Ground Water Monitoring Report
Initial Eight Quarterly Events

Former Gulf States Creosoting Site
Hattiesburg, Mississippi

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Executive Summary

Kerr-McGee Chemical, LLC (KMC) has conducted investigations and remediation at the former Gulf States Creosoting site in Hattiesburg, Mississippi since 1996. During that time, site ground water quality and conditions have been characterized through multiple phases of investigation, which have included the installation and sampling of 24 monitoring wells and over 30 temporary well points. The lateral extent of affected ground water has been fully delineated, and has been confirmed by eight quarterly monitoring events during which both affected wells and plume-defining wells have been sampled.

Two separate and distinct areas of ground water contamination have been identified: the former Process Area/northeast drainage ditch area and the Fill Area. The shallow geology beneath these areas is significantly different, and the shallow water-bearing zones beneath the two areas are not hydraulically connected. The two affected ground water zones are unused for any purpose in the Hattiesburg area. Furthermore, in 2002, the Hattiesburg City Council adopted an ordinance prohibiting the development and use of ground water resources within the City limits.

In 2003, KMC completed remedial measures that included the removal and offsite disposal of materials constituting potential sources of ground water contamination (i.e., free product or creosote-saturated soils). In addition, remedial measures included containment and control elements designed to either reduce the potential for migration of constituents via the ground water pathway or to preclude the potential for infiltration/percolation of water through affected soils left in place.

The results of the initial eight quarterly ground water monitoring events indicate that concentrations in both affected areas have reached either steady-state or declining conditions. Furthermore, a preliminary evaluation indicates that conditions are favorable for natural attenuation of ground water constituents. KMC proposes to conduct annual ground water monitoring to demonstrate that constituents are no longer migrating via the ground water pathway, and that natural attenuation of affected ground water is continuing to occur.

1.0 Introduction

This *Ground Water Monitoring Report* documents the results of ground water monitoring activities conducted at the former Gulf States Creosoting site in Hattiesburg, Mississippi from December 2001 through October 2003. Ground water monitoring was performed in accordance with the Mississippi Department of Environmental Quality (MDEQ)-approved *Ground Water Monitoring Plan* (Michael Pisani & Associates, June 25, 2001). This report is organized as follows:

- Section 1 includes background information on the site, a summary of previous ground water investigations, and information on the current ground water monitoring well network.
- Section 2 describes procedures for the collection, handling, and analysis of ground water samples.
- Section 3 presents the results from the initial eight quarterly sampling events, including potentiometric surface maps, tables summarizing analytical results, graphical charts, and a preliminary site-specific evaluation of monitored natural attenuation parameters.
- Section 4 presents proposed changes to the program for future ground water monitoring activities.

1.1 Site Description and Background

The former Gulf States Creosoting site is located in Hattiesburg, Mississippi near the intersection of U.S. Highways 49 and 11. The site is situated entirely within Section 16 of Township 4 North, Range 13 West, in Forrest County, Mississippi (Figure 1-1). Creosoting operations were conducted at the site between the early 1900s and approximately 1960. Wood treating operations were confined to a 2.5-acre area at the northeast corner of the site; this area is referred to as the former Process Area (see Figure 1-2).

The property was developed commercially beginning in approximately 1962. During the redevelopment of the site, fill materials containing creosote residuals were apparently placed in the southwestern portion of the site adjacent to Gordon's Creek; this area is referred to as the Fill Area. The original plant area is currently occupied by automobile dealerships, auto parts retailers, and other commercial operations (Figure 1-2).

1.2 Summary of Previous Ground Water Investigations

Ground water beneath the Gulf States Creosoting site has been studied extensively beginning in 1994. In 1994, Environmental Protection Systems (EPS) conducted a limited investigation of the former Process Area only, which included the installation of four ground water monitoring wells. From early 1997 through December 2001, Kerr-McGee Chemical, LLC (KMC) conducted ground water assessment activities during five different phases of investigation.

In February through April 1997, KMC conducted a Remedial Investigation (RI). The RI included detailed site-wide stratigraphic characterization, as well as the installation of four new monitoring wells. Water level data, ground water quality data, and aquifer characterization data were obtained from the four new wells and four existing wells.

In 1998, KMC conducted a Phase II RI. The Phase II RI included additional stratigraphic characterization, the collection of ground water samples from 13 temporary well points, the installation of eight new monitoring wells, and the collection of water level data and ground water quality data from the eight new wells and six of the existing wells.

In August and September 2000, KMC conducted additional site investigation activities. The additional activities included the collection of ground water samples from 18 temporary well points, the plugging and abandonment of three of the monitoring wells installed during the 1994 EPS investigation, the installation of two new monitoring wells, and the collection of water level data and ground water quality data from the two new wells and 13 existing wells.

In February and March 2001, KMC conducted additional site investigation activities. The additional activities included the collection of ground water samples from two temporary well points.

In June 2001, KMC submitted a *Ground Water Monitoring Plan* (GWMP) for the site. The plan included the installation of nine additional monitoring wells, with proposed locations based on the results of sampling from existing wells and temporary well points. LDEQ approved the GWMP, including the proposed monitoring well locations, in a letter dated July 17, 2001. The nine new monitoring wells were installed and developed in November and December 2001. Figure 1-3 depicts the locations of all monitoring wells in the existing monitoring network.

Major conclusions from these ground water investigations were:

- The shallow geology of the former Process Area and the Fill Area are significantly different. The shallow water bearing zones beneath the two areas are not hydraulically connected.
- Ground water flow within the sand channel beneath the former Process Area is eastward in the general direction of the Leaf River. Ground water flow continues in an easterly direction beneath the adjacent residential area. Ground water within the Fill Area sands flows toward Gordon's Creek and downstream along the creek. This provides further evidence that the shallow water bearing zones beneath the two areas are not hydraulically connected.
- Shallow ground water (i.e., ground water at depths less than 200 feet below land surface) is unused for any purpose in the Hattiesburg area. Furthermore, in 2001, the Hattiesburg City Council adopted an ordinance resolution prohibiting the development and use of ground water resources within the City limits.
- Ground water beneath the former Process Area has been impacted by historical creosoting operations. However, no free-phase DNAPLs are present in monitoring wells within the former Process Area. Affected ground water does not extend westward, southward, or northward from the former Process Area.

- Creosote constituents have migrated offsite to the east of the former Process Area via the ground water pathway. However, the number and concentrations of constituents decrease dramatically with distance from the former Process Area. The former Process Area plume extends to a maximum distance of 500 feet offsite.
- Historically, a ditch that flowed offsite to the east from the former Process Area (the northeast drainage ditch) may have conveyed process wastewater from wood treating operations. Ground water beneath and immediately adjacent to this ditch has been impacted by the vertical migration of constituents from the ditch itself. Affected ground water is confined to a narrow band beneath and adjacent to the ditch.
- Affected ground water beneath the Fill Area is generally confined to portions of the site where historical filling with impacted materials occurred. The area containing affected ground water extends northward from the Fill Area in a narrow band along the east bank of Gordon's Creek.

1.3 Source Area Remediation

In 2003, KMC completed the vast majority (i.e., over 95 percent) of site remediation specified in the MDEQ-approved *Final Remedial Action Work Plan* (MP&A, August 3, 2001) and *Removal Action Work Plan – Northeast Drainage Ditch* (MP&A, August 21, 2002). Each of these plans included the removal and offsite disposal of materials that constituted potential sources of ground water contamination (i.e., free product or creosote-saturated soils). In addition, each plan included containment and control elements designed to either reduce the potential for migration of constituents via the ground water pathway or to preclude the potential for infiltration/percolation of water through affected soils left in place.

Specifically, cleanup activities undertaken in part to address affected ground water included the following:

- Approximately 2,400 tons of affected material and associated liquids were removed from two subsurface features within the former Process Area (the concrete sump and wooden substructure). Solids were transported and disposed offsite at a permitted Subtitle C landfill. Liquids were transported to KMC's facility in Texarkana, Texas facility for reuse/recycle.
- Affected soils remaining in place within the former Process Area were capped with an impermeable composite liner and 4 inches of asphalt.
- Approximately 13,300 tons of affected soils and debris were removed from the northeast drainage ditch. These materials were transported and disposed offsite at permitted Subtitle C and Subtitle D landfills.
- Prior to the installation of culvert pipe in the former ditch, HDPE liner was installed above potentially-affected soils remaining in place.
- Approximately 800 tons of affected sediment, soils, and associated liquids were removed from Gordon's Creek adjacent to the Fill Area. Solids were transported and disposed offsite at a permitted Subtitle C landfill. Liquids were transported to KMC's facility in Columbus, Mississippi facility for reuse/recycle.

- A Waterloo Barrier System (i.e., interlocking sheet piling) was installed around the Fill Area to eliminate the potential for seepage of free product and affected ground water to Gordon's Creek. Geosynthetic Clay Liner (GCL) was installed above the Fill Area to reduce the potential for ground water mounding behind the sheet piling barrier.
- Monitoring and recovery wells were installed within the Fill Area containment cell to allow for the recovery of free product. Approximately 800 phreatophytic trees (i.e., hybrid poplars and black willows) were planted within the containment cell to uptake affected ground water.

These source removal/containment and control activities were all completed within the last 24 months, and their effects on reducing constituent concentrations in ground water will likely take time to observe. However, once source materials are removed and/or contained, monitored natural attenuation of ground water contamination typically becomes a viable ground water remedy.

2.0 Ground Water Monitoring Program

This section describes the ground water monitoring program for the site. Ground water sampling procedures are discussed in greater detail in Sections 3 and 4 of the GWMP.

2.1 Ground Water Monitoring Well Network

A network of 24 monitoring wells currently exists to monitor ground water quality and conditions beneath the site. Existing monitoring well locations are depicted on Figure 1-3. Well completion information is summarized in Table 2-1.

The rationale for the locations of the 24 existing monitoring wells is as follows:

- Wells MW-1R, MW-2R, and MW-4 were installed to monitor ground water beneath the former Process Area.
- Wells MW-06 through MW-09 and MW-16 through MW-22 were installed to monitor ground water downgradient of the former Process Area and/or ground water beneath and adjacent to the northeast drainage ditch.
- Wells MW-10 through MW-15 were installed to monitor ground water within and adjacent to the Fill Area.
- Wells MW-01, MW-03, MW-04, and MW-05 were installed to characterize ground water conditions on a site-wide basis.

2.2 Summary of Ground Water Monitoring Activities

The first quarterly ground water monitoring event was conducted shortly after the installation and development of wells MW-14 through MW-22, during the week of December 17, 2001. The remaining seven quarterly monitoring events were conducted during the weeks of March 18, 2002, June 3 and 10, 2002, September 16, 2002, December 16, 2002, March 24, 2003, June 23, 2003, and October 6, 2003. Activities undertaken during each event included:

- Recorded static water levels in all existing monitoring wells;
- Purged wells to facilitate the collection of representative ground water samples;
- Collected samples for laboratory analyses; and
- Analyzed samples for site constituents and biogeochemical parameters.

Ground water monitoring activities are described in further detail in the following subsections.

2.2.1 Sample Containers and Preservatives

Prior to each sampling event, clean, dedicated sample containers were provided by KMC's contract laboratory, Lancaster Laboratories of Lancaster, Pennsylvania. The laboratory added the appropriate type and volume of chemical preservative to each sample container prior to shipping. The appropriate container type, preservative, and prescribed holding time for each analysis are summarized in Table 3-1 of the GWMP.

2.2.2 Water Level Measurement and Well Purging

Prior to purging, the water level in each well was measured to the nearest 0.01 foot with an electronic water level indicator. Water level data were used in conjunction with surveyed top-of-casing data to determine ground water elevations, flow direction, and hydraulic gradient. A discussion regarding ground water flow beneath the site is presented in Section 3.1 of this report.

Prior to sampling, wells were purged with an adjustable-rate, low-flow submersible pump and disposable polyethylene tubing. When necessary, the pumping rate was adjusted so that the purge rate was equal to the recharge rate (i.e., little or no drawdown was induced in the well). During purging, a multiprobe meter with a flow-through cell was used to monitor field parameters (i.e., pH, Eh, specific conductance, temperature, and dissolved oxygen). The approximate volume of water removed during purging was measured and recorded. Well purging was considered complete when field indicator parameters had stabilized to within 10 percent of the mean for three consecutive readings and less than 0.1 meter of drawdown was induced.

2.2.3 Sample Collection and Handling

Once well purging was complete, ground water samples were collected with the low-flow pump and dedicated tubing. In accordance with US EPA-prescribed procedures, the intake for the tubing was placed at the approximate midpoint of the screened interval. Ground water was discharged directly from the tubing into clean, laboratory-supplied sample containers. Samples for analyses of biogeochemical analysis were collected first, followed by samples for PAH analysis. Samples were placed immediately on ice in insulated coolers. Strict chain-of-custody documentation was maintained during sample collection, transport, and laboratory analysis.

Samples were packaged in a manner that minimized the potential for leakage or breakage. Sample coolers were delivered to the analytical laboratory via overnight courier. The temperature of the samples was recorded upon receipt at the laboratory.

2.2.4 Chain-of-Custody Control

Chain-of-custody forms were utilized to document sample custody from collection through analysis. Custody forms contain the following information:

- Sample identification number;
- Sampler's printed name and signature;
- Date and time of sample collection;
- Sample matrix;
- Analyses requested;
- Chemical preservatives; and
- Signatures of individuals in possession of the samples at any time.

The sampler retained one copy of each chain-of-custody form. Two copies of each form were shipped to the laboratory inside the sample coolers. Chain-of-custody seals were placed on each cooler to prevent tampering with the samples. Samples remained in the physical possession of the sample custodian, in direct view of the sample custodian, or stored in a secured area at all times.

2.2.5 Analytical Program

Samples were analyzed for polycyclic aromatic hydrocarbons (PAHs) by SW-846 Method 8270 (initial quarterly event only) or SW-846 Method 8310 (during all subsequent events, to achieve lower detection limits). Samples were also analyzed for biogeochemical parameters in order to evaluate the viability of monitored natural attenuation (MNA) as a ground water remedy. Data obtained from these analyses will be used to document intrinsic remediation of ground water constituents and may, in the future, be utilized in the evaluation of solute fate and transport. Specific parameters for the analytical program are listed in Table 2-2.

3.0 Ground Water Monitoring Results

This section summarizes the results from the initial eight quarterly ground water monitoring events. Information on ground water flow, a summary of laboratory analytical results, and a preliminary site-specific evaluation of monitored natural attenuation are provided in the following subsections.

3.1 Ground Water Flow Assessment

Prior to sampling, water level measurements were recorded in all wells in the monitoring well network. Water level data were used in conjunction with surveyed top-of-casing data to determine ground water elevations. A summary of ground water elevation data is presented in Table 3-1.

Ground water elevation data were then contoured to determine ground water flow direction and gradient beneath the site. Figures 3-1 through 3-8 depict the potentiometric surface beneath the former Process Area and offsite areas during the first four quarterly events; the Fill Area potentiometric surface is shown on Figures 3-9 through 3-16.

The quarterly ground water elevation data are consistent with the data from previous ground water investigations at the site. The data indicate that the shallow water-bearing zones beneath the former Process Area and the Fill Area are not hydraulically connected. Ground water flow within the sand channel beneath the former Process Area is eastward in the general direction of the Leaf River, generally at an extremely flat gradient. Ground water flow continues in an easterly direction beneath the adjacent residential area. The shallow ground water system shows minimal seasonal variability in flow direction and gradient, with the average hydraulic gradient between MW-03 and MW-22 approximately 0.002 to 0.003 ft/ft.

Ground water within the Fill Area sands flows westward toward Gordon's Creek and downstream along the creek, also with minimal seasonal variability in flow direction and gradient. The average hydraulic gradient between MW-11 and the stream gauge (directly toward the stream) is 0.02 ft/ft and between MW-10 and MW-15 (downstream) is 0.003 ft/ft.

Figure 3-17 and 3-18 are charts depicting water level elevations over time in wells completed in the Process Area sand channel and Fill Area sands, respectively. The seasonal water level fluctuations track very closely from well to well. This is to be expected, given the relatively flat hydraulic gradients and homogeneous nature of both aquifers. The ground water elevation data demonstrate very little lateral movement of ground water, with most of the variation being "up and down" movement caused by seasonal fluctuations.

3.2 Ground Water Analytical Results

Ground water analytical results from the initial eight quarterly sampling events are summarized in Table 3-2. Due to their volume, laboratory reports are provided under separate cover. Consistent with previous ground water monitoring results, the number and concentrations of PAH compounds are highest in wells within areas where creosote and creosote residuals were handled and/or deposited (i.e., the former Process Area, the Fill Area, and the northeast drainage ditch). The number and concentrations of PAHs decrease dramatically with distance from these areas. Figure 3-18 shows the approximate extent of affected ground water in both the Fill Area and the former Process Area/northeast drainage ditch area.

Of the 21 wells sampled during the initial eight quarterly events, 10 wells contained target constituents. Naphthalene is the most prevalent PAH compound detected in site ground water, and is the only constituent reported at levels exceeding MDEQ Tier 1 Target Remediation Goals (TRGs) in wells located outside of historical source areas. This is to be expected, as naphthalene: 1) is the most abundant single constituent of coal tar (*The Merck Index*, 12th Edition, 1996); and 2) has the highest water solubility of any of the PAHs (31 milligrams per liter, or mg/L).

Charts showing naphthalene concentrations over time are provided in Appendix A. Initially, concentrations were plotted on a linear scale. Where necessary due to highly variable concentrations, concentrations were also plotted on a logarithmic scale. For comparative purposes, the MDEQ Tier 1 TRG for naphthalene (6.2 micrograms per liter, or µg/L) is shown on the graphs. However, as previously stated, shallow ground water in the Hattiesburg area is unused, and a City ordinance prohibits the development and use of ground water resources within the City limits.

In most wells, naphthalene concentrations were relatively consistent over the initial eight quarterly events (i.e., concentrations remained within the same order of magnitude). However, significant decreasing trends were identified in wells MW-1R, MW-12, MW-17, and MW-18. None of the wells showed significant increasing trends, nor were target constituents reported for the first time in any plume defining wells.

Should plume defining wells consistently exceed MDEQ Tier 1 TRGs, the Contingency Plan for the site calls for additional ground water assessment. During 2001-2003 ground water monitoring activities, naphthalene was detected at levels exceeding the MDEQ Tier 1 TRG (again, 6.2 µg/L) in two plume-defining wells, MW-14 and MW-18. The initial eight

monitoring events yielded the following naphthalene results for the two wells, reported in µg/L:

Date	MW-14	MW-18
December 2001	3J	470
March 2002	23	830
June 2002	10	170
September 2002	42	27
December 2002	6.2J	480
March 2003	ND	140
June 2003	ND	ND
October 2003	ND	13

J values represent estimated concentrations between the method detection limit (MDL) and the laboratory limit of quantitation (LOQ)

Naphthalene concentrations in samples collected from well MW-14 results during the last four sampling events did not exceed the Tier 1 TRG. MW-14 appears to be located immediately at the edge of the former Fill Area plume. The rapidly declining naphthalene concentrations in well MW-12, located just outside and downgradient of the Fill Area containment cell, indicates that the Waterloo Barrier System is beginning to achieve its desired effect (i.e., cutting off seeps and the migration of affected ground water). If this is the case, future naphthalene concentrations in MW-14 should continue to be below the Tier 1 TRG.

Naphthalene concentrations in samples from well MW-18 during the past year exhibited an overall downward trend. Furthermore, source removal activities conducted in the former Process Area are anticipated to result in continued attenuation of ground water constituents in the years to come.

For the above-stated reasons, KMC does not believe that additional ground water assessment activities in the vicinity of MW-14 and MW-18 are warranted at this time. Instead, KMC proposes to continue monitoring PAH concentrations in these wells. Should results indicate increasing concentration trends, KMC will submit a plan for additional site investigation activities.

3.3 Preliminary Natural Attenuation Evaluation

Ground water samples were analyzed for biogeochemical parameters in order to help evaluate the viability of monitored natural attenuation (MNA) as a ground water remedy. As discussed in the GWMP, KMC does not view MNA as a stand-alone ground water remedy. As previously stated, KMC has performed site remediation that includes source removal/ containment and control measures that address potential sources of affected ground water in the former Process Area, the Fill Area, and along the northeast drainage ditch. KMC does not view MNA to be a "no action" remedy, but rather an alternative that augments source

removal/control measures in helping to achieve remedial objectives that are protective of human health and the environment.

The biogeochemical results are presented with the PAH data in Tables 3-2. The first step in the natural attenuation evaluation process is to determine if conditions in the affected aquifers are favorable for natural attenuation to occur. A "line of evidence" for this demonstration is developed by evaluating and comparing values for biogeochemical indicator parameters in samples collected from wells within the plume to those in samples from wells outside the plume. Table 3-3 presents the results of such a comparison for the initial eight quarterly monitoring events.

According to the US EPA, trends that support occurrence of natural attenuation include the following:

- Dissolved oxygen concentrations below background;
- Nitrate concentrations below background;
- Iron (+2) concentrations above background;
- Sulfate concentrations below background; and
- Methane concentrations above background.

The results summarized in Table 3-3 indicate that, with the exception of MW-2R, most wells within the former Process Area/northeast drainage ditch plume showed strong evidence or positive trend analysis indicating natural attenuation. The evaluation was less meaningful for the Fill Area, as only a single well (MW-12) is located within the Fill Area plume. Overall, however, the data demonstrate that conditions are favorable for natural attenuation to occur.

4.0 Proposed Future Ground Water Monitoring Activities

This section presents proposed modifications to the ground water monitoring program.

4.1 Monitoring Frequency

The analytical results from the first eight quarterly monitoring events do not indicate rapid increases, or "spikes," in target constituent concentrations over the initial two-year monitoring period. Though water level elevation data do show seasonal fluctuations, no significant changes in ground water flow direction or gradient were observed from event to event. In addition, as noted in Section 3.2, target constituents were not reported for the first time in any plume defining wells during the initial eight quarterly monitoring events. For these reasons, KMC believes that annual ground water monitoring is sufficient to demonstrate that:

- Lateral migration of constituents via the ground water pathway is not occurring;
- Source removal/containment and control activities are achieving their desired effects; and
- Natural attenuation of constituents in ground water is occurring.

MP&A conducted a ground water sampling event in December 2004. From this point forward, KMC proposes conducting annual ground water monitoring in the fall (September through November) of each year. MDEQ will be notified of sampling a minimum of two weeks in advance of each annual event.

4.2 Monitoring Well Network

There are currently 24 monitoring wells onsite, not including those within the Fill Area containment cell. Of those wells, all but MW-01, MW-04, and MW-07 were sampled during the initial eight sampling events. Based on the analytical data and the ground water flow conditions, KMC proposes deleting from the program and plugging and abandonment of eight monitoring wells. These wells, and the rationale for plugging and abandonment, are as follows:

- **MW-01, MW-03, MW-04, MW-05 and MW-10** – All of these wells are upgradient of affected ground water, and no samples from any of these wells has historically contained target constituents at levels above Tier 1 TRGs. In fact, only MW-03 has ever contained target constituents above laboratory reporting limits.
- **MW-20 and MW-21** – These wells were installed to determine the width of the plume associated with the northeast drainage ditch. Neither has yielded samples containing target constituents, and because source material have been removed and ground water flow direction is to the east, lateral migration of constituents from the former ditch is highly unlikely.
- **MW-13** – KMC has received objections from the leaseholder of the property, which is located across Gordon's Creek from the Fill Area. MP&A was denied access to the well during the last two monitoring events. No target constituents have ever been reported in samples from MW-13.

KMC does not propose to plug any wells located within either plume or any downgradient plume defining wells. KMC will not plug and abandon the wells proposed above until MDEQ approval is received.

5.0 Summary and Conclusions

The following summary and conclusions are based on the results of ground water monitoring activities at the site:

1. KMC has conducted ground water investigations at the site since 1996. Affected ground water is present in two separate and distinct areas. The extent of affected ground water in both areas has been fully delineated.

2. The affected shallow water-bearing zones are not used for any purpose in the Hattiesburg area. Furthermore, a 2002 City ordinance prohibits the development and use of ground water within the City limits.

3. KMC has completed remedial measures that included the removal of potential sources of ground water contamination. Additional containment measures reduce the potential for migration of affected ground water and preclude infiltration/percolation of water through affected soils left in place.

4. Constituent concentrations in both affected areas have reached either steady-state or declining conditions. Furthermore, a preliminary evaluation indicates conditions are favorable for natural attenuation of ground water constituents.

5. KMC is requesting MDEQ approval of annual ground water monitoring. In addition, KMC is requesting MDEQ permission to plug and abandon eight existing monitoring wells.

Figures

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