risks from future exposure to hazardous constituents at the RVS property under industrial/commercial land use. In addition, it evaluates the risks associated with the use of the property as a school, based on the use of the property as a school until the fall of 2003. This risk evaluation compares maximum site concentrations to site-specific preliminary remediation goals based on the industrial/commercial worker exposure scenario presented in *the Draft Industrial Worker Risk Scenario Addendum River Valley School Property, Operable Unit 1 – Former Disposal Area, Draft Remedial Investigation Report* (Montgomery Watson, 2001a) and the ballplayer exposure scenario presented in *the Draft Revision to the River Valley School Property, Operable Unit 1 – Former Disposal Area, Draft Remedial Investigation Report* (Montgomery Watson, 2001b). The site-specific preliminary remediation goals developed in the OU1 addendum (Montgomery Watson, 2001a) represent the screening criteria used in this ESRE. Both of these exposure scenarios are conservative and health protective for the RVS students until relocation occurs and for the intended future land reuse as an industrial/commercial operation. The results of the ESRE are intended to assist in making risk management decisions concerning the necessity for remediation, the nature and extent of remediation, and selection of remedial alternatives.

7.3.1 Summary of Human Health Risks

Based on the results of the comparison of the maximum detected site concentrations to site-specific preliminary remediation goals, adverse effects to human health are not expected from exposure to chemicals detected during the ESI activities. Most of the compounds detected in surface and subsurface soil samples collected from the RVS Property outside of OU1 are present at concentrations less than both the industrial/commercial worker site-specific preliminary remediation goals and the recreational user (ballplayer) site-specific preliminary remediation goals. For the four PAHs that exceeded site-specific preliminary remediation goals, an examination of the sample locations where the remediation goals were exceeded and their association with a likely anthropogenic source would indicate that these PAH exceedances are not significant. This is further supported by a PAH literature review and the site-specific background sampling for PAHs along roadsides near the River Valley School. The significance of the exceedance of site-specific preliminary remediation goals and the background criteria for arsenic is diminished by the fact that arsenic was detected at concentrations only slightly greater than the background criteria in a small number of samples. The significance of the exceedance of site-specific preliminary remediation goals and background criteria for lead is diminished by the fact that lead was detected above the preliminary remediation goals in only two of 131 samples. Lead concentrations at the site range from 6.91 mg/kg to 1090 mg/kg. The average soil-lead concentration is 62 mg/kg (Montgomery Watson, 2001b). This average soil-lead concentration (62 mg/kg) is below both the industrial/commercial and residential USEPA screening levels of 750 mg/kg and 400 mg/kg, respectively. For this reason, current and possible future exposures to lead in soils are not expected to pose a public health concern for the ballplayer nor the industrial worker.

7.3.2 Summary of Potential Ecological Risks

Normal operating activities at the River Valley School place certain restrictions on the exiting ecosystem. This does not imply that the ecosystem is stressed or unhealthy, however, the ecosystem that exists on site and along with the operation of the school is not expected to be the natural ecosystem for this region of Ohio. For example, little vegetation is available for food or cover within the school campus. Frequent human activity at the site will likely inhibit activities of animals. In the future, the site is restricted to industrial/commercial land reuse; therefore, soil ecosystems are limited by present and future human disturbance activities at the site. Endangered, threatened or special species of plants or animals have not been identified within a one-half mile radius of the former MED (Refer to letter from Ohio Department of Natural Resources, letter dated March 30,1998, Montgomery Watson, 2001b).

As this unmowed portion is characterized by disturbed or artificial conditions and surrounded by areas maintained for human uses (eg., manicured school grounds, mowed areas of the nature preserve), it is doubtful that this unmowed grass portion of the site would be considered an ecologically important resource. Further, the low concentrations of VOCs, PAHs, and lead detected in the unmowed area would not be expected to pose an ecological health concern. All analyte concentrations were lower than available toxicity benchmarks (i.e., HQs were less than one).

In summary, based on the results of this ESERE, Level 1 Assessment, important ecological resources are, or potentially could not be impacted by site related ecological stressors. Therefore, an additional ecological risk assessment is not warranted for the remainder of the River Valley School property.

7.4 CONCLUSIONS

The findings and conclusions drawn in this report are based on the compilation of results derived from the ESI activities performed at the site. The evaluation of the extent of contamination used several types of screening criteria. Should other criteria be deemed applicable for addressing and/or determining the extent of materials above these levels, then conclusions in this report may be partially or wholly revised.

Most of the compounds detected in surface and subsurface soil samples collected from the RVS Property outside of OU1 are present at concentrations less than the screening criteria. PAHs, arsenic and lead were the only contaminants detected above screening criteria in surface soils. Arsenic was the only contaminant identified above screening criteria in subsurface soil samples. These identified contaminants in the surface and subsurface soils were identified at discrete locations throughout the RVS Property. The limited contamination may be related to the past activities associated with the former military use of the property prior to 1961. Although PAHs exceeded screening criteria in surface soils, an examination of the sample locations where the remediation goals were exceeded and their association with a likely anthropogenic source would indicate that these PAH exceedances are not significant. The significance of the exceedance of screening criteria (site-specific preliminary remediation goals and the background levels) for arsenic and lead is diminished by the fact that arsenic was detected at concentrations only slightly greater than the background criteria in a small number of samples and the fact that lead was detected above the screening criteria in only two samples.

Based on the results of the comparison of the maximum detected site concentrations to site-specific preliminary remediation goals, adverse effects to human health are not expected from exposure to chemicals detected during the ESI activities. Therefore, no further action at the RVS Property outside of OU1 is recommended.

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