TETRA TECH

March 26, 2013

Mr. Kipp Eckert, Portfolio and Project Manager
Greenfield Environmental Trust Group
Greenfield Environmental Multistate Trust, LLC
1920 232nd Place SE
Bothell, WA 98021

Subject: **Final Interim Remedial Investigation Report**
14th Avenue Ditch Area
Tasks 10 and 16
Master Professional Services Agreement (MPSA)

Dear Mr. Eckert:

Tetra Tech, Inc. (Tetra Tech), is pleased to submit the final interim remedial investigation (RI) report for the 14th Avenue Ditch Area in Columbus, Lowndes County, Mississippi. This final interim RI report was prepared in accordance with Tasks 10 and 16 of the MPSA between Tetra Tech and the Greenfield Environmental Multistate Trust, LLC, Trustee of the Multistate Environmental Response Trust. The final interim RI report presents the results of field activities conducted from July 17 to 26, 2012. The results of surface water samples collected from the 14th Avenue Ditch on September 26, 2012 also have been incorporated into this final interim RI report.

Please call me at (678) 775-3090 if you have any questions.

Sincerely,

Andrew J. Kandray

Andrew Kandray
Project Manager

Enclosure

cc: Andrew Johnson, Tetra Tech Atlanta Operations Manager
Mike Wanta, Tetra Tech Contract Manager

1955 Evergreen Blvd., Building 200, Suite 300, Duluth, GA 30096
Tel 678.775.3080 Fax 678.775.3138
www.tetratech.com

FINAL
INTERIM REMEDIAL INVESTIGATION REPORT

14TH AVENUE DITCH AREA
COLUMBUS, LOWNDES COUNTY, MISSISSIPPI

Prepared for

Greenfield Environmental Multistate Trust, LLC
Trustee of the
Multistate Environmental Response Trust
44 Shattuck Road
Watertown, MA 02472

Date Prepared	:	March 26, 2013
Contract No.	:	Tasks 10 and 16 of the MPSA
Prepared by	:	Tetra Tech, Inc.
Tetra Tech, Inc. Project Manager	:	Andrew Kandray

Prepared by	Reviewed by	Approved by
Wendy Robinson	Sandra Harrigan	Andrew F. Johnson
Wendy Robinson	Sandra Harrigan	Andrew F. Johnson
Environmental Scientist	Technical Reviewer	Quality Control Coordinator

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APPENDICES

ATTACHMENTS

1.0 INTRODUCTION

Under Tasks 10 and 16 of the Master Professional Services Agreement, the Greenfield Environmental Multistate Trust LLC, Trustee of the Multistate Environmental Response Trust (MST), tasked Tetra Tech, Inc. (Tetra Tech), to conduct an interim remedial investigation (RI) for the 14th Avenue Ditch Area. This report presents the results of the interim RI conducted from July 17 to 26, 2012 and September 26, 2012. The 14th Avenue Ditch Area is adjacent to the former Kerr-McGee Wood Treating facility (Site) located in Columbus, Lowndes County, Mississippi (see Figures 1 and 2 in Appendix A). MST is working closely with the Site Beneficiaries (the U.S. Environmental Protection Agency [EPA] and the Mississippi Department of Environmental Quality [MDEQ]) to ultimately remediate the Site, which was placed on the National Priorities List (NPL) in 2011 in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA). This interim RI report was prepared in general accordance with the EPA Guidance for Conducting Remedial Investigations and Feasibility Studies (FS) under CERCLA (Ref. 1).

1.1 PURPOSE OF REPORT

The City of Columbus has proposed an improvement project to relocate the existing stormwater ditch between 14th Avenue and the Site, but existing data was not sufficient to delineate the nature and extent of environmental impacts from historical Site activities on this area. This interim RI report presents and discusses the results of the July 2012 14th Avenue Ditch Area sampling event. These results assess environmental impacts from the Site on this area and will assist MST, the Beneficiaries, and the City of Columbus in evaluating the extent of environmental remediation needed to safely conduct the City's 14th Avenue Ditch Improvement Project. This project will accommodate widening 14th Avenue and adding a center turn lane in the future. A new ditch will be installed with a concrete culvert parallel to the current 14th Avenue Ditch, about 75 feet south of 14th Avenue, and situated on a parcel of property that will have been conveyed to the City (Ref. 2).

The goals of the interim RI are as follows:

- Define the nature and extent of contaminated soil, sediment, surface water, and groundwater in and near the 14th Avenue Ditch
- Provide data to estimate the volume of contaminated soil within the proposed excavation area for the 14th Avenue Ditch Improvement Project
- Identify and estimate management and disposal requirements and costs for excavated, contaminated soil

- Obtain adequate data for a preliminary baseline risk assessment (PBRA)
- Obtain adequate data from this area to include in a site-wide FS

This interim RI report will supplement the pending site-wide RI/FS and is organized into eight sections:

- Section 1.0 provides an introduction to and purpose of the interim RI, briefly discusses the Site history, and discusses previous investigations conducted to date for the 14th Avenue Ditch Area.
- Section 2.0 discusses the interim RI field activities conducted to characterize the 14th Avenue Ditch Area, including topographic surveys; soil, sediment, surface water, and groundwater sampling; and field analysis activities. This section also discusses any deviations from the approved final interim RI work plan, data quality objectives (DQO), and laboratory analysis and data quality assessment procedures established in the final interim RI work plan. Note that evaluation of contaminated air is not applicable for this interim RI, was not tasked by MST, and will not be discussed.
- Section 3.0 discusses the physical characteristics, including the topography, climate, surface water hydrology, geology, and hydrogeology of the Site and surrounding area.
- Section 4.0 presents the nature and extent of contamination present in the 14th Avenue Ditch Area and summarizes the analytical results for the interim RI.
- Section 5.0 presents the fate and transport of contaminants in the 14th Avenue Ditch Area, including potential routes of migration, contaminant persistence, and contaminant migration.
- Section 6.0 presents the PBRA, including a human health and an environmental evaluation.
- Section 7.0 presents the summary and conclusions.
- Section 8.0 presents the references used in this report.
- Appendix A contains figures depicting the site location, ditch locations, and sampling locations with results above Regional Screening Levels (RSL). Appendix B presents the analytical data summary tables. Appendix C contains the photographic log. Appendix D presents the logbook notes. Appendix E contains the boring logs and monitoring well completion diagrams. Appendix F contains the analytical data and quality assurance/quality control (QA/QC) evaluation results in a data validation report. Appendix G presents a technical memorandum on remediation goals for the 14th Avenue Ditch sediments for the Former Kerr-McGee Wood Treating Site, in Columbus, Mississippi (Site). Appendix H presents the calculation tables for the PBRA.
- Attachments 1 and 2 are the topographic survey figures prepared by Neel-Schaffer with additional notations by Tetra Tech. Attachments 3 and 4 are the potentiometric maps for the alluvial and Eutaw Formations prepared by AquAeTer.

1.2 SITE BACKGROUND

The following subsection provides a description of the 14th Avenue Ditch Area, a brief discussion of the Site history, and previous investigations conducted to date for the 14th Avenue Ditch Area.

1.2.1 14th Avenue Ditch Area Description and Environmental Setting

The 14th Avenue Ditch Area is an approximately 1,830-foot long stormwater ditch located along 14th Avenue North that extends from North 23rd Street (on the west) to the railroad tracks between North 27th Street and Moss Street (on the east), and traverses the northern corner of the Site. Residential and commercial properties and the former Pine Yard of the Site are located to the north, and the Main Plant of the Site is located south of the 14th Avenue Ditch Area (See Figure 2 in Appendix A).

1.2.2 Site History

From 1928 to 2003, the Site was an active wood preserving facility. The facility manufactured pressure-treated railroad products, including wooden cross ties, switch ties, and timbers using several preservatives including pentachlorophenol (PCP), creosote, and creosote coal tar solutions. Creosote and creosote coal tar consists of polynuclear aromatic hydrocarbons (PAH), phenols, heterocyclic oxygen, sulfur, and nitrogen compounds. PCP was used from 1928 through 1976. Xylene was also used as a drying agent for untreated wood from 1970 through 1974 (Refs. 3, 4).

During operations, green lumber was received at the Main Plant and sorted by type and grade of wood. The wood was then seasoned by natural air drying, which required the wood to be stacked in a drying yard for up to 12 months, or by artificial seasoning using the Boulton process. Wood that was allowed to dry naturally was stored in the green tie storage areas and in the Pine Yard. The Boulton drying process involved subjecting the green lumber to heated creosote under a vacuum, which boils the sapwater out of the wood. After it had been seasoned, the wood was then pressure-treated in a retort. The pressure treating process involved filling a cylinder with creosote and applying pressure to force the creosote into the wood. After treatment, the wood was placed on a drip pad for drying, and the excess preservative (creosote and PCP) was allowed to drip onto bare soil (Refs. 4, 5). In 1988, a drip pad (below the drip track) was constructed of 1 to 1.5 feet of clay overlain by a crushed rock buffer of 1 to 1.5 feet, overlain by 12 inches of concrete with a 6-inch concrete berm (Ref. 4). The preserved and dried wood was stored in the black tie storage area before it was shipped off-site (see Figure 3 in Appendix A).

Wood treating operations ceased at the Site in 2003, subsequently all tanks, equipment, and buildings in the process area were removed. The Site currently consists mainly of a gravel-covered lot with concrete pads, several rail spurs, a building housing a groundwater treatment system, a vacant wooden office building, groundwater extraction pumping stations, and a fenced area in the northwestern portion of the Main Plant, where two surface impoundments were closed as one unit (Ref. 6).

During historical operations, stormwater runoff from the Site was discharged to an unlined drainage ditch system via five outfalls under National Pollutant Discharge Elimination System (NPDES) permit number MSR20010. The permit required the facility to sample all stormwater outfalls annually for releases to surface water from the drainage ditches. The permit required testing for pH, oil and grease, total phenols, and total suspended solids, and monthly visual inspections of drainage ditches and stormwater outfalls for oil sheens or other indicators of releases to the environment. The outfalls emptied into various off-site drainage ditches on the northern, eastern, and southern boundaries of the Site, including the 14^{th} Avenue Drainage Ditch, located to the north. These off-site drainage ditches converge with a drainage ditch east of the Site (referred to as the Main Drainage Ditch), which flows for about 1 mile before it empties into Luxapillila Creek (see Figure 2 in Appendix A).

During operations, stormwater runoff from the northwestern portion of the Site discharged to an unlined drainage ditch that received runoff from the process area, wastewater treatment, and creosote recovery area; the mill; and the surface impoundments. This unlined drainage ditch exited the property through Outfall 002 of its NPDES permit and entered the 14^{th} Avenue Ditch. Sediments contained in the 14^{th} Avenue Ditch are a concern for the Site because of the potentially contaminated stormwater runoff that may have entered the 14^{th} Avenue Ditch. See Figures 2 and 3 in Appendix A.

1.2.3 Previous Investigations

The following subsections briefly describe previous investigations and remedial measures along the 14^{th} Avenue Ditch.

1.2.3.1 2001 to 2002 Phase II RFI Sampling

In 2001 and 2002, Kerr-McGee conducted supplemental Phase II Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) sampling at the Site. The supplemental sampling was conducted to characterize constituent distribution in the sediment and surface water in off-site drainage ditches surrounding the Kerr-McGee property. During the Phase II RFI sampling event, four sediment samples were collected from the 14^{th} Avenue Ditch along the northern boundary of the Site. The analytical results of the sediment samples revealed the presence of creosote constituents including benzo(a)anthracene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene (Ref. 7).

1.2.3.2 2004 Interim Remedial Measures

In 2004, ERM EnviroClean-Southwest, LLC (ERM), conducted interim remedial measures at the Site on behalf of Kerr-McGee. The interim measures focused on excavation and off-site disposal of ditch sediments contaminated by PAHs that exceeded their EPA Region 9 Preliminary Remediation Goals (PRG) of 1×10^{-4}. Contaminated ditch sediments were removed from four areas in drainage ditches on and bordering the Site, including the 14th Avenue Ditch. Approximately 90 cubic yards of sediments from 375 linear feet of the 14th Avenue Ditch were removed down to 2.5 feet below the ditch bottom. Clean fill material from an unspecified location was reportedly used to restore the excavated ditch contours, including a portion of the 14th Avenue Ditch, and concrete or wooden retaining structures were installed at selected locations during the 2004 interim remedial measures (Ref. 8).

1.2.3.3 2010 EPA SESD Sediment Sampling

In 2010, the EPA Region 4 Science and Ecosystem Support Division (SESD) collected sediment samples from drainage ditches surrounding the Site. Sediment samples TN16S and TN20S were collected from the 14th Avenue Ditch. Sample TN16S, collected just west of the Pine Yard, contained creosote constituents including benzo(a)anthracene, benzo(a)pyrene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, and naphthalene. Constituents related to creosote were not detected at or above the reporting limit in sample TN20S, collected just east of North 23rd Street (Ref. 9).

1.2.3.4 2011 Greenfield Environmental Multistate Trust Sampling

In 2011, URS Corporation (URS), on behalf of MST, collected soil samples along the proposed realignment route for the 14th Avenue Ditch. This route is located in part on the northern edge of the Main Plant of the Site, adjacent to the existing 14th Avenue Ditch. Twelve soil borings were advanced to 7 feet below ground surface (bgs). Composite soil samples were collected from 0 to 5 feet bgs and sent to an off-site laboratory for analysis. Creosote constituents were not detected at or above the detection limit in four of the soil samples. The remaining eight soil samples contained creosote constituents including benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and naphthalene. PCP was detected in six of the soil samples. Low concentrations of various dioxin and furan isomers were detected in three of the soil samples (Ref. 10). The URS sampling locations are depicted on Figures 4 and 5 in Appendix A, and summary results are presented in Table 1 in Appendix B.

2.0 INTERIM REMEDIAL INVESTIGATION

This section discusses the interim RI activities conducted from July 17 to 26, 2012, to characterize the 14th Avenue Ditch Area. This section also discusses any deviations from the approved final interim RI work plan, DOQs, and laboratory analysis and data quality assessment procedures established in the final interim RI work plan (Ref. 6).

The sample nomenclature used during the interim RI sampling event is as follows. All sample identifications (IDs) begin with 14AD, which stands for 14th Avenue Ditch Area. To define the sampling areas, FA stands for 14th Avenue, KM stands for the former Kerr-McGee Wood Treating facility (the Site), and RP stands for residential property. A station ID number is used (for example: 00, 01, 02) for specific samples collected at those areas. Sample media information is defined as SD (sediment), SS (surface soil), SB (subsurface soil), and GW (groundwater). For sediment samples, the sampling depth interval is defined as A (0- to 3-inches below the surface water-sediment interface at the bottom of the 14th Avenue Ditch [bsw-si]), B (6- to 12- inches bsw-si), and C (12- to 24- inches bsw-si). For soil samples, the sampling depth interval is defined as A (0- to 6-inches bgs), B (5- to 6- feet bgs), C (6- to 7- feet bgs), and D (3- to 3.5-feet bgs). Duplicate samples were identified as DUP, which appears at the end of the sample ID.

All samples were collected in accordance with the final interim RI work plan for the 14th Avenue Ditch Area (Ref. 6) and the specific sampling procedures that follow. Sediment samples were collected in accordance with the EPA Region 4 SESD Field Branches Quality System and Technical Procedures (FBQSTP) for Sediment Sampling, SESDPROC-200-R2. Surface water samples were collected in accordance with the EPA Region 4 SESD FBQSTP for Surface Water Sampling, SESDPROC-201-R1. Soil borings were advanced and surface and subsurface soil samples were collected in accordance with the EPA Region 4 SESD FBQSTP for Soil Sampling, SESDPROC-300-R2. Groundwater samples were collected in accordance with the EPA Region 4 SESD FBQSTP for Groundwater Sampling, SESDPROC-301-R2. Field measurement parameters for groundwater, including pH, specific conductivity, temperature, and turbidity, were collected in accordance with the EPA Region 4 SESD FBQSTP for Field Measurements, SESDPROC-100-R2, SESDPROC-101-R2, SESDPROC-102-R3, and SESDPROC-103-R2 (Ref. 11).

Sampling locations are depicted on Figure 4 in Appendix A. A photographic log of sampling activities is provided in Appendix C. Logbook notes are provided in Appendix D. Boring logs, including lithological information, are presented in Appendix E.

2.1 GEOPHYSICAL AND TOPOGRAPHIC SURVEYS

Tetra Tech procured a Mississippi-licensed land surveyor (Neel-Schaffer) to conduct geophysical and topographic surveys of the Site to define the horizontal and vertical positions of the major fixed reference points on the Site and to determine the contours of the ground surface on the northern portion of the Site. The geophysical survey could not be completed because of interferences posed by the layers of gravel and riprap located at the Site. The topographic survey identified the locations of utilities and piping systems that were associated with wood treating operations. Contour lines were also identified by Neel-Schaffer and were used to determine surface water flow patterns from the Site to the 14th Avenue Ditch. Attachments 1 and 2 contain the topographic survey figures prepared by Neel-Schaffer with additional notations by Tetra Tech, which depict the on-site structures, locations of surface features such as riprap and concrete pads, drainage pipes, aboveground utility lines, similar features, and contour markings.

The topographic surface survey identified the locations of two on-site buildings. The wood-frame building in the northwestern portion of the Site is the former office building for the Kerr-McGee Wood Treating facility. This building is locked, boarded up, and not currently in use. The metal frame building located in the central portion of the Site is the operational groundwater treatment system building, which is used for on-going treatment of contaminated groundwater.

Several areas of riprap are present at the Site. Riprap intermittently extends along the northwestern boundary of the Site to the eastern Site boundary, parallel to the 14th Avenue Ditch. Riprap is also located in eight different areas in the central portion of the Site. Several concrete pads are located throughout the Site. Concrete pads are located in the northeastern, central, and southwestern portions of the Site. Chain-link fence surrounds the Site, with an additional fence around the closed surface impoundment located in the western portion of the Site. An aboveground power line bisects the central portion of the Site from north to south, east of the groundwater treatment system building. An aboveground power line is also located in the southwestern corner of the Site.

2.2 SEDIMENT SAMPLING

Tetra Tech used hand augers to collect sediment samples from the bed of the 14th Avenue Ditch to delineate the nature and extent of site-related contaminants and to provide data for the Site-wide human health and ecological risk assessments. When encountered, observations of visibly contaminated soil (staining) and noticeable chemical odors were documented. In addition, field screening for elevated organic vapors above background ambient air levels in the work area was conducted using a photoionization detector (PID).

Twenty grab sediment samples, including a duplicate, were collected from depositional areas at depths from 0 to 3 inches bsw-si. The sediment samples were collected at approximately 100-foot horizontal intervals along the entire length of the 14th Avenue Ditch, from North 23rd Street to approximately 100 feet before the railroad spurs adjacent to the eastern property boundary of the Site. Figure 5 in Appendix A depicts the sample locations. Analytical results are summarized in Section 4.2. Surface water was observed flowing in the 14th Avenue Ditch at the time of sampling. A sheen was observed in sediment sample 14AD-FA01-SD-A, and a slight creosote odor was noted in sample 14AD-FA03-SD-A.

All sediment samples were submitted to a Tetra Tech procured laboratory for analysis of the site-specific preliminary contaminants of concern (COC). The table below provides a list of the site-specific preliminary COCs. This list was derived from COCs for the Site's groundwater monitoring program, the evaluation of existing data, and preliminary risk assessment evaluations.

PRELIMINARY CONSTITUENTS OF CONCERN

CONSTITUENTS OF CONCERN	
2,3,4,6-Tetrachlorophenol	Dibenzo(a,h)anthracene
2,4,6-Trichlorophenol	Fluoranthene
2,4-Dimethylphenol	Indeno(1,2,3,-cd)pyrene
2,4-Dinitrophenol	Naphthalene
2-Chlorophenol	Pentachlorophenol
4-Chloro-3-methylphenol	Phenanthrene
Acenaphthylene	Phenol
Benzene	Total phenol
Benzo(a)anthracene	Total xylene
Benzo(a)pyrene	Arsenic
Benzo(b)fluoranthene	Chromium
Bis(2-ethylhexyl)phthalate	Lead
Carbazole	

2.3 SOIL SAMPLING

Surface and subsurface soil samples were collected, using hand augering or direct-push technology (DPT) drilling methods, from the 14th Avenue Ditch, the northern portion of the Site, and residential and commercial properties north of 14th Avenue. The surface and subsurface soil samples were collected at 0-

to 6-inches, 5- to 6- foot, and 6- to 7-foot intervals. Soils encountered were generally loose clay, sand, and silt loams.

The sample locations were chosen based on risk assessment requirements for spatial distribution and to characterize soil in the proposed excavation area for the 14th Avenue Ditch Improvement Project. Figure 5 in Appendix A depicts the sample locations. Analytical results are presented in Section 4.3. The samples were collected to better define the nature and extent of soil and sediment contamination in the 14th Avenue Ditch, in the northern portion of the Site, and at locations north of the 14th Avenue Ditch; and to help determine whether site-related COCs are migrating into the 14th Avenue Ditch through subsurface soils or groundwater. Sampling depths were chosen to coincide with the proposed excavation depths for the City's 14th Avenue Ditch Improvement Project.

Observations of visibly contaminated soil (staining) and noticeable chemical odors were documented, when encountered. In addition, A PID was used to screen all soil samples for elevated organic vapors above background ambient air levels. Field screening results of subsurface soil at each sample location were used to select the depth interval to collect samples for laboratory analysis when there was little differentiation among the depth intervals based on visual observations.

2.3.1 14th Avenue Ditch

A total of 40 subsurface soil samples were collocated with the sediment samples discussed in Section 2.2. Using hand augering methods, grab subsurface soil samples were collected based on field screening results. In all, 20 grab subsurface soil samples, including a duplicate, were collected from 6 to 12 inches bsw-si, and 20 grab subsurface soil samples, including a duplicate, were collected from 12 to 24 inches bsw-si. The 14th Avenue Ditch is approximately 3.5 feet deep (at the surface water-sediment interface). A sheen or creosote odor was observed in the following samples: 14AD-FA01-SB-B, 14AD-FA01-SB-C, 14AD-FA03-SB-B, 14AD-FA03-SB-C, 14AD-FA08-SB-C, 14AD-FA13-SB-B, and 14AD-FA13-SB-C. Samples 14AD-FA01-SB-B, 14AD-FA01-SB-C, 14AD-FA03-SB-B, and 14AD-FA03-SB-C were collected after a rain event, when a sheen was also observed on the water in the 14th Avenue Ditch (see Photograph 15 in Appendix C).

2.3.2 Northern Portion of the Site

Surface and subsurface soil samples were collected from eight locations along the northern portion of the Site, generally adjacent to the 14th Avenue Ditch. Using DPT drilling methods, grab surface and subsurface soil samples were collected based on field screening results. Nine grab surface soil samples, including a duplicate, were collected from 0 to 6 inches bgs. Eight grab subsurface soil samples were collected from 5 to 6 feet bgs. Eight grab subsurface soil samples were collected from 6 to 7 feet bgs. One additional grab subsurface soil sample was collected at station KM02 from 3 to 3.5 feet bgs based on field screening results and olfactory observations. All on-site soil samples were located between the 2011 URS soil boring locations, which were spaced about 100 feet apart along the northern portion of the Site.

2.3.3 Nearby Residential and Commercial Properties

Surface and subsurface soil samples were collected from six residential or commercial properties located along the northern side of 14^{th} Avenue. Using DPT drilling methods, grab surface and subsurface soil samples were collected based on field screening results. Seven grab surface soil samples, including a duplicate, were collected from 0 to 6 inches bgs. Six grab subsurface soil samples were collected from 5 to 6 feet bgs. Six grab subsurface soil samples were collected from 6 to 7 feet bgs.

2.4 MONITORING WELL INSTALLATION AND GROUNDWATER SAMPLING

Tetra Tech procured a Mississippi-licensed drilling subcontractor (Walker-Hill Environmental, Inc.) to install monitoring wells on the north side of the 14^{th} Avenue Ditch. Three monitoring wells were installed to an approximate depth of 14.5 to 16.5 feet bgs in the shallow alluvial aquifer. The locations of the monitoring wells are depicted on Figure 4 in Appendix A. A photographic log depicting select soil boring locations is provided in Appendix C. Logbook notes are provided in Appendix D. Analytical results are summarized in Section 4.5. All monitoring wells were installed using a hollow-stem auger drill rig in accordance with the EPA Region 4 SESD FBQSTP, Guidance for the Design and Installation of Monitoring Wells, SESDGUID-101-R0 (Ref. 11).

The wells were installed with 10 feet of 0.010-inch slot screen extending from 14 to 16 feet bgs. All wells were installed to ground surface and included water-tight, flush-mounted manhole covers with a 3- by 3-foot by 4-inch-thick concrete pad at the surface of each well. A 20-40 sand filter pack encased the well screen, extending a minimum of 2 feet above the top of the screened interval. A bentonite plug (minimum of 2 feet) was placed on top of the sand filter pack. The remainder of the annular space, if any, was filled with bentonite grout to a depth within 2 feet of the ground surface. Boring logs, including lithological information, and well construction diagrams for each newly installed permanent monitoring well are presented in Appendix E. The top of the casing at each well was surveyed to establish its elevation above mean sea level. The elevations are also presented on Attachments 1 and 2.

Groundwater samples were collected from the three newly installed monitoring wells to assess the direction of groundwater flow and to determine the presence or absence of site-related COCs in groundwater north of 14th Avenue and the Site. Groundwater samples were collected using a peristaltic pump and dedicated Teflon tubing in accordance with the EPA Region 4 SESD FBQSTP, Groundwater Sampling, SESDPROC-301-R2 (Ref. 11). During sampling, the tubing was positioned at the midpoint of the screened interval for each well sampled. Each well was purged and groundwater parameters, including pH, specific conductivity, temperature, and turbidity, were measured. Once the groundwater parameter measurements stabilized (within 10 percent), the sample was collected.

2.5 FIELD ANALYSIS ACTIVITIES

Tetra Tech analyzed the soil and sediment samples collected from the 14th Avenue Ditch and on-site locations using portable field equipment and methods. These samples were analyzed for total polynuclear aromatic hydrocarbons (PAHs) by both immunoassay testing and ultraviolet fluorescence (UVF) spectroscopy. The results from these field analysis tests were compared with the total PAH results from separate aliquots of the same samples (a total of 85) also sent to Gulf Coast Analytical Laboratories, Inc. (GCAL), for fixed-base laboratory analysis. A comparison of the field analysis results to the corresponding laboratory results is presented in Section 4.4. This comparison was performed to evaluate the technologies being considered for the Adaptive Soil Sampling Approach discussed in Section 7.1 of the RI/FS work plan (Ref. 6).

2.5.1 Immunoassay Testing

The immunoassay testing for total PAHs was performed in accordance with Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846) Method 4035. The RaPID PAH Test Kit (provided by Modern Water, Inc.) was used for this field analysis, following the instructions included in the test kits. A total of 85 soil and sediment samples were analyzed using these test kits. The results of this testing are summarized in Section 4.4.1.

2.5.2 UVF Spectroscopy

The UVF spectroscopy testing for total PAHs was performed in accordance with procedures developed for the QROS, LLC, QED UVF analyzer. This testing was originally intended to be performed while the field crew was on Site; however, QROS, LLC, was unable to provide a trainer for the QED analyzer during the scheduled field event. Therefore, once the immunoassay testing had been performed for a sample, the remaining sample volume was sent to KB Labs in Newberry, Florida, to perform bench-scale UVF spectroscopy analysis using a field portable instrument. The results of this testing are summarized in Section 4.4.2.

2.6 DEVIATIONS FROM THE WORK PLAN

During the interim RI field sampling event, some sampling locations and procedures deviated from those proposed in the approved final work plan in response to environmental conditions. Deviations are summarized below.

- Although the final work plan specified to sample the14th Avenue Ditch in the center of the 100-foot interval in order to more-fully characterize the nature and extent of contamination within the 14th Avenue Ditch, access to and/or the prevalence of vegetation, rock, etc. required that sediment and subsurface soil sampling locations often (if not always) be adjusted up or downstream.
- Rail lines between the Site and 14th Avenue Ditch on the eastern portion of the Site limited access to sampling locations FA15, FA16, FA17, and FA18. Also, the acetate liners provided by the subcontracted drillers (Walker Hill Environmental, Inc.) were of insufficient size for the sample volume required. Therefore, Tetra Tech utilized hand augers to collect all sediment samples from the 14th Avenue Ditch. Sediment samples obtained from the 14th Avenue Ditch were collected in accordance with EPA SESD FBQSTP for Sediment Sampling, SESDPROC-200-R2 (ref. 11).
- One additional grab subsurface soil sample was collected at station KM02 from 3 to 3.5 feet bgs based on field screening results and olfactory observations that indicated potentially high creosote contamination was present. In order to preserve the established sample nomenclature for specific sampling intervals, this new sampling interval was given a code of “D”.
- Residential/commercial sampling location RP-01 was offset approximately 10 feet north of the proposed location due to overhead power lines, buried utilities, and a steep incline.
- Residential/commercial sampling location RP-03 was offset approximately 10 feet north of the proposed location due to overhead power lines and buried utilities.
- Three subsurface soil samples (14AD-FA02-SB-C, 14AD-FA05-SB-C, and 14AD-FA18-SB-B) were additionally analyzed for dioxins and furans. In order to correlate dioxins and furans data to low levels of PAHs, 14AD-FA02-SB-C and 14AD-FA05-SB-C were chosen because the PAH results of these samples were below the EPA RSLs. Sample 14AD-FA18-SB-B was chosen because it was collected farthest downstream in the 14th Avenue Ditch and would provide an idea of dioxins and furans constituents migrating off-site.
- On September 26, 2012, four surface water samples, including a duplicate, were collected from the 14th Avenue Ditch (14AD-FA20-SW, 14AD-FA21-SW, 14AD-FA22-SW, and 14AD-FA22-SW-DUP). One surface water sample (14AD-FA19-SW) was collected from a ditch north of 14th Avenue and was designated as the background surface water sampling location (see Figure 17 in Appendix A). These samples were analyzed for VOCs, SVOCs, pesticides, PCBs, dioxins and furans, and metals.

2.7 DATA QUALITY OBJECTIVES

DQOs were established to define the quantity and quality of the data to be collected to support the goals of this interim RI, which are to define the nature and extent of contaminated soil, sediment, surface water, and groundwater in and near the 14th Avenue Ditch; provide data to estimate the volume of contaminated soil within the proposed excavation area for the 14th Avenue Ditch Improvement Project; identify and estimate management and disposal requirements and costs for excavated, contaminated soil; obtain adequate data for a PBRA; and obtain adequate data from this area to include in a site-wide FS.

Sampling and laboratory analysis were conducted to define the nature and extent of soil, sediment, and surface water contamination in the 14th Avenue Ditch; soil contamination in the northern portion of the Site and at locations north of the 14th Avenue Ditch; and to help determine whether site-related COCs are migrating into the 14th Avenue Ditch through subsurface soils or groundwater. Analytical data for environmental samples were evaluated to assess whether contaminant concentrations are present above sample-specific and analyte-specific laboratory reporting limits (RL) and exceed screening levels and comparison criteria. The RL is the analyte concentration that corresponds to the lowest demonstrated level of acceptable quantitation. The RL accounts for preparation weights and volumes, dilutions, and moisture content in soil and sediment samples. Sediment and soil analytical results were compared with EPA RSLs for residential soil, dated April 2012. Groundwater analytical results were compared with EPA RSLs for tapwater, dated April 2012 (Ref. 12). Surface water samples were compared with EPA maximum contaminant levels (MCL) and secondary drinking water levels, dated May 2009 or EPA RSLs for tapwater, dated April 2012 (Refs. 12; 36).

2.8 LABORATORY ANALYSIS AND DATA QUALITY ASSESSMENT

All sediment, soil, and groundwater samples were submitted to Tetra Tech-procured laboratory GCAL for analysis of the site-specific preliminary COCs. Ten percent of the samples collected for each matrix were also submitted for target compound list (TCL) volatile organic compounds (VOCs), TCL semivolatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), target analyte list (TAL) metals, hexavalent chromium, and dioxin/furan analysis, in addition to the site-specific preliminary COCs.

The samples were analyzed using SW-846 methods indicated below (Ref. 13).

- TCL and COC VOCs by SW-846 Method 8260B
- TCL and COC SVOCs by SW-846 Method 8270D

- Pesticides by SW-846 Method 8081B
- PCBs by SW-846 Method 8082A
- TAL and COC metals by SW-846 Methods 6010C (soil/sediment), 6020A (water), 7470A (mercury for water), and 7471B (mercury for soil/sediment)
- Hexavalent chromium by SW-846 Method 7196A
- Dioxins/furans by SW-846 Method 8290A and EPA Method 1613B

Tetra Tech reviewed the data packages for completeness and conducted a Stage 4 (full) data validation. Tetra Tech implemented a QA/QC process for data validation support that included a random QA/QC comparison between the data in the electronic data deliverables and the electronic portable document format copy of the analytical data package. Data validation was conducted in accordance with the EPA Contract Laboratory Program (CLP) National Functional Guidelines (NFG) for Superfund Organic Methods Data Review, EPA540-R-08-01, June 2008; the EPA CLP NFG for Inorganic Superfund Data Review, EPA540-R-10-011, January 2010; and the EPA Analytical Services Branch NFG for Chlorinated Dibenzo-p-Dioxins and Chlorinated Dibenzofurans Data Review, EPA540-R-05-001, September 2005. The analytical data packages and the data validation report, with modifier definitions, are presented in Appendix F.

3.0 PHYSICAL CHARACTERISTICS

This section describes the physical characteristics, including the topography, climate, surface water hydrology, geology, and hydrogeology, of the Site and surrounding area. This information is important in interpreting the potential impacts of wood treating constituents in environmental media, because the physical characteristics influence the movement of constituents and how they might affect possible receptors.

3.1 TOPOGRAPHY AND SOIL TYPE

The Site is underlain by unconsolidated Quaternary age alluvial sediments consisting of a downward coarsening sequence of interbedded clay, silt, sand, and gravel. According to the United States Department of Agriculture soil survey website (Ref. 14), two prevalent soil types are found on site (Prentiss-Urban land complexes and the Rosella silt loam). Surface elevation at the Site ranges from 170 to 190 feet above mean sea level (amsl). Generally, surface water on the northern portion of the site flows to the north and northeast into the 14th Avenue Ditch. Surface water on the southern portion of the site flows to the south and off-site (see Attachments 1 and 2 and Section 3.3). A review of the boring logs, including lithological information, prepared for the 14th Avenue Ditch sampling locations (FA00 through FA18), indicated the presence of saturated, poorly sorted clays, silts, sands, and gravels; soils are primarily sands and silts. The boring logs are presented in Appendix E.

3.2 METEOROLOGY

Meteorological data were not collected during field activities. Based on information available on line for the past 10 years (2002 to 2012) from WolframAlpha for Columbus, MS (http://wolfr.am/PpcqP6), the average low temperature is 39 degrees Fahrenheit (°F), and the average high temperature is 86 °F. The average annual precipitation is 48 inches. The humidity averages 71 percent with an average wind speed of 6 miles per hour (Ref. 15).

During the summer months (June to September), the average low temperature is 72°F and the average high temperature is 84°F. Rainfall ranges from 0 to 0.59 inch per day, with an average humidity of 83 percent and an average wind speed of 3 miles per hour.

3.3 SURFACE WATER HYDROLOGY

The Mississippi-licensed land surveyor, Neel-Schaffer, conducted a topographic surface survey of the property to determine the horizontal and vertical positions of the major fixed reference points on the property. Figures depicting the findings of the survey, with additional notations by Tetra Tech, are included as Attachments 1 and 2.

The survey identified the locations of several drainage pipes in the western, central, and eastern portions of the Site. A drainage pipe (DP1), located in the western portion of the Site, extends approximately 144 feet from the northwestern riprap area southwestward to the closed surface impoundment. A second drainage pipe (DP2), located in the western portion of the Site, extends approximately 120 feet from the northwestern riprap area southward into the closed surface impoundment. A preferential surface flow pathway extends from DP2 for approximately 300 feet within the closed surface impoundment area. A third drainage pipe (DP3), as well as another preferential surface flow pathway, extends approximately 460 feet from the same northwestern riprap area southward along the central portion of the Site, past the western side of the groundwater treatment system building, toward a concrete wall. This preferential surface flow pathway continues from DP3 to the southeast for approximately 120 feet. A fourth drainage pipe (DP4), as well as another preferential surface flow pathway, extends approximately 20 feet to the southeast, then 160 feet to the south, from the same northwestern riprap area, toward the central portion of the Site.

Two drainage pipes (DP5 and DP6) are located in the northeastern corner of the Site. DP5 extends approximately 70 feet to the southwest from an area of riprap located in the northeastern corner of the Site. DP6 extends approximately 90 feet to the southwest from the northeastern corner of the Site. An approximate 460-foot preferential surface flow pathway is present in the eastern portion of the Site, and an approximate 360-foot preferential surface flow pathway is present in the western portion of the Site. An approximate 360-foot preferential surface flow pathway is present in the northwestern riprap area. Additional preferential surface flow pathways are present at various locations throughout the Site.

Based on the topographic survey, surface water in the northwestern corner of the Site flows southeastward until it is captured by the DP1 or DP2 drainage systems, which discharge to the 14th Avenue Ditch. Surface water in the central portion of the northern half of the Site flows toward the DP3 and DP4 drainage systems, which also discharge to the 14th Avenue Ditch. This area of the Site is characterized by very shallow topographic relief and may be subject to localized flooding during heavy rain events. Surface water flow in the northeastern corner of the Site is influenced by a network of former railroad lines that create topographic highs. These topographic highs channel surface water toward the northeastern corner of the Site, where runoff discharges to the 14th Avenue Ditch. The drainage ditch continues to flow to the south then east, where it discharges into Luxapallila Creek approximately 3,300 feet southeast of the Site (see Figures 1 and 2 in Appendix A).

3.4 GEOLOGY

The Site is underlain by unconsolidated Quaternary age alluvial sediments consisting of a downward coarsening sequence of interbedded clay, silt, sand, and gravel. Lithological logs of newly installed wells indicate the thickness to be approximately 14 to 16 feet in the vicinity of the Site (see Appendix E). These sediments were likely deposited by Luxapallila Creek, which is located about one-half mile east of the Site. Gravel is abundant at the base of the alluvial sediments because of an erosional contact between it and the underlying Eutaw Formation.

Underlying the alluvial deposits is the lower permeability Eutaw Formation, which is composed of two members: the uppermost Tombigbee Sand Member, and the “typical” Eutaw. Generally, it consists of fine- to medium-grained silty sand. Regionally, the Eutaw Formation is up to 500 feet think and serves as a major aquifer at approximately 200 feet below land surface for industrial and domestic use. Based on reported slug-test and aquifer-test data, the upper part of the Eutaw Formation restricts downward movement and is less permeable than the alluvial deposits at the Site (ref. 16).

A review of the boring logs, including lithological information, prepared for the on-site soil sampling locations (KM01 through KM08), indicated the presence of clays, silts, and sands; generally, a sand/silt loam is present. Generally, the surface soils were brown to light brown and subsurface soils consisted of light brown to grey soils, which is consistent with soil survey data of Lowndes County, Mississippi.
A review of the boring logs, including lithological information, prepared for the residential/commercial sampling locations (RP01 through RP06), indicated the presence of clays, silts, and sands; soils are primarily a sand/silt loam. Generally, the surface soils were dark brown to light brown and subsurface soils consist of light brown to grey soils, which are consistent with soil survey data of Lowndes County, Mississippi. The boring logs, including lithological information, are presented in Appendix E.

3.5 HYDROGEOLOGY

Two distinct aquifers underlie the Site: the surficial alluvial aquifer and the deeper Eutaw aquifer (which correspond to the Alluvial Formation and the Eutaw Formation). The saturated zone of the alluvial aquifer is generally about 20 feet thick and is subject to seasonal fluctuations. The average depth to water in the alluvial aquifer is approximately 5 feet bgs. Attachment 3 provides the potentiometric surface map (dated November 2011) of the alluvial formation at the Site as prepared by AquAeTer. The groundwater flow direction in the alluvial aquifer in the northern portion of the Site is to the southeast, but is locally influenced by the on-site collection trenches for the groundwater extraction system.

The groundwater flow velocity of the alluvial aquifer is approximately 40 feet per year, based on an average hydraulic conductivity (2.33 feet/day) measured from slug tests and a pumping test conducted by AquAeTer (Ref. 16); an average gradient of 0.009 feet per foot; and an assumed effective porosity of 0.2.

In July 2012, as part of this interim RI, three monitoring wells were installed on the north side of 14th Avenue. A review of the groundwater elevations suggests that groundwater north of 14th Avenue flows in an easterly to southeasterly direction.

The upper part of the Eutaw Formation, the Tombigbee Sand Member, contains finer grain sizes and greater silt content than the overlying alluvial deposits and produces little water. The Eutaw Formation more readily yields water at an approximate depth of 200 feet below land surface and serves as a major aquifer for industrial and domestic use.

The depths of monitoring wells at the Site that are completed in the Eutaw Formation range from 48 to 53 feet bgs and the static water levels range from 6 to 13 feet bgs. Attachment 4 provides the potentiometric surface map (dated November 2011) of the Eutaw Formation at the Site as prepared by AquAeTer. The groundwater flow direction of the Eutaw Formation is to the southeast with an average gradient of 0.01 feet per foot. The alluvial and Eutaw aquifers appear to be interconnected because the available boring log data indicate that no continuous layer of significantly lower hydraulic conductivity separates the two aquifers at the Site or in the general vicinity. A downward hydraulic gradient exists between the Eutaw aquifer and the overlying alluvial aquifer.

3.6 DEMOGRAPHY AND LAND USE

Based on data from the 2010 U. S. Census (www.census.gov), the population in the City of Columbus, Mississippi, in 2010 was an estimated 23,640 persons. According to data from the 2000 U. S. Census, approximately 8,976 people live within 1 mile of the Site. Approximately 1,030 persons living within 1 mile of the Site are children aged 6 years or younger. Approximately 1,186 persons living within 1 mile of the Site are persons aged 65 years or older (Ref. 17).

Commercial, industrial, and residential properties surround the Site. Six public schools are located within about 1 mile of the Site. The nearest school, Hunt Intermediate School, is located about 400 feet southwest of the Site. Approximately 16 daycare facilities are located within 1 mile of the Site. The nearest daycare facility, Buttons and Bows, is located approximately 50 feet north of the Site.

According to the U.S. Census Bureau, 1,526 businesses operate in Lowndes County, Mississippi. Approximately 20.1 percent are retail establishments, approximately 10.6 percent operate as health care and social assistance facilities, and approximately 9.2 percent are construction companies. The remaining 60.1 percent are made up of various establishments including, but not limited to, food service; financial services; professional, scientific, and technical services; transportation and warehousing; and wholesale trade.

The 14th Avenue Ditch drains a large portion of the City of Columbus, north of 14th Avenue. Residential, commercial, and industrial properties in the surrounding area could contribute to contamination; however, the site-specific COCs are creosote-related and not likely to originate from operations at these properties.

The future land use of the study area is for the City's 14th Avenue DIP. The City's 14th Avenue Ditch Improvement Project will include excavating contaminated soils in the current 14th Avenue Ditch and compacting clean fill material in the current 14th Avenue Ditch to ground surface. This project will accommodate widening 14th Avenue and adding a center turn lane in the future. A new ditch will be installed with a concrete culvert parallel to the current 14th Avenue Ditch, about 75 feet south of 14th Avenue, and situated on a parcel of property that will have been conveyed to the City (Ref. 2).

3.7 ECOLOGY

Ecological habitats that have been preliminarily identified for the Site include: a terrestrial habitat that would include the current Site; and Luxapallila Creek, which receives surface water runoff and stormwater from the Site.

The terrestrial habitat is located in a commercial/industrial setting, and so a viable terrestrial habitat is not considered present at the Site; any exposure would be considered *de minimis* and would not be evaluated as part of the ecological risk assessment. Surface water runoff from the Site enters various drainages that discharge into Luxapallila Creek. The only ecological receptors that were evaluated as part of this risk assessment are those receptors present in Luxapallila Creek or those that feed on organisms from the creek. These receptors include plankton, benthic organisms, fish, piscivorous birds and mammals, shorebirds, waterfowl, reptiles, amphibians, and raptors.

4.0 NATURE AND EXTENT OF CONTAMINATION

The following sections describe the nature and extent of contamination in the 14th Avenue Ditch Area and summarize the analytical results for the interim RI.

4.1 SOURCES OF CONTAMINATION

Impacts to soil, surface water, sediment, and groundwater at the Site resulted primarily from creosote wood treating operations. Spills, leaks, and other releases likely occurred during operations at the Main Plant, which contained the pressure vessel and raw material tanks. Fugitive emissions in the form of mists, particulates, and particle-bound contaminants were likely released from the Site and deposited on site and on surface soils at adjacent properties. Releases also likely occurred to surface soils in the areas where treated wood was stored before it was shipped off-site (Ref. 18). These contaminated soils likely moved off-site to adjacent properties and to surface water and sediment of the 14th Avenue Ditch and eventually to Luxapallila Creek via surface water runoff and soil erosion. Constituents deposited in soil may also leach into groundwater. Specific source areas are discussed below.

4.1.1 Surface Impoundments

The two surface impoundments, located in the northwestern corner of the Main Plant, were used to store and dispose of creosote and PCP wastewater and sludge generated from wood treating operations (Ref. 5). One of the impoundments served as a small supplemental aeration and settling basin after most of the sludge settled from wastewater in the primary impoundment. Sludge, which settled at the bottom of the surface impoundments from carryover of creosote, was classified as EPA RCRA hazardous waste K001: “bottom sediment sludge from the treatment of wastewaters from wood preserving processes that use creosote and/or pentachlorophenol.” The primary constituent compounds of K001 waste include 2-chlorophenol; 2,4-dimethylphenol; p-chloro-m-cresol; PCP; phenol; 2,4,6-trichlorophenol; 2,3,4,6-tetrachlorophenol; 2,4-dinitrophenol; and PAHs, including acenaphthylene; benzo(a)anthracene; benzo(a)pyrene; benzo(b)fluoranthene; carbazole; dibenz(a,h)anthracene; fluoranthene; indeno(1,2,3-cd)pyrene; naphthalene; and phenanthrene (Ref. 4). These contaminants likely moved offsite to adjacent properties and to surface water and sediment in drainage ditches, and eventually to Luxapallila Creek via surface water runoff and soil erosion. Constituents deposited in soil also may have leached to groundwater.

4.1.2 Drip Pad

The drip pad (referred to as a drip track in some documents) was located in the southwestern portion of the Main Plant in front of the pressure cylinders (see Figure 2 in Appendix A). After treatment, the wood was dried and excess preservative (creosote and PCP) was allowed to drip onto bare soil (Ref. 4). In 1988, the facility installed a concrete drip pad (track) in this area to collect excess preservative that dripped off the treated wood after it was removed from the pressure cylinder. Before construction of the new drip pad (track), visibly contaminated soil from the area was excavated to a depth of 4 feet. Soil samples were collected from 6 inches below the base of the excavation. Contaminants detected in these samples included 2,4-dimethylphenol; p-chloro-m-cresol; PCP; phenol; 2,4,6-trichlorophenol; 2,3,4,6-tetrachlorophenol; acenaphthylene; benzo(a)anthracene; benzo(a)pyrene; fluoranthene; indeno(1,2,3-cd)pyrene; naphthalene; phenanthrene; and carbazole. The soil contamination left in place is considered a threat to groundwater through infiltration of precipitation and fluctuating groundwater elevations (Refs. 4, 5).

After 1988, wastewater and creosote that collected on the drip pad (track) flowed into a drain and a sump and was then pumped into an oil-water separator via underground pipes. It is not known whether these pipes were removed when the facility was decommissioned in 2003 (Refs. 4, 5). Contaminants likely moved off-site to adjacent properties and to surface water and sediment in drainage ditches, and eventually to Luxapallila Creek via surface water runoff and soil erosion. Constituents deposited in soil also may have leached to groundwater. Leaks in underground piping also may have occurred, which could have contributed to groundwater contamination.

4.1.3 Black Tie Storage Areas

After the wood was treated and excess preservative drained to the drip pad (track) area, the wood was loaded directly from the drip pad (track) area onto rail cars or trucks for shipment off-site or was stored on bare soil in the black tie storage yards located in the central portion and southeastern corner of the Main Plant to await shipment (see Figure 2 in Appendix A). This practice was used from 1928, when the facility was initially constructed, until 2003. Because treated wood was stored directly on the soil (before construction of the drip pad [track] in 1988), wood preservatives drained from the wood into the soil. During the 1988 visual site inspection (VSI), stains were observed on the soil beneath and surrounding the wood stored in the black tie storage areas. During recent site visits, black staining was also observed on the soil in the former black tie storage areas (Ref. 5). Contaminants likely moved off-site to adjacent properties and to surface water and sediment of drainage ditches, and eventually to Luxapallila Creek via surface water runoff and soil erosion. Constituents deposited in soil also may have leached to groundwater.

4.1.4 Oil Water Separators

While the facility was in operation, Kerr-McGee operated two oil-water separators to treat wastewater. The oil-water separators were located in the western portion of the Site and were part of the wastewater treatment system. The oil-water separators were partially below grade and open-topped for venting. Wastewater passed through the oil-water separators before discharge to the aeration and sedimentation impoundments (discussed in Section 4.1.1). Wastewater and creosote that collected in the drip pad (track) were also routed to the oil-water separators. Creosote recovered from the oil-water separator was recycled into the wood treating process. In 1988, staining was observed on the soil around one of the oil-water separators (Ref. 5).

During decommissioning of the Site, it is not known whether the oil-water separators were intact or if evidence of releases was observed (Ref. 4). Based on recent visits conducted in 2011 and 2012, the two oil-water separators are no longer present on the Main Plant. Therefore, the potential exists that releases to on-site soils and groundwater might have occurred from the oil-water separators before they were removed.

4.1.5 Holding Tanks

Numerous above- and below-ground holding tanks were located in the process area in the western portion of the Main Plant, some of which were located in a tank farm along the southwestern Main Plant boundary. The holding tanks (both above and below ground) were used for various purposes that included storage of the following: creosote product brought onto the property; creosote and PCP that were recycled from the drip pad (track) or oil-water separator; diesel fuel; and, non-contact cooling water. Some of the holding tanks were located within concrete-diked areas, while others were located directly on the ground surface. During the 1988 VSI, soil staining was observed in the vicinity of various holding tanks (Ref. 5). Holding tanks were not observed on the Main Plant during recent site visits; however, the potential exists that releases to on-site soils and groundwater might have occurred from the holding tanks before they were removed.

4.1.6 Underground Structures and Piping

Various underground structures including sumps, pits, and pipes were formerly located at the Main Plant. These structures primarily received creosote and wastewater from the drip pad (track), pressure cylinders, and oil-water separators. The sumps and pits received leaks and spills from the drip pad (track), pressure cylinders, tank car truck and unloading areas, and vapor tanks. Creosote and wastewater was then routed by the underground pipes to the oil-water separators, surface impoundments, or the rainwater tank. It is not known whether the integrity of these structures was compromised during operations. From 1970 to 1974, the drying agent xylene was allowed to drain onto the soil surrounding the vapor tank sump that was located in the process area (Ref. 5). Some indications of remaining underground structures are still visible at the Site, including covered pipe trenches and covered manholes in the former process area. Underground piping may have also leaked, which could have contributed to groundwater contamination.

4.1.7 Unlined Ditches

Surface water runoff across the Main Plant and Pine Yard flows via sheet flow and ditches into unlined drainage ditches located adjacent to the Main Plant. Kerr-McGee was authorized to discharge stormwater to drainage ditches at five outfall locations under NPDES Permit MSR20010. The permit required the facility to sample all stormwater outfalls annually for constituent releases to surface water from the drainage ditches. The Site permit specified for testing pH, oil and grease, total phenols, and total suspended solids. In addition, monthly visual inspections of drainage ditches and stormwater outfalls for oil sheens or other indicators of creosote (or other wood treating solution) releases to the environment were required. During the 1988 VSI, soil staining and dead vegetation were observed in the unlined drainage ditches. In 1993, analysis indicated that the stormwater discharge from the facility did not exceed the limits in the stormwater permit, thus indicating that creosote constituents were not leaching from the drainage ditches into the surface water (Ref. 4). Contaminants likely moved off-site to adjacent properties and to surface water and sediment in drainage ditches, and eventually to Luxapallila Creek via surface water runoff and soil erosion. Constituents deposited in soil also may have leached to groundwater.

4.2 SEDIMENT IN THE 14TH AVENUE DITCH

In 2007, the Agency for Toxic Substances and Disease Registry (ATSDR) conducted a public health assessment and concluded that children exposed to contaminated sediments in ditches near the facility may have increased risk of adverse health effects. ATSDR recommended collection of surface soil samples for analysis of dioxin and furan compounds and PAHs in residential yards near the 14th Avenue Ditch to better define the nature and extent of contamination (Ref. 19).

Contaminated sediments were identified during previous investigations and removal actions in stormwater ditches located north and east of the Site, as well as downgradient of the Site. In addition to sediment-bound PAH contaminants, the observed contamination included non-aqueous phase liquids (NAPL) at several locations. The contamination of the sediments is attributed to deposition of contaminated soil historically transported in surface water runoff from the former process area and the former black tie storage areas, which flowed into offsite drainage ditches, including the 14th Avenue Ditch, adjacent to the Site. These contaminated sediments may act as secondary sources of contamination to properties adjacent to the stormwater ditches during seasonal flooding and may act as a contaminant source through leaching of soluble constituents into groundwater.

During this interim RI, all sediment samples collected exceeded the EPA RSL for at least one site-specific preliminary COC. Specifically, the list below presents the sample that contained the highest concentrations of the SVOCs, the toxicity equivalent (TEQ) for dioxins and furans, and arsenic above their RSLs.

- 14AD-FA08-SD-A, benzo(a)anthracene at 4,910 micrograms per kilogram (µg/kg)
- 14AD-FA01-SD-A-DUP, benzo(a)pyrene at 2,900 µg/kg
- 14AD-FA01-SD-A-DUP, benzo(b)fluoranthene at 6,380 µg/kg
- 14AD-FA01-SD-A-DUP, benzo(k)fluoranthene at 2,220 µg/kg
- 14AD-FA01-SD-A-DUP, dibenzo(a,h)anthracene at 345J (estimated) µg/kg
- 14AD-FA01-SD-A-DUP, indeno(1,2,3-cd)pyrene at 1,150J µg/kg
- 14AD-FA01-SD-A, TEQ for dioxins and furans ND=0 at 279 picograms per gram (pg/g)
- 14AD-FA01-SD-A, TEQ for dioxins and furans ND=0.5 at 279 pg/g
- 14AD-FA16-SD-A, arsenic at 13.5 milligrams per kilogram (mg/kg)

Sampling locations, with results above RSLs, are depicted on Figure 6 in Appendix A. A complete summary of results for all sediment samples collected from the 14th Avenue Ditch is presented on Table 2 in Appendix B. This table identifies the RSL associated with each analytical parameter.

4.3 SOIL

In June 2008, EPA requested on-site soil samples be collected and analyzed for dioxins and furans. Ten surface soil samples collected from 0 to 1 foot bgs contained several polychlorinated dibenzo-dioxin (PCDD) and polychlorinated dibenzofuran (PCDF) congeners. Sample COL-SSB-04, collected from the black tie storage area located in the central portion of the Site, revealed a dioxin toxicity equivalent of 1,172 parts per trillion (Ref. 20).

In 2011, EPA conducted an additional removal site evaluation sampling, which resulted in an emergency response after creosote-contaminated soil was identified at the Maranatha Faith Center, located about 1,280 feet southeast of the Site. Excavation and disposal of creosote-contaminated soil occurred at three properties: Hunt Intermediate School, located about 750 feet southwest of the Site; 1009 Moss Street, located about 370 feet east of the Site; and the Maranatha Faith Center.

During this interim RI, contaminant levels were above EPA RSLs in the subsurface soil down to a depth of 2 feet below the bottom of the 14th Avenue Ditch. Contaminant levels were also above RSLs for all surface samples collected from the northern portion of the Site. Contaminant levels were also above RSLs for the subsurface soil samples collected from the northwestern half of the Site adjacent to the 14th Avenue Ditch, from North 26th Street westward (see Figures 9 and 10), and also from subsurface samples collected at the extreme northeastern corner of the Site. Contaminant levels were below RSLs for all site-specific preliminary COCs except for arsenic in subsurface soil samples collected on the northeastern half of the Site adjacent to the 14th Avenue Ditch; however, arsenic levels were below typical background levels for soils in Mississippi.

4.3.1 14th Avenue Ditch

Several SVOCs, the TEQ for dioxins and furans, and arsenic were detected above their RSLs in subsurface soil samples collected beneath the 14th Avenue Ditch. Subsurface sampling locations, with results above RSLs, are depicted on Figures 7 and 8 in Appendix A. Complete summaries of results for subsurface samples collected beneath the 14th Avenue Ditch are presented in Tables 3 and 4 in Appendix B. Each table identifies the RSL associated with each analytical parameter.

14th Avenue Ditch - Subsurface Soil Results (6 to 12 inches bsw-si)

All subsurface soil samples collected from 6 to 12 inches bsw-si exceeded the EPA RSL for at least one site-specific preliminary COC. Specifically, the list below presents the sample that contained the highest concentrations of the SVOCs, the TEQ for dioxins and furans, and arsenic above their RSLs.

- 14AD-FA01-SB-B, benzo(a)anthracene at 8,480 µg/kg
- 14AD-FA12-SB-B, benzo(a)pyrene at 9,640 µg/kg
- 14AD-FA12-SB-B, benzo(b)fluoranthene at 15,800 µg/kg
- 14AD-FA01-SB-B, benzo(k)fluoranthene at 3,770 µg/kg
- 14AD-FA12-SB-B, dibenzo(a,h)anthracene at 1,150J µg/kg
- 14AD-FA12-SB-B, indeno(1,2,3-cd)pyrene at 3,380J µg/kg
- 14AD-FA01-SB-B, TEQ for dioxins and furans ND=0 at 540 pg/g
- 14AD-FA01-SB-B, TEQ for dioxins and furans ND=0.5 at 541 pg/g
- 14AD-FA05-SB-B, arsenic at 10.7 mg/kg

Sampling locations, with results above RSLs, are depicted on Figure 7 in Appendix A. A complete summary of results for subsurface samples collected 6 to 12 inches below the 14th Avenue Ditch is presented in Table 3 in Appendix B. The table identifies the RSL associated with each analytical parameter.

14th Avenue Ditch - Subsurface Soil Results – Additional Analysis (6 to 12 inches bsw-si)

Subsurface soil sample 14AD-FA18-SB-B was selected as an additional soil sample for dioxins and furans analysis. It was collected farthest downstream in the 14th Avenue Ditch and its dioxins and furan results provides an idea of the extent, if any, that dioxins and furans constituents are migrating offsite. The list below presents the concentrations of the dioxins and furans TEQ detected in sample 14AD-FA18-SB-B above the RSL.

- 14AD-FA18-SB-B, TEQ for dioxins and furans ND=0 at 5.83 pg/g
- 14AD-FA18-SB-B, TEQ for dioxins and furans ND=0.5 at 11.1 pg/g

A complete summary of results for the additional dioxins and furans analysis for subsurface soil sample 14AD-FA18-SB-B is presented in Table 15 in Appendix B.

14th Avenue Ditch - Subsurface Soil Results (12 to 24 inches bsw-si)

All subsurface soil samples collected from 12 to 24 inches bsw-si exceeded the EPA RSL for at least one site-specific preliminary COC. Specifically, the list below presents the sample that contained the highest concentrations of the SVOCs, the TEQ for dioxins and furans, and arsenic above their RSLs.

- 14AD-FA01-SB-C, benzo(a)anthracene at 9,550J- µg/kg
- 14AD-FA01-SB-C, benzo(a)pyrene at 4,280J- µg/kg
- 14AD-FA01-SB-C, benzo(b)fluoranthene at 7,720J- µg/kg
- 14AD-FA01-SB-C, benzo(k)fluoranthene at 3,270J- µg/kg
- 14AD-FA01-SB-C, dibenzo(a,h)anthracene at 427J- µg/kg
- 14AD-FA12-SB-C, indeno(1,2,3-cd)pyrene at 1,280 µg/kg
- 14AD-FA01-SB-C, naphthalene at 19,200J- µg/kg
- 14AD-FA01-SB-C, TEQ for dioxins and furans ND=0 at 463 pg/g
- 14AD-FA01-SB-C, TEQ for dioxins and furans ND=0.5 at 477 pg/g
- 14AD-FA17-SB-C, arsenic at 9.59 mg/kg

Sampling locations, with results above RSLs, are depicted on Figure 8 in Appendix A. A complete summary of results for subsurface samples collected 12 to 24 inches below the 14th Avenue Ditch is presented in Table 4 in Appendix B. The table identifies the RSL associated with each analytical parameter.

14th Avenue Ditch - Subsurface Soil Results – Additional Analysis (12 to 24 inches bsw-si)

Subsurface soil samples 14AD-FA02-SB-C and 14AD-FA05-SB-C also were selected as soil samples for additional dioxins and furans analyses because the PAH results of these samples were below the EPA RSLs, and provide correlation data for samples with low levels of dioxins and furans. The list below presents the concentrations of the dioxins and furans TEQs detected in samples 14AD-FA02-SB-C and 14AD-FA05-SB-C above the RSL.

- 14AD-FA02-SB-C, TEQ for dioxins and furans ND=0.5 at 6.39 pg/g
- 14AD-FA05-SB-C, TEQ for dioxins and furans ND=0 at 40.7 pg/g
- 14AD-FA05-SB-C, TEQ for dioxins and furans ND=0.5 at 64 pg/g

A complete summary of analytical results for the additional dioxins and furans analyses for subsurface soil samples 14AD-FA02-SB-C and 14AD-FA05-SB-C is presented in Table 15 in Appendix B.

4.3.2 Northern Portion of the Site

Several SVOCs, the TEQ for dioxins and furans, and arsenic were detected above their respective RSLs in soil samples collected from the Site, south of the 14th Avenue Ditch. Sampling locations, with results above RSLs, are depicted on Figures 9, 10, and 11 in Appendix A. Complete summaries of results are presented in Tables 5, 6, and 7 in Appendix B. The tables identify the RSL associated with each analytical parameter.

Northern Portion of the Site - Surface Soil Results (0 to 6 inches bgs)

All surface soil samples collected from 0 to 6 inches bgs exceeded the EPA RSL for at least one site-specific preliminary COC. Specifically, the list below presents the sample that contained the highest concentrations of the SVOCs, the TEQ for dioxins and furans, and arsenic above their RSLs.

- 14AD-KM08-SS-A, benzo(a)anthracene at 74,300J µg/kg
- 14AD-KM08-SS-A, benzo(a)pyrene at 75,900J µg/kg
- 14AD-KM08-SS-A, benzo(b)fluoranthene at 180,000J µg/kg
- 14AD-KM04-SS-A, benzo(k)fluoranthene at 2,570 µg/kg
- 14AD-KM08-SS-A, dibenzo(a,h)anthracene at 19,000J µg/kg
- 14AD-KM08-SS-A, indeno(1,2,3-cd)pyrene at 57,100J µg/kg
- 14AD-KM08-SS-A-DUP, PCP at 8,570J µg/kg
- 14AD-KM04-SS-A, TEQ for dioxins and furans ND=0 at 138 pg/g
- 14AD-KM04-SS-A, TEQ for dioxins and furans ND=0.5 at 139 pg/g
- 14AD-KM08-SS-A-DUP, arsenic at 20.8 mg/kg

Sampling locations, with results above RSLs, are depicted on Figure 9 in Appendix A. A complete summary of results is presented in Table 5 in Appendix B. The table identifies the RSL associated with each analytical parameter.

Northern Portion of the Site - Subsurface Soil Results (3 to 3.5 feet bgs)

Sample 14AD-KM02-SB-D was collected from 3 to 3.5 feet bgs based on field screening results and olfactory observations that indicated potentially high creosote contamination was present. The following SVOCs and arsenic were detected above their RSLs.

- Benzo(a)anthracene was detected at 20,300 µg/kg
- Benzo(a)pyrene was detected at 18,200 µg/kg
- Benzo(b)fluoranthene was detected at 36,500 µg/kg
- Dibenzo(a,h)anthracene was detected at 3,050J µg/kg
- Indeno(1,2,3-cd)pyrene was detected at 11,500 µg/kg
- PCP was detected at 1,450J µg/kg
- Arsenic was detected at 4.56 mg/kg

The sampling location, with results above RSLs, is depicted on Figure 11 in Appendix A. A complete summary of results is presented in Table 7 in Appendix B. The table identifies the RSL associated with each analytical parameter.

Northern Portion of the Site - Subsurface Soil Results (5 to 6 feet bgs)

All subsurface soil samples collected from 5 to 6 feet bgs exceeded the EPA RSLs for at least one site-specific preliminary COC. Specifically, the list below presents the sample that contained the highest concentrations of the SVOCs and arsenic above their RSLs.

- 14AD-KM02-SB-B, benzo(a)anthracene at 473 µg/kg
- 14AD-KM02-SB-B, benzo(a)pyrene at 505 µg/kg
- 14AD-KM02-SB-B, benzo(b)fluoranthene at 812 µg/kg
- 14AD-KM02-SB-B, dibenzo(a,h)anthracene at 92.5J µg/kg
- 14AD-KM02-SB-B, indeno(1,2,3-cd)pyrene at 300J µg/kg
- 14AD-KM08-SB-B, arsenic at 1.74 mg/kg

Sampling locations, with results above RSLs, are depicted on Figure 10 in Appendix A. A complete summary of results is presented in Table 6 in Appendix B. The table identifies the RSL associated with each analytical parameter.

Northern Portion of the Site - Subsurface Soil Results (6 to 7 feet bgs)

Two subsurface soil samples collected from 6 to 7 feet bgs (14AD-KM04-SB-C and 14AD-KM05-SB-C) did not exceed the EPA RSL for any site-specific preliminary COC. All other samples from this interval exceeded the EPA RSL for at least one site-specific preliminary COC. Specifically, the list below presents the samples that contained the highest concentrations of benzo(a)pyrene and arsenic above their RSLs.

- 14AD-KM06-SB-C, benzo(a)pyrene at 21.0J µg/kg
- 14AD-KM02-SB-C, arsenic at 1.37 mg/kg

Sampling locations, with results above RSLs, are depicted on Figure 11 in Appendix A. A complete summary of results is presented in Table 7 in Appendix B. The table identifies the RSL associated with each analytical parameter.

4.3.3 Nearby Residential and Commercial Properties

Several SVOCs, the TEQ for dioxins and furans, and arsenic were detected above their RSLs in soil samples collected north of 14th Avenue. Sampling locations, with results above RSLs, are depicted on Figures 12, 13, and 14 in Appendix A. Complete summaries of results are presented in Tables 8, 9, and 10 in Appendix B. The tables identify the RSL associated with each analytical parameter.

Nearby Residential and Commercial Properties – Surface Soil Results (0 to 6 inches bgs)

All off-site surface soil samples collected from 0 to 6 inches bgs exceeded the EPA RSL for at least one site-specific preliminary COC. Specifically, the list below presents the sample that contained the highest concentrations of the SVOCs, dioxin and furan TEQ, and arsenic above their RSLs.

- 14AD-RP02-SS-A, benzo(a)anthracene at 199J µg/kg
- 14AD-RP02-SS-A, benzo(a)pyrene at 166J µg/kg
- 14AD-RP03-SS-A-DUP, benzo(b)fluoranthene at 245J µg/kg
- 14AD-RP02-SS-A, dibenzo(a,h)anthracene at 32.2J µg/kg
- 14AD-RP04-SS-A, TEQ for dioxins and furans ND=0 at 5.40 pg/g
- 14AD-RP04-SS-A, TEQ for dioxins and furans ND=0.5 at 5.45 pg/g
- 14AD-RP03-SS-A, arsenic at 2.66 mg/kg

Sampling locations, with results above RSLs, are depicted on Figure 12 in Appendix A. A complete summary of results is presented in Table 8 in Appendix B. The table identifies the RSL associated with each analytical parameter.

Nearby Residential and Commercial Properties – Subsurface Soil Results (5 to 6 feet bgs)

Three subsurface soil samples collected at off-site locations from 5 to 6 feet bgs (14AD-RP02-SB-B, 14AD-RP04-SB-B, and 14AD-RP05-SB-B) did not exceed the EPA RSL for any site-specific preliminary COC. All other samples from this interval exceeded the EPA RSL for at least one site-specific preliminary COC. Only arsenic was detected above its RSL, up to 5.31 mg/kg in sample 14AD-RP06-SB-B.

Sampling locations, with results above RSLs, are depicted on Figure 13 in Appendix A. A complete summary of results is presented in Table 9 in Appendix B. The table identifies the RSL associated with each analytical parameter.

Nearby Residential and Commercial Properties – Subsurface Soil Results (6 to 7 feet bgs)

One off-site subsurface soil sample (14AD-RP02-SB-C) collected from 6 to 7 feet bgs did not exceed the EPA RSL for any site-specific preliminary COC. All other samples from this interval exceeded the EPA RSL for at least one site-specific preliminary COC. Specifically, the list below presents the samples that contained the highest concentrations of benzo(a)pyrene and arsenic above their RSLs.

- 14AD-RP04-SB-C, benzo(a)pyrene at 20.3J µg/kg
- 14AD-RP06-SB-C, arsenic at 4.42 mg/kg

Sampling locations, with results above RSLs, are depicted on Figure 14 in Appendix A. A complete summary of results is presented in Table 10 in Appendix B. The table identifies the RSL associated with each analytical parameter.

4.4 FIELD ANALYSIS EVALUATION

Tetra Tech analyzed the soil and sediment samples collected from the 14th Avenue Ditch and on-site locations using portable field instruments and methods. These samples were analyzed for total PAHs by both immunoassay testing and UVF spectroscopy. Separate aliquots of the same samples (a total of 85) were also sent to GCAL for fixed-laboratory analysis. The sections below compare the field analyses results with the corresponding laboratory results.

4.4.1 Immunoassay Testing

The comparison of the total PAH laboratory results to the immunoassay field analysis results is presented on Table 11 in Appendix B. This field analysis technique required a large amount of time and effort to perform during actual field conditions. For this reason, no dilutions were performed for the 75 samples (out of the total of 85 samples) that produced concentrations above the calibration range for the test. Nine samples displayed no PAH detections in the laboratory results; however, none of the corresponding immunoassay results were non-detect. Furthermore, half of the corresponding immunoassay results were above the calibration range for the test, and two samples (14AD-KM05-SB-C and 14AD-KM07-SB-C), although not requiring dilution, were detected at a concentration approaching the upper end of the calibration range. Results above the calibration range cannot be accurately quantitated and are therefore considered estimates. It should be noted that most of the laboratory samples were not analyzed for the full list of 16 PAH compounds; however, similar correlations were observed for the eight samples that were submitted to the laboratory for full PAH analysis.

4.4.2 UVF Spectroscopy

The comparison of the total PAH laboratory results to the UVF spectroscopy field analysis results is presented in Table 12 in Appendix B. As discussed in Section 2.5, the UVF spectroscopy analysis was performed by KB Labs as a bench-scale analysis using a field portable instrument. This occurred as a result of a scheduling conflict. The instrument results were originally compared to a “Restek Calibration Standard” for creosote because this standard has historically most closely resembled the creosote formulations used in the United States. However, these results were reprocessed by QROS by comparing the chromatographs with a “United Kingdom Calibration Standard” because of the chromatographic shift observed during the sample analysis. Of the 84 samples reprocessed (no reprocessing was performed for sample 14AD-FA16-SB-B), all but three samples produced better correlation with the laboratory results for total PAHs using this standard, as indicated by the relative percent difference calculations presented in Table 12 in Appendix B.

Of the nine samples that displayed no PAH detections in the laboratory results, only two samples displayed detections using UVF spectroscopy. However, one result (for sample 14AD-KM04-SB-B) was detected at the lower reporting limit for the UVF analysis (0.1 parts per million [ppm]). Four additional samples were non-detect for the UVF analysis, but detected PAHs in the laboratory samples. However, in all but one of these four cases (for sample 14AD-KM03-SB-B), the laboratory detected concentration was below the RL for the UVF analysis. For sample 14AD-KM03-SB-B, the laboratory detected concentration was 0.148 ppm, which is very close to the associated reporting limit (RL). Therefore, the UVF analyses results correlate very well to the laboratory results for non-detects and for total PAH results near the UVF analysis RL of 0.1 ppm.

In addition to the total PAH results, the UVF spectroscopy analysis also provides results in carcinogenic benzo(a)pyrene equivalents (cBaP). A comparison of these cBaP results to the laboratory benzo(a)pyrene results is presented in Table 13 in Appendix B. Unlike the total PAH results comparisons, there is no clear advantage to using the “United Kingdom Calibration Standard” over the “Restek Calibration Standard” to improve correlation between cBaP and laboratory benzo(a)pyrene results.

Of the 14 samples that displayed no benzo(a)pyrene detections in the laboratory results, only two samples displayed cBaP detections using UVF spectroscopy. However, one result (for sample 14AD-FA02-SB-C) was detected at 0.07 ppm, which is near the RL for the UVF analysis (ranging from 0.01 to 0.06 ppm undiluted). Five additional samples were non-detect for the UVF analysis, but detected PAHs in the laboratory samples. However, in all but one of these five cases (for sample 14AD-KM03-SB-B), the laboratory detected concentration was below the RL for the UVF analysis. For sample 14AD-KM03-SB-B, the laboratory detected concentration was 0.0217 ppm, which is very close to the cBaP UVF analysis RL for that sample (0.02 ppm). Therefore, the UVF analyses results correlate very well to the laboratory results for benzo(a)pyrene non-detects and for cBaP results near the UVF analysis RL.

At concentrations above the RL for the UVF analysis, the correlation between UVF and laboratory analyses was not well defined. When UVF results indicated the presence of PAHs or cBaP, the respective laboratory results confirmed their presence. However, there was not a well-defined correlation at low, medium, or high concentrations. This indicates that field UVF analysis represents a useful tool to identify soil uncontaminated by PAHs, but will not be a reliable tool to determine concentrations of PAHs when detected.

4.5 GROUNDWATER

During the November 2011 groundwater monitoring event conducted to monitor the closed surface impoundments and the groundwater extraction and treatment system, groundwater samples collected from monitoring wells completed in the alluvial aquifer contained several PAHs and PCP above the groundwater protection standards (GPS), which are the MCLs or method detection limits (MDLs) if MCLs have not been established. For example, sample CMW36, located on the northwestern portion of the Site south of the 14th Avenue Ditch, contained acenaphthylene (61 micrograms per liter [µg/L]), benzo(a)anthracene (590 µg/L), benzo(a)pyrene (290 µg/L), naphthalene (190 µg/L), and phenanthrene (2,000 µg/L), among others (Ref. 21).

During this interim RI, groundwater samples collected from the three monitoring wells installed in the shallow aquifer on the north side of 14th Avenue did not contain any site-specific preliminary COCs above the EPA RSLs for tap water. However, one sample (14AD-RP04-GW) contained benzene above its RSL. This well was installed at the reported location of a former gas station (sampling location RP04) and was also downgradient of an existing gas station (near sampling location RP03) where visible contamination has been identified during sampling events. During the interim RI sampling activities, an oily sheen was observed in a drainage ditch emanating south of RP03, which is north of 14th Avenue. This drainage ditch flows south and converges with the 14th Avenue Ditch. In addition, used oil totes and surface staining were observed upgradient of sampling location RP03 (see Photographs 12 through 15 in Appendix C).

Analytical results for groundwater samples were compared with RSLs for tap water. Only one groundwater sample exceeded the EPA RSL for at least one site-specific preliminary COC. Specifically, the list below presents the sample that contained the highest concentrations of the VOC, SVOCs, and arsenic above the RSLs for tap water.

- 14AD-RP04-GW, benzene at 327 µg/L; sampling location RP04 was located southeast of Gardner's Superette (a gas station and convenience store)
- 14AD-RP04-GW, naphthalene at 26.5 µg/L
- 14AD-RP04-GW, arsenic at 6.90J µg/L

Monitoring well locations are depicted on Figure 4 in Appendix A. Monitoring well locations, with results above RSLs, are depicted on Figure 15 in Appendix A. A complete summary of results is presented in Table 14 in Appendix B. The table identifies the RSL associated with each analytical parameter.

4.6 SURFACE WATER

On September 26, 2012, four surface water samples, including a duplicate, were collected from the 14th Avenue Ditch (14AD-FA20-SW, 14AD-FA21-SW, 14AD-FA22-SW, and 14AD-FA22-SW-DUP). One surface water sample (14AD-FA19-SW) was collected from a ditch located north of 14th Avenue and was designated as the background surface water sampling location (see Figure 17 in Appendix A). The surface water samples were analyzed for VOCs, SVOCs, pesticides, PCBs, dioxins and furans, and metals.

All surface water samples exceeded a screening level (primary or secondary MCL or RSL for tapwater) for at least one site-specific preliminary COC. Specifically, the list below presents the sample that contained the highest concentrations of SVOCs and metals above their respective screening levels.

- 14AD-FA22-SW-DUP, 1,4-dioxane at 1.22J micrograms per liter (µg/L)
- 14AD-FA22-SW, benzo(b)fluoranthene at 0.119 µg/L
- 14AD-FA19-SW, aluminum at 429 µg/L

- 14AD-FA19-SW, iron at 2,400 µg/L
- 14AD-FA19-SW, manganese at 887 µg/L

Surface water sampling locations are depicted on Figure 17 in Appendix A. A complete summary of results for the surface water samples collected from the 14th Avenue Ditch is presented in Table 16 in Appendix B. This table identifies the RSL associated with each analytical parameter.

5.0 CONTAMINANT FATE AND TRANSPORT

5.1 POTENTIAL ROUTES OF MIGRATION

The primary release/transport mechanisms for the Site have been reviewed based on background information available about the Site. These mechanisms include dissolved-phase contamination of groundwater, NAPL contamination of groundwater and possibly surface water, suspension of contaminated sediments and transport to downstream locations, and leaching of contaminants from sediment to groundwater.

Exposure routes were evaluated for various human and biota receptors for three migration pathways: ingestion, inhalation, and dermal contact. Current and future human receptors applicable to the Site include residents, school children, construction workers, and utility workers. Environmental receptors applicable to the Site include both terrestrial (plants and animals) and aquatic biota (fish and aquatic plants).

The two surface impoundments, located in the northwestern corner of the Site, were used to store and dispose of creosote and PCP wastewater and sludge generated from wood treating operations (Ref. 5). Sludge, which settled at the bottom of the surface impoundments from the carryover of creosote, was classified as EPA RCRA hazardous waste K001: "bottom sediment sludge from the treatment of wastewaters from wood preserving processes that use creosote and/or pentachlorophenol." The primary constituent compounds of K001 waste include 2-chlorophenol; 2,4-dimethylphenol; p-chloro-m-cresol; PCP; phenol; 2,4,6-trichlorophenol; 2,3,4,6-tetrachlorophenol; 2,4-dinitrophenol; and PAHs including acenaphthylene; benzo(a)anthracene; benzo(a)pyrene; benzo(b)fluoranthene; carbazole; dibenz(a,h)anthracene; fluoranthene; indeno(1,2,3-cd)pyrene; naphthalene; and phenanthrene (Ref. 4).

Analytical results related to this sampling event revealed the presence of PAHs associated with wood treating operations including, benzo(a)anthracene; benzo(a)pyrene; benzo(b)fluoranthene;

benzo(k)fluoranthene; dibenz(a,h)anthracene; indeno(1,2,3-cd)pyrene; and naphthalene above their RSLs for residential soil. The TEQ for dioxins and furans is also directly related to wood treating processes and was identified to be above RSLs for residential soil. Benzene and arsenic were detected above their RSLs in groundwater during this sampling event. Benzene is not considered directly related to wood treating processes, and most of the elevated analytical results for arsenic were generally within naturally occurring levels for the area. Therefore, benzene and arsenic will not be discussed in the fate and transport subsections below. The fate and transport are properties of constituents related to wood treatment processes that were detected above the RSLs for residential soil are discussed separately in the following subsections.

5.1.1 POLYNUCLEAR AROMATIC HYDROCARBONS

According to ATSDR, hazardous waste sites such as abandoned wood-treatment plants (sources of creosote) can be a concentrated source of PAHs on a local scale. PAHs can enter surface water through atmospheric deposition and from discharges of industrial effluents from wood-treatment plants. Several of the PAHs have been detected at hazardous waste sites. PAHs are transported from surface waters by volatilization and sorption to settling particles. The compounds are transformed in surface waters by photooxidation, chemical oxidation, and microbial metabolism. In soil and sediments, microbial metabolism is the major process for degradation of PAHs. Although PAHs are accumulated in terrestrial and aquatic plants, fish, and invertebrates, many animals are able to metabolize and eliminate these compounds (Ref. 22).

The global movement of PAHs can be summarized as follows: PAHs released to the atmosphere are subject to short- and long-range transport and are removed by wet and dry deposition onto soil, water, and vegetation. In surface water, PAHs can volatilize, photolyze, oxidize, biodegrade, bind to suspended particles or sediments, or accumulate in aquatic organisms (with bioconcentration factors often in the 10 to 10,000 range). In sediments, PAHs can biodegrade or accumulate in aquatic organisms. PAHs in soil can volatilize, undergo abiotic degradation (photolysis and oxidation), biodegrade, or accumulate in plants. PAHs in soil can also enter groundwater and be transported within an aquifer. In general, PAHs have low water solubilities. Some of the transport and partitioning characteristics of PAHs are roughly correlated to their molecular weights (Ref. 22).

The most important processes contributing to the degradation of PAHs in water are photooxidation, chemical oxidation, and biodegradation by aquatic microorganisms. The contribution of the individual processes to the overall fate of a PAH will depend largely on the temperature, depth, pollution status, flow rate, and oxygen content of the water. As a result, a process that is a major loss/degradation process for a particular PAH in a certain surface water may not be so in another surface water with different water quality (Ref. 22).

Microbial metabolism is the major process for degradation of PAHs in soil and sediment environments. Photolysis, hydrolysis, and oxidation generally are not considered important processes for the degradation of PAHs in soils and sediments. The rate and extent of biodegradation of PAHs in soil are affected by a number of environmental factors, including: the organic content; structure and particle size of the soil; characteristics of the microbial population; the presence of contaminants such as metals and cyanides that are toxic to microorganisms; and the physical and chemical properties of the PAHs. The rate of biodegradation may be altered by the degree of contamination. Half-lives may be longer at hazardous waste sites because other contaminants at the site may be toxic to degrading microorganisms (Ref. 22).

5.1.2 PENTACHLOROPHENOL

According to ATSDR, PCP releases to surface water occur through direct discharge and direct entry from numerous nonpoint sources, including treated wood. PCP was most likely released to soils as a result of its past use in the wood treatment processes including leaching from treated wood products and spills. PCP released into the atmosphere from treated wood can be transported back to surface waters and soils via wet and dry deposition. Atmospheric PCP is transformed via photolysis; the compound may slowly undergo free radical oxidation with an estimated half-life of approximately 2 months. In surface waters, PCP undergoes biotransformation and photolysis and is adsorbed to sediments. Hydrolysis, oxidation, and volatilization do not significantly affect surface water concentrations. In soils and sediments, PCP is metabolized by acclimated microbes, under both aerobic and anaerobic conditions, or is adsorbed. PCP may also be methylated to form pentachloroanisole, a more lipid soluble compound. Adsorption of PCP in soils is pH dependent. The compound has a dissociation constant (pK_a) value of 4.7 and consequently exists in the ionic forms at environmentally relevant pH values. For example, at pH 4.7, PCP is 50 percent ionized, whereas at pH 6.7, the compound is about 99 percent ionized. Adsorption decreases in neutral and basic soils and is strongest in acidic soils. Therefore, the compound is most mobile in neutral-to-basic mineral soils and least mobile in acidic organic soils.

Volatilization and photolysis do not appear to be important transport and transformation processes for PCP in soils. The adsorption or mobility of PCP in soils is controlled primarily by soil pH. Photolysis of PCP on soil surfaces is not a major transformation process. The rate of PCP degradation from adsorption and metabolism in soil does not depend on soil texture, clay content, free iron oxides, or the degree of base saturation; however, it depends in part on the ion exchange capacity of the soil. Biodegradation is considered the major transformation mechanism for PCP in soil. Half-lives are usually on the order of 2 to 4 weeks. PCP is metabolized rapidly by most acclimated microorganisms. PCP has been observed to degrade more rapidly in anaerobic environments than in aerobic ones. Photolysis and biodegradation are believed to be the dominant transformation processes for PCP in aquatic systems. The molecular structure of PCP is indicative of its resistance to hydrolysis or oxidation. PCP is biotransformed in aqueous systems by acclimated microorganisms (Ref. 23).

5.1.3 DIOXINS/FURANS

Chlorinated dibenzo-p-dioxins (CDDs) and furans are produced by processes such as wood burning in wood treatment processes. According to ATSDR, combustion-generated CDDs may be transported long distances in the atmosphere. CDDS enter water by a number of different mechanisms, resulting in contamination of surface and groundwater. The migration of CDDs has also resulted in environmental contamination of sediment. They eventually may be deposited on soils or surface water as a result of wet or dry deposition. CDDs will slowly volatilize from the water column or, more likely, will adsorb to suspended particulate materials in the water column and be transported to the sediment. CDDs deposited on soils will strongly adsorb to organic matter. They are unlikely to leach to underlying groundwater, but may enter the atmosphere on soil or dust particles or enter surface water in runoff. Low water solubilities and high lipophilicity indicate that CDDs will bioconcentrate in aquatic organisms, although actual uptake by these organisms may be less than predicted as a result of their binding to suspended organic matter. Plant uptake and bioconcentration is similar to aquatic organisms, although foliar deposition and adherence may be significant (Ref. 24).

6.0 PRELIMINARY BASELINE RISK ASSESSMENT

Tetra Tech conducted a preliminary baseline risk assessment (PBRA) to determine whether contaminants within and surrounding the 14th Avenue Ditch pose a current or potential risk to human health and the environment in the absence of any remedial action. The PBRA was conducted consistent with EPA Risk Assessment Guidance for Superfund (RAGS), Volume 1: Human Health Evaluation Manual (Part A), Interim Final, EPA/540/1-89/002, December 1989, known as “RAGS” (Ref. 25). Tetra Tech identified contaminants, assessed exposure, assessed toxicity, and characterized the risk. The findings of this PBRA will be included in a site-wide baseline risk assessment (BRA) report that will be used to determine whether remediation will be necessary at the Site, provide justification for performing remedial action, and determine what exposure pathways must be remediated. A technical memorandum of remediation goals for the 14th Avenue Ditch sediments for the Site is presented in Appendix G. The sections that follow present PBRA results based on exposure to contaminants contained in sediments within the 14th Avenue Ditch. Exposure to contaminants in soil north and south of the 14th Avenue Ditch and groundwater will be presented in the site-wide BRA.

6.1 HUMAN HEALTH EVALUATION

The human health risk assessment (HHRA) conservatively characterizes risks to hypothetical human receptors potentially exposed to constituents detected in the sediment in the 14th Avenue Ditch adjacent to the Site. The objectives of the PBRA were as follows:

- Evaluate whether site-related constituents detected in sediment pose unacceptable risks to potential current and future human receptors under conditions at the time of the interim RI (unremediated conditions); and

- Provide information to support decisions concerning the need for further evaluation or action based on current and reasonably anticipated remedial actions.

Consistent with standard risk assessment practice and EPA guidance, this PBRA includes the following components:

- ***Data Evaluation and Selection of Constituents of Potential Concern (COPC):*** The analytical data used in the PBRA are summarized in this report. COPCs in environmental media are identified through comparisons of maximum detected concentrations to conservative, risk-based screening levels and, where relevant, background levels.

- ***Exposure Assessment:*** Current and reasonably anticipated future land use scenarios under which exposure to site-related constituents could occur are qualitatively discussed for the Site. For each land use scenario, a set of exposure assumptions is developed to quantitatively evaluate these scenarios by calculating current and future risks. Medium-specific exposure point concentrations (EPCs) are developed for each COPC in each human health exposure area, and conservative estimates of the intake of each COPC by each receptor through the selected pathways are calculated.

- ***Toxicity Assessment:*** The dose-response characteristics of carcinogens (including mutagens) and noncarcinogens are described and toxicity values for each COPC are presented.

- ***Risk Characterization:*** The information provided by the exposure and toxicity assessments for each receptor and exposure scenario is combined to yield quantitative risk estimates that characterize the relationship between hypothetical exposures and potential toxicity. Estimates for potential theoretical excess cancer risks and noncancer hazards are provided and discussed, both qualitatively and quantitatively. Uncertainties associated with the risk assessment are also discussed.

Although the PBRA follows and is consistent with EPA's risk assessment guidance discussed above, it does not present the results in the RAGS Part D format (Ref. 35).

6.1.1 HUMAN HEALTH CONCEPTUAL SITE MODEL

This section presents the conceptual site model (CSM) for human receptors at the Site. The human health CSM identify potentially complete exposure pathways by which receptors could come in contact with site-related constituents. The human health CSM is used throughout the Site investigation and remediation processes to: (1) provide a framework for addressing potential risks; (2) evaluate the need for additional data collection; and (3) evaluate health risks and the need for corrective measures.

As defined in RAGS Part A (Ref. 25), the following four elements are necessary to form a complete exposure pathway:

- A source or release from a source;
- A mechanism of release and transport;
- A point of contact for potential receptors; and
- An exposure route.

If any one of the four elements is missing, the exposure pathway is incomplete. In general, only potentially complete exposure pathways were evaluated in the PBRA.

As noted in Section 4.0, there is clearly a source of contamination – the sediment – and a mechanism of release and transport of this sediment within the 14th Avenue Ditch and downstream. The point of contact is assumed to be within the 14th Avenue Ditch, and there are several routes of exposure that may come into play at the Site. Although there is surface water in the 14th Avenue Ditch, it is not the focus of the interim RI and no current data are available to evaluate exposure via this pathway. Therefore, a surface water exposure route is not included in the HHRA. In addition, based on the saturated nature of the sediments, it is assumed that the sediment particles will not become airborne and therefore that the inhalation pathway is not a complete exposure pathway and is not included in the HHRA.

Potential receptors and exposure points. The 14th Avenue Ditch is located adjacent to 14th Avenue, a major thoroughfare in Columbus, and it is anticipated that current potential receptors are also limited because of its construction with vertical banks, and limited access; these are summarized below.

- ***Current and Future Trespasser:*** There is limited evidence that the local population routinely uses the 14th Avenue Ditch for any activities. However, it was assumed that trespassing occurs and that there is exposure to the 14th Avenue Ditch. Therefore, current trespassers could be exposed to site-related constituents in the 14th Avenue Ditch sediment.

- ***Future Construction Worker*:** The future on-site construction worker could be exposed to site-related constituents in sediment while performing short-duration construction related to possible Site remediation. Therefore, the future on-site construction worker could be exposed to site-related constituents in sediment.

Potential Exposure Routes. The exposure routes that were quantitatively evaluated are described below.

- ***Current and Future Trespasser:*** Current and future trespassers were assumed to be exposed via incidental ingestion of and dermal contact with sediment at the Site.

- ***Future Construction Worker:*** Future construction workers were assumed to be exposed via incidental ingestion of and dermal contact with sediment at the Site.

6.1.2 DATA EVALUATION AND SELECTION OF COPCs

The section presents the PBRA data sets, describes the approaches for data evaluation and screening, and presents the COPCs for the Site. Only analytical data collected during the interim RI were evaluated in the PBRA. These data are considered the most up-to-date available and provide reasonable coverage. It was conservatively assumed that conditions at the time of the interim RI (unremediated conditions) represent current and future conditions.

All sediment samples were analyzed for TAL metals, mercury, cyanide, and SVOCs (including PAHs), and a limited number of samples were analyzed for dioxins. A summary of the data has been presented in Section 4.2.

As a PBRA, the data were screened to identify the COPCs. The screening approach involved comparing the results from each sediment sample with the associated residential RSL (Ref. 12). This approach is conservative since the RSLs are based on a greater level of exposure than would be expected for the populations of concern at the Site – trespassers or construction workers. Both have limited exposure durations and frequency when compared with a resident. The data are presented in Tables 2, 3, and 4 in Appendix B. Based on the review of the data, the following constituents were identified in at least one sample at concentrations above the residential RSL for soils and are COPCs for the Site:

- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene

- Benzo(k)fluoranthene
- Dibenz(a,h)anthracene
- Indeno(1,2,3-cd)pyrene
- Dioxins and Furans
- Arsenic

6.1.3 EXPOSURE ASSESSMENT

Exposure assessment is the process of measuring or estimating the intensity, frequency, and duration of human exposure to a chemical in the environment. This section describes current and future land use assumptions, characterizes exposure factors for potential receptors, discusses the mechanisms by which these receptors might come in contact with COPCs in environmental media, and estimates the degree of contact between potential human receptors and COPCs. This information is integrated with EPC estimates and intake assumptions to quantitatively estimate exposure (dose). In accordance with EPA guidance, an exposure assessment consists of three basic steps (Ref. 25):

- Characterization of the exposure setting (physical environment and potential receptors)
- Identification of exposure pathways (constituent sources, exposure points, and exposure routes)
- Quantification of pathway-specific exposures (EPCs, calculation of receptor intakes, and exposure assumptions)

The first two components are described in detail in Sections 3.0 and 6.1.1 and diagrammatically presented in the human health CSM (Figure 16). The third component, quantification of pathway specific exposures, is described in the following subsections. Risks were estimated under a reasonable maximum exposure (RME) scenario. The RME is estimated by selecting values for exposure variables such that the combination of all variables results in the maximum exposure that can reasonably be expected to occur.

Exposure Point Concentrations. Two EPCs were calculated from the available sediment data to evaluate exposures to sediment: surface sediment and total sediment. Surface sediment data from the upper layer of sediment — 0 to 3 inches bsw-si — were assumed to represent the most likely sediment to be contacted under the current conditions. The total sediment EPC was calculated using the entire sediment profile – 0 to 24 inches bsw-si. This EPC represents the likely concentration to which very active trespassers and construction workers involved in Site remediation could likely be exposed. It is assumed that both the trespasser and construction worker will be exposed to sediments from various locations throughout the 14th Avenue Ditch. EPCs were calculated as the 95 percent upper confidence limit (UCL) on the mean using EPA's ProUCL Version 4.1.00 statistical software package (Ref. 26). The EPC was generally selected as the 95 percent UCL of the statistical method recommended by ProUCL; however, following EPA guidance (Refs. 26, 27), this value may be estimated by either a 95, 97.5, or 99 percent UCL, depending on the sample size, skewness, and degree of censorship. Statistical treatment was not conducted for constituents with less than eight detected results. In this circumstance, the maximum detected concentration was used as the EPC. A summary of the results is presented in Tables 1 and 2 in Appendix H.

EPA has identified seven carcinogenic PAHs as potential mutagens; these are benzo(a)anthracene, benzo(a)pyrene (BaP), benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene. Concentrations of these seven PAHs can be converted to an equivalent concentration of benzo(a)pyrene using a toxicity equivalency factor (TEFs) (Ref. 12). This approach was used to evaluate the potential exposures to PAHs in the sediment. The calculated EPC for these constituents were used to calculate a site-wide BaP TEF. Since benzo(k)fluoranthene and chrysene were analyzed in only a limited number of samples, the maximum value was used in the calculation. The calculation of the BaP equivalency (EQ) is presented in Table 3 in Appendix H.

For the dioxins and furans, the analytical data was reported for the individual components and also as the 2,3,7,8-TCDD TEF following the World Health Organization protocols (Ref. 28). Based on discussions with EPA Region 4 risk assessment staff, the TEF value used as the EPC was the value calculated using "0" for the nondetected samples.

Exposure Factors. Based on discussions with EPA risk assessment staff, it was decided that the receptors best representing the current exposures are trespassers (adolescent and adult) and construction workers. Below is a discussion of exposure factors for these receptors.

Current and Future Trespasser

Because the 14th Avenue Ditch is adjacent to 14th Avenue North, exposure to sediments in the 14th Avenue Ditch will be limited and is best represented by the trespasser scenario for the general public. The following text provides the rationale for the exposure factors for both adolescent and adult trespassers who may come in contact with the sediments in the 14th Avenue Ditch. Currently, the 14th Avenue Ditch is about 3 to 4 feet deep, has steep side walls, and usually contains water; therefore, the exposure assumptions likely overestimate actual exposures. Limited evidence (observation) indicates that trespassers are in the 14th Avenue Ditch on a regular basis. A fence runs along the 14th Avenue Ditch, which allows access to the 14th Avenue Ditch but limits access to the soils on the Site. Therefore, exposures to Site soils are not included in this exposure scenario.

Age-Adjusted Adolescent Trespasser Exposure Factors. Age-adjusted values are used to estimate exposure because the adolescent trespasser presumably will be a receptor 6 to 16 years old (Ref. 35). The age-adjusted adolescent trespasser sediment exposure factors are presented in Table 4 in Appendix H and are summarized as follows:

- The RME age-adjusted ingestion rate of soil ($IRSED_{adj}$) of 22.2 milligrams-year (mg-year)/kilogram-day (kg-day) is based on EPA (Ref. 29) exposure inputs for residents 6 to 16 years old and was calculated as follows:

$$IRSED_{adj} = \frac{ED_{6-16} \times (10\ years) \times IRSED_{adult}(\frac{100mg}{day})}{BW_{adolescent}(45kg)}$$

- EPA assumes that adolescents 6 to 16 years old are three times more susceptible to potential mutagenic effects. The RME mutagenic $IRSED_{adj}$ ($IRS[M]_{adj}$) of 66.6 mg-year/kg-day is based on EPA (Ref. 29) exposure inputs for residents 6 to 16 years old and was calculated as follows:

$$IRSED\ (M)_{adj} = \frac{ED_{6-16} \times (10\ years) \times IRSED_{adult}(\frac{100mg}{day}) \times 3}{BW_{adolescent}(45kg)}$$

- For adolescent trespassers, the RME fractional intake (FI) term of 0.125 was selected based on best professional judgment. The FI term assumes that a trespasser has 16 total hours of activity time per day and will spend 2 of these hours in the 14th Avenue Ditch.

- The RME age-adjusted dermal contact rate ($DFSED_{adj}$) of 109 mg-year/kg-day is based on EPA (Ref. 29) exposure inputs for residents 6 to 16 years old and was calculated as follows:

$$DFSED_{adj} = \frac{ED_{6-16} \times (10\ years) \times SA(1{,}640cm^2 \times AFSED_{adult}(0.3mg/cm^2)}{BW_{adolescent}(45kg)}$$

  The surface area (SA) value of 1,640 square centimeters (cm^2) represents the surface area of hands and feet (Ref. 30). The adherence factor for sediment (AFSED) of 0.3 milligrams per square centimeter (mg/cm^2) is the EPA (Ref. 30) value for reed gatherers.

- EPA assumes that adolescents 6 to 16 years old are three times more susceptible to potential mutagenic effects. The RME mutagenic $DFSED_{adj}$ ($DFSED[M]_{adj}$) of 328 mg-year/kg-day is based on EPA (Ref. 29) exposure inputs for residents 6 to 16 years old and was calculated as follows:

$$DFSED\ (M)_{adj} = \frac{ED_{6-16} \times (10\ years) \times SA(1{,}640cm^2 \times AFSED_{adult}(0.3mg/cm^2) \times 3}{BW_{adolescent}(45kg)}$$

- The RME exposure frequency (EF) of 65 days per year is based on best professional judgment and assumes an adult trespasser will visit the 14th Avenue Ditch 2 days per week during the summer (13 weeks) and 1 day per week during the remainder of the year (39 weeks).

- The adolescent trespasser ED is by default 10 years (6 to 16 years old).

- Consistent with EPA guidance (Ref.25), the averaging time for noncancer (AT_{nc}) is equal to the ED and corresponds to a value of 3,650 days for RME. The averaging time for cancer (AT_c) for both the RME scenarios represents an average 70-year lifetime and corresponds to 25,550 days.

Adult Trespasser Exposure Factors**.** The adult trespasser sediment exposure factors are presented in Table 5 in Appendix H and are summarized as follows:

- An RME IRSED of 100 mg/day was selected for the adult trespasser. This IRSED is the EPA default rate for an adult in an outdoor occupational exposure setting (Ref. 31) and was deemed representative of potential ingestion for the adult trespasser.

- For adult trespassers, the RME FI term of 0.125 was selected based on best professional judgment. The FI term assumes that a trespasser has 16 total hours of activity time per day and will spend 2 of these hours in the 14th Avenue Ditch.

- The RME AFSED of 0.3 mg/cm^2 is the EPA (Ref. 30) value for reed gatherers.

- The RME SA of 2,129 cm^2 is based on the average skin surface area for the hands and feet of adult males and females (Ref. 30).

- The RME exposure frequency (EF) of 65 days per year is based on best professional judgment and assumes an adult trespasser will visit the 14th Avenue Ditch 2 days per week during the summer (13 weeks) and 1 day per week during the remainder of the year (39 weeks).

- The exposure duration (ED) of 25 years is the EPA (Ref. 32) default RME values for residents.

- The RME body weight (BW) of 70 kg is the EPA (Ref. 25) default adult body weight.

- Consistent with EPA guidance (Ref. 25) AT_{nc} is equal to the ED and corresponds to a value of 10,950 days for the RME cases. The AT_c for the RME scenario represents an average 70-year lifetime and corresponds to 25,550 days.

Future Construction Worker Exposure Factors. The future construction worker exposure scenarios include potential exposure to sediments in the 14th Avenue Ditch. It is expected that exposure will take place during removal of the sediments from the 14th Avenue Ditch and replacement with fill material. Most of the assumptions used for the sediment exposure are consistent with exposure to surface soils. The parameters used to estimate potential exposure to chemicals in sediments are presented in Table 6 in Appendix H, and are summarized below.

- The RME IRSED of 330 mg/day is the EPA (Ref. 27) default value for a construction worker.

- It was conservatively assumed that construction worker would receive all of his or her daily incidentally ingested sediment from the 14th Avenue Ditch (FI = 1).

- The RME AFSED of 0.3 mg/cm^2 is the EPA (Ref. 30) soil default value for construction workers.

- The RME SA for contact with soil of 3,300 cm^2 is the EPA default value for outdoor workers; this value was applied for sediments as well. The default SA assumes that a worker wears pants and a short-sleeved shirt while engaging in on-site activities and is calculated as the 50th percentile surface area occupied by one-third of the head, the forearms, and the hands for the average male and female.

- Construction workers are assumed to be involved in short-duration redevelopment projects. For RME, construction workers were assumed to be present at the Site for 5 days a week during the course of an 8-week redevelopment project, which corresponds to an RME EF of 40 days per year.

- The RME ED of 1 year is based on professional judgment.

- The ET for the RME sediment/soil exposure scenario was assumed to be 8 hours per day, 40 hours per week over a period of 5 days.

- The construction worker BW of 70 kg is the EPA (Ref. 32) default value for adults.

- Consistent with the EPA guidance (Ref. 25), the AT_{nc} is equal to the length of the construction project and corresponds to a value of 56 days (8 weeks) for the RME scenario. The AT_c for the RME scenario represents an average 70-year lifetime and corresponds to 25,550 days.

6.1.4 TOXICITY ASSESSMENT

The toxicity assessment provides a description of the relationship between a dose of a chemical and the potential likelihood of an adverse health effect. The purpose of the toxicity assessment is to provide a quantitative estimate of the inherent toxicity of COPCs for use in risk characterization. In the context of the regulatory risk assessment process, potential effects of chemicals are separated into two categories: carcinogenic (cancer) and noncarcinogenic (noncancer) effects. This division relates to current EPA policy that the mechanisms of action for these endpoints are different. The EPA generally makes the conservative assumption that carcinogenic chemicals do not exhibit a response threshold[1] (Refs. 33, 34), while noncarcinogenic effects are universally recognized as threshold phenomena. However, chemicals that are believed to be carcinogenic may also be capable of producing noncancer health effects. Potential health risks for COPCs are evaluated for both carcinogenic and noncarcinogenic risk.

The risk assessment used the default toxicity values presented in the EPA RSL tables (Ref. 12). The default values were obtained from the following sources in the order in which they are presented below:

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[1] A threshold indicates that a minimum amount of drug or chemical agent is required to elicit an effect. For example, certain metals such as iron and selenium are toxic above a threshold dose but safe and, in fact, required dietary components at lower doses. For carcinogens, EPA assumes that no threshold exists and that there is some increased risk at every dose level.

- Integrated Risk Information System (IRIS) on-line database
- Provisional Peer Reviewed Toxicity Values (PPRTV) derived by EPA's Superfund Health Risk Technical Support Center for the EPA Superfund Program
- The ATSDR minimal risk levels (MRL)
- The California Environmental Protection Agency/Office of Environmental Health Hazard Assessment's toxicity values
- Screening toxicity values in appendices to certain PPRTV assessments
- The EPA Superfund Program's Health Effects Assessment Summary Tables (HEAST)

Toxicity values used in the HHRA are presented in Table 7 in Appendix H.

6.1.5 RISK CHARACTERIZATION

The risk characterization step estimated the potential excess lifetime cancer risk and calculates a hazard index (HI) to quantify the potential for adverse health effects other than cancer for human receptors that may be potentially exposed to COPCs at the Site. Risk was calculated using a sum of ratios approach. In this approach, cancer risk was estimated by taking the ratio of the EPC of detected chemicals in sediment to the risk-based criteria (RBC); the COPC-specific risks for each exposure pathway applicable to a trespasser or construction worker were then summed to estimate the cumulative risk associated with exposure to COPCs at the Site. The following equations were used in the calculations.

$$\text{Cancer Risk} = \sum \left[\frac{EPC_{COPC}}{Cancer\ RBC_{COPC}} \times 10^{-6} \right]_{pathway}$$

$$\text{Hazard Index} = \sum \left[\frac{EPC_{COPC}}{Noncancer\ RBC_{COPC}} \times 1 \right]_{pathway}$$

RBCs were developed for COPCs at the Site by "back calculating" from a target risk level or algebraically reversing risk equations to obtain a concentration term. The target risk level used in this HHRA was a cancer risk of 1x 10^{-6} and an HI of 1. RBCs for sediment exposure from ingestion and dermal contact were calculated using equations used by EPA in developing RSLs (Ref. 12). The exposure factors used in the calculations were those outlined in Section 6.1.3 and the toxicity factors were those noted in Section 6.1.4. The RBCs are presented in Table 8 in Appendix H.

Results

The following paragraphs present the risk results for the identified receptors and are summarized in Tables 9 and 10 in Appendix H.

Current and Future Adolescent Trespasser. The estimated risk for a potential adolescent trespasser who might be exposed to surface sediment at the Site was an excess cancer risk of 1 x 10^{-6} and an HI of 0.02. The cancer risk estimate was within the "risk management range" of 1 x 10^{-4} and 1x 10^{-6} provided by EPA as guidance on risk and exposure levels considered protective of human health (Ref. 25). An HI less than 1 indicates there is no concern for adverse noncancer health effects under the defined exposure conditions. The risk from sediment was driven by PAHs.

The estimated risk for a potential adolescent trespasser who might be exposed to full profile sediment column at the Site was an excess cancer risk of 2 x 10^{-6} and an HI of 0.1. The cancer risk estimate was within the risk management range of 1 x 10^{-4} and 1x 10^{-6} provided by EPA as guidance on risk and exposure levels considered protective of human health (Ref. 25). An HI less than 1 indicates there is no concern for adverse noncancer health effects under the defined exposure conditions. The risk from sediment was driven by PAHs.

Current and Future Adult Trespasser. The estimated risk for a potential adult trespasser who might be exposed to surface sediment in the 14th Avenue Ditch was an excess cancer risk of 2 x 10^{-6} and an HI of 0.005. The cancer risk estimate was within the risk management range of 1 x 10^{-4} and 1x 10^{-6} provided by EPA as guidance on risk and exposure levels considered protective of human health (Ref. 25). An HI less than 1 indicates there is no concern for adverse noncancer health effects under the defined exposure conditions. The risk from sediment was driven by PAHs.

The estimated risk for a potential adult trespasser who might be exposed to full profile sediment column in the 14th Avenue Ditch was an excess cancer risk of 3 x 10^{-6} and an HI of 0.1. The cancer risk estimate was within the risk management range of 1 x 10^{-4} and 1x 10^{-6} provided by EPA as guidance on risk and exposure levels considered protective of human health (Ref. 25). An HI less than 1 indicates there is no concern for adverse noncancer health effects under the defined exposure conditions. The risk from sediment was driven by PAHs and dioxins.

Future Adult Construction Worker. The estimated risk for a potential future construction worker who might be exposed to surface sediment in the 14th Avenue Ditch was an excess cancer risk of 3 x 10^{-7} and an HI of 0.08. The cancer risk estimate was less than EPA's 1x 10^{-6} point of departure and therefore considered insignificant (Ref. 25). An HI less than 1 indicates there is no concern for adverse noncancer health effects under the defined exposure conditions.

The estimated risk for a potential future construction worker who might be exposed to full profile sediment column in the 14th Avenue Ditch was an excess cancer risk of 8×10^{-7} and an HI of 0.7. The cancer risk estimate was less than EPA's 1×10^{-6} point of departure and therefore considered insignificant (Ref. 25). An HI less than 1 indicates there is no concern for adverse noncancer health effects under the defined exposure conditions.

6.2 ENVIRONMENTAL EVALUATION

The 14th Avenue Ditch is located between 14th Avenue and the Site and is an engineered structure with no bank features. The 14th Avenue Ditch is a stormwater conveyance ditch and, given its location and structure, is not considered an ecological habitat, and has not been evaluated for exposure to ecological receptors.

As discussed in Section 1.1, Purpose of Report, this Interim RI was conducted to collect data to assist with the City of Columbus 14th Avenue Ditch Improvement Project. The environmental actions that could involve the MST may include excavating contaminated soils from the area of the current 14th Avenue Ditch and from the area of the planned new ditch. The City of Columbus is expected to install the new ditch parallel to the current 14th Avenue Ditch. The new ditch will be located south of 14th Avenue and situated on a parcel of property that will have been conveyed to the City. The planned over-excavation of contaminated soil from the current and new14th Avenue Ditch areas, installation of a new concrete-lined structure, and sediment control measures on the Site to prevent the release of site-related contaminated sediments from entering the new ditch will mitigate exposure to contaminated soil and sediment discussed in the current and future exposure scenarios of the PBRA. As of January 31, 2013, the City of Columbus Ditch Improvement Project remains in the design phase. The MST will amend the Interim RI for the 14th Avenue Ditch to incorporate details regarding the Ditch Improvement Project as they become available.

7.0 SUMMARY AND CONCLUSIONS

7.1 SUMMARY

In July 2012, Tetra Tech conducted an interim RI in the anticipated vicinity of the City of Columbus 14th Avenue Ditch Improvement Project to assess environmental impacts from the Site on this area and assist MST, the Beneficiaries, and the City of Columbus in evaluating the extent of environmental remediation needed to safely conduct the City's 14th Avenue Ditch Improvement Project. Field activities conducted during the interim RI included:

- Performing a topographic survey of surface features on the Site and evaluating surface hydrology and stormwater flow patterns that affect the 14th Avenue Ditch.
- Collecting sediment samples from 19 locations at the bottom of the 14th Avenue Ditch to evaluate the nature and extent of contamination present.
- Collecting subsurface soil samples directly beneath the sediment sampling locations in the 14th Avenue Ditch to evaluate the extent of contamination in soils that will require excavation during the City's 14th Avenue Ditch Improvement Project.
- Collecting surface and subsurface soil samples at eight locations on the Site adjacent to the 14th Avenue Ditch to evaluate the extent of contamination in on-site soils that will require excavation during the City's 14th Avenue Ditch Improvement Project.
- Collecting surface and subsurface soil samples at six locations on the northern side of 14th Avenue for future use during the site-wide RI/FS.
- Installing and sampling three new groundwater monitoring wells on the northern side of 14th Avenue to evaluate the quality and flow direction of groundwater in this area, and
- Performing field analysis for PAHs on selected soil and sediment samples using immunoassay test kits and ultraviolet fluorescence spectrometry.

7.1.1 NATURE AND EXTENT OF CONTAMINATION

All sample results were compared to the residential RSLs for site-specific preliminary COCs to determine whether the materials they represented would require special handling and management during the City's 14th Avenue Ditch Improvement Project.

- Contaminant levels were above RSLs in all of the sediment samples collected from the 14th Avenue Ditch, as well as in samples collected from the subsurface soil to a depth of 2 feet below the bottom of the 14th Avenue Ditch.
- Contaminant levels were above RSLs for all surface soil samples collected in the northern portion of the Site.

- Contaminant levels were also above RSLs for the subsurface soil samples collected in the northwestern portion of the Site adjacent to the 14th Avenue Ditch from North 26th Street westward (see Figures 9 and 10 in Appendix A) and from subsurface soil samples collected at the extreme northeastern corner of the Site.

- Contaminant levels were below RSLs for all the site-specific preliminary COCs except for arsenic in subsurface soil samples collected on the eastern half of the Site adjacent to the 14th Avenue Ditch; however, arsenic levels were below typical background levels for soils in Mississippi.

- Groundwater on the northern side of 14th Avenue flows generally to the east and southeast toward 14th Avenue and the site. Only one groundwater sample collected from the three newly installed monitoring wells in this area contained any site-specific preliminary COCs above RSLs. This groundwater sample, collected at station RP04, contained benzene, naphthalene, and arsenic above RSLs. This well was installed at the reported location of a former gas station and was also downgradient of an existing gas station where visible contamination has been identified during sampling events. During the interim RI sampling activities, an oily sheen was observed in a drainage ditch emanating south of sampling location RP03, which is north of 14th Avenue. This drainage ditch flows south and converges with the 14th Avenue Ditch. In addition, used oil totes and surface staining were observed upgradient of sampling location RP03 (see Photographs 12 through 15 in Appendix C).

7.1.2 FATE AND TRANSPORT

Analytical results related to this sampling event revealed the presence of PAHs associated with wood treating operations including, benzo(a)anthracene; benzo(a)pyrene; benzo(b)fluoranthene; benzo(k)fluoranthene; dibenz(a,h)anthracene; indeno(1,2,3-cd)pyrene; and naphthalene above their RSLs for residential soil. The TEQ for dioxins and furans are also directly related to wood treating processes and was identified to be above their RSLs for residential soil. These constituents were likely transported to surface and subsurface soils as well as sediments. Naphthalene and dioxins and furans were also found to have been transported to groundwater.

7.1.3 RISK ASSESSMENT

The PBRA conducted for the interim RI was based on the environmental media from the sediment in the 14th Avenue Ditch adjacent to the Site. The COPC indicated eight constituents at concentrations above the RSL for residential soils benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, dioxins and furans, and arsenic. The exposure assessment used a toxicity equivalency factor of these eight constituents as calculated based on a reasonable maximum exposure scenario from sediment data (surface and total sediment) and based on the receptors best representing the current and future exposure population (adolescent and adult site trespassers and adult construction workers). Risk characterization was estimated using a sum or ratios approach.

The PBRA demonstrates that the environmental media in the 14th Avenue Ditch continues to be a low risk to human health for current and future adolescent and adult trespassers and construction workers who might be exposed to surface sediment. Potential risk to total sediment columns were higher, but still less than EPA's point of departure, and is therefore insignificant. However, any soil removed from the 14th Avenue Ditch will be reassessed using an industrial exposure scenario and could therefore pose a higher risk to future adult construction workers.

7.2 CONCLUSIONS

The following conclusions may be drawn from the results of the interim RI:

- Based on the presence of site-specific COCs above RSLs in sediment and subsurface soil to be excavated from the existing 14th Avenue Ditch, in surface soil samples collected from the northern portion of the Site, in subsurface soil samples collected from the northwestern portion of the Site adjacent to the 14th Avenue Ditch from North 26th Street westward, in subsurface soil samples collected at the extreme northeastern corner of the Site, and the results of the PRBA, management as contaminated material will be required.

- Because site-specific COCs were below RSLs (PAHs) or within typical background levels (arsenic), subsurface soil samples collected on the eastern half of the Site adjacent to the 14th Avenue Ditch do not require management as contaminated material and may be reused during construction of the new 14th Avenue Ditch if their geotechnical characteristics are acceptable.

- Groundwater sample 14AD-RP4-GW was the only groundwater sample that contained site-specific COCs above RSLs. The new well from which this sample was collected was installed in the vicinity of a former gas station and downgradient of an existing gas station where visible contamination had been observed during previous investigations. Groundwater on the north side of the 14th Avenue Ditch flows to the east and southeast toward 14th Avenue and the Site. Therefore, groundwater flowing into the 14th Avenue Ditch from the northern side of 14th Avenue is not impacted by conditions at the Site.

- Field UVF spectrometry analysis represents a useful screening tool to identify soil uncontaminated by PAHs, but does not appear to be as reliable for determining concentrations of PAHs when present.

- The length of time needed for immunoassay field analysis for PAHs combined with the need to dilute and re-run samples that contain even moderate PAH concentrations suggests that field immunoassay testing does not represent a feasible method for screening contaminated soil or soil samples for creosote constituents.

8.0 REFERENCES

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