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Revised Phase I Sampling and Analysis Work Plan

USEPA RCRA 3013(a)
Administrative Order
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Hattiesburg, Mississippi

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1. Introduction

Hercules Incorporated (Hercules) submits this Revised Phase I Sampling and Analysis Work Plan (Work Plan) pursuant to Paragraph 74 of the May 9, 2011, Administrative Order (the AO) issued by Region 4 of the United States Environmental Protection Agency (USEPA) and USEPA's August 25, 2011, "Review of Phase I Sampling and Analysis Work Plan dated July 14, 2011", August 30, 2011, "Review of Phase I Sampling and Analysis Work Plan, dated July 14, 2011", and December 9, 2011, "Approval of Phase I Work Plan" letters. This submittal addresses items discussed in previous conferences calls between the USEPA, Mississippi Department of Environmental Quality, and/or Hercules and items identified in the December 9, 2011, correspondence from USEPA. The AO was issued pursuant to Section 3013(a) of the Resource Conservation and Recovery Act (RCRA), 42 United States Code §6934(a), and is specific to Hercules' Hattiesburg, Mississippi, site (referred to as the "Site" or the "former Hercules Plant" herein). As discussed during the June 9, 2011, USEPA meeting in Atlanta, Georgia, and subsequent comments conference calls, components of the Phase II activities, as required in Paragraph 75 of the AO, are also addressed in this Work Plan. Specifically, a portion of the groundwater assessment identified as part of Phase II will be conducted under Phase I as required to properly assess the potential migration of Site-related constituents to off-site properties because this may affect the soil gas and indoor air. Additionally, it was agreed during the comments conference calls that many of the comments received on the Phase I Work Plan will be addressed in the Phase II Work Plan currently under development.

1.1 Purpose and Scope

The scope of the AO, and the activities required under the AO, including implementation of the Work Plan, is limited to assessing the presence, magnitude, extent, direction, and rate of movement of the constituents to be monitored under the AO (the "Constituents"). The Work Plan approach includes incorporating and utilizing existing sampling data previously collected as part of Site-related assessments conducted in the area by Hercules, USEPA, or the State of Mississippi (the State) that relate to the purposes of the AO, including assessments to characterize the source(s) of Constituents, characterize the potential pathways of migration of Constituents, define the degree and extent of the presence of any Constituents, and identify actual or potential human and/or ecological receptors. Detected Constituents will be investigated to determine the nature and extent of these Constituents relative to any identified or potential human or ecological receptors.

2. Background

The Hercules Hattiesburg facility began operations in 1923. Throughout the facility's history the operations consisted of extracting and/or working with rosins to produce rosin derivatives, paper chemicals, toxaphene, and Delnav, an agricultural insecticide (miticide). Structures at the Site included offices, a laboratory, a powerhouse, production buildings, a wastewater treatment plant, settling ponds, a landfill, and central loading and packaging areas. The plant began to reduce production in the 1980s. Process operations at the Site were shut down at the end of 2009. Many of the former plant buildings have been demolished. Hercules has had air, storm water, National Pollutant Discharge Elimination System, and State of Mississippi-issued Water Pollution Control (pre-treatment) permits that covered discharges from the Site when it was in operation. Hercules continues to conduct sampling and reporting activities associated with storm water and pre-treatment discharges.

As part of plant demolition and decommissioning activities, Hercules has been working with MDEQ to decommission the on-site wastewater treatment impoundment basin (IB) and is working with MDEQ to obtain approval of the August 2010 IB Decommissioning Work Plan (ARCADIS 2010) and supplemental information provided to MDEQ in January 2011.

Various environmental investigations have been conducted at the Hercules Site since the early 1980s. The work has included geophysical investigations and sampling of soil, groundwater, surface water (Greens Creek), and stream sediment for analysis of various constituents, including volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), metals, cyanide, dioxathion, and dioxenethion.

In 2005, after site investigations conducted under the MDEQ Voluntary Evaluation Program were approved, a Corrective Action Plan (2005 CAP, Groundwater & Environmental Services, Inc. 2005) was submitted to MDEQ. MDEQ approved the 2005 CAP, which called for a remedy that included monitored natural attenuation (MNA) with institutional controls. Additionally, Hercules and MDEQ established a Restricted Use Agreed Order (RUAO, No. 5349 07) in 2008 for management of the Site. The components of the 2005 CAP and RUAO are discussed further in Section 2.3. A monitoring program was implemented and controls were established to restrict the land use and activities on site. The monitoring program for groundwater and surface water is currently conducted on a semiannual basis and consists of water level gauging and analysis of select samples for VOCs (semiannually) and dioxathion/dioxenethion (annually).

2.1 Site Location

The Hercules Site is located on approximately 200 acres of land north of West Seventh Street in Hattiesburg, Forrest County, Mississippi (Figure 1). The Site is located in Township 4 North, Range 13 West, within Sections 4 and 5 just north of Hattiesburg, Mississippi. The geographic coordinates of the Site are 31° 20' 20" North latitude and 89° 18' 25" West longitude. The physical address of the Site is 613 West Seventh Street, Hattiesburg, Mississippi. Figure 2 presents a plan view of the Site depicting the physical layout of the Site.

The Site is bordered to the north by Highway 42, beyond which is the Illinois-Central & Gulf Railroad, as well as various residential and commercial properties. The southern property boundary is bordered by West Seventh Street and by Roseland Park cemetery and Zeon Chemical Corporation to the south-southwest. Across from these locations are residential areas. The eastern and western boundaries are bordered by residential and commercial areas.

The Site is zoned for industrial use and this zoning category is unlikely to change in the future due to the size of the property and available infrastructure, as well as the RUAO. Figure 3 shows the zoning categories for the parcels located in the vicinity of the Hercules Site.

2.2 Previous Investigations

Various investigations have been conducted at the Hercules Site since the early 1980s. The work has included geophysical investigations and sampling of soil, groundwater, surface water, and stream sediment for analysis of various constituents, including VOCs, SVOCs, pesticides, PCBs, metals, cyanide, dioxathion, and dioxenethion. The results of previous investigations are discussed in reports, which have been submitted to or developed by the MDEQ and/or USEPA. Summaries and findings of the non-routine groundwater monitoring reports are included below:

- *Preliminary Assessment,* Mississippi Bureau of Pollution Control, December 1989.

  A state preliminary assessment was completed in December 1989 and indicated two source areas which included approximately 38 acres of contaminated soil and a cluster of six unlined surface impoundments containing approximately 900,000 cubic

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feet of material. These quantities were defined using five sampling locations. Constituents such as acetone, benzene, toluene, methyl ethyl ketone (MEK), PCBs, cadmium, cobalt, lead, and mercury were identified in the soil and the surface impoundment contained arsenic, benzene, toluene, MEK, and heavy metals.

- *Site Inspection Report*, Black & Veatch (B&V) Waste Science and Technology Corp., April 1993 (commissioned by USEPA).

  In 1992, a site inspection, field investigation, and geophysical survey were conducted by B&V as a contractor for USEPA to collect information regarding potentially hazardous environmental conditions at the Site. The USEPA was concerned about potential releases to groundwater, surface water, soil, and air and the potential threats to human health and ecology. The geophysical survey program was initiated to identify sample locations and evaluate former areas where drums, sludge, boiler ash, and other process wastes were reportedly landfilled, land applied, or buried. Four sediment, two surface water, five surface soil, two subsurface soil, and three groundwater samples were collected from a number of strategic locations selected based on historical information, hydrological data, field observations, and geophysical survey results. All samples were analyzed for parameters in the Target Compound List (TCL) and Target Analyte List including organics, pesticides, PCBs, metals, and cyanide. Surface water sample results summarized in the 1993 B&V report indicated that arsenic and sodium concentrations exceeded background concentrations. The inorganics barium, copper, iron, magnesium, manganese, nickel, and zinc were detected at concentrations above background or the sample quantitation limit. No TCL organics were detected in sediment or surface water samples.

- *Work Plan for Well Installation,* Bonner Analytical Testing Company (BATCO), June 1997; *Installation, Sampling, and Analysis Report,* BATCO, December 1997; and *Quarterly Monitor Well Sampling Event Reports, BATCO, June 1998* through *October 1998.*

  BATCO prepared a report dated December 1, 1998, which presented results of four quarterly groundwater monitoring events conducted between December 1997 and December 1998. BATCO installed six shallow groundwater monitoring wells in December 1987. The wells were competed at depths between 10 and 20 feet below ground surface (ft bgs). The results of the four quarterly sampling events are summarized in the December 1, 1998, report and indicate no significant detections of the eight RCRA metals (low levels of metals were detected above the laboratory method detection limit [MDL] in various wells over the quarterly events, as well as several detections of the non-RCRA metals beryllium, nickel, copper, and zinc). Acetone was detected above the MDL twice in two different wells. MEK and isopropyl benzene were each detected once, and an aromatic hydrocarbon compound was tentatively identified in one well. An organophosphate compound was tentatively identified in all four sampling events in MW-4. In general, MW-4, located near the sludge pits, indicated low levels of metals and the organic compounds discussed above.

- *Site Investigation Work Plan, Eco-Systems, Inc. (Ec*o-Systems), February 1999.

  A site investigation was conducted in accordance with the *Site Investigation Work Plan* (Eco-Systems 1999) and additional comments from MDEQ in an approval letter dated April 5, 1999. The activities described in the work plan centered on efforts to determine whether dioxathion, the miticide contained in Delnav, was present in Site soil and groundwater. The investigation also included an evaluation of the groundwater flow regime and refinement of the Site hydrogeologic model.

  The scope of the 1999-2000 investigation included the installation of fourteen piezometers, five monitoring wells, and four staff gauges to provide hydrogeologic and groundwater quality information near the former dioxathion production areas and near the former wastewater sludge pits. Piezometers TP-1 through TP-14 were installed to evaluate groundwater flow conditions in the uppermost saturated interval beneath the Site. Monitoring Wells MW-7, MW-8, and MW-9 were installed to assess groundwater quality at points near the former Delnav production areas and Monitoring Wells MW-10 and MW-11 were installed to assess groundwater quality between the sludge disposal pits and Greens Creek.

  Prior to the sampling of the new and existing monitoring wells, questions arose regarding the analytical method for dioxathion and the quality of dioxathion for use as a laboratory standard. As a result, Hercules in conjunction with MDEQ's consultant Mississippi State University developed analytical protocols for soil and groundwater. These protocols were documented in the *Sampling and Analysis Protocol for Determination of Dioxathion in Water* (Hercules, 2002).

  Because the quality of available analytical standards was questionable, Hercules contracted with Sigma-Aldrich Chemicals to synthesize dioxathion standards. In August 2002, dioxathion of a suitable quality had been manufactured to be used as a laboratory standard and Hercules and MDEQ agreed to a laboratory protocol.

In October 2002, groundwater samples were collected from Wells MW-1, MW-4, MW-5, MW-8, MW-9, and MW-11 for analyses of dioxathion and dioxenethion by both BATCO and Mississippi State Chemical Laboratory to test the newly established protocol. Monitoring Wells MW-5 and MW-6 were also sampled for analysis of VOCs and SVOCs.

Isomers of dioxathion were detected in Wells MW-4, MW-5, MW-8, MW-9, and MW-11; however, no concentrations were detected at concentrations above the MDEQ Tier 1 Target Remediation Goals (TRGs). No VOCs or SVOCs were detected above the MDL in samples collected from MW-5 and MW-6. A complete summary of the sampling/analytical methods and results of the October 2002 sampling was provided in the *Site Investigation Report* (ESI 2003).

In December 2002, groundwater samples were collected for analysis of dioxathion (MW-1 through MW-11), VOCs (MW-4 and MW-7 through MW-11), and SVOCs (MW-7 through MW-11). Samples were analyzed by BATCO and a split sample for MW-11 was collected by MDEQ. Concentrations of dioxathion, dioxenethion, VOCs, and SVOCs were detected at various locations. Various VOCs were detected at concentrations exceeding the TRGs in Wells MW-4, MW-8, MW-9, and MW-11. No other constituents were detected at concentrations above the applicable TRG.

- *Interim Groundwater Monitoring Report,* Eco-Systems, January 2003; and *Site Investigation Report, Eco-Systems,* April 2003.

The *Interim Groundwater Monitoring Report (E*SI 2003) was submitted describing the results of this sampling and recommending confirmation sampling prior to completing the remaining activities outlined in the 1999 Work Plan. In response, the MDEQ issued a letter dated February 3, 2003 approving the proposed confirmation sampling and requesting completion of the work plan tasks. In addition, MDEQ requested submittal of a supplemental work plan for groundwater delineation and a geophysical survey. A summary of the December 2002 sampling was provided in the *Site Investigation Report* (ESI 2003).

On February 11, 2003, groundwater, surface water, and stream sediment samples were collected in accordance with the February 3, 2003, MDEQ request. Wells MW-4, MW-8, MW-9, and MW-11 were sampled for confirmation of the 2002 VOC results. In addition, surface water and sediment samples were collected from five locations (CM-1 through CM-5) in Greens Creek for analysis of dioxathion and

VOCs. Total organic carbon (TOC) and grain size analyses were also performed on sediment samples. Duplicate samples of surface water and sediment were collected by MDEQ at location CM-3.

VOCs were detected in groundwater at concentrations exceeding the TRGs in Wells MW-4, MW-8, MW-9, and MW-11. The sample collected from MW-8 had the highest reported VOC concentrations.

Various VOCs were detected in each of the samples collected from surface water locations CM-1 (upgradient) through CM-5. The greatest number of VOCs were detected in the surface water sample collected from CM-1 (the westernmost location), possibly indicating an upstream source for VOCs. Dioxathion was detected in surface water at CM-2 and dioxenethion was detected in surface water at CM-3, CM-4 and CM-5.

Various VOCs were detected in each of the samples collected from stream sediment locations CM-1 through CM-5. Similar to results for the surface water samples, the greatest number of VOCs were detected in the sediment sample collected from CM-1 (upgradient). Dioxathion was detected in sediment at CM-1, CM-3, and CM-5. TOC was reported in sediment samples at concentrations ranging between 2 and 7 parts per million (ppm). The sample collected from CM-3 showed primarily silt and clay and the samples collected from CM-4 and CM-5 showed primarily sand and gravel.

A summary of the sampling/analytical methods and results of the February 2003 sampling was provided in the *Site Investigation Report* (ESI 2003).

- *Work Plan for Supplemental Site Investigation,* Eco-Systems, June 2003; and *Supplemental Site Investigation Report, Eco-Sy*stems, November 2003.

  A supplemental site investigation was conducted in accordance with the *Work Plan for Supplemental Site Investigation* (ESI June 2003) approved by MDEQ in a letter dated July 11, 2003. The supplemental work plan was prepared at the request of MDEQ to delineate the lateral and vertical extent of constituents of concern (COCs) in groundwater, collect hydrogeologic information, conduct a geophysical investigation to delineate the lateral boundaries of the waste in the former landfill and locate accumulations of buried metal in the landfill and in a potential burial area identified in the western portion of the Site, conduct single-well response tests to provide hydraulic conductivity estimates, and collect surface water and stream

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sediment from Greens Creek to evaluate locations upstream from previous sampling locations.

To obtain the required data, Hercules advanced eighteen Geoprobe® borings (GP-1 through GP-18) to define the lateral and vertical extent of VOCs in groundwater and to investigate groundwater quality in the vicinity of select piezometers, collected groundwater samples from permanent Monitoring Wells MW-1, MW-4, MW-10, and MW-11 for analysis of VOCs and dioxathion, conducted a geophysical investigation using ground conductivity and magnetic intensity methods at two areas of the Site (former landfill area and small grid area located west of the main plant), and collected surface water samples from two locations (upstream location CM-0 and previous location CM-1) and a stream sediment sample from one location (upstream location CM-0).

The results of the above activities provided a summary of known conditions in the area and further defined the extent of on-site areas.

- *Hattiesburg, Mississippi, Investigations, MDEQ*, April 2004.

As part of a response to requests by the public, in April 2004, MDEQ conducted a sampling event in the drainage pathways discharging from the Hercules facility. Four sediment samples (two from Greens Creek and two from the former "Hercules Ditch") and three surface water samples (two from Greens Creek and one from the former "Hercules Ditch") were collected and analyzed for VOCs, SVOCs, pesticides/PCBs, metals, and dioxathion. Samples collected from locations S-1 and S-2 were collected from Greens Creek across Highway 42 from the facility. Samples collected from locations S-3 and S-4 were collected downgradient of an on-site process water storage tank (Tank ET-10, referred to in the memo as the "NPDES tank"). No surface water was collected from location S-3 because it was dry.

Concentrations of toluene below the MDEQ TRGs were detected in soil collected at locations S-3 and S-4. No other constituents were detected in soil and no constituents were detected in surface water. While some trace concentrations of target analytes were detected, the report concluded that "the results of these samples did not detect any compounds above MDEQ's target remediation goal levels."

- *Remedial Action Evaluation,* Eco-Systems, July 2004; *and Corrective Action Plan Revision 01,* Groundwater & En*vironmental Services, Inc., January* 2005.

  A Remedial Action Evaluation was prepared to evaluate and recommend remedial alternatives for the following areas: Sludge Pits, Landfill, Greens Creek, and Groundwater. Each of the remedial alternatives were evaluated with respect to the protection of human health and the environment and based on the following criteria: long-term effectiveness; potential to reduce mobility, toxicity, or volume; short term effectiveness; implementability; and cost efficiency.

  The following conclusions were presented for each evaluated area:

  - Sludge Pits: sludge does not pose a significant risk to human health and the environment; potential direct exposure risk for site workers and wildlife; potential indirect exposure risk resulting from leaching and natural weather events overflowing the pit berms;

  - Landfill: no current risk to human health and the environment; future land use changes could expose landfill materials and/or mobilize constituents from the landfill into the groundwater or nearby surface water;

  - Groundwater: VOCs present in on-site groundwater at concentrations above TRGs; no VOCs above TRGs in off-site groundwater; and

  - Greens Creek: surface water and sediment containing VOCs and dioxathion do not pose a significant risk to human health and the environment; the results from samples collected upstream of Hercules property may indicate an off-site source.

  In the final revised CAP (GES 2005), the primary components of the proposed remedial alternatives consisted of groundwater and surface monitoring networks, deed restrictions, and fencing as summarized below for each evaluated area:

  - Sludge Pits: MNA combined with institutional controls/deed restrictions to restrict current/future land use and ensure that contaminated groundwater does not migrate from the sludge pits at unacceptable levels.

- Landfill: MNA combined with deed restrictions to restrict future land use and ensure that contaminated groundwater does not migrate from the landfill at unacceptable levels.

- Groundwater: MNA combined with deed restrictions to restrict future land use in the area of groundwater containing VOCs in excess of TRGs and to ensure that contaminated groundwater does not migrate from the Site at unacceptable levels.

- Greens Creek: MNA combined with institutional controls/deed restrictions to restrict current/future land use of Greens Creek to ensure that contaminated water does not migrate at unacceptable levels from Greens Creek.

The CAP also called for contingency plans for specific units, if groundwater monitoring indicated a potential release. These contingency plans included such actions as installation of an engineered cap, installation of a horizontal barrier, or implementation of in-situ chemical oxidation. To date, groundwater monitoring results have not indicated a need to implement the contingency plan for any unit.

- *Memorandum, Sludge Sample Analyses, Hattiesburg, Mississippi,* Eco-Systems, October 2008.

  In 2008, Hercules conducted sludge characterization sampling as part of plans to decommission the IB. The initial sampling event conducted on July 1, 2008, included collection of composite samples from the west end of the IB (SS-1), east end of the IB (SS-2) and from the wastewater holding tank (SS-3). Individual sample aliquots were collected from various locations via hand auger and combined in the field to produce composite samples. Prior to collection, each aliquot location was vertically mixed to the extent practicable by advancing and extracting the hand auger from the surface to the limit of the auger rods. Samples were submitted for toxicity characteristic leaching procedure (TCLP) analysis of VOCs, SVOCs, pesticides, PCBs, herbicides, and metals, and also for reactive cyanide, reactive sulfide, pH, and percent solids. Based on the results of this initial sampling, two additional events were conducted to confirm and further characterize sludge at the west end of the IB, where a TCLP benzene concentration (1.3 milligrams per liter [mg/L]) was detected above TCLP limits (0.5 mg/L) in SS-1.

On July 30, 2008, one composite sludge sample (SS-1-073008) was collected to confirm the benzene concentrations detected in SS-1 during the July 1st sampling event. The confirmation sample was collected following the same procedures and from the same general aliquot locations as was completed for the original sample SS-1. Samples were analyzed for TCLP-VOCs by TestAmerica and BATCO. One benzene result (0.586 mg/L) was detected above the TCLP limit in the confirmation sample analyzed by BATCO while the result of the TestAmerica analysis (0.44 mg/L) was below the TCLP limit.

In September 2008, a third sludge sampling event was conducted to investigate whether a potential localized source area for VOCs existed within the western end of the IB. Six discrete soil samples (SS-5 through SS-10) were collected and analyzed for VOCs by TCLP. Three of the samples contained concentrations of benzene below the TCLP limit, while the other three samples (SS-5 at 5.5 mg/L, SS-6 at 3.2 mg/L, and SS-8 at 3.2 mg/L) contained concentrations of benzene above the TCLP limit.

- *Groundwater Assessment Report*, Eco-Systems, November 2009.

  Hercules submitted a work plan to MDEQ in July 2009 to evaluate groundwater conditions near the IB. The work plan outlined the locations and procedures for the installation and sampling of five monitoring wells. MDEQ approved the work plan with revisions in a letter dated July 22, 2009. On September 15-16, 2009, five soil borings were advanced near the IB. Each boring was converted to a monitoring well (MW-20 through MW-24). Groundwater samples were collected from each monitoring well and analyzed for VOCs, SVOCs, pesticides, PCBs, metals, and Delnav. The analytical results were compared to TRGs. Concentrations of VOCs and SVOCs were reported above the TRGs. Pesticides, PCBs, metals, and Delnav groundwater concentrations were reported below TRGs for each of these analyses. Based on the VOC and SVOC results, Wells MW-20 through MW-24 were included in routine groundwater sampling events in 2010.

- *Sludge Characterization and Bench Scale Treatability Work Plan*, ARCADIS, March 2010; *Sludge Characterization and Bench Scale Treatability Report,* ARCADIS, August 2010; *and Response to Sludge Characterization and Bench Scale Treatability Report*, ARCADIS, January 2011.

  The focus of this investigation was to collect data necessary to assess potential options for managing the sludge contained in the IB.

Hercules is currently working with MDEQ toward the approval of a decommissioning plan to remove and properly dispose of the sludge.

- USEPA Sludge Pit Sampling (2010)

  In September 2010, at the request of MDEQ, representatives of the Science and Ecosystem Support Division (SESD) conducted a sampling investigation at the on-site sludge disposal area. Between September 28-29, 2010, SESD representatives collected 13 subsurface waste samples (HERC01 through HERC13) ranging from depths between 0 and 7 ft bgs. Twelve of the locations were collected from the Sludge Pit area (referred to in the SESD report as the "back forty" area). These samples were collected from various areas within the Sludge Pit which are delineated by berms and represent areas where the facility placed sludge at different times. One sample (HERC08) was collected from a lined pond referred to in the SESD report as the "wetlands" area. Samples were collected based on visual observations and results from field screening conducted with a Thermo Toxic Vapor Analyzer 1000B. Samples were analyzed by the SESD laboratory for total VOCs, SVOCs, metals, and/or toxicity characteristics.

  Various VOCs, SVOCs, and metals were detected in the sludge samples. USEPA compared the analytical data to the TRGs for unrestricted soil use and the USEPA Regional Screening Levels (RSLs). Benzene (10 samples), ethylbenzene (1 sample), isopropylbenzene (1 sample), toluene (11 samples), 1,1'-biphenyl (1 samples), naphthalene (7 samples), arsenic (4 samples), Chromium VI (13 samples), and vanadium (9 samples) exceeded the MDEQ TRGs and/or residential USEPA RSLs.

  USEPA analyzed samples with detected total analyte concentrations by the TCLP method. Benzene was above the TCLP regulatory limit of 0.5 mg/L in six of the samples. No other VOCs, SVOCs, or metals failed the TCLP limits or exceeded USEPA or MDEQ regulatory levels. A summary of the investigation activities and analytical results was provided in the *Field Investigation Report* (SESD 2011).

As demonstrated by the chronology of reports presented above, Hercules has worked with MDEQ for more than 20 years to understand the environmental conditions at the Site. Figure 4 is a composite map that shows the location where previous sampling was conducted at the Site. Based on the mutual understanding of Site conditions (i.e., the delineation of impacted areas, an understanding of groundwater flow regimes, exposure pathways), in 2005 MDEQ and Hercules began formalized corrective action and ongoing management activities in a RUAO. Since the implementation of the RUAO, Hercules and MDEQ continued to work together to address environmental issues at the Site not covered by the RUAO.

2.3 Corrective Action Plan and Restrictive Use Agreed Order

The 2005 CAP (Groundwater & Environmental Services, Inc. 2005) summarized the findings of the Site investigations between 1999 and 2003 as follows:

- Delineation of the lateral limits of the Landfill based on geophysical investigation;
- Detection of VOCs in groundwater at concentrations above MDEQ TRGs near the Landfill and other areas of the Site related to industrial operations;
- Presence of VOCs and dioxathion at concentrations less than TRGs in surface water and sediment samples collected from Greens Creek with some indication of upstream off-site sources;
- Presence of VOCs and dioxathion in one of three groundwater monitoring wells located hydraulically downgradient of the sludge pits; and
- No migration of VOCs or dioxathion onto off-site properties via groundwater or surface water.

Additionally, the 2005 CAP presented the following conclusions:

- Sources, source area COC concentrations, and vertical and horizontal extent of groundwater containing COC were defined sufficiently for remedial planning purposes;
- The existing data do not indicate that the Site poses a significant threat to human health and the environment in its current use as a chemical production facility; and
- If changes in land use occur or additional information is obtained, the current risk scenario for the Site could also change.

Based on an evaluation of the data obtained during the previous site investigations, a remedy consisting of MNA and institutional controls was proposed in the 2005 CAP to address the environmental conditions at the Site. In 2005, MDEQ approved the implementation of MNA of groundwater and surface water and institutional controls as proposed in the 2005 CAP. In January 2008, Hercules also entered into a RUAO with MDEQ to restrict the land use and activities on site while constituents in site-wide groundwater attenuate. In conjunction with the RUAO, Hercules executed a Notice of Land Use Restrictions documenting that soil and groundwater contained benzene, chlorobenzene, carbon tetrachloride, chloroform, 1,1,2-dichloroethane, and toluene in excess of MDEQ's TRGs. As a result, the following restrictions were placed on the property:

- There shall be no excavating, drilling, or other activities that could create exposure to contaminated media without approval from MDEQ;
- The groundwater at the Site shall not be used, unless otherwise approved by MDEQ;
- Monitoring wells shall be protected and maintained. In the event that a monitoring well is destroyed or damaged or is no longer needed, a plan for repair, reinstallation or abandonment of the well(s) must be submitted to MDEQ for approval; and
- No wells shall be installed without prior approval from MDEQ.

MDEQ indicated in the RUAO that, "…once the requirements of it have been completed that (1) the Site will be protective of the public health and the environment; and (2) no further corrective action will be required at this time."

The Site has been operated in accordance with the 2005 CAP and RUAO since 2007. Compliance with the RUAO has consisted of routine groundwater sampling and reporting. Since 2007, Hercules has conducted groundwater sampling and submitted routine groundwater monitoring reports to MDEQ in accordance with the RUAO. To date, COC concentrations have not increased at the Site to warrant implementation of contingency plans (capping of the Sludge Pits and/or Landfill) called for in the Remedial Action Plan.

An on-site well network was installed to monitor areas of impacted groundwater identified prior to implementation of the RUAO. Since the implementation of the sampling required by the RUAO, additional wells have been added to the monitoring well network and included in routine sampling events. The most recent additions to the well network are Monitoring Wells MW-20 through MW-24. These wells were installed at the request of MDEQ in the vicinity of the IB. The current configuration of the monitoring network is shown on Figure 5.

Groundwater monitoring data for VOCs and/or dioxathion generated during routine sampling events are submitted to MDEQ. The most recent data submitted to MDEQ to comply with the RUAO, which did not include dioxathion sampling, were developed using samples analyzed in July 2011. These sampling data are included in Table 1. In addition to the prescribed VOC compounds, groundwater samples from selected wells were submitted to accredited analytical laboratories for Appendix IX VOCs, SVOCs, pesticides, herbicides, PCBs, dioxins, furans, metals, sulfide, and cyanide from the July 2011 sampling. These data are also included in Table 1. With the exception of Wells MW-19 and MW-23, exceedances of MDEQ Tier 1 TRGs for groundwater have not been detected in monitoring wells adjacent to Site boundaries. Evaluation of off-site groundwater concentrations in the vicinity of Wells MW-19 and MW-23 will be conducted during the implementation of this Work Plan and is further described in Sections 6.3 (Groundwater) and 6.6 (Soil Gas). Additional on-site groundwater sampling activities will be conducted during the implementation of the Phase II Work Plan required by the AO, which is being submitted under a separate cover.

In addition to the groundwater sampling, the RUAO requires the collection and analysis of surface water samples from Greens Creek during routine monitoring events. Surface water sample CM-00 is collected from surface water entering the Site from Greens Creek. Surface water samples CM-01 through CM-05 are collected downgradient from sample CM-00 in sequential order. The CM-05 sample represents the surface water from Greens Creek as it exits from the Site. These data are presented in Table 2. A review of the surface water data indicates that sporadic detections of COCs have been observed in Greens Creek. COC concentrations in surface water exiting the Site have been less than Tier 1 TRGs since 2005. Evaluation of upstream and downstream surface water concentrations in Greens Creek, other surface water drainage features that exit the Site, and the covered City ditch shown as Drainage C on Figure 6 will be conducted during the implementation of this Work Plan and is further described in Section 6.2 (Surface Water and Sediment). Additional on-site groundwater, soil, surface water, and sediment sampling activities will be conducted during the implementation of the Phase II Work Plan required by the AO.

3. Preliminary Conceptual Site Model

The regional geology, Site-specific geology, known physical characteristics of the Site, and observations made of the community near the Hercules Site were composited into a graphical conceptual site model (CSM) (Figure 7). The graphic CSM highlights potential areas of release (former production operations, wastewater IB, landfill, sludge pits), impacted media, transport mechanisms, and exposure pathways specific to the Site. As shown on the CSM, soil, groundwater, surface water, sediment, and soil gas to indoor air pathways potentially exist at the Site, and, therefore, will be the focus of the data collection efforts of this Phase I Investigation. Additional detail related to the development and use of the CSM to investigate conditions at the Site is provided in the subsections below. Data collected during subsequent phases of investigation will be used to refine and update the CSM so that a better understanding of the nature of impacts, migration pathways, and potential receptors can be constructed.

3.1 Regional Hydrology

The Site is located within the Pine Hills physiographic region of the Coastal Plain physiographic province (Foster 1941). The topography of the region is characterized by a maturely dissected plain which slopes generally to the southeast. The topography is dominated by the valleys of the Bouie and Leaf Rivers coupled with the nearly flat or gently rolling bordering terrace uplands.

The geologic formations beneath the Site are as follows (in descending order):

- Pleistocene alluvial and terrace deposits;
- The Miocene-aged Hattiesburg and Catahoula Sandstone formations;
- The Oligocene-aged Baynes Hammock Sand and Chickasawhay Limestone formations; and
- The Oligocene-aged Bucatunna Clay member of the Byron formation of the Vicksburg group.

The recent-aged alluvial and terrace deposits consist of gravel, silts, and clays. The thicknesses of the alluvial and terrace deposits are variable due to erosion. Based upon driller’s logs of wells located in the vicinity of the Site, thickness of the alluvial and terrace deposits is estimated to be approximately 30 feet on site and extends to 50 feet closer to the rivers. The first groundwater-bearing unit at the Site occurs within the alluvial and terrace deposits.

Beneath the alluvial and terrace deposits lies the Hattiesburg formation, which is comprised predominantly of clay. Regionally within Forrest County, the Hattiesburg formation contains at least two prominent sand beds at depth beneath the clay from which a viable water supply is obtained. Logs from area wells indicate that the Hattiesburg formation ranges from approximately 130 feet to 260 feet in thickness.

The Catahoula sandstone underlies the Hattiesburg formation. It is not exposed near the Site, but is penetrated by numerous wells in the area. A driller's log of a municipal well approximately 1.25 miles northwest of the Site indicated that approximately 770 feet of Catahoula sandstone was encountered.

Near the Site, the Catahoula sandstone overlies the Chickasawhay limestone. Neither the Chickasawhay limestone nor the Bucatunna formation is considered to be a viable aquifer. The Bucatunna formation is comprised of clay and effectively acts as a confining layer for the underlying Oligocene aquifer.

The Miocene aquifer is comprised of both the Hattiesburg and Catahoula sandstone formations. The aquifer system is composed of numerous interbedded layers of sand and clay. Because of their interbedded nature, the Hattiesburg and Catahoula sandstone cannot be reliably separated. The formations dip southeastward approximately 30 feet to 100 feet per mile. While this dip steepens near the coast, the formations thicken. The shallowest portions of the aquifer system are unconfined with the surficial water table ranging from a few inches to greater than 6 ft bgs. Deeper portions of the aquifer are confined, with artesian conditions common.

3.2 Site-Specific Hydrogeology

Surficial soils in the vicinity of the Hercules Site include the Prentice-Urban Land Complex; the Trebloc silt loam; and the Brassfield-Urban Land complex. In general, these soils are described as poorly to moderately well drained and strongly acidic. The parent material from which the soil was derived is mainly marine deposits of sandy, loamy, and clayey material.

Borings installed during Site investigations encountered soils that are generally described as gray and tan, fine-grained sand with varying amounts of silt, clay, and gravel from the surface to depths ranging from 5 ft bgs to greater than 18 ft bgs. These sandy soils are typical of the Pleistocene alluvial and terrace deposits. Underlying the sandy soils is a gray to orange-brown, stiff, silty and/or sandy clay.

Descriptions of the clay are consistent with descriptions of the Miocene Hattiesburg formation.

The Hattiesburg Formation has been encountered in all Site borings that have penetrated the overlying alluvial material indicating the formation is consistent across the Site. An exploratory boring was installed in the northern portion of the Site to obtain Site-specific information for thickness and vertical permeability of the Hattiesburg Formation (EcoSystems 2004). Information obtained from the boring indicates that the Hattiesburg formation is at least 20 feet thick beneath the Site and has a hydraulic conductivity of 1.28×10^{-7} centimeters per second (cm/sec).

Water level information is routinely collected from monitoring wells, piezometers, and several Greens Creek staff gauges. Groundwater in the uppermost, saturated interval beneath the Site tends to follow the surface topography. In the former production areas, which are located in the southeastern portion of the Site, the potentiometric surface indicates the presence of a groundwater divide, which trends southwest to northeast. Historical potentiometric surface maps (Appendix A) indicate that groundwater located to the northwest of the divide moves northwestward toward Greens Creek. Groundwater southeast of the divide moves southeastward. On the north side of Greens Creek, the potentiometric surface indicates that groundwater in the uppermost, saturated interval moves generally southward toward Greens Creek.

Slug testing was conducted at on-site Monitoring Wells MW-2 (Northern Area), MW-6 (Former Landfill Area), and MW-7 (Former Production Area) (EcoSystems 2004). See Figure 5 for a map showing these well locations. Estimates of hydraulic conductivity were calculated using methods described by Bouwer & Rice (Bouwer and Rice 1976; Bouwer 1989). Hydraulic conductivity estimates varied from 1.31×10^{-3} cm/sec (3.71 feet per day [ft/day]) for MW-6 to 4.19×10^{-3} cm/sec (11.9 ft/day) for MW-2 with an average of 2.51×10^{-3} cm/sec (7.12 ft/day). Using the mean of the hydraulic conductivity estimates and historic potentiometric data, the estimated horizontal groundwater velocity from three areas of the Site were estimated using Darcy's Law. Darcy's Law can be expressed by the following equation:

$$V = \frac{Ki}{\eta}$$

Where:

V = Average linear groundwater velocity

K = Hydraulic conductivity

i = Hydraulic gradient

η = Effective porosity

Based on a review of historic potentiometric maps and published information, the following inputs were used to calculate the estimated groundwater flow for each area:

Area	Hydraulic Conductivity (ft/day)	Effective Porosity (%)	Hydraulic Gradient (ft/ft)	Groundwater Velocity (ft/day / ft/yr)
Northern Area (MW-2)	11.9	33%	0.006	0.216 / 78.8
Former Landfill Area (MW-6)	3.71	33%	0.03	0.337 / 123
Former Production Area (MW-7)	8.14	33%	0.007	0.173 / 63.0

ft/day Feet per day.
ft/ft Feet per feet.
ft/yr Feet per year.

This analysis determined that the horizontal groundwater velocity ranged from 0.173 ft/day (63 feet per year [ft/yr]) in the Former Production Area (MW-7) to 0.337 ft/day (123 ft/yr) in the Former Landfill Area (MW-6).

3.3 Topography and Surface Water

The topography of the Site ranges from 170 feet mean sea level (ft msl) to 150 ft msl. Surface water drainage patterns at the Site conform generally to the topography. Topography slopes generally to the south in the Sludge Disposal Area and to the north/northwest in the former Industrial Landfill Area and the Former Delnav Production

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Area (Figure 5). A topographic divide located south/southwest of the Former Delnav Production Area separates surface water drainage flowing in a northerly direction from surface water that flows in an east to southeasterly direction. The approximate location of the topographic divide is shown on Figure 8. The east-trending, perennial stream Greens Creek and its natural and man-made tributaries are the main surface drainage features in the area (Drainage A). Greens Creek leaves the Site at its northeast corner and subsequently flows into Bouie River, located approximately 1 mile to the north/northeast. Two unnamed intermittent drainage features that originate on Site are also present. One flows from the northeast corner of the Site (Drainage B) and the other flows from the southeastern portion of the Site (Drainage C). These drainage features are depicted on Figure 6. North of the sludge disposal area, a drainage ditch enters the Site from the West. This ditch previously flowed north of the sludge disposal area in a generally southeasterly direction and discharged into Greens Creek. To minimize the off-site flow of surface water in the vicinity of the sludge disposal area, this drainage ditch was rerouted to direct water southward along the Hercules fenceline until it ultimately discharges into Greens Creek.

Elevations of surface water within Greens Creek are significantly lower than the groundwater. This indicates that, while groundwater may contribute to flow in Greens Creek, hydraulic connection between the uppermost saturated interval and Greens Creek is retarded. The retardation of the water moving from the alluvial material to the creek is likely due to silt and clay in the sand adjacent to the creek.

3.4 Preliminary Conceptual Exposure Model

A component of the CSM is a preliminary conceptual exposure model. An exposure model evaluates potential exposure pathways that may result in exposure of a target population. An exposure pathway consists of the following four elements: (1) a source and mechanism of constituent release to the environment; (2) a retention or transport medium for the released constituent; (3) a point of potential contact by the receptor with the impacted medium (the exposure point); and (4) a route of exposure to the receptor at the exposure point (e.g., ingestion, inhalation, or dermal contact).

The conceptual exposure model provides the framework for the exposure assessment. It characterizes the primary and secondary potential sources and their release mechanisms and identifies the primary potential exposure points, receptors, and exposure routes. Exposure points are places or “points” where exposure could potentially occur, and exposure routes are the basic pathways through which constituents may potentially be taken up by the receptor (e.g., ingestion, inhalation, dermal contact).

The conceptual exposure model incorporates the Site-specific analytical data with constituent-specific fate and transport information to identify migration pathways, and activity and use patterns to identify the unique receptors and exposure pathways. Figure 9 identifies the sources, release mechanisms, transport pathways, and potential receptors for the Hattiesburg Site. These are discussed in detail below.

3.4.1 Sources

Operations began at the Hattiesburg Site in 1923. Rosin derivatives, paper chemicals, and Delnav (a miticide), were produced at the Site. Structures at the Site included offices, a laboratory, a powerhouse, production buildings, a wastewater treatment plant, settling ponds, a landfill, and central loading and packaging areas. Site-related constituents associated with these operations have been detected in soil, groundwater, surface water, and sediment on the Hercules property.

3.4.2 Release Mechanisms

Constituents detected in environmental media during the previous Site investigations have included organic constituents, metals, and pesticides. The migration of constituents released in the past is influenced by Site environmental factors and the physical and chemical properties of the constituents.

Constituents could potentially migrate from the former Hercules Plant via several mechanisms. When the Hercules Plant was active, normal permitted operations and potential inadvertent releases could have resulted in distribution of constituents at the Site. Because the Hercules Plant is no longer operational, these types of releases are not expected to occur. The potentially impacted soils at the Site can act as a source of constituents to other media. Migration into air may occur via volatilization or fugitive dust emissions; transport into the surface water can occur via surface runoff and groundwater discharge; and migration into groundwater can occur by infiltrating rainwater through impacted soil with subsequent leaching and transport. One other process that will influence migration is the attenuation of certain constituents through naturally occurring processes.

3.4.3 Potential Receptors

The Site is inactive and thus exposure of current Site workers is not expected to be significant because they do not routinely work around former process areas or disposal locations (landfill, sludge pits) and there are no significant subsurface construction activities; however, in the future, the Site could be redeveloped for industrial use and hypothetical future construction workers and Site workers could be exposed to constituents in soil on the Site. The evaluation of hypothetical future site workers will be a more conservative assessment of site worker exposure because such workers are more likely to work around the Site. It is unlikely that exposure to constituents in groundwater would occur because of restrictions to use of on-site groundwater as a potable water supply.

The Site is surrounded by commercial, industrial, and residential land uses. Data collected during the Phase I and Phase II Site investigations under the AO will be used to evaluate the potential exposure to Site-related constituents. This will include an evaluation of potential exposure to off-site receptors.

3.4.4 Potential Exposure Pathways

There are currently no points of exposure to groundwater on site. Workers on the property could be exposed to constituents in the surface soil through incidental ingestion, dermal contact, and inhalation of vapors or dust. While the presence of trespassers is unlikely, any trespassers on the property could also contact the surface soils and be exposed to Site-related constituents. If the hypothetical trespasser were to wade in the surface water on or leaving the Hercules property, they could contact Site-related constituents in the surface water or sediments. Additionally, aquatic and terrestrial biota are identified as potential receptors.

Shallow groundwater at the property boundary contains Site-related constituents. If Site-related constituents in groundwater extend beyond the property boundary, and groundwater is extracted for some purpose, then the potential exists for this pathway to be complete. Further, if volatile constituents associated with the former Hercules Plant are present off site, these VOCs could migrate from the groundwater into the vapor phase resulting in potential exposure. However, the Notice of Land Use Restrictions filed and recorded with the Forrest County Chancery Clerk's office on February 25, 2008 (Appendix B) prohibits the use of groundwater at the Site.

4. Preliminary Constituents of Concern

Consistent with the AO, the historic operations, past investigation results, and the Appendix IX constituent list were considered to identify preliminary constituents for the Phase I and Phase II investigations. In July 2011, Hercules discussed with MDEQ collecting samples from selected wells and analyzing for the Appendix IX list during the course of routine semiannual groundwater sampling per the RUAO. The Appendix IX analyte list was used in the most recent groundwater sampling of selected wells conducted in July 2011 to assess current conditions relative to this comprehensive analyte list. The laboratory reports from this sampling event are included in Appendix C. The data are provided in tabular format in Tables 1 and 2. An evaluation and screening of the current and historic groundwater and surface water data were conducted to identify the Site-related constituents on which to focus future assessments (Tables 3 and 4). The constituents detected during the previous investigations were compared to the MDEQ TRGs and USEPA RSLs, conservatively assuming the groundwater or surface water would be used as a potable water supply, even though this is unlikely to occur due to the restricted covenant put in place as part of the RUAO and the low yield of the first water-bearing zone.

The following summarizes the process used to evaluate the constituents detected in groundwater and surface water. The groundwater and surface water data from the previous investigations were compared to the screening levels (Tables 3 and 4). The maximum detected concentrations were compared to the TRGs and RSLs. Additionally, the minimum and maximum detection limits were compared to the TRGs and RSLs.

4.1 Groundwater

The groundwater data were evaluated first by class of compounds and then by individual constituents within a class. A discussion of this evaluation is provided below.

4.1.1 Polychlorinated Biphenyls

PCBs were not detected in the groundwater at the Site. The reporting limits were above both the TRGs and RSLs (i.e., screening levels); however, there is no evidence that these constituents were manufactured or used extensively at the plant.

4.1.2 Pesticides

Although there were no detections of toxaphene, there was limited manufacturing of the compound at the Site. Therefore, toxaphene will be included on the analyte list.

Two pesticides, alpha-BHC and gamma-BHC (Lindane), were detected during the most recent routine groundwater sampling. The other pesticides on the Appendix IX analyte list were not detected.

Endosulfan I; endosulfan II; endosulfan sulfate; endrin; endrin aldehyde; endrin ketone; kepone; and methoxyclor did not have reporting limits exceeding the screening levels and there was no manufacturing of these compounds.

4,4’-DDD; 4,4’-DDE; 4,4’-DDT; heptachlor; heptachlor epoxide; and technical grade chlordane had maximum reporting limits above their respective screening levels, but their minimum reporting limits were below their screening levels. There was no manufacturing or known use of these compounds at the Hercules Site.

4-Chlorobenzilate; aldrin; beta-BHC; delta-BHC; dieldrin; and isodrin had reporting limits that exceeded their respective TRGs and RSLs. These compounds were not manufactured or used at the Site.

4.1.3 Herbicides

2,4-D was detected in the groundwater at a concentration below the TRG and RSL. Reporting limits of 2,4,5-T and 2,4,5-TP were below their respective screening levels. These compounds were not manufactured at the Site. The other herbicides on the Appendix IX analyte list were not detected.

4.1.4 Volatile Organic Compounds

The following constituents were detected at concentrations exceeding either their TRG or RSL and were identified as constituents for the analyte list: 1,1-dichloroethene; 1,2-dichloroethane; 1,2-dichloropropane; 4-methyl-2-pentanone; acetone; benzene; bromodichloromethane; carbon tetrachloride; chlorobenzene; chloroform; chloromethane; dibromochloromethane; ethylbenzene (detected above the RSL but not the TRG); methylene chloride; tetrachloroethene; toluene; trichloroethene; and vinyl chloride.

4.1.5 Semivolatile Organic Compounds

The following constituents were detected at concentrations exceeding either their TRG or RSL and were identified as constituents for the analyte list: 1,1'-biphenyl; 1,4-dioxane; naphthalene; 1,4-dichlorobenzene; and 1,2,4-trichlorobenzene.

4.1.6 Inorganics

None of the inorganics detected in the groundwater were reported at concentrations above their TRGs. Arsenic was detected at a maximum concentration exceeding the RSL, but the detections were below the TRG. The maximum chromium concentration of 5 micrograms per liter (µg/L) is below the drinking water standard Thallium's reporting limits were above the RSL.

Mercury was not detected in groundwater and the detection limits were below the TRG and RSL. Cyanide was not detected in groundwater, and the detection limits were below the TRG and RSL.

4.1.7 Dioxins/Furans

There were no reported detections of 2,3,7,8-TCDD; however, the reporting limits were above the TRG and RSL. The dioxin/furan total toxic equivalent (TEQ) for all samples was reported at 0.00.

4.2 Surface Water

Six surface water sampling locations are routinely monitored. The data are included in Table 1 and the locations are designated with a "CM" followed by the sampling location. The following constituents were detected in surface water (including detections in upgradient sampling locations): 1,1-dichloroethene; 1,2,3-trichlorobenzene; 1,2,4-trimethylbenzene; 1,3,5-trimethylbenzene; 1,2-dichlorobenzene; 1,3-dichlorobenzene; 1,4-dichlorobenzene; 1,2-dichloroethane; 2-chlorotoluene; 4-chlorotoluene; acetone; benzene; bromobenzene; carbon tetrachloride; chlorobenzene; chloroethane; cis-1,2-dichloroethene; ethylbenzene; methyl ethyl ketone; styrene; tetrachloroethene; toluene; trichloroethene; vinyl chloride; dioxenethion; and dioxathion.

cis-1,2-Dichloroethene and vinyl chloride were the only constituents detected in the most recent sampling round. cis-1,2-Dichloroethene was never detected above the screening levels. Vinyl chloride has exceeded the screening level.

MDEQ derived a TRG for total dioxathion. The concentrations of dioxathion were below the screening level. A screening level is not available for the dioxenethion isomer, which is a breakdown product of dioxathion.

The following VOCs were not detected at concentrations above both of the screening levels: 1,1-dichloroethene; 1,2,4-trichlorobenzene; 1,2,4-trimethylbenzene; 1,3,5-trimethylbenzene; 1,2-dichlorobenzene; 1,3-dichlorobenzene; 1,4-dichlorobenzene; 2-chlorotoluene; 4-chlorotoluene; acetone; bromobenzene; carbon tetrachloride; chlorobenzene; methyl ethyl ketone; styrene; and toluene.

4.3 Summary

Based on the evaluations of the July 2011 sampling data and discussions with USEPA, historical analytical data, and a review of the manufacturing processes at the Site, the following analyte list is proposed for the Phase I soil and groundwater assessment activities:

- Appendix IX. VOCs (SW-846 8260B or equivalent drinking water standards):
- Appendix IX. SVOCs (SW-846 8270C or equivalent drinking water standards):
- Appendix IX. Metals (SW-846 6010 or equivalent drinking water standards):
- Appendix IX. Pesticides (USEPA 8081A or equivalent drinking water standards):
- Appendix IX. Herbicides (USEPA 8151 or equivalent drinking water standards):
- Appendix IX. PCBs (USEPA 8082 or equivalent drinking water standards):
- Appendix IX. Dioxins and Furans (USEPA 1613 or equivalent drinking water standards):
- Appendix IX. Dioxathion/Dioxenethion (BATCO 088.1).

All surface water and groundwater samples will be analyzed for VOCs, SVOCs, and metals. Selected surface water and groundwater samples will also be analyzed for pesticides, herbicides, dioxins, furans, and PCBs. This will result in approximately 10 percent of the surface water and groundwater samples being analyzed for the complete list of analytes. Specific locations will be communicated to USEPA and MDEQ after reviewing the Phase I data and prior to conducting Phase II sampling. This preliminary COC list will be revised after completion of the initial investigation. Additionally, modifications to this analyte list will be made to address the soil gas, sub-slab, and indoor air media after the preliminary groundwater sampling is complete.

5. Phase I Project Objectives

5.1 Administrative Order Objectives

The objectives of the Phase I Work Plan are to:

- Determine the presence of Site-related Constituents at off-site locations; and
- Evaluate the nature and extent of Site-related Constituents at off-site locations.

Execution of the activities set forth in this Work Plan will obtain data that can be used to determine if impacts from the Hercules Site exist off site. Media that will be evaluated may include surface water, groundwater, sediment, soil, soil gas, and/or indoor air.

5.2 Data Quality Objectives

Data collected in accordance with the procedures described in this Work Plan will be evaluated in accordance with the objectives described in the Quality Assurance Project Plan (QAPP) included in Appendix D. Data quality objectives (DQOs) established for this project are included in the QAPP. The project activities will be performed as required by the USEPA AO for the investigation of potential environmental impacts at or emanating from the Site.

6. Phase I Environmental Investigation

The scope of work for the investigation described below is designed to meet the requirements of the AO. All field work will be conducted in accordance with the Health and Safety Plan included in Appendix E. All non-dedicated sampling equipment will be decontaminated prior to use in accordance with the USEPA SESD guidance document SESDPROC-205-R1 (Appendix F).

6.1 Drinking Water Wells

The AO requires that Hercules perform "an inventory of all wells on and within a 4-mile radius of the Site, and a schedule for sampling of all such wells either on or within a 0.5-mile radius of the Facility." Details of the well inventory were discussed at a June 9, 2011, technical meeting and the USEPA provided clarification that the inventory should include public and private drinking water, irrigation, and production supply wells where water is extracted for human consumption or where humans may come in direct contact with the water. Other types of wells such as those used for groundwater monitoring, environmental remediation, injection, or dry wells would not need to be included in the inventory. The water wells located within the 0.5-mile radius of the Site will be sampled. These wells, identified from a database search, are shown on Figure 6. Water wells located outside of the 0.5-mile radius will be evaluated consistent with the decision matrix provided on Figure 10.

Initial response actions performed by Hercules shortly after receiving the AO included performing a public records search of registered wells that exist within a 4-mile radius of the Site. This initial well inventory, conducted by Environmental Data Resources, Inc. (EDR), identified a total of 806 well records within the search radius. The Site property boundary as defined in Exhibits 2 and 3 of the AO was provided to EDR. The search was conducted on data contained in the following public databases:

- Public Water Systems data from the Federal Reporting Data System;
- Public Water Systems Violation and Enforcement Data;
- MS Radon;
- National Radon Database;
- U.S. Geological Survey (USGS) Water Wells;
- USGS Public Wells;
- Permitted Wells;

- USGS Private Wells;
- Health Department Wells; and
- Oil and Gas Well Location Listing.

A figure showing the wells identified by EDR within 4 miles of the Site is included in Appendix G. The well inventory search radius was refined to show only the registered wells that exist on or within a 0.5-mile radius of the Site and those wells are listed in Table 5 and shown on Figure 6. The EDR map erroneously lists Wells 173 and 212 as being located within the 0.5-mile radius of the Site; however, these wells are 217 feet and 100 feet farther than the 0.5-mile radius from the Site, respectively. This initial public records survey indicates that 20 wells potentially exist within a 0.5-mile radius of the Site; however, there may be other wells within this radius that are not listed in public records or these wells may not be present. Further investigation into the existence of wells in the area will be performed as described in the following sections.

6.1.1 Identification of Drinking Water Well Locations

An initial evaluation of public records has already been performed as described above to identify public and private drinking water wells within the search radii specified in the Order. Site records indicated that historical well surveys including the 1993 B&V Waste Science and Technology Corporation report (1993 B&V) have also been performed. The 1993 B&V report documented that five municipal suppliers of potable water having wells within 4 miles of the Site existed at that time. Seventeen public supply wells were identified in the EDR well survey. The locations of the identified public supply wells are shown in Appendix G.

Hercules is also in the process of performing a neighborhood survey of residents and businesses located within a 0.5-mile radius of the Site by distributing a questionnaire to collect information on the presence and use of public and private wells. A copy of the questionnaire is provided in Appendix H. The questionnaire was mailed to 1,809 addresses (residents and businesses) located within the 0.5-mile radius to inform them of the importance of the survey and requested that respondents provide information regarding wells on their property. As of September 12, 2011, 389 questionnaires had been returned. The address information was obtained from the City of Hattiesburg and questionnaires were sent to the owners of the parcels. A summary of the responses is included in Appendix H. Parcels where the owner stated a well was present are shown on Figure 11.

The survey will be further supported by performing a "windshield" survey" of properties within the 0.5-mile radius to look for signs typically associated with private water well use (staining on structures and sidewalks, small enclosures or well houses, etc.). Well verification may be performed using a door-to-door follow-up survey to further support either a questionable windshield survey observation or a response from the questionnaire that requires clarification. Data collected from survey responses, the windshield survey, and from other public information sources mentioned above will be compiled into a geographic information system database for use in determining wells that may require sampling.

6.1.2 Water Well Sampling Procedure

Hercules will pursue access to properties where private or public potable wells, irrigation wells, and process water wells exist within the 0.5-mile radius of the Site. Specifically excluded from the well sampling effort are groundwater monitoring wells installed in response to environmental investigations not related to the Site, heat pump wells, injection wells, or other non-contact groundwater withdrawal points. Figure 11 provides the location of known or suspected wells within the 0.5-mile radius and additional data will be collected and reviewed to identify other wells that may exist within 0.5 mile of the Site. Access agreements will be presented to each well owner for review and approval. The sampling event will be scheduled with the well owner once the access agreement is signed. No samples will be collected without the owner's signed access agreement.

The sampling team will perform a short interview with the owner during the sampling event to ascertain information regarding the well and water use at the property. Interviews will be conducted with the owners (or their current tenants) using a form developed to record specific information on the well and each form will be added to the data record for the investigation. A copy of the interview form is provided in Appendix I.

It is Hercules' intent, for wells that are equipped with an operable pump system, to use the existing pumping system for purging the well and samples will be collected from a valve or spigot in the piping system. For public or private wells to be sampled that do not have an operable pump in place, a method for properly purging and sampling the well (either pump or bailer) will be developed based on specific construction details of the well to be sampled.

Hercules will utilize USEPA SESD guidance document SESDPROC-305-R1, as appropriate, during the collection of water samples for laboratory analysis. Conditions that require deviations from practices in the guidance will be documented in field books, well sampling sheets, and final reports that will become part of the project records. Samples that are collected from water wells will be preserved, handled, and shipped in accordance with SESDPROC-305-R1 and the project-specific QAPP. The analytical program for the water well program is discussed in Section 7 and the evaluation process is described in Section 8.

6.1.3 Schedule of Sampling

Well sampling will be initiated upon approval of this Work Plan for properties where the owner has granted access to the property to collect water samples. The existing well database, responses to private well questionnaires, and county tax records will be reviewed to determine the name and address of properties where wells may exist. Parcels that will be verified as having wells are identified on Figure 11. Access agreements will be presented to the property owner for review and approval and the sampling event will be scheduled once access agreements are obtained. A preliminary schedule for private well sampling is included as Table 6. No samples will be collected without the owner's signed access agreement.

6.2 Surface Water and Sediment

A survey will be conducted to identify any wetlands, creeks, lakes, or other surface water bodies, including any ditches (collectively called “water bodies”), located on and within a 0.5-mile radius of the Site. A preliminary evaluation of the potential for these water bodies to be used for public recreational purposes or which may contain threatened and endangered (T&E) species will be included in this survey. Based on the location and hydrogeologic characteristics of these water bodies, the water bodies that could potentially be connected to discharges from the facility will be identified for sampling and analysis of surface water and sediment.

Preliminary analysis of surface water on the Site has identified three major drainages which will, at a minimum, be sampled during implementation of Phase I under the AO, as described below. Other water bodies, not currently identified, which are identified in the survey and which may be influenced by the Site, will be considered for sampling in a similar manner.

6.2.1 Identification of Surface Water and Sediment Sampling Locations

Initial actions performed by Hercules in response to the AO included performing a review of available maps, historical reports, and related resources that identify surface water features within and beyond the 0.5-mile search radius specified by USEPA. There are numerous small drainage features on the Hercules Site that collect storm water runoff from rain events but these ditches are typically dry except in periods of heavy rainfall. A detailed evaluation of hydrologic setting at the Site was performed by B&V and summarized in 1993 B&V Report. The report concluded that, and as discussed in Section 3.3, Topography and Surface Water, the Site is predominantly drained by three waterways, which include:

- The perennial Greens Creek, which flows in an easterly direction (Drainage A);
- An unnamed, intermittent drainage ditch that flows in a northerly direction and exits the northeast corner of the Hercules Site, crosses North Main Street, and flows within a culvert below a neighboring industrial facility until it daylights approximately 1,000 feet northeast of the Hercules property line (Drainage B); and
- An unnamed, intermittent drainage ditch located in the southeastern portion of the Site, which flows south of the Site's wastewater treatment plant and exists in both closed-culvert and open conditions along its generally easterly flow path (Drainage C).

Figure 6 provides an illustration of these three main drainage features. The Site's three drainage pathways flow northeast for 1.0 to 1.2 miles before entering the Bouie River, which flows in a southeasterly direction (B&V 1993). Depending on which pathway surface water enters the Bouie River from the Site, it then travels between 0.9 and 1.9 miles southeast and enters the Leaf River. The Bouie and Leaf Rivers are utilized for sport and commercial fishing according to the 1993 B&V report; however, the report states that Greens Creek is too small to be used for fishing or swimming. The use determination of Greens Creek, including human activity patterns in and around the creek, will be confirmed during Phase I sampling activities.

In accordance with the AO, the off-site portions of the surface water features identified in historical reports and those sampled by MDEQ in 2004 (MDEQ 2004) will be the focus of the proposed sediment and surface water sampling program outlined in this Work Plan. The on-site portions of the identified surface water features will be sampled during implementation of an approved Phase II Work Plan, as required by the AO.

Off-site surface water and sediment sampling will be conducted within 0.5 mile of the Site at the locations shown on Figure 12. The rationale for selecting these sampling locations is included in Table 7. Sampling of surface water and sediment locations outside of the 0.5-mile radius of the Site will be conducted following the logic contained in the decision flow chart shown on Figure 13.

Potential surface water and sediment sample collection locations along the reaches of the three drainage features are shown on Figure 12. Three co-located surface water and sediment samples (where possible) will be collected within the facility boundary to evaluate Constituent concentrations on Hercules property. Each drainage will be sampled along its flow path on 500-foot intervals until a distance of 2,640 feet is reached from the Hercules property boundary. In the case of Greens Creek, which originates upgradient of the Site, five co-located surface water and sediment samples will be collected on the upstream reach on 500-foot intervals until the 0.5-mile boundary is reached. Some adjustment in the sampling interval may be needed along the flow path to optimize areas where both surface water and sediment exist. Sampling will not be performed in closed culverts or conveyances that are not readily accessible and open to the surface. Surface soil samples will be collected at 500-foot intervals along the culverted portion of Drainage C to evaluate the potential for current exposure resulting from historic flows. These samples will be collected from the 0 to 1 ft bgs interval using a clean, stainless steel hand auger. Proposed surface water and sediment sample locations are shown on Figure 12. Access agreements will be presented to each landowner for review and approval. The sampling event will be scheduled with the landowner once the access agreement is signed. No samples will be collected without the owner's signed access agreement. Details of the sample collection procedures and analytical parameters are provided in the following sections of this Work Plan.

At each surface water and sediment sampling location, a screening-level assessment of surface water use, habitat, and potential for T&E species will be performed to capture visual observations at the time of the sampling.

6.2.2 Surface Water Sampling Procedure

The USEPA SESD guidance document SESDPROC-201-R1 will be utilized during the collection of surface water samples for laboratory analysis. Surface water sampling will be performed and documented in accordance with procedures outlined in the document and with the standard operating procedure (SOP) provided in Appendix J. Where conflicts exist between the two guidance documents, the SESD guidance will prevail. Conditions that require deviations from practices in the guidance will be documented in field books, surface water sampling sheets, and final reports that will become part of the project records. Surface water samples will be preserved, handled, and shipped in accordance with SESDPROC-201-R1 and the project-specific QAPP. The analytical program for the surface water program is discussed in Section 7 and the evaluation process is described in Section 8.

6.2.3 Sediment Sampling Procedure

The USEPA SESD guidance document SESDPROC-200-R2 will be utilized during the collection of sediment samples for laboratory analysis. Sediment sampling will be performed and documented in accordance with procedures outlined in the document and with the SOP provided in Appendix K. Where conflicts exist between the two guidance documents, the SESD guidance will prevail. Conditions that require deviations from practices in the guidance will be documented in field books and sediment sampling sheets that will become part of the project records. Sediment samples will be preserved, handled, and shipped in accordance with SESDPROC-200-R2 and the project-specific QAPP. The analytical program for the sediment program is discussed in Section 7 and the evaluation process is described in Section 8.

6.2.4 Schedule of Sampling

Surface water and sediment sampling will be initiated in all reaches of the drainage features upon approval of this Work Plan and obtaining access agreements for off-site sampling locations. A review of county tax records will be performed to determine which proposed sampling locations identified on Figure 12, if any, will require private property access. Access agreements will be presented to the property owner for review and approval. The sampling event will be scheduled once all access agreements are obtained. A preliminary schedule for surface water and sediment sampling is included as Table 6. No samples will be collected without the owner's signed access agreement.

6.3 Groundwater (Temporary and Permanent Wells)

Temporary or permanent groundwater monitoring wells will be installed and sampled to investigate the presence of Site-related Constituents in groundwater:

<u>Step 1:</u> Install pre-packed well screens using direct push technology to collect screening-level groundwater data.

Step 2: Based on a review of the screening level groundwater data, install permanent monitoring wells, if required, to collect shallow groundwater confirmation samples.

This section describes the sampling activities that will be performed to evaluate Constituents in groundwater.

6.3.1 Identification of Groundwater Sampling Locations

Based on Hercules' preliminary evaluation of the CSM, to address USEPA comments during the June 9, 2011, meeting, and to augment the monitoring data (Tables 1 and 2) collected during routine groundwater monitoring events, groundwater screening data from the upper water-bearing zone will be collected in the locations depicted on Figures 12 and 14:

- Sample AO-GP-01 will be collected near the northwestern property boundary (near the sludge pits).
- Samples AO-GP-03 and AO-GP-04 will be collected near the southwestern property boundary (near TP-7).
- Samples AO-GP-20 and AO-GP-21 will be collected near the western corner of the southernmost property boundary.
- Samples AO-GP-22, AO-GP-23, and AO-GP-24 will be collected near the eastern corner of the southernmost property boundary (near TP-2).
- Sample AO-GP-27 will be collected near the western property boundary adjacent to Greens Creek.
- Samples AO-GP-19, AO-GP-25, AO-GP-26, AO-GP-28, AO-GP-29, and AO-GP-30 will be collected near the eastern property boundary near Wells MW-19, MW-22, and MW-23.
- Sample AO-GP-31 will be collected near the northeastern property boundary.
- Samples AO-GP-32 and AO-GP-33 will be collected near the northern property boundary.

The rationale for selecting the groundwater sampling locations shown on Figure 14 is provided in Table 8. The actual groundwater sample locations will be determined in the field and will be based on utility clearances and property access. Access agreements will be presented to each landowner for review and approval. The sampling event will be scheduled with the landowner once the access agreement is signed. No samples will be collected without the owner's signed access agreement.

Groundwater samples collected using pre-packed well screens are considered screening-level data, suitable for obtaining an understanding of groundwater quality.

6.3.2 Groundwater Sampling Procedure

The USEPA SESD guidance document SESDPROC-301-R1 will be utilized during the collection of groundwater samples for laboratory analysis. Groundwater sampling will be performed and documented in accordance with procedures outlined in the document and with the SOP provided in Appendix L. Where conflicts exist between the two guidance documents, the SESD guidance will prevail. Conditions that require deviations from practices in the guidance will be documented in field books, surface water sampling sheets, and final reports that will become part of the project records. Groundwater samples will be preserved, handled, and shipped in accordance with SESDPROC-301-R1 and the project-specific QAPP. The analytical program for the groundwater sampling program is discussed in Section 7 and the evaluation process is described in Section 8.

Groundwater samples from the first water-bearing zone will be collected by installing temporary groundwater monitoring wells completed with pre-packed well screens using a direct push technology (DPT) drilling rig. In addition, depth-to-water measurements and ground-surface elevations at each well point will be determined to assess the direction and gradient of groundwater flow. All groundwater samples from the temporary wells will be collected in accordance with the procedures specified in the SOP provided in Appendix L. Additional details of the Phase I well installation program are provided in this section.

Small-diameter (3/4-inch internal diameter) polyvinyl chloride wells equipped with 10 feet of pre-packed well screen will be installed in the locations illustrated on Figure 14 so that groundwater quality samples can be collected. The screened interval of these temporary monitoring wells will be set so that approximately 2 feet of the screened interval is above the static water table and 8 feet is below the water table. This will ensure that the screen interval intersects both the saturated and unsaturated zones of the shallow aquifer. Following utility clearing, a DPT rig will be used to collect continuous soil samples using a macro-core sampler from the ground surface to a depth equivalent to the base of the first water-bearing zone. After the cores are collected, they will be opened and immediately screened with an organic vapor analyzer (OVA) equipped with a flame-ionization detector (FID) or photoionization detector (PID) to field-assess concentrations of VOCs. The lithology will be logged at each location in accordance with the ASTM International (ASTM) 2488-09a, Description and Identification of Soils (ASTM 2009). At the completion of the boring, all soil cores will be laid adjacent to each other with the shallowest core on the left and deepest on the right so that a photograph can be taken of the entire cored section. The USEPA guidance document for monitoring well installation is included as Appendix M (SESDGUID-101-R0).

Permanent groundwater monitoring wells may be installed to facilitate the collection of shallow groundwater samples and the measurement of groundwater elevations, if deemed necessary based on an evaluation of the groundwater screening data. A temporary well will be converted to a permanent well depending upon whether any reported constituent concentrations from that well, or in the vicinity, are greater than applicable regulatory standards. In addition, the impact of plugging and abandoning a temporary well would have on the spatial coverage of the monitoring well network will be considered in the determination to remove or convert a temporary well to a permanent well. The preferred alternative is to convert the temporary well pre-packed screens into permanent wells, but in some instances the original pre-packed screens may be removed and a monitoring well installed adjacent to the screening location. The wells will be screened so that the top of the well screen is just above the water table. All monitoring wells will be installed and developed in accordance with the procedures specified in the SOP provided in Appendix M. Procedures for both the conversion of Geoprobe® temporary wells to permanent wells and installation of traditional wells are provided in the SOP.

A groundwater sample will be collected from each of the groundwater monitoring wells (either temporary or permanent) following installation and well development. Samples from the monitoring wells will be collected using low-flow/low-stress sampling techniques in accordance with the procedures specified in the SOP.

Hercules will utilize USEPA SESD guidance document SESDPROC-301-R2 during the collection of groundwater samples for laboratory analysis. Monitoring well purging and sampling will be performed and documented in accordance with procedures outlined in the document. Conditions that require deviations from practices in the guidance will be documented in field books and groundwater sampling sheets that will become part of the project records. Samples that are collected from temporary or permanent monitoring wells will be preserved, handled, and shipped in accordance with SESDPROC-301-R2 and the project-specific QAPP. The analytical program for the groundwater program is discussed in Section 7 and the evaluation process is described in Section 8.

6.3.3 Schedule of Sampling

Groundwater sampling will be initiated upon approval of this Work Plan and obtaining access agreements for off-site sampling locations. A review of county tax records will be performed to determine which proposed sampling locations identified on Figure 12, if any, will require private property access. Access agreements will be presented to the property owner for review and approval. A preliminary schedule for groundwater sampling is included as Table 6. No samples will be collected without the owner's signed access agreement.

6.4 Soil

The AO requires that soil sampling be conducted during the implementation of Phase II activities. Hercules will also collect soil samples during the groundwater sampling activities proposed in Phase I, as described below.

6.4.1 Identification of Soil Sampling Locations

Soil sampling locations during the Phase I investigation will coincide with drilling to support groundwater sampling, as discussed above to evaluate soil quality in shallow (0 to 2 ft bgs) and subsurface soil (greater than 2 ft bgs). Soil samples will be collected from the following intervals and retained for chemical analyses:

- The soil sample exhibiting the highest OVA reading[1];
- The soil sample collected at the soil/groundwater interface;

[1] If no OVA readings above background are recorded for the soil samples collected at a particular probehole, the soil sample collected from the 0 to 2 ft bgs interval will be retained.

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- The soil sample at the base of the probehole; and

- Soil samples that are visibly stained.

Details of soil sample collection techniques are provided in the following sections and maps showing proposed soil sampling locations during Phase I are provided as Figures 12 and 14.

6.4.2 Soil Sampling Procedure

The USEPA SESD guidance document SESDPROC-300-R1 will be utilized during the collection of soil samples for laboratory analysis. Soil sampling will be performed and documented in accordance with procedures outlined in the document and with the SOP provided in Appendix N. Where conflicts exist between the two guidance documents, the SESD guidance will prevail. Conditions that require deviations from practices in the guidance will be documented in field books, soil sampling sheets, and final reports that will become part of the project records. Soil samples will be preserved, handled, and shipped in accordance with SESDPROC-300-R1 and the project-specific QAPP. The analytical program for the soil program is discussed in Section 7 and the evaluation process is described in Section 8

6.4.2.1 Lithologic Logging

The lithology of the soil samples collected will be described through visual observations of the soil/bedrock cores using the Unified Soil Classification System (USCS) and/or the ASTM Standard D 2488 for Description and Identification of Soils. The Boring/Well Construction Log (Appendix O) will be used to record lithologic logging observations. The following logging sequence will be used for the description of unconsolidated materials:

- Describe major soil type and percentage;

- Describe composition of the soil;

- Describe the moisture, texture, and color of the soil;

- Document other geologic observations such as bedding characteristics, structure and orientation, and primary and secondary permeability/porosity (if possible); and

- Document observations on drilling progress including sample interval loss and recovery.

Samples will be preserved according to the selected analytical method. Specific method preservation requirements, size, and type of sample containers to be used, and holding times for each parameter are contained in the QAPP.

6.4.2.2 Direct Push Borings and Sample Collection

Direct-push soil sampling consists of hydraulically pushing or driving a small-diameter, hollow steel rod to a target depth and collecting a soil or groundwater sample. The equipment necessary for the collection of samples using the direct push technique is self-contained or a vehicle-mounted unit. The steel probe rods, 3 to 5 feet in length, are threaded for easy connection and have tight seals to provide a continuous length of rod. The rods are hydraulically driven or hammered to target depths. The steel rods can be driven to depths of up 150 feet through unconsolidated sediments.

6.4.3 Soil Sample Collection

The following procedures will be used during the collection of soil samples from direct push borings:

1. Record borehole location and intended sample depth intervals on the Boring/Well Construction Log.

2. Line the steel soil sampler core barrel with an acetate, polyethylene, or Teflon liner and attach sampler to end of steel rods.

3. Hydraulically push or drive the soil sampler and rods to intended depth.

4. Open the core barrel and disassemble, revealing the soil core sample within the liner.

5. Remove a portion of the liner over the entire length of the core using an appropriate cutting tool.

6. Screen soils immediately in the field using an OVA (e.g., PID, FID) to document the levels of organic vapors present. To collect volatile organic headspace readings, place the soil sample in a sealed plastic bag approximately two-thirds full allowing

for approximately 30 percent headspace. Place the bag in a dry area, which is as close to room temperature (70º F) as practicable. After 10 minutes, use a PID or FID to measure the vapors that accumulate in the bag due to off-gassing from the sample. Base PID/FID usage on the target analytes. If a PID is used, select the appropriate lamp based on the target analyte. Record the measurement on the Sample/Core Log (Appendix O).

7. Collect soil sample(s) for laboratory analysis based on the selection of sampling intervals discussion in Section 6.4.1. If a soil sample is needed for the analysis of VOCs from an interval that was not automatically sampled (e.g., the interval with the highest OVA reading may not coincide with a previously collected sample interval), install a second boring in the vicinity of the initial boring for the collection of the required sample. Don a clean pair of disposable gloves immediately prior to sample collection. VOC samples will be collected directly from the target depth interval of the soil core to minimize disturbance using an EnCore™ sampler or equivalent (Terra Core). Transfer the remaining soil from the target depth interval to a stainless steel bowl. Mix the soil using a stainless steel spoon until the sample is visually uniform. Remove any debris or larger rocks observed during mixing using the spoon. Collect non-VOC analysis samples from the bowl and place in appropriate sample container, label the container, and place on ice. Note on the field sample log the depth interval from which the sample aliquot was collected. The container and preservative requirements for soil samples are outlined in Appendix D).

8. Extract from the liners the portion of the soil core not submitted to the laboratory for analysis and use for logging purposes.

9. Describe the soil samples in the field. The lithology of the soil will be described by a qualified and experienced ARCADIS representative through visual observations of the soil core using the USCS or ASTM designation.

10. Place all soil cuttings in drums or roll-off box.

11. Properly decontaminate all down-hole sampling equipment prior to subsequent use in consecutive sample collection in accordance with the procedures contained in SESDPROC-205-R1.

6.4.4 Schedule of Sampling

Soil sampling will be conducted at the locations where drilling for groundwater sampling is to be conducted. Soil sampling will be conducted concurrently with groundwater sampling. Soil sampling will be initiated upon approval of this Work Plan and obtaining access agreements for off-site sampling locations. A review of county tax records will be performed to determine which proposed sampling locations, if any, will require private property access. Access agreements will be presented to the property owner for review and approval. A preliminary schedule for soil sampling is included as Table 6. No samples will be collected without the owner's signed access agreement.

6.5 Vapor Intrusion Evaluation

The vapor intrusion pathway will be evaluated consistent with the sample decision flow chart provided on Figure 15. This approach starts with a broad view of the potential pathway, characterizing sampling media one step at a time originating with groundwater, then progressing to soil gas, sub-slab, and indoor air evaluations, as appropriate. The key is to focus the sampling efforts on those areas or buildings with the greatest potential for indoor air exposure to Site-related constituents. Generally, buildings within 100 feet of the source (in this case groundwater) will be the focal point of any further investigation; however, if the groundwater exhibits concentrations below screening levels that are protective of indoor air exposures, then further evaluation would not be warranted.

The following sections describe the specific procedures for screening shallow groundwater data and for collecting and evaluating soil gas data near the edge of the delineated shallow groundwater plume. Soil gas data will be screened using USEPA RSLs assuming a 0.1 attenuation factor moving from soil gas to indoor air. If soil gas samples exceed the screening levels, sub-slab soil gas and indoor air sampling in buildings will be warranted.

6.5.1 Groundwater Screening

The first step in the evaluation of the vapor intrusion pathway is the comparison of shallow (water table) groundwater data to calculated groundwater screening levels (SLs) protective of indoor air exposure. These SL values have been calculated using the most recent USEPA residential indoor air RSLs (June 2011 table) consistent with USEPA (2002) guidance as follows:

$C_{gw} = C_{ia} \times CF \times 1/HLC * 1/AF$

Where:

C_{gw} = groundwater to indoor air screening level (or groundwater SL)

C_{ia} = concentration in indoor air (residential air concentrations from the USEPA RSL table)

CF = conversion factor (0.001 m^3/L)

HLC = Henry's Law Constant (unitless and constituent-specific)

AF = attenuation factor (0.001)

If the calculated groundwater SL is below a federal drinking water standard such as the Maximum Contaminant Level (MCL), the MCL will be used as the criteria instead. The calculation of groundwater SLs are presented in Table 9. Groundwater SLs were calculated corresponding to a target cancer risk level of 1×10^{-6} (1 in 1,000,000) or a Hazard Quotient (HQ) of 1.0 for screening purposes, although the entire Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) target risk range (1×10^{-6}) and an HQ of 1 may be considered prior to sampling additional environmental media. If Constituents are identified that are not listed in Table 9, appropriate screening levels will be calculated using the same methodology as presented above.

Recent shallow Site groundwater data from 2009 and 2010 were compared to the groundwater SLs calculated as described above. The results of this initial screening are presented in Table 10. Groundwater wells with Constituents exceeding the calculated residential groundwater SLs at a 1×10^{-6} risk or an HQ of 1.0 include MW-19, MW-21, MW-22, and MW-23 located on the southeast side of the Site. Constituents detected in groundwater wells to the north, west, southwest, and northeast are all non-detect or present at concentrations below the calculated screening criteria, except MW-8, MW-13, and MW-17 located in the central portion of the Site which contain Constituents that exceed the conservative groundwater SLs.

The initial screening of current groundwater data indicates that additional evaluation of constituents in shallow groundwater is warranted for the southeastern portion of the Site for the vapor intrusion exposure pathway. Soil gas samples will be collected along the southeast portion of the Site at selected locations (Figure 14). In addition, shallow groundwater samples will be collected as described in Section 6.3 until concentrations are below either the calculated groundwater SLs or the MCLs, whichever is greater. At the completion of the shallow plume delineation and initial soil gas sampling, Hercules will determine if additional soil gas samples should be collected within a 0.5-mile radius of the Site or if the data indicate that no further evaluation of the vapor intrusion exposure pathway is warranted.

6.6 Soil Gas

Soil gas sampling will be conducted in public right-of-ways, easements, and/or private property to assist in the delineation and evaluation of the vapor intrusion exposure pathway. The overall goal of the soil gas sampling program is to confirm that VOCs associated with historical plant operations are not migrating within the vadose zone at concentrations that could be of concern for vapor intrusion. As noted above, a focused number of soil gas samples will be collected from the southeast portion of the Site. Additional soil gas samples may be collected based on the results of shallow groundwater and soil gas sampling and screening as outlined in Figure 15 and Section 6.6.4.

6.6.1 Identification of Soil Gas Sampling Locations

Soil gas samples will be collected in the public right-of-way or private property near the southeastern boundary of the Site, approximately 1 to 2 feet above the water table. The exact location of the samples will be determined in the field and will be subject to subsurface utility restrictions and access agreements. A total of three soil gas samples will be initially collected southeast of the Site at the locations shown on Figure 14. The rationale for selecting the sampling locations shown on Figure 14 is included in Table 11. Additional soil gas samples may be collected based on the results of shallow groundwater delineation, initial soil gas sampling, and the decision logic shown on Figure 15. Additional sample locations will be provided to USEPA and MDEQ for approval in advance of any sampling.

6.6.2 Soil Gas Sampling Procedure

Soil gas sampling probes will be installed as temporary (or semi-permanent) points consistent with the SOP SESDPROC-307-R2. Specifically, 6-inch stainless steel screens (or implants) will be installed using a DPT drilling rig. An extraction pit will be created around the stainless steel screen using either glass beads (as specified in the SOP) or clean sand. The sample probe will be finished at the ground surface with a temporary well cover. Soil gas samples will be collected approximately 24 hours after sample port installation and after the sample probe has been allowed to come to equilibrium. At this time, the vapor probe will be connected to a sample container (i.e., SUMMA® canister) at ground surface. All samples will be collected at a flow rate no greater than 200 milliliters per minute or 30 minutes for a 6-liter SUMMA® canister. After the prescribed sampling period, the sample containers will be closed and disconnected.

Soil gas samples will be preserved, handled, and shipped in accordance with SESDPROC-307-R2 and the project-specific QAPP. The analytical program for the soil gas program is discussed in Section 7 and the evaluation process is described in Section 8.

During the soil gas sampling, potentially affected homes near the soil gas locations will be evaluated to determine the building construction. This information will supplement data available from tax assessor records regarding home construction.

6.6.3 Schedule of Sampling

Soil gas sampling, if required, will be initiated upon receipt of an access agreement or permit to sample in the right-of-way from the City of Hattiesburg and any private property. The sampling event will be scheduled once all access agreements are obtained. A preliminary schedule for soil gas sampling is included as Table 6.

6.6.4 Soil Gas Screening

Soil gas data collected will be evaluated using multiple lines of evidence, as follows:

- Evaluation of potential background sources of Constituents detected in soil gas;
- Comparison to conservative SLs (i.e., soil gas SLs); and
- Evaluation of the CSM to assess how Site-specific conditions may affect interpretation of the results.

As a first step in the analysis of the soil gas data, an analysis of potential background sources of Constituents detected in soil gas will be conducted to assess whether the Constituent is related to the Hercules Site, or may be the result of an alternate source in the vicinity of the sampling point. If Constituents are clearly not identifiable as being Site-related, a petition for no further analysis will be made to USEPA/MDEQ.

For potentially Site-related Constituents, soil gas SLs will be calculated from the USEPA residential air (or indoor air) RSLs (current date is May 2011) as follows:

$$C_{sg} = C_{ia} \times AF$$

Where:

C_{sg} = soil gas to indoor air screening level (or soil gas SL)

C_{ia} = concentration in indoor air (residential air RSL from current RSL table)

AF = attenuation factor (0.01)

The soil gas results will then be compared to the calculated soil gas SLs at a target risk range of 1×10^{-6} and an HQ of 1. If all Constituent concentrations are below the soil gas SLs, then no further evaluation may be necessary. If any Constituent concentrations exceed a soil gas SL, then sub-slab soil gas and indoor air sampling may be warranted. As part of this process, the CSM will be evaluated and a determination made if there are any Site-specific factors (i.e., geology, hydrogeology, and building construction) that could influence the interpretation of the data. The results of the soil gas screening will be used to identify the next step in the evaluation of the vapor intrusion pathway (i.e., sub-slab soil gas and/or indoor air sampling).

6.7 Sub-slab, Soil Gas, and Indoor Air

Based on the soil gas sampling results and data evaluation, a sub-slab soil gas and indoor air sampling program may be implemented. Sub-slab soil gas and indoor air sampling will be initially focused on buildings within a 0.5-mile radius of the Site, but may be extended beyond the 0.5-mile radius based on data results.

6.7.1 Identification of Potential Indoor Air Sampling Locations

Soil gas, sub-slab, and/or indoor air sample locations will be selected, as necessary, based on the results of soil gas sampling and analysis.

6.7.2 Sub-slab, Soil Gas, and Indoor Air Sampling Procedure

Soil gas, sub-slab, and/or indoor air sampling will be conducted consistent with SOPs provided in Appendix P, SESDPROC-303-R4, and SESDPROC-307-R2, as appropriate. Prior to sampling, a Site reconnaissance will be conducted at each building. The overall goal of the Site reconnaissance is to complete a building survey that identifies construction conditions, heating, ventilation, and air conditioning operation, any preferential vapor migration pathways (i.e., sump pump), and products that are stored or used within the building. Any products that contain Site-related VOCs will be requested to be removed from the occupied structure 48 hours prior to sampling. A copy of the building survey and product inventory form is provided as an attachment to the SOP.

Indoor air samples may also be collected at all buildings where a sub-slab soil gas sample will be obtained. Indoor air samples will be collected using SUMMA® canisters. Indoor air samples will be preserved, handled, and shipped in accordance with SESDPROC-303-R1, SESDPROC-307-R2, and the project-specific QAPP. The analytical program for the indoor air program is discussed in Section 7 and the evaluation process is described in Section 8.

6.7.3 Schedule of Sampling

Soil gas, sub-slab, and/or indoor air sampling will be initiated after completion of soil gas sampling and analysis and obtaining access agreements for off-site sampling locations. Access agreements will be presented to the property owner for review and approval. The sampling event will be scheduled once access agreements are obtained. No samples will be collected without the owner's signed access agreement.

7. Analytical Program

The DQOs for all data collection are described in Section 5.2 and the QAPP in Appendix D. The Constituent and analytical methods that will be used to complete the assessments of the various media are included in the QAPP. The detection limits that will be used as the reporting limits will be the selected laboratory's method detection limits for the instruments utilized in their particular laboratory.

Appropriate quality assurance and quality control (QA/QC) samples will be prepared as groundwater, surface water, sediment, soil gas, and indoor air samples are being collected. The QA/QC samples will include:

- Trip blanks (1 per day per cooler for VOC samples);
- Field blanks (1 per day or 1 per 20 samples, whichever is less);
- Rinse blanks (1 per day or 1 per 20 samples, whichever is less);
- Field duplicates (1 per 20 samples); and
- Matrix spike/matrix spike duplicate samples (1 per 20 samples or 1 per week).

The sampling personnel will complete a chain-of-custody form that will accompany the samples to the laboratory. Additional information on the QA/QC program is provided in the QAPP in Appendix D.

8. Data Evaluation

Data generated during this assessment will be managed in accordance with the procedures identified in the QAPP (Appendix D). The data verification process outlined in the QAPP will ensure that data collected during the assessment activities meet the DQOs and are acceptable for evaluation.

The lower of the USEPA RSLs and MDEQ Tier 1 TRG standards and screening levels will be used to evaluate the analytical data to determine if concentrations are protective of human health and the environment. Detections of Constituents will be evaluated using the decision matrices provided for the targeted media (Drinking Water, Figure 10; Surface Water and Sediment, Figure 13; Groundwater, Figure 10; and Indoor Air, Figure 15).

If maximum detected concentrations of the Constituent are below USEPA and MDEQ standards or screening levels for any medium, then the Constituent is dropped from further consideration because there will be no excess risk to human health and adverse effects would not be expected to occur.

9. Reporting

At a minimum, quarterly progress reports will be submitted to USEPA and MDEQ during the assessment activities. During periods of increased activity, monthly progress reports will be submitted to USEPA and MDEQ. The progress reports will consist of the following:

- Summary of work performed during the reporting period;
- Discussion of work expected to be performed in the next reporting period;
- Summary of investigation results received during the reporting period; and
- Issues that have arisen and/or been resolved.

Upon completion of field activities and analytical data validation, a project final report will be prepared. The final report will document all field activities and present an interpretation of drinking water, groundwater, surface water, sediment, soil, soil gas, and indoor air conditions. Appropriate tables, figures, and appendices will be included in the report to support the text. The report will present a risk evaluation of the data focusing on the areas of investigation and will conclude by presenting recommendations for a path forward.

10. Project Schedule

An estimated schedule for the implementation of this Work Plan is included in Table 6. Implementation will begin upon receiving approval of the Work Plan from USEPA and MDEQ. The duration of assessment activities will be dependent on obtaining property access and field conditions. In the event additional time is required due to unforeseen issues, the schedule will be adjusted accordingly.

11. Project Team

The Project Management Plan (PMP) included in Appendix Q contains the roles and responsibilities of supervisory personnel included on the Project Team. In addition, the roles and responsibilities of parties that may be subcontracted to provide services during the implementation of this Work Plan are also included in the PMP.

12. References

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Tables

Figures

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Appendix A

Historical Potentiometric Maps

Appendix B

Notice of Land Use Restrictions

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Appendix C

Analytical Data (July 2011)

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Appendix D

Quality Assurance Project Plan

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Appendix E

Health and Safety Plan

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Appendix F

Field Equipment Cleaning and Decontamination Standard Operating Procedures

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Appendix G

EDR Well Search Map

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Appendix H

Community Well Questionnaire and Summarized Community Responses

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Appendix I

Well Owner/Operator Interview Form

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Appendix J

Surface Water Sampling Standard Operating Procedures

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Appendix K

Sediment Sampling Standard Operating Procedures

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Appendix L

Groundwater Sampling Standard Operating Procedures

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Appendix M

Monitor Well Installation Standard Operating Procedures

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Appendix N

Soil Sampling Procedures

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Appendix O

Field Forms

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Appendix P

Soil Gas, Sub-slab, and Indoor Air Sampling Standard Operating Procedures

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Appendix Q

Project Management Plan