FILE COPY

COMPREHENSIVE GROUNDWATER ASSESSMENT PLAN
THIRD STAGE

Kuhlman Electric Corporation
Crystal Springs, Mississippi

Prepared for

BorgWarner Inc.

August 2026

GeoEnvironmental Associates, LLC | MARTIN & SLAGLE

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MARTIN&SLAGLE GEOENVIRONMENTAL ASSOCIATES, LLC
PO Box 1023
Black Mountain, North Carolina 28711

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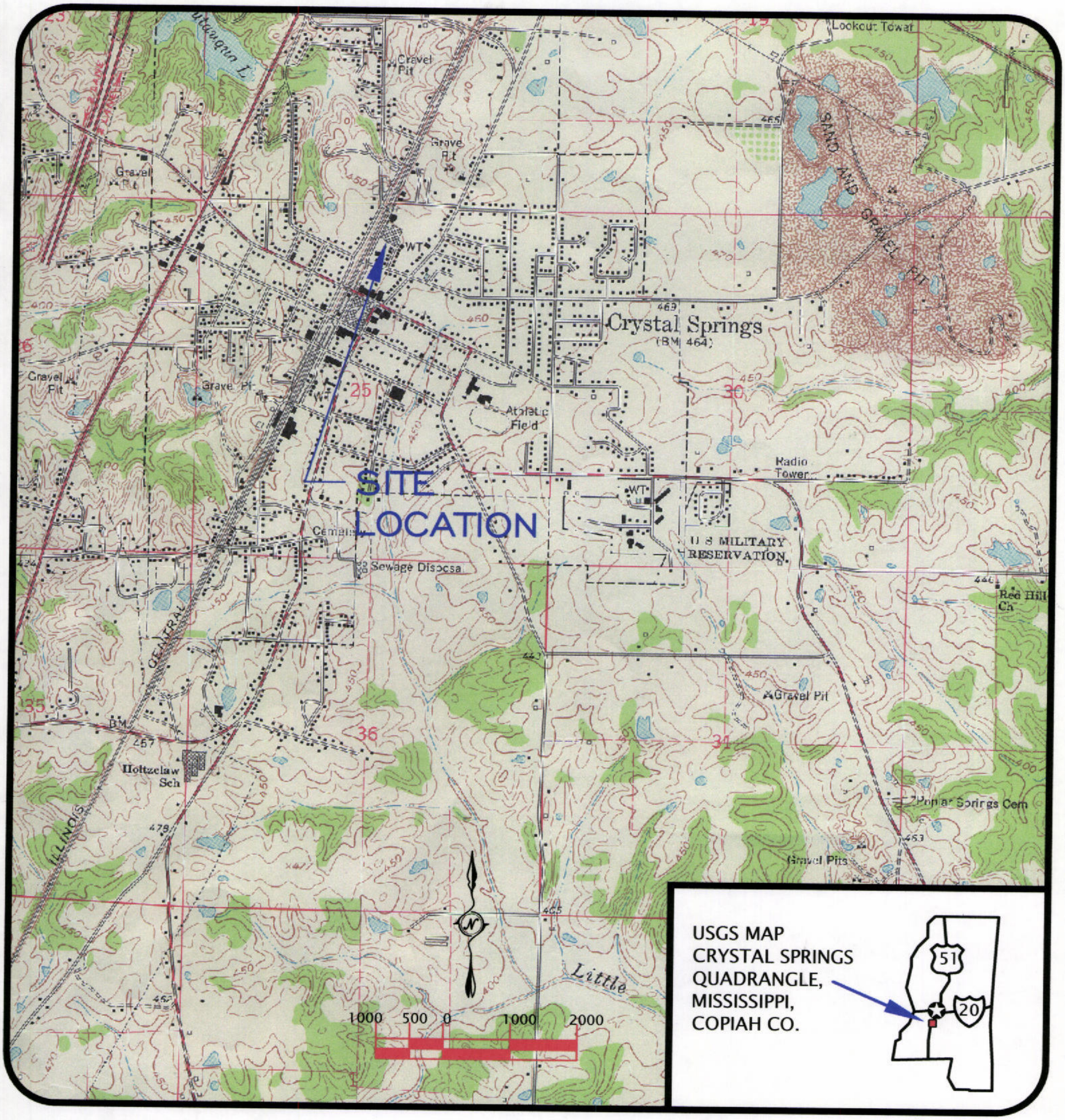
FIGURES

1.0 INTRODUCTION

1.1 Background

Kuhlman Electric Corporation (KEC) owns and operates a transformer manufacturing plant in Crystal Springs, Mississippi (Figure 1). The KEC plant in Crystal Springs, Mississippi was constructed and has been owned and operated as a transformer manufacturing plant since the 1950s by KEC or its predecessors (collectively "KEC"). KEC continued to own and operate the plant in March 1999 when BorgWarner Inc. purchased the stock of Kuhlman Corporation, the parent of KEC, and thereafter as well. Seven months later, on October 5, 1999, Kuhlman Corporation sold KEC's stock to KEC Acquisition Corporation. BorgWarner and Kuhlman Corporation indemnified KEC, KEC Acquisition Corporation and their affiliates for historic contamination at the site and have, under the purchase agreement, exercised their right to control any remediation of such contamination. Neither BorgWarner nor Kuhlman Corporation nor KEC Acquisition Corporation has ever owned or operated the plant. On April 19, 2000, BorgWarner received notification from KEC, in accordance with the purchase agreement, that areas of contaminated soil had been found at the plant site.

Environmental assessments conducted at the KEC Plant site indicated the presence of soil contaminated with polychlorinated biphenyls including Aroclor 1260 (PCB) and various chlorinated benzenes. BorgWarner, on behalf of KEC, engaged Martin & Slagle GeoEnvironmental Associates, L.L.C. (MSGA) to prepare a groundwater assessment work plan for review and approval by the Mississippi Department of Environmental Quality (MDEQ) and the United States Environmental Protection Agency (USEPA). The groundwater assessment plan was prepared in response to Mississippi Commission on Environmental Quality Order No. 4449-02, issued to Kuhlman Electric Corporation on July 23, 2002.



USGS MAP
CRYSTAL SPRINGS
QUADRANGLE,
MISSISSIPPI,
COPIAH CO.

MARTIN&SLAGLE

GeoEnvironmental Associates, LLC

PO Box 1023
Black Mountain NC 28711
828.669.3929 828.669.5289

PREPARED FOR:
BorgWarner Inc.

FIGURE 1

SCALE = 1":2000'
REV: 0
DATE: 6/10/04
DR: DGR
CHK: RLM

KUHLMAN ELECTRIC
CORPORTATION
SITE LOCATION MAP
KUHLMAN ELECTRIC CORPORATION
101 KUHLMAN DRIVE
CRYSTAL SPRINGS, MS

The preliminary groundwater assessment was conducted in March and April 2004 to determine if groundwater beneath the plant site was impacted by chemical constituents previously detected in site soils. During the preliminary groundwater assessment, eight permanent monitoring wells were installed in areas that contained the highest concentrations of PCBs as identified during the plant site soil assessment. During the installation of the monitoring wells soil, perched groundwater, and groundwater from the uppermost aquifer were sampled and analyzed for the presence of PCBs, volatile organic compounds (VOCs) and semi-volatile compounds (SVOCs). Chlorinated and non-chlorinated organic compounds were detected in groundwater samples collected during the preliminary groundwater assessment. The source of these detected compounds was not determined. A Preliminary Groundwater Assessment Report was prepared and submitted to MDEQ in July 2004.

After MDEQ's review of the preliminary groundwater assessment, a Comprehensive Groundwater Assessment Work Plan was prepared and submitted to MDEQ for review and approval.

The Comprehensive Groundwater Assessment Work Plan described the processes and procedures to be implemented to determine the nature and extent of impacted groundwater at the KEC plant site. The Comprehensive Groundwater Assessment Work Plan was designed to be implemented in a three-staged approach. The first stage involved the sampling and analysis of groundwater within the uppermost aquifer at the KEC property, the second stage concentrated on plume delineation within the upper aquifer downgradient of the plant site, and the third stage, described in greater detail in this work plan, incorporates the installation and sampling of a system of monitoring wells to monitor the aquifer characteristics and movement of the identified plume.

1.2 Site Description

The Kuhlman plant is located at 101 Kuhlman Drive, Crystal Springs, Copiah County, MS 39059, at latitude N 31° 15' 20" and longitude W 90° 21' 20". The plant site is located within the town limits of Crystal Springs. The town center is located south of the plant approximately 0.25 miles (Figure 1). The Kuhlman property is bordered to the south by commercial businesses and residences located across Lee Street, and to the west by a railroad line and residences. Across Fulgham Avenue to the northwest is a vacant lot formerly occupied by an icehouse and to the northeast are private residences. East of the plant and abutted to the property are residences and one funeral home. The residences are all single-family dwellings with individual yards. The single-family dwellings extend for several blocks in all directions except north. At least one church and a public swimming pool are located within two blocks of the site to the east. The predominant land-uses in the surrounding area are commercial, former industrial, institutional, and residential.

The KEC property consists of a manufacturing plant building situated on about 15 acres of land. This site has been used for industrial manufacturing purposes since the mid-1950s. The future use of the property is anticipated to remain industrial.

1.3 Summary of Previous Work Performed at the KEC Plant

Results of the plant site soil assessments are included in the *Preliminary Site Characterization Report* (July 2000) and the *Addendum to the Site Characterization Report* (February 2001) submitted to MDEQ and the United States Environmental Protection Agency (USEPA). Impacted soils and paving materials were remediated from June 2002 to June 2004. The plant site remediation is described in the *Plant Site Remediation Report* (June 2004).

1.3.1 Preliminary Groundwater Assessment Summary

Groundwater and soil samples were collected from the eight monitoring wells installed during this phase of the assessment. Sampling results indicated that various VOCs and SVOCs were present in the sub-grade of the plant site. Both the perched groundwater and the upper aquifer have detectable concentrations of organic constituents, which exceed the Target Remediation Goals (TRG) limits established by MDEQ. Samples from six of the eight monitoring wells have detectable concentrations of VOCs. 1,1-dichloroethene (1,1-DCE) was detected at concentrations ranging from 4.85 µg/l to 87.7 µg/l. The MDEQ TRG for 1,1-DCE is 7.0 µg/l. Results of this sampling event were included in the *Preliminary Groundwater Assessment Report* (July 2004).

1.3.2 Source Identification and Groundwater Sampling – First Stage

The first stage of activities associated with the comprehensive groundwater assessment updated the existing information from the monitoring wells that were installed at the KEC site during the preliminary groundwater assessment activities.

- Groundwater levels were measured in the existing wells and the potentiometric map was revised based on the new measurements.

- A piezometer was installed in the parking area south of the maintenance building near Lee Avenue. Water levels from the piezometer were used in conjunction with water level measurements from the existing wells to update the potentiometric map.

- Groundwater from existing monitoring wells was sampled and analyzed by the on-site laboratory for VOCs and chlorinated benzenes. At least 10% of the samples were split and sent to the off-site laboratory for quality control purposes.

- Updated information obtained from existing wells and the new piezometer was used to locate groundwater-sampling points on the plant site, downgradient of the plant building. A line of groundwater sampling points were placed across the front of the plant building and sampled. The results were mapped to locate the area of highest concentration and determine the lateral extent of impacted groundwater.

Groundwater sampling was accomplished using a Waterloo Profiler (Profiler) data acquisition system. The Profiler is able to:

- Collect groundwater samples at predetermined depth intervals,
- Collect multiple groundwater samples in depth profiles from the same borehole,
- Measure an index of hydraulic conductivity of the aquifer material,
- Measure pH, specific conductance, dissolved oxygen, oxidation/reduction potential, and temperature,
- Collect samples from depths exceeding 120 feet.

The second stage of groundwater assessment was implemented since impacted groundwater was detected downgradient of the plant site.

1.3.3 Plume Delineation – Second Stage

Data collected from the First Stage of the Comprehensive Groundwater Assessment indicated the presence of a plume of impacted groundwater emerging from beneath the southwest corner of the KEC plant building. The second stage of groundwater assessment involved the systematic sampling of groundwater while moving downgradient both laterally and parallel to the groundwater flow direction, until the edge of impacted groundwater was located. Groundwater samples were collected in 34 locations using the

Profiler. Sampling locations were selected and distributed downgradient of points exhibiting detections of concentrations of concern based on the First Stage field data. The Field Project Manager prepared a layout of a series of transects perpendicular to the direction of groundwater flow. An array of sampling points extending from the water table in the upper aquifer to the bottom of the plume or the top of the confining unit were situated along the transects and extended to the lateral edges of the plume. The transects were extended downgradient until the edge of the plume was identified.

1.4 Comprehensive Groundwater Assessment – Third Stage Objectives

This work plan describes project activities for the third stage of groundwater assessment. The general groundwater assessment objectives for this scope of work are to:

1. Identify the source(s) of groundwater contamination,
2. Obtain chemical aquifer characteristics, including natural conditions and conditions within the plume,
3. Determine the aquifer flow conditions, including horizontal and vertical hydraulic conductivities and velocities,
4. Determine the fate of contaminants in the plume.

2.0 FIELD SAMPLING PLAN

This Third Stage of the Comprehensive Groundwater Assessment plan was prepared in accordance with the guidance published in the USEPA, Region IV *Environmental Investigations Standard Operating Procedure and Quality Assurance Manual,* November 2001 (EISOPQAM). The field sampling plan details the procedures and practices necessary to:

1. Investigate and sample the source(s) of 1,1-dichloroethene in groundwater.
2. Install a system of permanent groundwater monitoring wells within the core of the plume and around the perimeter of the plume as defined during the Second Stage of groundwater assessment completed in 2005.
3. Collect and analyze groundwater samples for the contaminants of concern, as well as geochemical parameters that may be used to evaluate the fate and transport of the contaminants of concern.
4. Determine the aquifer flow conditions, including horizontal and vertical hydraulic conductivities and velocities.

2.1 Regional Geology

Published literature indicates that sediments consisting of fine-grained sands with local lenses of clay and gravel underlie Crystal Springs and the surrounding area. These red and orange sediments comprise the Citronelle Formation. The Citronelle Formation covers approximately 30 percent of Copiah County and is present at ground surface at Crystal Springs. Gravel, mainly consisting of chert and quartz, is present throughout the formation near Crystal Springs and is heavily mined in the surrounding area. The thickness of this formation ranges from a few feet to a maximum of 100 feet, with average depths ranging from 20 to 80 feet. Thickness of the unit is controlled by erosion of surface soils. The thinner segments are located in washes and drainage channels, while the thicker portions are located on topographically high areas. In the vicinity of

Crystal Springs, the Citronelle formation lies unconformably over the Catahoula Formation. The base elevations of this Citronelle range from 375 to about 430 feet mean sea level (msl).

The surficial aquifer exists under phreatic conditions. No extensive clay confining units were identified above this first aquifer during the preliminary groundwater assessment activities.

2.2 Regional Hydrogeology

According to published literature, the uppermost aquifer in the area of Crystal Springs exists under phreatic conditions (unconfined) and rises into the Citronelle Formation. Groundwater generally exists near the base of the Citronelle. Depth to groundwater ranges from 20 to greater than 100 feet, with more than half of the water levels measured in wells deeper than 50 feet.

Average rainfall totals 57.2 inches per year in the Copiah County area. Precipitation that does not evaporate (approximately 44 inches of evaporation per year) or runs off into streams and drainages recharges the surficial aquifer. Precipitation infiltrates vertically through the upper sediments to a saturated zone near the bottom of the Citronelle Formation.

2.3 Site Geology

The site geology, as determined by soil samples collected during the installation of the monitoring wells, consists of interlayered orange, pink, and tan silty, clayey and gravelly sands and sandy gravels to a depth of about 25 to 30 feet. The top of a discontinuous, stiff, gray clay unit is present at this depth. The thickness of the clay layer ranges from 20 feet at monitoring well MW-1 to 5 feet at MW-6, but the clay layer is absent at MW-7 and MW-5. Beneath the clay layer are interlayered sands and gravels to at least 73 feet below grade at MW-1.

2.4 Site Hydrogeology

Groundwater was encountered in all site borings. Perched groundwater was present in six of the eight well locations. The top of the perched groundwater ranged in depth from 15 to 24 feet below ground surface (bgs). In all locations where perched groundwater was found, the clay layer was also present. Neither MW-5 nor MW-7 had perched groundwater.

The upper aquifer was detected in all monitoring wells, except for MW-5, at depths ranging from 50 to 61 feet bgs. This appears to be the unconfined aquifer that rises into the Citronelle Formation as described in the literature. Site data indicate that the upper aquifer is under phreatic conditions. Groundwater flows from northeast to southwest across the site based on groundwater level measurements from the monitoring wells.

The groundwater level measured in MW-5 was at 20 feet bgs and appeared consistent with the perched groundwater levels across the site. However, the clay unit was absent at this location to a depth of 42 feet bgs.

2.5 Initial Data Collection

Prior to any new investigation activities, water levels will be measured in the existing monitoring wells located on the KEC property, and the wells will be sampled. Water level measurements will be used to revise the potentiometric map for the site. Groundwater samples will be collected from each well and analyzed by the on-site laboratory. Groundwater levels and analytical data will be compared to previous sampling results. Groundwater flow directions and analytical results will be reviewed prior to siting sample locations.

2.6 Source Identification

Results of groundwater sample analysis and data mapping from the first two stages of assessment indicate that the core of the contamination plume appears to emanate from beneath the plant building along the southwest corner. Potential sources of solvent releases may include but are not limited to:

- Paint spray booth
- Current and former drum storage area
- Current and former hazardous waste storage area
- Former closed dip tank
- Current and former floor drains and associated process sewer lines
- Current and former above ground storage tank (AST) locations
- Current and former underground storage tank (UST) locations, if any

The source investigation will begin with research of existing information and data. Information sources typically employed in site investigations also will be used. These may include historical plant and site drawings, aerial photographs, Spill Prevention Control and Countermeasure (SPCC) plans, Stormwater Pollution Prevention Plans (SWPPPs), wastewater discharge permits, waste manifests, and other sources of information.

The source investigation will concentrate on areas beneath the plant floor and in the immediate vicinities of exterior plant doors. The investigative tools and techniques will include a geophysical survey of the plant subgrade using ground penetrating radar (GPR), in line electrical probing, and an active soil vapor survey. The geophysical survey can locate underground structures (such as sewer lines, pits, buried material, etc.). The active soil vapor survey involves the direct sampling of air that may contain contaminant vapors in soil pore spaces. Vapor concentrations detected in the subgrade soil may indicate a contamination source.

2.6.1 Geophysical Survey

The subgrade conditions beneath the plant structure are unknown. A geophysical survey utilizing GPR will be conducted to locate underground structures so that they may be avoided with probing tools during sampling efforts. These underground structures may also represent areas for further investigation.

Underground structures will be marked on the floor and mapped against existing plant site drawings. Sampling points will be located in close proximity to the underground structures.

2.6.2 Soil Vapor Survey

An active soil vapor survey will be conducted within and outside the perimeter of the plant building. An "active" soil vapor survey is a screening technique when used in conjunction with data from the GPR survey that can assist in locating potential sources of VOC releases. The technique involves direct collection of volatile organic vapors from the subgrade and analysis of the vapor samples by a laboratory.

Liquid phase VOCs migrating from a source through the vadose zone (unsaturated soils above the watertable) volatilize, filling pore spaces between soil grains with vapor in the vicinity of a release. The vapor concentrations generally decrease with distance from the source. As it moves toward increasing concentrations, the sampler may lead to the release source(s). Soil vapors should be easily sampled due to the sandy nature of the site soils.

Initially, a grid based on 100-foot centers will be used for sampling in the plant along with discretionary locations next to sub-grade sumps, clarifiers or piping connections as well as through expansion joints and floor cracks. Based on the area of the plant floor, at least 27 sample points will be located on this grid. Sample points will be off-set from the grid to avoid process equipment, utilities, and high traffic areas. Up to three vapor samples will be collected from each sample point: one at a depth of 3 feet below ground surface (bgs), one at a depth of 8-10 feet bgs, and if possible one near perched groundwater.

Vapor samples will be collected using a direct push sampling rig and the GeoProbe® "Post Run Tubing System" (PRT). The PRT is an active soil vapor sampling tip attached to the end of direct push sampling rods that are driven into the ground to the desired depth. The PRT and attached Teflon® tubing is lowered through the sample rod and is threaded to an expendable drive-point end. Following installation, each sample point will be allowed to "rest" for a minimum of 30 minutes before sampling to allow the disturbed soil and surrounding vapor to equilibrate. Sample probe installation will continue at other locations while the sample probe equilibrates.

The sampling process will proceed by attaching the free end of the Teflon® tubing to the sampling apparatus consisting of a flow meter, a port to insert a photoionization detector (PID) to monitor flow and vapor concentration during sampling, a 250 ml Tedlar® sampling bag and a vacuum pump. The sampling apparatus will be plumbed in-line ahead of the vacuum pump. Once connected, a mild vacuum will be applied to the system and the system will be purged of approximately two tube volumes at a flow rate of approximately 0.2 liters per minute. Air flowing through the drive point and up the tubing to the surface will be monitored with the flow meter to ensure that the appropriate volume of vapor is purged. The PID will be used to obtain an indication of the VOC concentration to avoid analytical instrument saturation.

Following purging the air flow will be diverted through a 250 ml Tedlar® bag in which the vapor sample will be collected. The Tedlar® bag will be filled while enclosed in a rigid container to prevent pressurization of the bag. The sample will be hand carried to the on-site laboratory for analysis of VOC concentrations using EPA Method 8260B.

As analytical results of the vapor analyses are obtained from the on-site laboratory, the concentrations will be mapped. Areas of elevated concentrations will be identified and at the completion of sampling on the 100-foot grid, additional sample points will be placed in the vicinities of elevated concentrations. Samples will be collected until maximum concentrations are determined. The soil vapor map will be compared to the GPR survey map. Areas of high vapor concentration, especially those coinciding with GPR anomalies, will warrant additional investigation.

2.6.3 Additional Investigations

Areas of high vapor concentrations coupled with GPR survey anomalies will require further investigation to assess concentrations of contaminants of concern in environmental media, and identify sources of contamination. Additional investigations will be conducted on a case-by-case basis and may include any of the following investigative techniques:

- Direct sampling of soils using a direct push rig.
- Direct sampling of groundwater using the Waterloo Profiler.
- Direct sampling of waste, if found.
- Vapor intrusion study.

If additional investigations are warranted, the field sampling plan will be amended to include investigative procedures.

2.7 Groundwater Assessment

The first and second stages of groundwater assessment identified a plume of impacted groundwater. The main contaminant of concern is 1,1-dichloroethene (1,1-DCE); groundwater samples will be analyzed for VOCs by EPA Method 8260B. The third stage of groundwater assessment at KEC and the City of Crystal Springs, Mississippi, will include the following activities in addition to the source investigation described in Section 2.6:

- Installation of permanent monitoring wells within the core of the groundwater contamination plume and outside the boundary of the plume as defined by the Waterloo Profiling assessment completed in 2005.

- Collection of groundwater samples and analysis of the samples for VOCs, as well as geochemical parameters that will be used to evaluate the migration and fate of the contaminant of concern.

- Collection of aquifer parameters to determine flow properties, including horizontal and vertical flow direction and velocity.

2.7.1 Well Installation

Monitoring wells will be installed to confirm the horizontal extent of contamination as determined during the preliminary groundwater assessment, the depth of contamination, flow velocities, and flow direction.

a) Single monitoring wells will be installed around the perimeter of the plume as delineated in the 2005 investigation. A single well will be installed within the plume and downgradient of the core of highest VOC concentrations within the plume. Each single well installed on the perimeter of the plume will be screened immediately above the top of the confining unit. The 2005 study indicated that the downgradient edge of the plume is situated at the top of the lower confining unit or hard layer. Wells screened at this depth will intercept the downgradient edge. The single well located within the plume will be screened in the core of the plume at the level of the highest concentration detected in 2005 preliminary assessment.

b) Two-well clusters will be installed within the plume and downgradient of the core of highest concentrations. The shallow well in each cluster will be screened across the water table. The deep well will be screened in the zone with the highest 1,1-DCE concentration as determined in the 2005 preliminary assessment.

c) Three-well clusters placed at shallow, intermediate and deep depths will be installed within the portion of the plume with the highest 1,1-DCE concentrations. The shallow well in each three-well cluster will be screened across the water table. The intermediate well will be screened in the core of the plume with the highest 1,1-DCE concentration. The deep well will be installed above the confining unit as determined in the 2005 preliminary assessment.

d) All wells will be screened to obtain representative groundwater samples. Well screens will be a maximum of 10 feet in length.

e) Wells will be installed by a state certified well driller using hollow stem rotary augers for the shallow wells and wet rotary for the deep wells. Surface casings will be installed in the deep wells that extend through the core of the plume to avoid carrying contaminated groundwater to the lower levels within the aquifer. Surface casings will be advanced through the upper soil zone and contaminant plume, and seated at the base of the plume. Once the casing is set in place, the base of the borehole and annulus between the borehole and the outer casing will be grouted using a lean cement and bentonite mixture consisting of a 30% solids pure bentonite grout with a minimum density of 10 lbs/gallon of water. Once in place, the bentonite grout will be allowed to cure for 24 hours.

If groundwater is present inside the surface casing it will be pumped out prior to further advancing the borehole. After the borehole is advanced to the desired depth a two-foot long well screen will be inserted into the borehole. The 0.010 inch slotted manufactured well screen attached to 2-inch diameter schedule 40 polyvinyl chloride (pvc) well casing will be set in the bottom of the borehole. A sand pack will be placed around the screen to a depth of 2 feet above the top of the screen. Bentonite pellets will be placed to 2 feet above the filter pack. The bentonite will be allowed to hydrate for 8 hours. The remaining annulus between the casing and the surface casing or borehole wall will be grouted to within 2 feet of the ground surface. A concrete collar and lockable, protective outer casing will be installed on each well.

f) A log of the borehole at each single well or well cluster location will be developed from soil samples described and classified under the supervision of a qualified geologist registered in the State of Mississippi. The soils in all single wells will be sampled with a split-spoon sampler during drilling and the lithology described by the field geologist. Soils in the deep well in each two well cluster will be sampled. Soil from the intermediate well and soils in the deep well below the bottom of the surface casing in each three-well cluster will be sampled using a split-spoon sampler.

g) During well installation, undisturbed samples of aquifer material (soils) will be collected and sent to a geotechnical soils laboratory for analysis of pH, grain size distribution, bulk density, permeability, total carbon and organic carbon.

h) Each well will be developed in accordance with MDEQ protocols. Well development will consist of surging the screened interval with a surge block or bailer and removal of water with suspended solids using a submersible pump. Field water quality and aquifer characteristic parameters including pH, specific conductance, oxidation reduction potential (ORP), dissolved oxygen, temperature, and turbidity will be measured as well development proceeds. Well development will proceed until clear representative formation water is produced and the analysis results for the water quality parameters stabilize.

i) All wellheads will be located horizontally and vertically to within 0.01 feet by a registered land surveyor. Elevations will be determined for the ground surface as well as the top of casing at each well.

2.8 Groundwater Sampling Plan

All wells will be sampled and analyzed for organic and inorganic parameters, which are described in Section 4.0. Low-flow sampling will be used for the monitoring wells. Low flow sampling is an appropriate sampling method for this site and the type of monitoring wells proposed in this work plan. The benefits of low flow sampling are:

- Minimum disturbance of the water column in the screened interval,
- Sample formation water without mixing of stagnant water from the casing above the screened interval,
- Minimum sample turbidity; no mobilization of otherwise immobile constituents such as metals,

- Small purge volume,
- Improved sample consistency.

Sampling activities will begin after all wells have been properly developed and water levels have stabilized. All observations and measurements made during sampling will be recorded in a bound field book by the field geologist.

a) Prior to sampling, the caps on each well will be removed and the water level allowed to equilibrate. Water levels will be measured in all wells to the nearest 0.01-foot and referenced to the top of casing elevation and ground elevation.

b) The sampling pump, a decontaminated Grundfos Redi-Flo 1/2 hp. submersible pump with new polyethylene tubing, will be carefully and slowly lowered into the well to a point immediately above the mid-point of the well screen in the deep and intermediate wells.

   The sampling points for wells with screens that bracket the water table will be determined after measuring water levels. At a minimum, the pump will be completely submerged but set above the bottom of the well screen.

c) To monitor drawdown during pumping, a water level indicator will be lowered into the well beside the tubing and wiring to the water table surface.

d) The pump will be slowly started and operated at a flow rate of less than 0.5 L/min while monitoring the water level. The outlet will be connected to a flow-through water quality cell to monitor pH, specific conductance, temperature, dissolved oxygen, oxidation/reduction potential, and turbidity. When the water quality parameters stabilize, the groundwater sample will be collected in approved sample containers provided by the laboratories. Each sample container will be marked with the well number, date, time, type of preservative, analytical parameters, and initials of the sampler. Once sealed, all sample containers will be placed in a cooler with ice, and cooled to 4° C for delivery to the on-site laboratory. Sample handling procedures are detailed in Section 4.

e) Water quality data will be recorded in the field book.

f) Before the first sample collected and between sampling of each well, the sampling pump and wire harness, water level indicator, water quality meter and any other tool or instrument that comes in contact with well water will be decontaminated using the following procedure:

- Disconnect used tubing from the pump and discard.
- Wash all outer surfaces of the pump, and water level indicator with phosphate-free soap and rinse with tap water.
- Pump deionized water through the pump and the flow-through cell.
- Rinse all outer surfaces with deionized water and air dry.

2.9 Aquifer Testing

The surficial aquifer is an unconfined, sedimentary formation (Citronelle) and consists of fine to coarse sand and gravel with interbedded silts and clays. The estimated average permeability of the formation from published data and based on estimates from soil grain size is 10^{-2} cm/sec.

Aquifer characteristics can be estimated by conducting a pump test. Ideally, the test should be performed close to the plume area but in an uncontaminated location. If the test is conducted outside the contamination plume, the following work is planned:

a) An unimpacted well will be selected or installed to be used as the pumping well. One observation well will be installed 30 feet and 150 feet from the pumping well. This arrangement may be modified as necessary to accommodate access or other pertinent issues.

b) A preliminary pump test will be conducted on the newly installed wells. The information collected during preliminary test will be used to determine:

- maximum drawdown in the pumping well
- pumping rate
- yield
- adequacy of observation well spacing

c) A 72-hour, constant-rate pump test will be conducted. Water from the pump test will be collected, sampled and, if clean, discharged to the POTW under a temporary discharge permit.

d) Pump test data will be used to determine:

- Specific capacity
- Transmissivity
- Storativity
- Hydraulic conductivity

Aquifer parameters may be estimated from slug tests conducted in new or existing wells. However, the sandy nature of the aquifer material may cause water levels to return to static levels rapidly and may prevent collection of useful data. Trial slug tests will be conducted to determine if this method is feasible.

If feasible, slug tests will be performed on three wells to determine the hydraulic conductivity of the upper hydrostratigraphic unit. Both a rising and falling head slug test will be performed. A pressure transducer connected to a data logger will be installed in the well to be tested. When the water in the well has been allowed to equilibrate following insertion of the transducers, a PVC blank or slug of known volume will be carefully lowered to the bottom of the well, which will cause the water level in the well casing to rise. Data will be recorded by the data logger as the water level in the well casing returns over time to its original level. As soon as the water level returns to normal, the slug will be quickly removed, leaving a void in the well screen. The data logger will record data as recharge occurs. Following slug testing on the three wells, data will be reduced and evaluated to determine the hydraulic conductivity for each well. The hydraulic conductivity and the hydraulic gradient, determined from the on-site water level measurements, will be used to calculate the average groundwater flow velocity.

2.10 Investigative Derived Waste Management Procedure

Management of investigative derived waste (IDW) will be the responsibility of the Field Project Manager. IDW includes, but is not limited to, soil cuttings, well development water, purge water, decontamination solutions and water, personal protective clothing, gloves, and any other material generated by field activities.

All solid IDW will be placed in open-top drums or designated roll-off box and stored in a secure location on the KEC plant site until removal to an appropriate disposal facility. Purge water will be placed in a designated polyethylene tank for storage until profiled and properly disposed of. The IDW will be profiled for disposal by either direct sampling and analysis of the material or using existing analytical data from the assessment activities. Drums and roll off boxes will be placed at the temporary storage area, catalogued, and labeled with date and contents. Drums and roll off boxes will be removed to a disposal facility within 90 days of final accumulation of the IDW. Properly containerized IDW will be manifested and disposed under KEC's EPA I.D. number.

3.0 ANALYTICAL PROGRAM

The analytical program involves laboratory analysis of organic compounds in both their vapor phase (Soil Vapor Survey) and dissolved liquid phase (Groundwater Assessment). All samples collected for Volatile Organic Carbon (VOC) analysis will be analyzed by the on-site laboratory, Environmental Chemistry and Consulting Services, Inc. (ECCS). Groundwater samples collected for analysis of organic and inorganic parameters related to aquifer geochemistry will be analyzed by Argus Analytical, Inc. Quality control duplicate and split samples will be analyzed by the off-site laboratory, Paradigm Analytical Laboratories, Inc.

3.1 Soil Vapor Analysis

The samples collected during the soil vapor survey will be analyzed for volatile organic compounds. The semi-volatile compounds including the tetrachlorobenzenes and pentachlorobenzene are not likely to volatilize sufficiently to sample. The on-site laboratory will analyze vapor samples using modified EPA Method 8260B. The modification to Method 8260B consists of the introduction of an aliquot of vapor sample to the mass spectrometer via direct injection or purge and trap.

3.2 Groundwater Analysis

The only compound detected above its TRG during the first and second stages of groundwater assessment that is associated with the apparent release(s) at the plant site is 1,1-dichloroethene. Several other aromatic compounds were detected at concentrations above their TRGs, but were associated with a fuel release at a gasoline station located on Highway 51.

Both the on-site and off-site laboratory will use EPA method 8260B to analyze groundwater for VOCs. The reporting limits established for water analysis by the on-site laboratory are 1.0 μg/L for VOCs. At least 10% of the samples will be sent to the off-site laboratory for quality control confirmation. Groundwater samples will be stored in a cooler on ice upon collection and transported to the on-site laboratory. Groundwater samples sent to the off-site laboratory will be stored in a secure refrigerator in the on-site laboratory until shipped.

Groundwater samples will be collected for aquifer geochemical parameters and will be analyzed for the following parameters:

- Methane/Ethane/Ethene
- Lithium
- Bromide
- Alkalinity
- Chloride
- Iron (ferrous and ferric)
- Manganese
- Nitrate Sulfate
- Sulfide
- Sodium
- Calcium
- Magnesium
- Potassium
- Total organic carbon
- Total dissolved solids

Carbonate and bicarbonate concentrations will be calculated based on alkalinity tests. The Quality Assurance/Quality Control Project Plan, which describes sample handling procedures and laboratory protocols, is included in Section 4.

4.0 QUALITY ASSURANCE /QUALITY CONTROL PLAN

As established by the MDEQ guidelines, all work related to the groundwater assessment on the KEC plant site will be performed in accordance with the USEPA, Region IV *Environmental Investigations, Standard Operating Procedures and Quality Assurance Manual,* November 2001 (EISOPQAM). Copies of relevant and applicable portions of the EISOPQAM will be maintained on site during all field activities and all field personnel will be trained in its implementation.

4.1 Sampling Objectives

The soil vapor sampling objective is to identify locations of potential sources of VOCs found in the groundwater contaminant plume. The soil vapor survey is a field screening tool used to determine VOC vapor concentrations in unsaturated soil above the water table. Data obtained from the analytical results and sample location distribution will be used to map vapor concentration gradients in the sub-grade. Increases in vapor concentrations may point to potential product or waste material release locations.

The groundwater sampling objective for the assessment work is to determine the horizontal and vertical distribution and extent of VOCs in groundwater, and to monitor the downgradient edge of the contaminant plume. Groundwater samples will be collected, by the field geologist, from the nine existing monitoring wells located on the KEC property and from the new proposed monitoring wells described in Section 2 of this work plan.

In addition the VOC analysis, groundwater samples will be analyzed for organic and inorganic constituents, the results of which will be used to evaluate the aquifer geochemistry.

4.2 Analytical Methods

Soil vapor samples will be analyzed for VOCs by the on-site laboratory, Environmental Chemistry Consulting Services (ECCS) of Madison, Wisconsin. The on-site laboratory will analyze the groundwater samples using modified EPA Method 8260B for VOCs, including mono-, di-, and trichlorobenzenes. This analytical procedure incorporates all the quality control rigors of Method 8260B including quantification based on 6 point calibration curves, continuing calibration verification, surrogate method performance monitoring, method blanks, laboratory control samples (LCS), and matrix spike/ matrix spike duplicate (MS/MSD) samples. Soil vapor sample analysis will not include a MS/MSD. However, 10% of the vapor samples will be re-analyzed as "in-lab" replicates. The reporting limits established for groundwater analysis are 1.0 µg/L. The reporting limits for vapor analysis are 0.2 parts-per-million (ppm) v/v and 0.01 ppm v/v for direct inject and purge and trap introduction, respectively.

At least 10% of all the groundwater samples collected will be split or blind duplicate samples and will be sent to the off-site laboratory, Paradigm Analytical Laboratories, Wilmington, NC. The off-site laboratory will analyze the same parameters as the on-site laboratory to verify the on-site laboratory results.

Groundwater samples collected for use in evaluating the aquifer geochemistry will be sent to Argus Analytical, Inc., Jackson, MS, and analyzed for the following parameters by the methods indicated:

Analyte	**EPA Method**
Methane/Ethane/Ethene	RSK SOP 175
Alkalinity	310.2
Chloride	352.2
Iron (ferrous and ferric)	010B
Manganese	6010B
Nitrate	353.2
Sulfate	375.2
Sulfide	376.1
Sodium	6010B
Calcium	6010B
Magnesium	6010B
Potassium	6010B
Lithium	6010B
Bromide	321.1
Total organic carbon	415.1
Total dissolved solids	160.1

Carbonate and bicarbonate concentrations will be calculated based on alkalinity tests.

At least 10% of all groundwater samples collected will be split or blind-duplicate samples and will be sent to the off-site laboratory, Paradigm Analytical Laboratory, Wilmington, NC. The off-site laboratory will analyze the same parameters as the on-site laboratory to verify the on-site lab results.

4.3 Key Personnel

The following is the list of key personnel dedicated to this project:

Field Project Manager: Robert Martin, Martin & Slagle GeoEnvironmental Associates, LLC

Duties: Field oversight of groundwater assessment activities, including field coordination efforts. Collection of samples. Maintenance of all field logs and records.

On-Site Laboratory

Manager: Joe Kubale, ECCS

Duties: Responsible for accepting custody of samples from the field personnel. Maintenance of laboratory records. Analyze samples.

QA/QC Coordinator: Christine Slagle, Martin & Slagle GeoEnvironmental Associates, LLC

Duties: Review daily sample logs. Confirm that QC samples are collected and sampling protocols are met. Assure that data quality objectives are met.

4.4 Quality Assurance Objectives for Data

The data quality objectives are pre-defined for the ECCS data in that Mississippi considers all on-site lab data screening level data. ECCS uses the same equipment and methodologies as the off-site lab. A total of 10% of the groundwater samples collected will be split and submitted to Paradigm Analytical Laboratory for confirmation analysis.

Following this procedure, the data will qualify as screening data with definitive confirmation under USEPA Region IV EISOPQAM guidelines.

For vapor samples, blank samples and LCS will be prepared with the sampling apparatus on a daily basis. Samples will be analyzed immediately upon receipt.

Groundwater samples designated for further VOC analysis by Paradigm will be delivered to the on-site lab in appropriate sample containers and stored in a refrigerator until shipped. If possible, six preserved VOC vials will be collected per sample to insure adequate sample volume for off-site and on-site laboratory analysis.

Equipment rinsates will be collected for evaluation of cross-contamination potential. These will be prepared by pouring deionized water over the sampling equipment after decontamination of equipment, and collecting and preserving the generated rinsate.

Field blanks will be collected. The field blanks will be prepared by filling sampling containers, which have been kept in the transition zone with distilled water. Trip blanks will be shipped with each cooler that is used to transport VOC samples to the off-site lab.

Blind duplicate samples will be collected for analysis and sent to both the on-site and off-site labs. Blind duplicates will be collected by filling extra sample containers. Blind duplicate sample containers will be marked only with the date of sampling and submitted to each laboratory for analysis. The origin, date, and time of sampling for each blind duplicate sample will be recorded in the field logbook.

4.5 Sample Control and Field Records

4.5.1 Sample Identification

Each sample will be assigned a unique alpha-numeric identifier that will be clearly recognizable by both laboratories. Sample labels will conform to the labeling requirements under section 3.2.1 of the EISOPQAM.

4.5.2 Chain of Custody Procedures

The field geologist will record the sample ID, date, and time sampled in the field logbook at the time of collection. Samples will be placed in a cooler on ice and transferred by the field geologist to the on-site laboratory. Upon arrival at the on-site lab, the samples will be transferred to the ECCS laboratory manager who will log each sample on ECCS chain of custody forms. Each sample will be assigned a unique ECCS internal ID for tracking purposes. The water samples will be stored in a sample refrigerator until analysis by the on-site lab or shipment to the off-site lab. The field geologist will fill out a new chain of custody form for samples sent to each laboratory, Paradigm or Argus Analytical, Inc., respectively. Vapor samples will be delivered to the on-site lab immediately upon collection. The samples will be analyzed immediately upon receipt by the on-site lab.

4.5.3 Field Records

Field records will be kept in accordance with procedures specified in section 3.5 of EISOPQAM.

4.6 Laboratory QA/QC

QA/QC for both labs is identical. Summaries of each laboratory's procedures follow.

4.6.1 On-Site Laboratory, ECCS:

- Continuing calibration standards analyzed every ten samples or less and at the end of a run (GC/MS criteria follows method specific tuning requirements per EPA 8260B).
- Blank and LCS samples analyzed every twenty samples or less with a minimum of one per day.
- MS/MSD samples analyzed every twenty samples or less with a minimum of one per day. MS/MSD will be analyzed for water samples only.

4.6.2 Off-Site Laboratory, Paradigm:

- Continuing calibration standards analyzed at least once every 12-hour shift plus a minimum of every 20 samples (GC/MS criteria follows method specific tuning requirements per EPA 8260B).
- Blank and LCS samples analyzed every twenty sample or less with a minimum of one per day.
- MS/MSD samples analyzed every twenty samples or less with a minimum of one per day.

4.7 Data Review and Validation

All laboratory reports will be reviewed for reporting accuracy and consistency with laboratory QA/QC protocols. The primary validation of the on-site lab data will be accomplished through comparison with the data from the off-site lab. The relative percent difference (RPD) between the laboratory's results for split samples will be calculated and compared to a 50% RPD acceptability threshold.

5.0 REPORT

A report will be prepared and submitted to MDEQ describing the findings of the Third Stage Comprehensive Groundwater Assessment. The report will include the details of the work that was performed; the analytical results; maps showing the direction of groundwater flow and velocity; the geometry of the plume; the laboratory data sheets; the chain of custody forms; groundwater well completion records, and associated boring logs.

6.0 REFERENCES

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