ARCADIS

Infrastructure, environment, buildings

ARCADIS
251 East Ohio Street
Suite 800
Indianapolis
Indiana 46204
Tel 317.231.6500
Fax 317.231.6514
www.arcadis-us.com

ENVIRONMENT

Ms. Jennifer Reno
Hazardous Waste Permits
Office of Land Quality
Indiana Department of Environmental Management
100 North Senate
Indianapolis, IN 46204-2241

Subject:
Class 1 Permit Modification Request
GM Former AGT Division, Indianapolis, Indiana, USEPA ID INR000021436

Date:
January 27, 2010

Contact:
Heather Gastineau-Lyons
Phone:
317-236-5214

Email:
heather.gastineau-lyons@arcadis-us.com

Our ref:
IN000297.0019.6

Dear Ms. Reno:

In accordance with 40 CFR 270.42(a), this letter serves as a request for a Class 1 permit modification on behalf of Motors Liquidation Company (MLC), (formerly known as General Motors Corporation (GM)) for the GM Former Allison Gas Turbine (AGT) Division surface impoundment that was closed as a land disposal facility (Facility) located in Indianapolis, Indiana (EPA ID INR000021436). The Post Closure Permit Renewal for the Facility was issued by the Indiana Department of Environmental Management (IDEM) on January 26, 2007.

As a result of GM's recent bankruptcy, the operating assets of GM were sold on July 10, 2009 to a newly formed company, which will be known as General Motors Company. Existing, non-continuing assets will remain the property of "old" GM, which changed its name to Motors Liquidation Company (MLC), in its capacity as a debtor-in-possession in the bankruptcy case. This Facility remained with MLC.

This Class 1 modification was completed to document the name change of the responsible party from General Motors Corporation to Motors Liquidation Company (MLC) currently has responsibility for this Facility. Provided below are the proposed changes to the Post Closure Permit.

Class 1 Modification Request:

1) MLC is requesting the last two paragraphs of Attachment A (General Description) of the Permit Renewal be changed to state the following:

"AEC Acquisitions Corporation has since sold Plant # 5 (including the former surface impoundment) to Rolls-Royce Corporation. To more effectively fulfill its obligation for post-closure care of the closed surface impoundment, GM purchased the property encompassing the former surface impoundment area from Rolls-Royce. As a result of GM's bankruptcy, the operating assets of GM were sold on July 10, 2009 to a newly formed company, known as General Motors Company. Existing, non-continuing assets (including the surface impoundment) will remain the property of "old" GM, which changed its name to Motors Liquidation Company (MLC), in its capacity as a debtor–in-possession in the bankruptcy case.

MLC is therefore, the current land owner of the Site. The Site is limited to the approximately 10 acre parcel as illustrated and described in Figure 3 and Appendix C. The Site address is 2701 West Raymond Street, and the ID number is INR000021436."

2) MLC is requesting Attachment B-1 (Written Inspection Plan) have the sixth sentence be revised to state the following:

   "Inspections will be performed by a MLC representative, or designee, familiar with the inspection procedure. Individuals performing post-closure inspections will be properly trained according to applicable RCRA and OSHA training requirements."

3) MLC is requesting updates to Attachment C-1(Post Closure Contact), specifically the reference to GM being changed to 'MLC' and the Project Manager for the project revised:

   "MLC (or its' designated representative) should be contacted if there are any questions concerning this project. The Vice President and Project Manager for this project are:

   James Redwine, Vice President, Environmental
   Motors Liquidation Company
   500 Renaissance Drive, Suite 1400
   Attn: James M. Redwine
   Detroit, MI 48243
   Telephone: 214-906-2146
   jredwine@alixpartners.com

   David M. Favero, Project Manager

Favero Geosciences
1210 South 5th Street
Springfield, Illinois 62703
Telephone: 217- 522-6714
dfavero@ameritech.net"

4) MLC is requesting updates to the reference 'GM' be changed to 'MLC' in the below Attachments:

   Attachment B-1(Written Inspection Plan)
   Attachment B-3(Inspection Log),
   Attachment C-1(Post Closure Contact),
   Attachment C-2(Post-Closure Security),
   Attachment C-5(Post Closure Cost Estimate),
   Attachment C-6b (Performance Bond),
   Attachment D-4d(4) (Chain-of-Custody)
   Attachment D-4d(7)(Statistical Determination) and
   Attachment D-4d(7)(a) (Statistical Procedure).

5) MLC is requesting updates to some misspelled words in the following:
   a) The ninth sentence of paragraph 4 of Section C-4b(2) Leachate Collection/Detection System Operation and Design, the word discharge is misspelled. The sentence should read: "The extracted groundwater is transmitted from the discharge building to the sanitary sewer line along Raymond Street."

   b) The second sentence of the first paragraph in Section D-4c(1)(d) Background Values, the word Attachment is misspelled. The sentence should read: "The statistical approach to establishing background values is included in Attachment D-4d(7)(a) and Appendix H."

   c) The first sentence of the first paragraph in Section D-4d(6) Annual Determination, the word downgradient is misspelled. The sentence should read: "Preparation of groundwater flow maps will allow confirmation that the upgradient well (MW-206B) continues to be upgradient and the downgradient wells (MW-201B, -202B and 2-03B) continue to be downgradient."

6) MLC is requesting updates to Appendix E of the Permit (Facility Identification and General Information). The new Owner/Operation information should be as follows:

"Owner/ Operator:
Motors Liquidation Company
500 Renaissance Drive, Suite 1400
Detroit, MI 48243
Attn: James M. Redwine"

The Emergency Coordinator for Sarah Fisher should be as follows:

"Sarah Fisher
ARCADIS
251 East Ohio Street, Suite 800
Indianapolis, Indiana 46204
First Phone Number: (317) 236-5213
Second Phone Number: 317-691-4011"

7) MLC is requesting updates to the reference 'GM' be changed to 'MLC' in all references in Appendix E.

8) MLC is requesting updates to Appendix E of the Permit (Emergency Coordinators), Alternate 1 be changed to the following:

"Alternate 1 Sarah Fisher, ARCADIS
First Phone Number: 317-236-5213
Second Phone Number: 317-691-4011

Alternate 2 Eric Moosbrugger
First Phone Number: 317-236-5212"

9) MLC is requesting updates to Appendix E of the Permit (Emergency Response Procedure for Spills), This page should be updated to read:

"Emergency Response Procedures for Spills

Immediately Upon Discovery of an Emergency

An employee discovering a spill involving hazardous waste will call:

Emergency Procedure

Rolls Royce Plant 5 Security (adjacent facility formerly owned by General Motors Corporation) 230-5555

Emergency Coordinators:

Principle: **Dave Favero**
1210 South 5th Street
Springfield, Illinois 62703
First Phone Number: (217) 522-6714
Second Phone Number: (217) 793-1695

Alternate: **Sarah Fisher**
ARCADIS
251 East Ohio Street, Suite. 800
Indianapolis, Indiana 46204
First Phone Number: (317) 236-5213
Second Phone Number: (317) 691-4011

Alternate: **Eric Moosbrugger**
ARCADIS
251 East Ohio Street, Suite. 800
Indianapolis, Indiana 46204
Phone Number: (317) 236-5212"

10) MLC is requesting updates to Appendix E of the Permit where all references of the address for ARCADIS be changed to:

    251 East Ohio Street, Suite 800

11) MLC is requesting to update Appendix E of the Permit (Required Reports) and capitalize 'Waste' (second to last sentence).

12) MLC is requesting the addition of the following in Appendix E of the Permit (Amendment of Contingency Plan) (first sentence):

    "MLC, or its representatives, will review and amend this contingency plan whenever the following situations apply:"

13) MLC is requesting the addition of the following in Appendix E of the Permit (Evacuation Plan) (second paragraph):
    "If evacuation is necessary, the contract employee will exit through the northeast gate. Drawing 1 contains the evacuation plan for the Site."

14) MLC is requesting updates to the reference 'GM' should be changed to 'MLC' in Appendix H: Sampling and Analysis Plan of the Permit. Section 2 (Background) of Appendix H paragraph should now read:

"The Site is located within the Rolls-Royce Corporation Plant 5 property boundary, east of Tibbs Avenue at 2701 West Raymond Street in Indianapolis, Indiana. In December 1993, General Motors Corporation (GM) sold its Allison Gas Turbine Division to AEC Acquisition Corp. AEC Acquisition Corp. changed their name and operated as the Allison Engine Company. Allison Engine Company then sold the plant to Rolls-Royce Aerospace. The plant is now doing business as Rolls-Royce. According to the Asset Purchase Agreement, GM retained post-closure care obligations at the Site. To more effectively fulfill its obligation for post-closure care of the closed surface impoundment, GM purchased the property encompassing the former surface impoundment area. As a result of GM's bankruptcy, the operating assets of GM were sold on July 10, 2009 to a newly formed company, which is now known as General Motors LLC. Existing, non-continuing assets (including the closed surface impoundment) remained the property of "old" GM, which changed its name to Motors Liquidation Company (MLC), in its capacity as a debtor–in-possession in the bankruptcy case. MLC is therefore, the current land owner of the Site. The Indiana Department of Environmental Management (IDEM) has deemed that the post-closure care period for the Site began on June 4, 1996."

15) MLC is requesting updates to all references of 'GM' being changed to 'MLC' in Appendix H: Sampling and Analysis Plan in Section 3.2 (Groundwater Chemical Monitoring) of the Permit.

16) MLC is requesting to update the acronym page in Appendix H: Sampling and Analysis Plan of the Permit:
ADD the following acronyms:
    a. ANOVA — Analysis of Variance
    b. GOF — Goodness of Fit
    c. IAC — Indiana Administrative Code
    d. IDEM — Indiana Department of Environmental Management
    e. IQR — Interquartile Range
    f. KM — Kaplan-Meier
    g. MLC — Motors Liquidation Company
    h. ROS — Rank-Ordered Statistics

i. SK Seasonal-Kendall

REMOVE the following acronym:

j. IDEM Indiana Department of Environmental Management

17) MLC is requesting to update the Appendix H: Sampling and Analysis Plan of the Permit, the first paragraph of Section 3.1 Hydraulic Monitoring Program to read:
‘Six monitoring well pairs (MW-201 A/B and 204 A/B through MW-208 A/B), two three-well groups (MW-202 A/B/C and MW-203 A/B/C) and one individual well (MW-200C) will be gauged semi-annually for depth to groundwater and total depth. The well pairs are screened in the upper sand and gravel unit/aquifer on either side (interior or “A” wells and exterior or “B” wells) of the slurry wall containment installed during the closure activities at the Site. The well groups are screened in the upper sand and gravel unit on either side of the slurry wall containment (“A” and “B” wells) and in the lower sand and gravel unit outside of the slurry wall containment (“C” wells). A summary of procedures that will be followed in completing post-closure care hydraulic monitoring activities is discussed in Section 4.1. In addition, the following items will be check every 90 days during inspection: 1) if the integrity of the concrete pads for the monitoring wells is adequate, 2) if the protective casings for the monitoring wells are damaged, 3) if the locks for the protective casings are in adequate condition and 4) if monitoring well labels are in place and readable. During each semi-annual sampling and gauging event, each well will be checked for sediment accumulation in the monitoring wells. Sediment accumulation and well redevelopment is described in Section 5 below.’

18) MLC is requesting to update Appendix H: Sampling and Analysis Plan of the Permit, Section 3.2 Groundwater Chemical Monitoring, the second paragraph, first sentence of to read:
”During the groundwater sampling, field measurements for temperature, conductivity, oxidation reduction potential (ORP), dissolved oxygen (DO), pH, and turbidity will be obtained, and one sample from the background well MW-206B and one sample from each of the three downgradient wells (MW-201B, MW-202B, and MW-203B) will be collected for analysis for dissolved arsenic, barium, cadmium, chromium, lead, mercury, silver, selenium, and cyanide.”

19) MLC is requesting to update Appendix H: Sampling and Analysis Plan of the Permit, Section 4.2 Groundwater for Chemical Analysis, the fourth paragraph, last two sentences to read:
”The field indicator parameters (pH, temperature, conductivity, ORP, DO and turbidity) will be measured through a flow-through cell and monitored every five minutes during the purging of the well. Stabilization is considered to be achieved when the final groundwater flow rate is achieved, and three consecutive readings for each parameter are within the following limits:”

20) MLC is requesting to update MLC is requesting to update Appendix H: Sampling and Analysis Plan of the Permit , Section 4.6 Calibration methods for Field Equipment, the first paragraph, first sentence to read:
“Field indicator parameter sensors (pH, ORP, conductivity and DO) will be calibrated the start of the sampling event using an appropriate calibration fluid.”

21) MLC is requesting to update Appendix G: Industrial Discharge Permit # 342403 to the current approved permit. The Permit should appropriately reference Appendix G in Section C-4b(2) Leachate Collection/Detection System Operation and Design, the fourth paragraph, last sentence to read:
“The total flow is submitted to the City according to the requirements of the Industrial Waste Discharge Permit (Appendix G).”

ARCADIS

In accordance with 40 CFR 270.42(a), ARCADIS, on behalf of GM, will make the required notification to interested parties within 90 calendar days of the date of this letter.

If you have any questions regarding these comments, please contact us at 317-231-6500 or David Favero at 217-522-6714.

Sincerely,

ARCADIS

Heather Gastineau-Lyons
Geologist

Jason Cosgrove, P.E.
Senior Engineer

Enclosures:

Permit Application (paper, electronic MS Word)
Appendix E: Contingency Plan (paper, electronic MS Word)
Appendix H: Sampling and Analysis Plan (paper, electronic MS Word)
Permit Modification Letter dated January 27, 2010 (paper, electronic pdf)

Copies:

David Favero, Favero Geosciences (Representing MLC) (paper and CD)

Infrastructure, environment, buildings

Imagine the result

Post-Closure Permit Application

GM Former AGT Division

Closed Surface Impoundment

USEPA INR000021436

Resubmitted January 2010

ARCADIS

Post-Closure Permit Application

GM Former AGT Division

Closed Surface Impoundment

USEPA INR000021436

Prepared for:

Motors Liquidation Company

Prepared by:

ARCADIS G&M, Inc.

251 E. Ohio Street

Suite 800

Indianapolis

Indiana 46204

Tel 317 231 6500

Fax 317 231 6514

Our Ref.:

IN000297.0018

Date:

27, January, 2010

bgs	Below Ground Surface
cm/s	centimeter/second
EQLs	Estimated Quantitation Limits
GCL	geosynthetic clay liner
GM	General Motors Corporation
gpm	gallons per minute
IDEM	Indiana Department of Environmental Management
MLC	Motors Liquidation Company
MSL	Mean Sea Level
NPDES	National Pollutant Discharge Elimination System
OSHA	Occupational Safety and Health Administration
PVC	polyvinyl chloride
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
TOC	Total Organic Carbon
TOX	Total Organic Halogens
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WWTP	Waste Water Treatment Plant

Appendices

Attachment A Facility Description

A-1 General Description

This application is being submitted as a renewal for the post closure permit which identifies the procedures and methods to be used to monitor and maintain the GM Former AGT Division surface impoundment (Site). The Post-Closure Permit was issued by the Indiana Department of Environmental Management (IDEM) on June 21, 2001, to the permittee (GM Former AGT Division).

The GM Former AGT Division (Site) is located in the southwestern portion of Indianapolis, Indiana in the NW 1/4 of Section 21, TI5N, R3E, Marion County (Figure 1). The Site is located within the boundaries of the Rolls-Royce Corporation Plant 5. The Rolls Royce Plant 5 is located in a heavily industrialized area and is primarily engaged in the manufacture and testing of gas turbine engines and diesel engine components. Manufacturing processes include plating, etching, anodizing, photo etching, machining, polishing and degreasing. These processes generate spent degreasers, spent acid and caustic solutions, spent chromic acid solution, spent cyanide solutions and plating bath sludges, waste oils and process wastewaters.

The former surface impoundment covered approximately 8 acres, as depicted in Figure 2. The surface impoundment previously received water from several sources prior to discharging to Eagle Creek under NPDES Permit Number IN000I813. Influents to the surface impoundment during its over 40 years of operation included precipitation run-off, boiler blowdown water, water softener rinsewater, ash quenching water, non-contact cooling water, and effluent from the WWTP. IDEM determined that the surface impoundment was used to treat F007 and F009 waste resulting in the impoundment being classified as a hazardous waste impoundment. Tables 1 through 4 provide sediment samples characterizing the waste at the Site. Additionally, Table 1 attached in Appendix J provides groundwater analytical results from 2002 to 2005 characterizing groundwater quality.

A Closure Plan, dated August 23, 1991, was prepared for the surface impoundment and approved by IDEM in 1992. The Closure Plan included: a soil-bentonite cutoff wall located around the perimeter of the impoundment and keyed into an underlying fine-grained layer; solidified sediment by mixing with a cement-fly ash grout; a composite cap system including a soil barrier and PVC liner; a groundwater control system to ensure an inward hydraulic gradient; and routine monitoring and inspection during both closure and post closure periods. The Closure Plan was later modified and approved by IDEM to include solidified sediment by consolidation surcharge instead of the cement-fly ash grout mixture.

Construction commenced in September 1992 with the soil-bentonite cutoff wall installation. The cutoff wall installation was completed in November 1992. The consolidation surcharge was constructed between April 1993 and November 1993. The composite cap and groundwater control network were completed between May 1994 and November 1994.

A Certification of Closure Report, dated September 15, 1995, was prepared and submitted to IDEM. The Certification of Closure Report included the Certification of Closure, and summaries of the results of quality control/quality assurance (QA/QC) testing and observations made during construction of the soil bentonite cutoff wall, consolidation surcharge, composite cap and groundwater control system at the Site. IDEM reviewed the Certification of Closure Report and sent GM a Notice of Deficiency in a letter dated April 18, 1996. An amendment to the Certification of Closure report responding to the noted deficiencies was submitted to the IDEM on May 30, 1996. The Certification of Closure was accepted by the IDEM and the total closure was considered complete as described in IDEM's March 4, 1997 letter. Based on a September 16, 1997, letter from Mr. Victor P. Windle, Chief, Hazardous Waste Permit Section, the 30-year post-closure care period began on June 4, 1996.

On or about December 1, 1993, General Motors Corporation sold Plant # 5 (i.e., the Rolls-Royce Plant), including the surface impoundment, to AEC Acquisitions Corporation. Pursuant to terms of the sales agreement, GM was to maintain responsibility for post-closure care of the surface impoundment.

AEC Acquisitions Corporation has since sold Plant # 5 (including the former surface impoundment) to Rolls-Royce Corporation. To more effectively fulfill its obligation for post-closure care of the closed surface impoundment, GM purchased the property encompassing the former surface impoundment area from Rolls-Royce. As a result of GM's bankruptcy, the operating assets of GM were sold on July 10, 2009 to a newly formed company, known as General Motors Company. Existing, non-continuing assets (including the surface impoundment) will remain the property of “old” GM, which changed its name to Motors Liquidation Company (MLC), in its capacity as a debtor–in-possession in the bankruptcy case.

MLC is therefore, the current land owner of the Site. The Site is limited to the approximately 10 acre parcel as illustrated and described in Figure 3 and Appendix C. The Site address is 2701 West Raymond Street, and the ID number is INR000021436.

A-2 Topographic Maps

Topographic maps containing the information specified in 40 CFR 270.14 are included as Figures 3 and 3a. Due to the size of the Site, Figure 3c was prepared to show Site features and surrounding land use.

A-3 Floodplain Standard

The Site is not within the 100-year floodplain, as defined by the Federal Emergency Management Agency. Refer to Figure 4 for the Site location with respect to the 100-year floodplain.

A-4 Post-Closure Notices

GM has submitted to the City of Indianapolis, Department of Metropolitan Development, and the Commissioner (via Mr. Victor P. Windle, Chief, Hazardous Waste Permit Section), a survey plat, prepared and certified by a registered land surveyor, indicating the location and dimensions of the closed surface impoundment unit with respect to permanently surveyed benchmarks. A note, which was prominently displayed on the survey plat, states GM's obligation to restrict disturbance of the closed unit. A record of the type, location and quantity of hazardous wastes remaining in the closed surface impoundment unit was also included in the same submittal. A copy of the notice to the local authorities is attached in Appendix A.

GM recorded an environmental disclosure with the Marion County Recorder's Office on May 7, 1997. The disclosure includes the following notations:

1. The land has been used to manage hazardous wastes and the legal description of the surface impoundment;

2. Its use is restricted under 40 CPR 264 Subpart G regulations; and,

3. The survey plat, and characterization, location and quantity of the hazardous wastes remaining in the closed surface impoundment unit have been filed with the Division of Permits, Department of Metropolitan Development, City of Indianapolis and with the Commissioner.

A copy of the environmental disclosure is also attached in Appendix A. GM also submitted a certification to the Commissioner on May 19, 1997 that the notation specified above had been recorded (Appendix A). A copy of the document in which the notation has been placed was submitted with the certification. GM certified the environmental disclosure in the original post-closure permit application submitted for this Site.

Attachment B Post Closure Inspection Requirements

B-1 Written Inspection Plan

To ensure adequate performance of the final cover, security control, run-on/run-off control, the groundwater control system and the groundwater hydraulic monitoring system, MLC will conduct periodic inspections throughout the remainder of the post-closure care period. The inspection procedures are presented on the inspection checklists (Figure 5) and are described in the following sections. Inspections were performed monthly from December 1994 to September 1998. Inspections after September 1998 have been performed approximately at least every 90 days; therefore, future inspections will be performed approximately at least every 90 days. This inspection frequency is adequate given the nature of the wastes in the impoundment, closure methods, Site features, and experience. Inspections will be performed by a MLC representative, or designee, familiar with the inspection procedure. Individuals performing post-closure inspections will be properly trained according to applicable RCRA and OSHA training requirements. Copies of this post-closure permit application and inspection checklists will be maintained in cabinets in the Rolls-Royce Environmental Department's office as the Site is not active or manned and does not have a building with a controlled environment. The documents will be maintained throughout the post-closure period. The following items will be checked at each inspection.

B-1a Security Control Devices

The impoundment is located adjacent to industrial property and is surrounded by a six foot high chainlink security fence (no barbed wire will be on top of the fencing) (Figure 3c). The post-closure inspections will be conducted quarterly and will only pertain to that fencing that directly encloses the closed unit. Additional fencing will be installed, if required, to ensure that unauthorized personnel cannot gain access to the Site. Periodic inspections will consist of checking for storm damage, vandalism and deterioration. In addition, warning signs will be inspected to verify they are still hanging properly on the fence and are readable from a distance of at least 25 feet from the sign. Repairs to the fence or warning signs will be performed within 3 months of discovery. Any damage or deterioration that would allow unauthorized access will be corrected immediately.

B-1b Erosion Damage

The area with final cover and extending to the center line of the perimeter drainage ditch will be visually inspected quarterly. Erosion gullies exceeding 3 inches in depth will be marked and repaired when appropriate weather conditions occur (generally the spring or fall of the year).

B-1c Cover Settlement, Subsidence and Displacement

A series of 8 settlement monuments have been installed in the final cover system. The monuments were surveyed semi-annually for the first 3 plus years of post-closure (through November 1999) and will be surveyed annually thereafter. If settlement is noted during the visual inspection (quarterly) the markers will be surveyed as soon as possible following the inspection to measure the amount of settlement. If the benchmarks are damaged, the benchmark will be replaced and resurveyed within 3 months and as weather permits. Any subsidence/settlement observed will be corrected during appropriate weather conditions in the spring or fall of the year.

B-1d Vegetative Cover Condition

The cover system will be inspected quarterly for bare areas and quality of vegetation. Problem areas will be noted on the inspection checklist and accompanying figure. If overall growth of vegetation is poor, soil samples may be obtained and analyzed to assess appropriate applications of lime and fertilizer. If fertilizer is needed, the composition will be adjusted according to the sample results. Reseeding and/or fertilizing of bare areas will be performed during appropriate weather conditions either in the spring or fall of the year.

B-1e Integrity of the Run-on and Run-off Control Measures

The two culverts that drain run-off from the perimeter ditch will be visually inspected quarterly to look for obstructions. In addition, the perimeter ditch will be visually inspected quarterly to look for areas where water could potentially pond. Any hindrances to flow in the drainage culverts or perimeter ditch will be removed during appropriate weather conditions.

B-1f Cover Drainage System Function

Discharge points of the cover drainage system will be inspected quarterly for obstructions. Obstructions will be removed during the inspection if possible, or within 3 months of discovery.

B-1g Gas Venting Systems

The gas venting system will be inspected quarterly for obstructions. Obstructions will be removed during the inspection if possible, or within 3 months of discovery.

B-1h Integrity of the Cutoff Wall

The integrity of the cut-off wall is observed through evaluation of the groundwater level measurements that are collected semi-annually (See Attachment C-4b(2) and Appendix H). The water level data is evaluated semi-annually to determine the elevation of the groundwater level inside the cut-off wall relative to the elevation of the groundwater in monitoring wells outside of the cut-off wall and the rate at which the water levels inside the cut-off wall are increasing. The rise rate is calculated (feet/day) be taking the change in groundwater elevation from any individual well from two different sampling periods divided by time (days). Any trend in the rates over time can be observed by comparing rates from different time periods. Attachment C-4b(2) of the Permit Application has been revised to include this process.

If groundwater level rates increase over a short time period the integrity of the cut-off wall may be compromised. Therefore, necessary corrective actions will be evaluated. The Post-Closure Care cost estimate (Table 5) provides the cost estimate to repair 10% of the total 2,219 lineal feet of the cut-off wall.

B-1i Well Condition

Protective casings, locks, and concrete surface pads will be inspected quarterly for integrity, tampering and erosion of soil from around the pad. Well numbers must be visible on the protective casings. Repairs to the casings, pads, or well number will be performed within 3 months of discovery. Additionally, the monitoring wells will be gauged during the semi-annual groundwater sampling events to evaluate the degree of siltation in the monitoring wells. The monitoring wells will be redeveloped within 3 months of discovery if greater than one foot of siltation is noted in the well (i.e. the total depth of the well is measured to be less than the total depth indicated on the revised monitoring well construction diagrams by one foot or more) (Appendix H). The monitoring wells from which samples are collected will be abandoned and replaced within 3 months of discovery if over 50% of the screened interval is filled with silt during the first monitoring event following redevelopment. Redevelopment procedures are described in Appendix H. Monitoring wells only used for hydraulic monitoring purposes will be evaluated to determine if replacement is necessary.

B-1j Extraction Well System

The extraction well system control box will be visually inspected on a quarterly frequency to determine if the control panel is properly functioning. In addition, each extraction well will be turned on at a frequency of at least yearly to verify that each well is functioning properly and inspected to ensure the integrity is adequate of covers of the concrete vaults housing the extraction wells (checked every 90 days). Any repairs to the extraction well system will be performed within 3 months of discovery that a repair is needed.

B-2 Inspection Remedial Actions

Remedial actions that may be required as a result of inspections are identified in Attachment B-1.

In the event that post-closure care remedial actions are necessary on the cover of the impoundment, a culvert and earthen drive to provide for access over the perimeter ditch to the top of the impoundment may be constructed in the northeast portion of the impoundment (Figure 3c). The culvert will allow for continued drainage of runoff through the perimeter ditch. The drive will provide access for maintenance vehicles to the cap area and minimize damage to the drainage ditch and vegetative cover.

B-3 Inspection Log

Notes will be made of all observations and measurements on inspection checklists and approximately located on a figure of the surface impoundment (Figure 5). Inspection checklists will be maintained by MLC at the adjacent Rolls-Royce Environmental Department's Office for review during the post-closure care period. These records will include the date and time of inspection, name of the inspector, a notation of the observations made. Where repair is needed, a brief description of the work required will be included on the inspection form. As work is completed, a memorandum will be placed in a maintenance file and maintained with the post-closure care records.

Attachment C Post Closure Plan

The following is the post-closure plan for the former surface impoundment area. The post-closure plan is based on the post closure permit previously approved by IDEM. Based on a September 16, 1997, letter from Mr. Victor P. Windle, Chief, Hazardous Waste Permit Section, the 30-year post-closure care period began on June 4, 1996.

C-1 Post Closure Contact

MLC (or its' designated representative) should be contacted if there are any questions concerning this project. The Vice President and Project Manager for this project are:

James M. Redwine, Vice President, Environmental
Motors Liquidation Company
500 Renaissance Drive, Suite 1400
Detroit, MI 48243
Attn: James M. Redwine
Telephone: 214-906-2146

jredwine@alixpartners.com

David M. Favero, Project Manager
Favero Geosciences
1210 South 5th Street
Springfield, Illinois 62703
Telephone: (217) 522-6714
dfavero@ameritech.net

C-2 Post-Closure Security

A 6 foot tall chain-linked fence will surround the entire cap area. There are access gates in the northeast, northwest, and southwest comers of the fence which are kept locked at all times except during maintenance and monitoring activities. The fence location is shown in Figure 3c. Warning signs marked "DANGER UNAUTHORIZED PERSONNEL KEEP OUT", “DO NOT ENTER AUTHORIZED PERSONNEL ONLY” or similar language to indicate only authorized personnel are allowed to enter the area are posted on each of the gates and around the perimeter of the fence. The gates are each padlocked such that only MLC, the Security Personnel at Rolls-Royce, and certain firms retained by MLC to perform post-closure care, have keys with which to enter the area. The potential for human contact with the sediment is also minimized due to the composite cap construction.

C-3 Request for Waiver of Preparedness and Prevention Requirements

The Site is an unmanned grass-covered field in which no hazardous wastes are stored; therefore, an alarm system is not necessary. Therefore, a partial waiver is requested to eliminate the need for an alarm system at the Site. The inspector or anyone completing work at the Site will carry a cell phone for communication purposes. Additionally, a fire extinguisher is housed inside the two buildings located on Site.

The Contingency Plan for the Site is attached in Appendix E.

C-4 Landfill Maintenance Plan

C-4a List of Wastes

A list of the various influent liquids that the surface impoundment formerly received while it was in operation is included in Section A1 General Description. The EP toxicity and total constituent analyses from the sediment sampling are included as Tables 1 through 4. IDEM determined that the unit was used to treat F007 and F009 waste, therefore IDEM classified the Site as a hazardous waste impoundment.

C-4b Liner and Cap System Description

C-4b(1) Liner System Foundation Description

The impoundment does not have a synthetic liner on the bottom or sides of the impoundment. However, the former surface impoundment is considered to be contained by the following: a soil bentonite cut-off wall around its perimeter; natural clay underlying the former surface impoundment area; and, a composite cap system.

A soil-bentonite cutoff wall was constructed around the perimeter of the surface impoundment and keyed into the underlying clay layer. Based on the geotechnical studies during the development of the Closure Plan, the clay layer is reported (Geraghty and Miller, 1991; refer to Appendix D) to have a hydraulic conductivity of 6.1 x 10^{-7} centimeters per second (cm/s). Based on the construction quality control/quality assurance (QC/QA) testing, the soil-bentonite cutoff wall is estimated to have an average hydraulic conductivity of approximately 2 x 10^{-8} cm/s. Bentonite powder used in the construction of the cutoff wall consisted of Federal Jel 90, manufactured by M-I Drilling Fluids Company of Houston, Texas. The cutoff wall is a linear distance of 2,219 feet, a total of 3 feet wide and is keyed into the underlying clay at approximately 55feet below ground surface. The perimeter of the cutoff wall is shown on Figure 3. A cross-section reference sheet and a cross-section of the cutoff wall are provided as Figures 5a and 5b, respectively.

The cap system, from top to bottom, is as follows: 3.5 feet of vegetative cover and topsoil; geotextile filter; geonet; 40-mil PVC liner; and either 2 foot soil barrier with hydraulic conductivity less than 1 X 10^{-6} cm/s (United Soil

Classification System (USCS) code of 'CL' representing a sandy silty clay) or geosynthetic clay liner (GCL). The geotextile filter and geonet were manufactured by the National Seal Company. The geotextile filter is 0.24 inches thick. The geonet is a 'poly-net 2000/3000' and is 0.16/0.2 inches thick. The 40-mil PVC liner was manufactured by Nan Ya Plastics Corporation of America and is 1.238 millimeters thick.

The final contours of the cap are shown in Figure 6. Figure 7 displays the area of the cap in which the GCL was installed. A cross-section of the final cover system is included in Figure 8. The GCL was used over approximately 10% of the Site, which may not have contained an adequate 2 foot barrier soil.

C-4b(2) Leachate Collection/Detection System Operation and Design

Nine groundwater extraction wells are located inside the perimeter of the cap area, and 16 hydraulic head monitoring wells are located in pairs on the inside and outside of the cutoff wall (Figures17 and 18). Construction details for monitoring and extraction wells located inside the cutoff wall are found in Appendix F. Figure 2 shows the transmission piping from the extraction wells to the discharge building. In addition, 3 monitoring wells were installed outside of the containment area into the lower aquifer. The groundwater extraction system, hydraulic monitoring systems, and cut-off wall substitute for the leachate collection system. Refer to Figure 2 and Figure 3c for locations of the extraction wells and hydraulic head monitoring wells.

A temporary groundwater extraction system of 6 extraction wells was installed in June 1993, during the consolidation surcharge construction. This temporary system was operated until the end of June 1994, when it was taken out of service to begin construction of the permanent system of 9 extraction wells within the cut-off wall. Once the temporary system was taken out of service, the groundwater elevations in the perimeter paired monitoring wells were measured approximately weekly to monitor the performance of the cut-off wall and soil barrier. Figures 9 through 16 plot the groundwater levels for each pair or pairs of monitoring wells with respect to time. In the figures, "A" represents the interior monitoring well, "B" represents exterior monitoring wells and "C" represents the lower aquifer monitoring wells. As can be seen in the attached figures, the recovery in the interior monitoring wells was slow, and inward hydraulic head differences of 8 to 12 feet were maintained across the cutoff wall without any groundwater being removed from the containment area, and without the PVC liner installed over the soil barrier.

In November 1994, the permanent groundwater extraction system was placed into service. Historical groundwater elevation data from 1985 to 1990 from within the cap area was reviewed to estimate the range of local groundwater fluctuations. Groundwater levels in the upper aquifer in this area during that period were measured between elevations 659 and 670. During the 1980's, groundwater withdrawal at the Site for operational use was higher than its current rate, thus causing the water table to be lower than its current levels. Because of the ranges of groundwater elevations observed between 1985 to 1990, a groundwater elevation of 663 feet was originally established as the elevation at which extraction well pumps would be started. However, more recent groundwater monitoring data suggests that the groundwater potentiometric level in the lower sand and gravel unit is approximately at an elevation of 666 to 670 feet and that the rate of rise in the containment area is very slow (0.003 feet per day). Table 3 attached in Appendix J provides the historical and current groundwater elevation data and the calculated rise rate for November 2005. Based on the very slow water level rise rate observed in the interior of the containment area, semi-annual monitoring of hydraulic head will provide ample time to commence pumping if necessary to maintain the prescribed head differential. Therefore, extraction wells will be manually turned on when groundwater elevations in one or more of the "A" series interior wells reach an elevation within 1 foot of the groundwater elevation observed in either aquifer (B and C series monitoring wells). .

The nine extraction pumps are normally in the ‘off’ position and may be manually turned on when the control button is moved to the ‘hand’ position. Generally, one or more extraction wells are turned on so that the pumping rate does not exceed the current discharge limit of 200 gallons per minute (all 9 wells are generally not activated at one time). Each extraction well pumps groundwater at approximately 25 gallons per minute (gpm). Pumping approximately 800,000 gallons of groundwater from the interior of the slurry wall lowers the water level in the interior of the slurry wall by about one foot. Therefore, in order to lower the water level in the interior of the slurry wall by 1 foot using one extraction well, it is estimated to take 22 days. The extraction wells are operated until they lower the groundwater level within the slurry wall to approximately 2 to 3 feet below the initial level. Because the recovery rates are low (0.003 feet per day), the extraction wells have been pumped every 2 or

3 years. The total amount of liquid pumped from the extraction wells is measured by a flow meter/totalizer located in the discharge building. The extracted groundwater is transmitted from the discharge building to the sanitary sewer line along Raymond Street. Upon completion of pumping, the extraction wells are manually returned to the ‘off’ position. The amount of liquid pumped and the total time (in days) pumped is recorded and provided in an annual report to IDEM submitted by March 1 of every year. The total flow is submitted to the City according to the requirements of the Industrial Waste Discharge Permit (Appendix G).

The inward hydraulic gradient is demonstrated by measuring groundwater elevations in monitoring wells installed within and outside the cut-off wall perimeter, and the upward hydraulic gradient is demonstrated by measuring groundwater elevations in monitoring wells installed in the lower aquifer. This will ensure that groundwater flow direction will be into the waste material, and prevent any release of waste constituents into the groundwater outside the cutoff wall. The groundwater elevations in the hydraulic head monitoring wells will be measured semi-annually to verify the inward hydraulic gradient and to allow for calculation of the rise rate of the groundwater inside the cut-off wall. The conceptual groundwater control and hydraulic monitoring system showing groundwater elevations in the two sand and gravel units, as well as inside the surface impoundment from November 2005 is attached as Appendix J.

For the post-closure care period, the groundwater monitoring will include the hydraulic head monitoring at 8-paired wells and 3 wells in the lower sand unit.

C-4c&d Run-On/Run-Off Control

A storm sewer is located around the perimeter of the cap area. A drainage ditch is located around the perimeter of the cap to collect storm water from both the cap area and outside the perimeter that drains to the ditch. Any storm water which percolates through the vegetative cover and topsoil to the PVC liner will drain toward the edge of the cap to be collected by drainage piping which rests on top of the geonet and below the geotextile. The drainage piping connects to the perimeter drainage ditch on the northern, southern, eastern and western edges of the cap. The drainage ditch connects to the storm sewer in the northeast and southwest comers of the cap. Refer to Figure 8 for the layout of the perimeter drainage ditch and drainage piping.

C-4e Cap Maintenance

C-4e(1) Erosion Damage

The area with final cover and extending to the center line of the perimeter drainage ditch will be visually inspected. Erosion gullies exceeding 3 inches in depth will be marked and repaired when appropriate weather conditions occur (generally the spring or fall of the year).

C-4e(2) Cover Settlement, Subsidence and Displacement

A series of 8 settlement monuments have been installed in the final cover system. The monuments were surveyed semi-annually for the first 3 plus years of post-closure (through November 1999) and will be surveyed annually thereafter. If settlement is noted during a visual inspection, however, the markers will be surveyed as soon as possible following the inspection to measure the amount of settlement. If the benchmarks are damaged, the benchmark will be replaced and resurveyed within 3 months and as weather permits. Any subsidence/settlement observed will be corrected during appropriate weather conditions in the spring or fall of the year.

C-4e(3) Vegetative Cover Condition

The cover system will be inspected for bare areas and quality of vegetation. Problem areas will be noted on the inspection checklist and accompanying figure. If overall growth of vegetation is poor, soil samples may be obtained and analyzed to assess appropriate applications of lime and fertilizer. If fertilizer is needed, the composition will be adjusted according to the sample results. Reseeding and/or fertilizing of bare areas will be performed during appropriate weather conditions either in the spring or fall of the year.

C-4e(4) Integrity of the Run-on and Run-off Control Measures

The two culverts that drain run-off from the perimeter ditch will be visually inspected to look for obstructions. In addition, the perimeter ditch will be visually inspected to look for areas where water could potentially pond. Any hindrances to flow in the drainage culverts or perimeter ditch will be removed during appropriate weather conditions.

C-5 Post-Closure Cost Estimate

The costs for annual post-closure care of the closed surface impoundment unit are itemized in Table 5 and Table 5a. The total estimated cost for annual post-closure care (monitoring and maintenance) are in accordance with the applicable post-closure requirements, and based on recent experience at the Site, is $49,100 (2006 dollars). The total post-closure cost estimate has been calculated by multiplying the annual post-closure cost by the number of years of post-closure care. Based on the September 16, 1997 letter from Mr. Victor P. Windle, Chief, Hazardous Waste Permit Section, post-closure care began on June 4, 1996. Therefore, as of December 31, 2006, the current post-closure care estimate is $967,379 with approximately 19.5 years remaining in the post-closure maintenance period. The annual post-closure cost was estimated based on the costs to MLC of hiring a third party to conduct post-closure activities. The post-closure monitoring and maintenance activities are detailed in Table 5 and summarized as follows:

1. Semi-annual groundwater sampling and semi-annual report documenting groundwater quality (2 events/year); annual report documenting the inward hydraulic gradient(1 event/year);
2. Replace (3,000 ft) security fence (1 event per 15 years);
3. Pump and discharge to sanitary sewer of 1.6 million gallons of interior ground water (1 event/ 2 year);
4. Replace soil, seed and fertilize soil (10,000 sqft);
5. Vegetative maintenance: mowing (6 events/year);
6. Groundwater monitoring well maintenance (1 event/ year);
7. Replace groundwater monitoring wells (1 event/30 years);
8. Routine inspections (4 events/year);
9. Cut-off Wall Inspection (Groundwater level measurements and data evaluation) (2 events/ year);
10. Surveying of settlement monuments (1 event/year);
11. Redevelop groundwater extraction wells (1 event per 30 years);
12. Replace groundwater extraction pump (1 event/10 years);
13. Administrative (40 hours/year);
14. Install access culvert (1 event/30 years); and,
15. Soil bentonite cut-off wall (replace approximately 220 linear feet (10% of 2,219 linear feet), 3 feet wide and 55 feet deep (1 event/30 years).

Table 5a provides a detailed cost breakdown of the following items:

1. Semi-annual groundwater monitoring, data evaluation, semi-annual report documenting groundwater quality (2 events/year) and annual report documenting the inward hydraulic gradient (1 event/year);
2. Groundwater monitoring well maintenance (1 event/ year);
3. Redevelop groundwater extraction wells (1 event per 30 years); and,
4. Replace groundwater extraction pump (1 event/10 years).

MLC will keep the latest post-closure care cost estimate, or revised post-closure care cost estimate, on file at the Rolls-Royce Environmental Department's Office during the post-closure care period for the Site.

MLC is using a performance bond for the purpose of establishing the post-closure financial assurance, during the post-closure period. Each year, the post-closure cost estimate and financial assurance mechanism will be updated. The update will take into account the previous year's activities, including one less year of required post-closure care. The revised cost estimate will be documented in the annual report to IDEM and the financial mechanism will reflect the new total. During the post-closure care period of the Site, MLC will revise the post-closure cost estimate no later than 90 days after a revision has been made to the post-closure plan that increases the cost of post-closure care. MLC will keep the revised post-closure cost estimate in the Rolls-Royce Environmental Department's Office during the post-closure period.

C-6 Financial Assurance for Post-Closure Care

C-6b Performance Bond

C-6b(1)Performance Bond Guaranteeing Payment into a Post-Closure Trust. MLC has provided a detailed written estimate of the annual cost of post-closure monitoring and maintenance of the closed surface impoundment. MLC has established financial assurance for both post-closure monitoring and maintenance for the Site. The performance bond is included in Appendix B.

Attachment D Groundwater Monitoring

D-1 Interim Status Period Groundwater Monitoring Data

This section is not applicable at this time.

D-2 Aquifer Identification

The surface impoundment was constructed in a glacial-outwash deposit within the White River Valley. The White River is located one mile southeast of the surface impoundment unit. Eagle Creek, a tributary of the White River, is located one-half mile east of the impoundment. Eagle Creek flows in a southerly direction. Numerous ponds are located north and south of the surface impoundment. These ponds are remnants of sand and gravel quarries within the glacial-outwash deposit. The land surface immediately surrounding the impoundment gently rises from east to west with elevations ranging from 685 to 690 feet, MSL.

A soil boring program was implemented in 1985 to obtain data for use in the design of the groundwater monitoring network and the design and construction of the cutoff wall around the surface impoundment unit. Appendix D contains the Geraghty & Miller's *Hydrogeological, Geophysical, and Geotechnical Investigation of the Area Around Retention Basins #1 and #2*, dated August 1991. Geraghty & Miller reported that an upper sand and gravel unit extends from a few feet below ground surface to a depth of approximately 50 to 55 feet below ground surface (bgs). Geraghty & Miller performed a falling head slug test on March 22, 1993. The data collected was analyzed using the Bower and Rice method. Based on the analysis, the average hydraulic conductivity of the upper aquifer was 160 ft/day. Slug tests, however, tend to under predict the hydraulic conductivity, because of well inefficiency. Based on the available data, ARCADIS Geraghty & Miller estimates the hydraulic conductivity of the upper aquifer beneath the Site is approximately 300 ft/day. Meyer et al., 1975 estimates the hydraulic conductivity values to range from 100-200 ft/day within the vicinity of the impoundment. The effective porosity of the upper sand and gravel aquifer was assumed to be 0.375.

The principal clay layer was encountered from approximately 50 to 55 feet bgs to approximately 70 feet bgs. The hydraulic conductivity values ranged from 5.5×10^{-7} cm/sec to 1.8×10^{-8} cm/sec (Appendix D). A clay lens was also encountered from approximately 31 to 40 feet bgs southeast of the surface impoundment, and south of the concrete retention basin #2 (Appendix D).

A lower sand and gravel unit (including silty-clayey sand and gravel with shale fragments) was encountered from approximately 65 or 70 feet bgs to approximately 105 feet bgs. Reported hydraulic conductivities for the lower sand and gravel aquifer range from 200 to 390 feet/day (Meyer et al., 1975). The effective porosity of the lower sand and gravel aquifer was assumed to be 0.35. Competent bedrock was encountered at approximately 115 bgs. A geologic cross-section is included as Figure 5a of Appendix D.

Based on static water-level measurements recorded outside the surface impoundment in November 2005, groundwater flow in the upper aquifer outside of the slurry wall flows from the west to the east with an estimated hydraulic gradient of 0.0054 (MW-208B and MW-201B) directly north of the surface impoundment. The piezometric surface in the lower aquifer generally is to the north to northeast (Appendix J). The piezometric surface in the lower aquifer is likely influenced by the pumping rates of two nearby production wells used to supply water for Rolls-Royce's operations. The hydraulic gradient of the lower aquifer, based on data collected from the monitoring wells installed in the lower aquifer, is estimated to be 0.004 (MW-202C and MW-203C). The historical and current groundwater elevation data is included as Table 2 in Appendix J.

D-3 Contaminant Plume Description

Background groundwater monitoring was completed for the surface impoundment in 1986. As described in the Closure Plan, no statistically significant increases in the indicator parameters were observed to trigger a compliance monitoring program. For the five year period before the construction of the cutoff wall, GM conducted groundwater quality monitoring around the surface impoundment unit. This monitoring system consisted of five well nests that were screened at depths that permitted monitoring of the top and base of the upper sand and gravel aquifer. The well nests were positioned around the surface impoundment such that two nests were hydraulically upgradient, two nests were downgradient, and one nest was cross-gradient to the regulated unit. These five well nests were abandoned prior to the construction of the cutoff wall.

As stated in Section C-4b, the sediment within the surface impoundment is encapsulated/contained from the environment via the soil barrier and composite cap, the soil-bentonite cut-off wall, and the clay layer separating the upper sand unit and lower sand unit. The surface impoundment was closed in a manner resulting in a low potential for the migration of hazardous waste constituents via the uppermost aquifer to water supply wells or surface water bodies. The integrated engineering control system installed makes use of traditional groundwater monitoring system components for monitoring groundwater hydraulic heads.

D-4 Detection Monitoring Program

Four of the exterior monitoring wells (one upgradient and three downgradient) will be sampled during each of the semi-annual monitoring events. These samples will be analyzed for the constituents identified below in accordance with the Sampling and Analysis Plan provided in Appendix H.

D-4a Indicator Parameters

Based on the nature of the waste and the historic groundwater monitoring results, selected metals and cyanide have been selected as indicator chemical parameters. Therefore, the post-closure monitoring program will include monitoring of four exterior wells for arsenic, barium, cadmium, chromium, lead, mercury, silver, selenium and cyanide.

D-4a(1) Hazardous Waste Characterization. Summaries of the analytical results from the 1984 EP toxicity; May, 1985 EP toxicity; May, 1985 total constituents; and the 1987 total constituents analyses on the surface impoundment sediments are shown in Table 1 through Table 4. IDEM determined that the impoundment was used to treat F007 and F009 waste and IDEM classified it as a hazardous waste impoundment.

D-4a(2) Behavior of Constituents. Due to the inward hydraulic gradient that will be maintained throughout post-closure, the constituents are not expected to be mobilized and leave the area capped and surrounded by a slurry wall. Also, the sediments were significantly dewatered during the surcharge construction. The waste types, metals and cyanide, are persistent but are generally not very mobile in groundwater. These constituents are not expected to be of concern since the waste has been deposited in its location for numerous years and there were no statistically significant increases in constituent concentrations in groundwater detected during the interim status detection monitoring period. Further, the waste will remain encapsulated in that location with a very low probability of migration out of the contained impoundment area.

D-4a(3) Detectability. The chemical constituents listed above are easily detected in groundwater at levels below concentrations of concern using standard analytical methods. The estimated quantitation limits (EQLs) for each of the chemical constituents listed above are found in Appendix H.

D-4b Groundwater Monitoring Program

The groundwater elevations and total well depths in the hydraulic head monitoring wells will be measured semi-annually. Four exterior wells (MW-201B, -202B, -203B, and -206B) will be sampled during each of the semi-annual episodes as described in the Sampling and Analysis Plan (Appendix H). A report documenting the inward hydraulic gradient will be sent annually to IDEM and a report on the groundwater quality will be sent semi-annually to IDEM.

D-4b(1) Description of Wells. A monitoring well construction report, including the monitoring well number, coordinate location, total depth, screened interval, and well construction materials is included in Appendix F.

D-4b(2) Representative Samples. The sampling and analytical methods selected for this monitoring program have been chosen to ensure that representative samples are collected of the exterior groundwater. The Sampling and Analysis Plan is included as Appendix H.

D-4b(3) Locations of Background Monitoring Wells That Are Not Upgradient. Since the sediment in the surface impoundment is contained by the soil barrier, composite cap, the perimeter soil-bentonite cutoff wall, and the maintained inward hydraulic gradient, all of the exterior wells are essentially upgradient of the waste. Regionally, monitoring well 206B has been selected to represent upgradient. Therefore, no additional background monitoring wells are installed or necessary.

D-4c Background Values

Background groundwater quality values for the indicator parameters are included in Appendix I and J. However, additional independent background samples will be collected from MW-206B and background water quality will be calculated as described below.

D-4c(1) Data Currently Available. Monitoring well MW-206B (background location) was sampled monthly for four consecutive months in accordance with procedures described in the Sampling and Analysis Plan approved in 2001. Additionally, monitoring well MW-206B has been monitored semi-annually since the start of the post-closure care groundwater monitoring program (2002 to 2005) in accordance with procedures described in the approved Sampling and Analysis Plan. The data obtained from this monitoring will be used to calculate the upgradient/background values for the indicator parameters.

D-4c(1)(a) Background Groundwater Quality Data. Background groundwater samples were collected from the background monitoring well, MW-206B, between August and November 2001. Based on the analysis of these samples, background concentrations and the statistical analysis for the monitored constituents were calculated and are summarized in a letter to IDEM dated March 12, 2002 (Appendix I). Additionally, Appendix I includes a letter from the laboratory summarizing the reevaluation of the EQLs (included as Attachment A to Appendix I) and a table summarizing the revised reporting limits (included as Table 2 in Appendix I). However, the background groundwater quality will be recalculated after sixteen independent samples are collected and analyzed from the background well. One background sample is collected from the designated background monitoring well semi-annually and is summarized in the Semi-Annual Monitoring Report (Table 1 in Appendix J). A summary of the historical Site groundwater elevation data is included in Table 7. Sample locations are show on Figure 17.

D-4c(1)(b) Sampling Frequency. One groundwater sample will be collected semi-annually from the background monitoring well and will be analyzed for the specified analytes for use in the background calculations. A summary of the background groundwater quality data is included in Appendix I and J.

D-4c(1)(c) Sampling Quantity. One sample will be collected semi-annually from the background monitoring well. Sample quantities needed for analysis of each indicator parameter is specified in the Appendix H.

D-4c(1)(d) Background Values. Upon completion of obtaining the required sixteen independent background samples from MW-206B, a report will be submitted to IDEM to show that the background values for each monitoring parameter or constituent are expressed in the form necessary to determine statistically significant increases. The statistical approach to establishing background values is included in Attachment D-4d(7)(a) and Appendix H. Background values will be updated semi-annually after each sampling event if appropriate, as specified in the approved statistical procedures.

D-4c(2) Plan for Establishing Groundwater Quality Data.

The following procedures will be used to establish water quality at the Site.

D-4d Sampling, Analysis and Statistical Procedures

Groundwater quality exterior to the containment area will be monitored semi-annually. Four of the exterior monitoring wells will be sampled during each of the semi-annual monitoring episodes.

D-4d(1) Sample Collection. The groundwater elevations in the hydraulic head monitoring wells will be measured using an electronic water level indicator. The water level indicator will be graduated with 0.01-foot markings and calibrated according to manufacturer's specifications. The probe will be rinsed with distilled water after each measurement. After obtaining groundwater elevation measurements, four wells will be sampled via low-flow/low-stress sampling procedures specified in the Sampling and Analysis Plan provided in Appendix H.

D-4d(2) Sample Preservation and Shipment. Samples will be preserved in accordance with the procedures specified in the Sampling and Analysis Plan (Appendix H).

D-4d(3) Analytical Procedures. Chemical analyses will be performed in accordance with the procedures specified in EPA Document SW-846 (e.g., Method 6010B for Ag, As, Ba, Cd, Cr, Pb, and Se; Method 7470A for Hg; and Method 9010B for cyanide) as detailed in the Sampling and Analysis Plan

(Appendix H). The chemical constituents listed above are easily detected in groundwater at levels below concentrations of concern using standard analytical methods. The EQLs for the chemical constituents listed above are provided in Appendix H. Additionally, Appendix I includes a letter from the laboratory summarizing the reevaluation of the EQLs (included as Attachment A to Appendix I) and a table summarizing the revised reporting limits (included as Table 2 in Appendix I).

D-4d(4) Chain-of-Custody. All samples will be handled under strict Chain-of-Custody controls and documentation, utilizing labels provided by the analytical laboratory and MLC-specific chains-of-custody as described in Appendix H.

D-4d(5) Additional Requirements for Compliance Point Monitoring.

D-4d(5)(a) Sampling Frequency. The compliance point groundwater monitoring wells will be sampled semi-annually for chemical analysis (Appendix H).

D-4d(5)(b) Compliance Point Groundwater Quality Values. Three wells have been selected for monitoring downgradient groundwater quality (MW-201B, MW-202B and MW-203B). Historical and current groundwater elevations and data collected during the post-closure monitoring program are provided in Table 6 and Appendix J, respectively.

D-4d(6) Annual Determination. Preparation of groundwater flow maps will allow confirmation that the upgradient well (MW-206B) continues to be upgradient and the downgradient wells (MW-201B, -202B and 2-03B) continue to be downgradient. Groundwater flow rate is calculated by taking the change in hydraulic head between two separate monitoring wells divided by the total distance between the monitoring wells, multiplying the result by the hydraulic conductivity, and dividing the product by the effective porosity. Groundwater flow direction is identified as being perpendicular to the groundwater elevation contours. The determination of the flow rate and direction will be included in the annual evaluation report that will be submitted to IDEM.

D-4d(7) Statistical Determination. MLC will compare groundwater quality in the downgradient wells to background groundwater quality observed in MW-206B to determine if there is a statistically significant increase in the concentration of the indicator parameters between MW-206B and the downgradient wells.

D-4d(7)(a) Statistical Procedure. The initial statistical comparison was conducted in 2001 through 2002 and summarized in a letter to IDEM dated March 12, 2002 (Appendix I of the January 20, 2006 permit application). The background quality will be established in accordance with the procedures described in Attachment D-4c(2). Data analysis of both the background and compliance well datasets will be conducted following the procedures detailed in the Sampling and Analysis Plan provided in

Section 4.3 (Data Analysis) of Appendix H. Statistical methods are proposed that are consistent with USEPA guidance, including the Statistical Analysis of Ground Water Monitoring Data at RCRA Facilities, Interim Final Guidance (EPA/530-SW-89-026, April 1989), Addendum to Interim Final Guidance (July 1992), Data Quality Assessment: Statistical Methods for Practitioners, EPA QA/G-9S (EPA/240/B-06/003, February 2006), and ProUCL Version 4.0 Technical Guide (EPA/600/R-07/041, April 2007). An upper bound background concentration will be defined by an upper tolerance interval that provides 99% coverage with 95% confidence (i.e., 95/99 UTL). The UTL calculation method that is recommended by USEPA (1992) will be selected based on the statistical properties of the dataset, including sample size, frequency of detects, goodness-of-fit tests, and probability plots. Specifically, for datasets with many nondetects, USEPA recommends calculating a Poisson UTL (USEPA, 1992; Section 2.2.5) based on a method originally described by Gibbons (1987, Statistical Models for the Analysis of Volatile Organic Compounds in Waste Disposal Sites. Ground Water, 25: 572-580; and 1994 [pp. 38-40], Statistical Methods for Groundwater Monitoring. John Wiley & Sons, New York). Compliance well data will be compared to the UTL on a point-by-point basis to determine if one or more site observations exceed an upper bound background concentration. Constituents for which one or more exceedances are noted in the compliance well dataset will be subsequently evaluated using hypothesis tests appropriate for evaluating differences in both central tendency (e.g., Wilcoxon Rank Sum and Gehan tests) and upper tails (e.g., quantile test) at an $\alpha=0.05$ significance level.

If statistically significant increases above background are observed, MLC will notify the Commissioner in writing within 60 days of the sampling date (document provided according to the Commissioner's requirements), and

sample and analyze groundwater from the well (or wells) indicating an increase to verify the observed result (within 75 days of the original sample date).

D-4d(7)(b) Results. The groundwater sampling results and statistical analysis report which documents the semi-annual monitoring program will be provided to IDEM within sixty (60) days of the final laboratory technical report. If groundwater quality results indicate a statistically significant change for any sampled parameters in the sampled wells, within sixty (60) days of sampling event, IDEM will be notified of which parameters and monitoring wells the statistically significant increase(s) occurred. After notifying IDEM of the statistically significant change, a verification sample from the non-statistically compliant monitoring well will be collected within fifteen (15) days later (or 75 days from the original sample date) and analyzed for the parameters that indicated a statistically significant change. IDEM will be provided the groundwater sampling results and statistical analysis report which documents the verification sample within sixty (60) days of the verification sample date. The groundwater quality report will be submitted to IDEM as 2 bound hard copies and one electronic copy (document provided according to the Commissioner's requirements). The hydraulic evaluation report will be submitted to IDEM annually by March 1 each year.

D-5 Compliance Monitoring Program

This section is not applicable at this time.

D-6 Corrective Action Program

This section is not applicable at this time.

Attachment E Correction Action for Solid Waste Management Units

E-1 Solid Waste Management Units

The only solid waste management unit at the Site is the closed surface impoundment.

E-2 Characterization of Solid Waste Management Units

See Attachment A.

E-3 Lack of Solid Waste Management Units

The Site is a solid waste management unit and no other solid waste management unit is present.

E-4 Releases

This section is not applicable.

E-4a Characterize Releases

This section is not applicable.

E-4b No Releases

This section is not applicable.

Attachment F Other Federal Laws

This post-closure permit application is not inconsistent with other federal laws such as the Wild and Scenic Rivers Act, National Historic Preservation Act of 1966, Endangered Species Act, Coastal Zone Management Act, and the Fish and Wildlife Coordination Act.

ARCADIS
Infrastructure, environment, buildings

Imagine the result

Post-Closure Permit Application

Appendix E: Contingency Plan

USEPA INR000021436

Updated: January 2010

ARCADIS

Post-Closure Permit Application

Appendix E: Contingency Plan

USEPA INR000021436

Prepared for:

Motors Liquidation Company

Prepared by:
ARCADIS .
251 E. Ohio Street
Suite 800
Indianapolis
Indiana 46204
Tel 317 231 6500
Fax 317 231 6514

Our Ref.:

IN000297.0018

Date:

January 11, 2006

Updated: January 2010

Table of Contents

Purpose

The purpose of this contingency plan is to comply with the submitted Post-Closure Permit Application Attachment C-3, to address requirements in section 40 CFR 264, Subpart C. The facility is designed, constructed, maintained and operated to minimize the possibility of any unplanned sudden or non-sudden release of hazardous waste or hazardous waste constituents to air, soil or surface water which could threaten human health or the environment.

Facility Identification and General Information

Name: Former General Motors Allison Gas Turbine Division
Address: 2701 West Raymond Street
Indianapolis, Indiana

Owner/ Operator:
Motors Liquidation Company
500 Renaissance Drive, Suite 1400
Detroit, MI 48243
Attn: James M. Redwine

Emergency Coordinators:

David Favero
Favero Geosciences
1210 South 5th Street
Springfield, Illinois 62703
First Phone Number: (217) 522-6714
Second Phone Number: (217) 793-1695

Sarah Fisher
ARCADIS
251 East Ohio Street, Suite 800
Indianapolis, Indiana 46204
First Phone Number: (317) 236-5213
Second Phone Number: 317-691-4011

Type of Facility:

The closed surface impoundment (Site) is an unmanned 10.269 acre grass-covered field. The Site is surrounded by a 6 foot tall chain-linked fence with access gates in the northeast, northwest, and southwest comers of the fence which are kept locked at all times except during maintenance and monitoring activities.

Facility Site Map is on next page (Drawing 1).

Description of Generator Activities

No hazardous waste is generated from the various processes at the Site.

Emergency Coordinators

Principle (24-Hour Emergency Contact):	David Favero, Favero Geosciences First Phone Number: 217-522-6714 Second Phone Number: 217-793-1695
Alternate 1	Sarah Fisher, ARCADIS First Phone Number: 317-236-5213 Second Phone Number: 317-691-4011
Alternate 2	Eric Moosbrugger, ARCADIS First Phone Number: 317-236-5212

The emergency coordinator or alternate are responsible for coordinating all emergency response measures for the facility required under this plan. They are thoroughly familiar with:

- The facility's contingency plan
- All operations and activities at the facility.
- The location and characterization of waste handled.
- The location of all records within the facility.
- The physical layout of the facility.

Implementation of the Contingency Plan

The Contingency Plan will be implemented if an incident might threaten human health or the environment. The emergency coordinator has full authority to make this decision.

The contingency plan must be implemented whenever an incident might involve hazardous waste anywhere at the Site. Depending on the degree of seriousness the following potential emergencies might call for the implementation of the contingency plan:

Spills

- A release of any on-Site generated waste resulting from broken piping which cannot be contained on-Site resulting in off-Site soil contamination and/or ground or surface water pollution.

Emergency Response Procedures for Spills

<u>Immediately Upon Discovery of an Emergency</u>

An employee discovering a spill involving hazardous waste will call:

Emergency Procedure

Rolls Royce Plant 5 Security (adjacent facility formerly owned by General Motors Corporation) 230-5555

Emergency Coordinators:

Principle: Dave Favero
1210 South 5th Street
Springfield, Illinois 62703
First Phone Number: (217) 522-6714
Second Phone Number: (217) 793-1695

Alternate:

Alternate: Sarah Fisher
ARCADIS
251 East Ohio Street, Suite. 800
Indianapolis, Indiana 46204
First Phone Number: (317) 236-5213
Second Phone Number: (317) 691-4011

Alternate: Eric Moosbrugger
ARCADIS
251 East Ohio Street, Suite. 800
Indianapolis, Indiana 46204
Phone Number: (317) 236-5212

The emergency coordinator or alternate will respond immediately to the call and assess the situation. The emergency response contractors are:

ARCADIS
251 East Ohio Street., Suite. 800
Indianapolis, Indiana 46204
(317) 231-6500

The emergency coordinator will assess the situation by identifying the character, exact source, amount and extent of released material. He or she will also make an assessment of possible threats to human health and the environment.

If an incident could threaten the environment or human health outside the Motors Liquidation Company (MLC) property, the emergency coordinator will contact the following:

In the unlikely event that an incident occurs that adversely impacts the Site the following local resources are available and should be contacted immediately if required to address an emergency situation:

Local Fire Department:	317-327-6091
Indianapolis Fire Department:	317-327-6041
St. Frances Hospital:	317-787-3311
Local Police:	317-327-3811
Indianapolis Police:	911
Marion County LEPC:	317-252-3230

The emergency coordinator will call and report the incident to the National Response Center at:

800-424-8802

The report will include the following:

- Name and telephone number of the reporter.
- Name and address of the facility.
- Time and type of incident.
- Identification and quantity of materials involved.
- The possible hazards to the environment and human health outside the facility.

In addition, the emergency coordinator will contact Indiana Department of Environmental Management (IDEM), Office of Emergency Response at:

888-233-7745

<u>During the Emergency Control Phase:</u>

The emergency coordinator will take all necessary measures to contain the hazard within the facility property and to prevent its spread to other nearby properties, with the assistance of emergency contractors and local emergency personnel. The emergency coordinator or designee will monitor for leaks, pressure build-up, gas generation, or ruptures in valves, pipes, or other equipment, wherever appropriate. Emergency personnel will be provided details concerning the on-Site types of emergency equipment to be used and the need for personal protective equipment.

<u>Immediately After the Emergency</u>

The emergency coordinator must provide for the storage and disposal of recovered waste, contaminated soil or surface water, or any other material. The material must be handled as a hazardous waste unless it is a characteristic hazardous waste only, which is analyzed and determined not to be hazardous.

All emergency equipment must be cleaned and made fit for its intended use before operations are resumed.

The emergency coordinator will investigate the cause of the emergency and will take steps to prevent recurrence of such or similar incidents.

The emergency coordinator will make sure that cleanup and restoration have progressed at least to the point of not jeopardizing the health and safety of the employees, and that the EPA and local authorities have been notified prior to permitting the resumption of the operation affected by the emergency.

Emergency Equipment

Fire extinguishers are present in the two buildings located on Site. Additionally, personnel entering the Site will have a first-aid kit available.

Coordination Agreements and Telephone Numbers

ARCADIS
251 East Ohio Street, Suite. 800
Indianapolis, Indiana 46204
(317) 231-6500

The above recipient has been sent a copy of the contingency plan and has agreed to provide emergency services to MLC in the event there is an emergency.

Evacuation Plan

Contract employees will be evacuated if the emergency coordinator decides that their personal safety is in danger.

If evacuation is necessary, the contract employee will exit through the northeast gate. Drawing 1 contains the evacuation plan for the Site.

Required Reports

Within fifteen (15) days of any incident requiring the implementation of the contingency plan, the emergency coordinator will file a report with the EPA Regional Administrator and the Assistant Commissioner of the Office of Solid Waste and Hazardous Waste Management (OSHWM). The report will include the following:

- Name, address and telephone number of the owner/operator.
- Name, address and telephone number of the facility.
- Date, time and type of incident.
- Name and quantity of material involved.
- An assessment of actual or potential hazards to human health and the environment.
- Estimated quantity and disposition of recovered material that resulted from the incident.

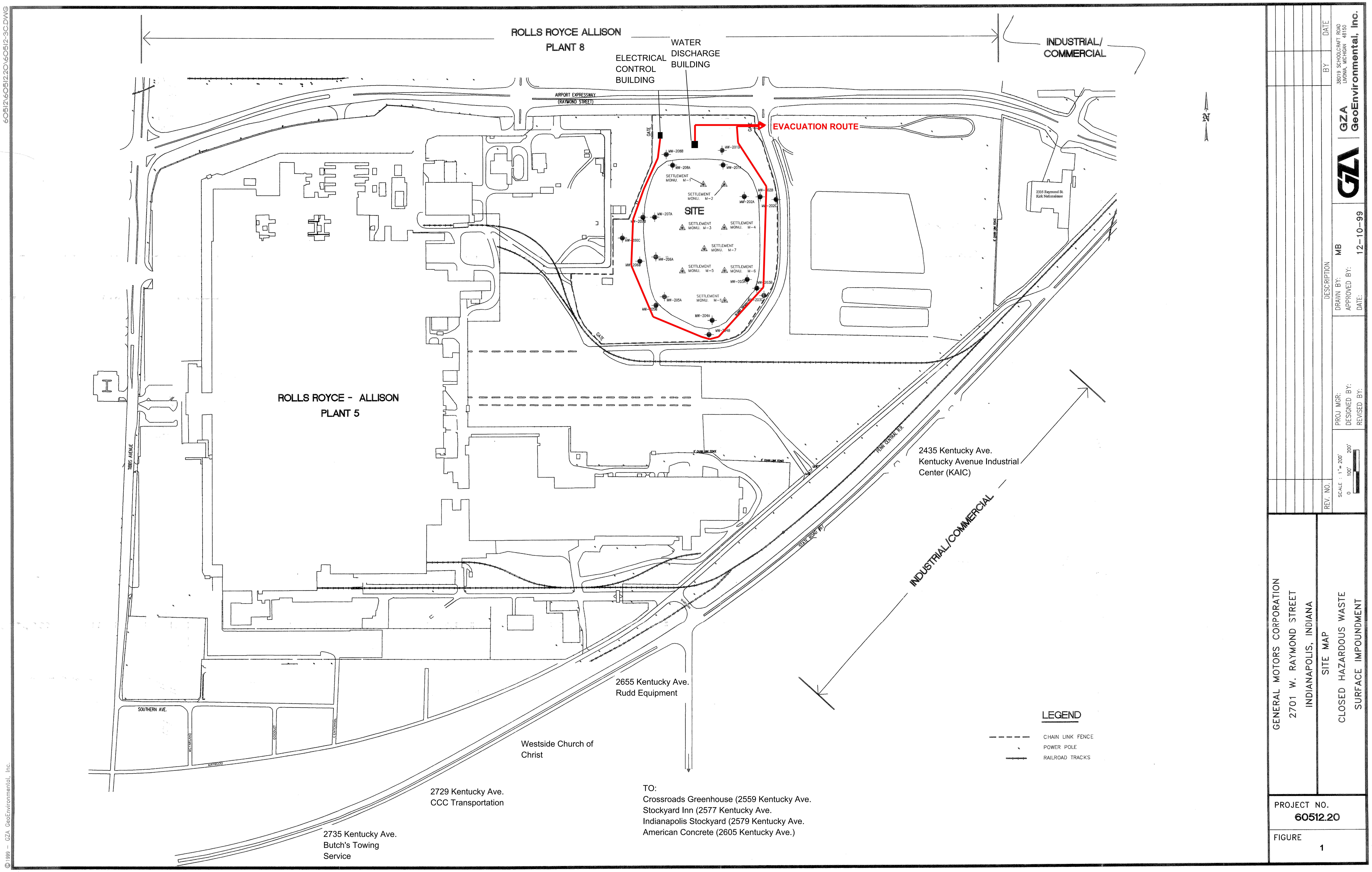
The emergency coordinator will note in the operating record the time, date and details of any incident that requires implementation of the contingency plan.

Amendment of Contingency Plan

MLC, or its representatives, will review and amend this contingency plan whenever the following situations apply:

- Applicable regulations are revised.
- The plan fails in emergency.
- The facility changes in its design, construction, operation, maintenance or other circumstances in a way that materially increases the potential for releases.
- The list of emergency coordinators changes.

The list of emergency equipment changes.


ROLLS ROYCE ALLISON
PLANT 8
ELECTRICAL
CONTROL
BUILDING
WATER
DISCHARGE
BUILDING
INDUSTRIAL/
COMMERCIAL
AIRPORT EXPRESSWAY
(RAYMOND STREET)
EVACUATION ROUTE
SITE
2335 Raymond St.
Kirk Nationalease
ROLLS ROYCE - ALLISON
PLANT 5
TIBBS AVENUE
2435 Kentucky Ave.
Kentucky Avenue Industrial
Center (KAIC)
INDUSTRIAL/COMMERCIAL
SOUTHERN AVE.
2655 Kentucky Ave.
Rudd Equipment
Westside Church of
Christ
2729 Kentucky Ave.
CCC Transportation
TO:
Crossroads Greenhouse (2559 Kentucky Ave.
Stockyard Inn (2577 Kentucky Ave.
Indianapolis Stockyard (2579 Kentucky Ave.
American Concrete (2605 Kentucky Ave.)
2735 Kentucky Ave.
Butch's Towing
Service
LEGEND
CHAIN LINK FENCE
POWER POLE
RAILROAD TRACKS
GZA
GeoEnvironmental, Inc.
38019 SCHOOLCRAFT ROAD
LIVONIA, MICHIGAN 48150
REV. NO.
DESCRIPTION
BY
DATE
PROJ MGR:
DESIGNED BY:
REVISED BY:
DRAWN BY: MB
APPROVED BY:
DATE: 12-10-99
SCALE: 1" = 200'
GENERAL MOTORS CORPORATION
2701 W. RAYMOND STREET
INDIANAPOLIS, INDIANA
SITE MAP
CLOSED HAZARDOUS WASTE
SURFACE IMPOUNDMENT
PROJECT NO.
60512.20
FIGURE
1
© 1999 - GZA GeoEnvironmental, Inc.
60512\60512.20\60512-3C.DWG

Attachment G Part B Certification

Certification: I certify, under penalty of law, that this document and attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

INR000021436	GM Former AGT Division
U.S EPA I.D. Number	Site Name

______________________	________________
Marilyn Dedyne, P.E. General Motors Corporation	Date

RESUBMITTED JULY 2008

Imagine the result

GM FORMER AGT DIVISION

Post-Closure Permit Application

Appendix H: Sampling & Analysis Plan

USEPA INR000021436

UpdatedJanaury 2010

ARCADIS

GM FORMER AGT DIVISION
Post-Closure Permit Application

Appendix H: Sampling and Analysis Plan

USEPA INR000021436

Prepared for:

Motors Liquidation Company

Prepared by:

ARCADIS.

251 E. Ohio Street

Suite 800

Indianapolis

Indiana 46204

Tel 317 231 6500

Fax 317 231 6514

Our Ref.:

IN000297.0018

Date:

Resubmitted April, 2009

Updated: January 2010

ANOVA	Analysis of Variance
BSL	Background Screening Level
DO	Dissolved Oxygen
EQL	Estimated Quantitation Limit
GM	General Motors Corporation
GOF	Goodness of Fit
IAC	Indiana Administrative Code
IDEM	Indiana Department of Environmental Management
IQR	Interquartile Range
KM	Kaplan-Meier
MLC	Motors Liquidation Company
MSL	Mean Sea Level
mL/min	milliliters per minute
mS/cm	millisiemens per centimeter
mV	millivolts
NTU	Nephelometric Turbidity Units
ORP	Oxidation Reduction Potential
PQL	Practical Quantitation Limit
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
ROS	Rank-Ordered Statistics
SAP	Sampling and Analysis Plan
SK	Seasonal-Kendall
UPL	upper prediction limit
USEPA	United States Environmental Protection Agency
UTL	upper tolerance limit
µg	microgram

1. Introduction

This document presents a sampling and analysis plan (SAP) for conducting the post-closure groundwater monitoring program at the GM Former AGT Division Surface Impoundment. A map showing locations of the hydraulic monitoring wells, extraction wells and elevation monuments is provided as Figure 1.

2. Background

The Site is located within the Rolls-Royce Corporation Plant 5 property boundary, east of Tibbs Avenue at 2701 West Raymond Street in Indianapolis, Indiana. In December 1993, General Motors Corporation (GM) sold its Allison Gas Turbine Division to AEC Acquisition Corp. AEC Acquisition Corp. changed their name and operated as the Allison Engine Company. Allison Engine Company then sold the plant to Rolls-Royce Aerospace. The plant is now doing business as Rolls-Royce. According to the Asset Purchase Agreement, GM retained post-closure care obligations at the Site. To more effectively fulfill its obligation for post-closure care of the closed surface impoundment, GM purchased the property encompassing the former surface impoundment area. As a result of GM's bankruptcy, the operating assets of GM were sold on July 10, 2009 to a newly formed company, which is now known as General Motors LLC. Existing, non-continuing assets (including the closed surface impoundment) remained the property of "old" GM, which changed its name to Motors Liquidation Company (MLC), in its capacity as a debtor–in-possession in the bankruptcy case. MLC is therefore, the current land owner of the Site. The Indiana Department of Environmental Management (IDEM) has deemed that the post-closure care period for the Site began on June 4, 1996.

3. Groundwater Monitoring Program

The groundwater monitoring program developed for the Site includes: 1) semi-annual monitoring of the hydraulic head differential between the internal monitoring wells and the upper and lower sand and gravel units exterior to the containment area; and 2) semi-annual chemical monitoring of groundwater from 4 exterior monitoring wells (one upgradient and three down gradient of the Site with respect to regional ground water flow in the upper unit). An annual report documenting inward gradient and potentiometric surface maps and the results of chemical analyses will be submitted to the Commissioner or the designated representative of IDEM. This report will include the data deliverables shown in Table 1 for the analyses performed during the year.

3.1 Hydraulic Monitoring Program

Six monitoring well pairs (MW-201 A/B and 204 A/B through MW-208 A/B), two three-well groups (MW-202 A/B/C and MW-203 A/B/C) and one individual well (MW-200C) will be gauged semi-annually for depth to groundwater and total depth. The well pairs are screened in the upper sand and gravel unit/aquifer on either side (interior or "A" wells and exterior or "B" wells) of the slurry wall containment installed during the closure activities at the Site. The well groups are screened in the upper sand and gravel unit on either side of the slurry wall containment ("A" and "B" wells) and in the lower sand and gravel unit outside of the slurry wall containment ("C" wells). A summary of procedures that will be followed in completing post-closure care hydraulic monitoring activities is discussed in Section 4.1. In addition, the following items will be check every 90 days during inspection: 1) if the integrity of the concrete pads for the monitoring wells is adequate, 2) if the protective casings for the monitoring wells are damaged, 3) if the locks for the protective casings are in adequate condition and 4) if monitoring well labels are in place and readable. During each semi-annual sampling and gauging event, each well will be checked for sediment accumulation in the monitoring wells. Sediment accumulation and well redevelopment is described in Section 5 below.

Hydraulic monitoring data and related data analysis will be included in the annual report to be submitted to the Commissioner of IDEM in accordance with a schedule established by the Commissioner covering the previous calendar year. The reports will consist of the following hydraulic monitoring information:

- Groundwater elevation data and calculation of groundwater flow rate
- Potentiometric surface maps
- Hydraulic gradient data for each monitoring well pair and calculation of rise rates
- Groundwater withdrawals from Rolls-Royce production wells
- Site dewatering volumes

3.2 Groundwater Chemical Monitoring

Groundwater in the upper unit from outside the containment area (represented by "B" wells MW-201 through MW-208) will be monitored for chemical contaminants on a semi-annual basis as described below. Because an inward hydraulic gradient will be maintained across the containment wall, and because of the very slow infiltration rate of groundwater into the containment area these wells are essentially "upgradient" of the contained materials. However, the regional groundwater flow in the upper unit is generally to the east. Therefore, monitoring well MW-206B has been selected as representative of upgradient, and monitoring wells MW-201B, MW-202B, and MW-203B have been selected as representative of downgradient. A summary of procedures that will be allowed in completing the groundwater quality monitoring is provided in Section 4.2.

During the groundwater sampling, field measurements for temperature, conductivity, oxidation reduction potential (ORP), dissolved oxygen (DO), pH, and turbidity will be obtained, and one sample from the background well MW-206B and one sample from each of the three downgradient wells (MW-201B, MW-202B, and MW-203B) will be collected for analysis for dissolved arsenic, barium, cadmium, chromium, lead, mercury, silver, selenium, and cyanide. These parameters were selected based on the historical use of the Site and the historical groundwater quality data obtained and are appropriate for detecting the potential release of hazardous constituents from the contained waste. A written summary of: the previous calendar year's chemical sampling conducted; the field procedures followed; and observations made will be included in the annual report to the Commissioner along with the tabulated analytical results. A data deliverable package (as described in Table 1) for the current year's sampling activities and the required statistical analysis for each of the chemical parameters in each of the monitored wells will also be provided.

The above tasks represent the groundwater chemical monitoring program. The quality assurance project plan (QAPP) for Pace Analytical Services (the selected analytical laboratory for this program) dated August 4, 2004 (Attachment A). In the event MLC proposes to utilize an alternative laboratory, MLC will submit a QAPP for the alternate laboratory to IDEM.

4. Field Equipment Operation and Maintenance Plan

Proper operation and maintenance of field equipment is necessary to ensure that the monitoring data collected is accurate and precise. The methods and procedures to be used to obtain, analyze, and evaluate data at the subject are described below. The methods include the following:

- Groundwater and Total Depth Gauging Procedures
- Groundwater Collection, Packaging and Chain-of-Custody Procedures
- Decontamination Procedures
- Water Level Indicator Maintenance

4.1 Groundwater and Total Depth Gauging Procedures

Water levels and total depths will first be measured in all exterior monitoring wells (i.e. "B" and "C" wells) beginning with the hydraulically upgradient wells (southwest to northeast). Following measurements of water level and total depth in each of the exterior wells, the water level indicator will be decontaminated. Water level and total depth will then be measured in each of the interior wells (i.e. "A" wells). The water level indicator will be decontaminated after measurements in each well. Static water level and total depth in each monitoring well will be measured with a contact electronic water level indicator with 0.01 foot measuring increments and recorded to the nearest 0.01 foot using a Solinst Model Number 101 (or equivalent). The data will be recorded on a standard form specific to the Site that is provided as Table 2.

The level indicator consists of a graduated tape, sensory probe, and a buzzer and/or light. The graduated tape provides an electrical connection between the sensory probe and the buzzer and/or light. The tape is unwound to lower the sensory probe into the monitoring well. When the probe makes contact with the water, the electrical circuit is completed and the buzzer sounds and/or the lamp lights up. The depth is recorded from the graduated tape at the reference notch on the top of the riser for each of the monitoring wells.

The total depth will be measured by allowing the probe to rest at the bottom of the well. The graduated tape is pulled so there is no slack in the tape and the tape is gently resting on the bottom of the well. The depth on the graduated tape is recorded at the reference notch on the top of the riser for each monitoring well. The water level and total depth can then be assigned an elevation according to means sea level (MSL) relative to the surveyed MSL elevation of the north lip of the casing at the relative monitoring well.

4.2 Groundwater for Chemical Analysis

One sample from the upgradient well (MW-206B) and each of the three downgradient wells (MW-201B, MW-202B, and MW-203B) will be collected for analysis. Sampling of groundwater from the selected monitoring wells will be conducted following the gauging activities described above at the respective well. Based on the historical depth to groundwater data, the limited volume of water expected to be present in each of the wells, and the chemical parameters to be measured, a submersible variable rate pump (i.e., bladder pump or equivalent) will be utilized to purge and sample each of the wells. The samples will be collected using Low Stress/Low Flow Methods. Samples collected for dissolved metals analysis will be filtered in the field using a dispos-a-filter™ (or equivalent) 0.45 micron (μm) high capacity in-line disposable filter (single-use cartridge system) prior to placing the sample into the sample bottle. Clean, pre-preserved sample containers obtained directly from the analytical laboratory will be used during this program.

Samples will be analyzed for arsenic, barium, cadmium, chromium, lead, mercury, silver, selenium and cyanide. Analytical methods, bottle requirements and sample preservative requirements are listed in the following table.

Sample Containers and Preservation Table

Analyses / Method / Estimated EQL	Matrix	Sample Containers	Preservation	Maximum Holding Time from Sample Collection*	Volume of Sample
Cyanide SW -846 9010B EQL = 0.02 mg/L	Groundwater	500 mL polyethylene	Cool to 4° C, NaOH to pH >12	14 days	Fill to neck of bottle
Mercury SW-846 7470A EQL = 0.002 mg/L	Groundwater	500 mL polyethylene. lined cap, field. filtered (0.41µm)	Cool to 4° C $HN0_3$ to pH<2	28 days	Fill to neck of bottle
Ag, As, Ba, Cd, Cr, Pb, and Se SW-846 6010B EQL for As and Se=0.01 mg/L; Ba=0.1 mg/L; Pb and Cr=0.01 mg/L; Ag = 0.05 mg/L Cd = 0.005 mg/L	Groundwater	500 mL polyethylene, field filtered (0.45µm)	Cool to 4° C $HN0_3$ to pH<2	180 days for Metals	Fill to neck of bottle

* Technical Holding Times are based on time elapsed from time of sample collection.

One set of quality assurance/quality control (QA/QC) samples (MS/MSD, field duplicate, and field equipment blank) will be collected for analysis during each sampling event.

To commence sampling activities, personnel will record the appropriate well information and current gauging data on the Well Purging Field Information Form and

Monitoring Well Record for Low-Flow Purging that is provided as Figure Nos. 2 and 3. The pump, safety cable, tubing and electrical lines will be lowered into the well so that the pump intake will be at the mid-point of the saturated portion of the well screen to prevent disturbance and resuspension of any sediment in the screen base. Prior to starting the pump, the water level will be measured again with the pump in the well leaving the water level measuring device in the well when completed. The well will be purged at a rate of 100 to a maximum of 500 milliliters per minute (mL/Min). During purging, the water level will be monitored approximately every 5 minutes, or as appropriate. A steady flow rate will be maintained that results in a drawdown of 0.3 feet or less. The rate of the pumping will not exceed the natural flow rate conditions of the well being sampled. Adjustments made to the pumping rates and water levels immediately after each adjustment will be recorded. The field indicator parameters (pH, temperature, conductivity, ORP, DO and turbidity) will be measured through a flow-through cell and monitored every five minutes during the purging of the well. Stabilization is considered to be achieved when the final groundwater flow rate is achieved, and three consecutive readings for each parameter are within the following limits:

- pH: +/- 0.1 pH units of the average value of the three readings;
- temperature: +/- three percent of the average value of the three readings;,
- conductivity: +/- 0.005 milliSiemen per centimeter (mS/cm) of the average value of the three readings for conductivity <1 mS/cm and +/-0.01 mS/cm of the average value of the three readings for conductivity >1 mS/cm.
- ORP: +/- ten millivolts (mV) of the average value of the three readings
- DO: +/- ten percent of the average value of the three readings; and
- Turbidity: +/- ten percent of the average value of the three readings, or a final value of less than 5 nephelometric turbidity units (NTU).

Should stabilization not be achieved for all field parameters, purging will be continued until a maximum of 3 standing water volumes have been purged from the well. The pump will not be removed from the well between purging and sampling. Water removed during the purging process will be temporarily contained, and (based on analytical data) disposed of properly.

Samples will be collected directly from the disposable tubing connected to the pump with the groundwater being discharge directly into the appropriate sample container. Samples shall be collected and containerized in order of the parameters' volatilization sensitivity (most volatile parameters will be collected first) as sufficient groundwater has entered the wells.

In the event that there is insufficient groundwater to sample for all required parameters the sample collection team shall return to the well at time intervals not to exceed two hours to complete the sampling. If after twelve (12) hours from purging there is not sufficient groundwater to collect all parameters, the attempt to collect samples will halt and the final purge volume and field parameters measured will be recorded on the Monitoring Well Record for Low-Flow Purging (Figure 3).

Upon completion of the purging process, the required number of samples (one sample will be collected from each monitoring well) will be obtained by directly discharging groundwater from the disposable tubing connected to the pump into a laboratory prepared and preserved bottle for cyanide analysis. Groundwater samples collected for dissolved metals analysis will be filtered in the field using a dispos-a-filter™ (or equivalent) 0.45 micron (μm) high capacity in-line disposable filter. Once field parameters have stabilized from the background well, each individual sample is collected (total of four individual samples). For low stress/low flow sampling, samples will be collected at a flow rate between 100 and 250 mL/min and such that drawdown of the water level within the well down not exceed the maximum allowable drawdown of 0.3 feet.

The filter is placed at the end of the tubing from the down-well pump. The water is discharged from the end of the filter directly into the sample container. The filter is supplied in a sealed plastic bag and is not removed from the bag until it is ready to be used.

Sample information including sample location, date and time of collection, sampler's initials, and parameters requested will be entered onto the sample container label. The sample container will then be placed on ice in a cooler in a manner to prevent breakage (e.g., wrapped in bubble wrap or placed in custom plastic holders) for shipment to the analytical laboratory. Samples will be either shipped overnight by commercial carrier, or delivered directly to the laboratory by the day following sample collection.

A complete Chain-of-Custody Form will accompany each cooler. An example is provided as Figure No. 4, however it is probable that the forms actually used will be provided by the analytical laboratory and will be substantially equivalent. A fully executed Chain-of-Custody form with all appropriate signatures will be returned by the laboratory along with the analytical data to document proper sample custody.

The Well Purging Field Information Form (Figure 2), Monitoring Well Record for Low-Flow Purging (Figure 3),data deliverable requirements as described in Table 1, and Chain-of-Custody forms will be included in the annual report submitted to the Commissioner.

4.3 Data Analysis

The statistical procedure for the comparison of the background well to compliance wells will be conducted in accordance with USEPA (1989, 1992, 2006, 2007a) and Indiana state (IDEM 1997, Indiana Administrative Code [IAC] 2004) guidance. These documents provide guidelines for the evaluation of groundwater quality that are protective of both human health and the environment. The first step in this process is conducting exploratory data analysis of both the background and compliance well datasets to ensure that observations within each dataset are representative of single populations and follow consistent temporal trends. There are multiple statistical techniques to compare concentrations in background and compliance wells depending on sample size, degree of censoring (i.e., the presence of nondetects), and probability distribution. The first technique relies on a point-by-point comparison of individual compliance wells to a single background screening level (BSL), which is based on a statistic such as an upper tolerance limit (UTL). The second technique involves hypothesis testing to compare the central tendencies or upper tails of distributions in background and compliance wells. These approaches are detailed below along with recommendations for their implementation.

4.3.1 Exploratory Data Analysis

The exploratory data analysis techniques described below will be used to evaluate distribution and temporal trends within both the background well and compliance wells. As previously described, the purpose of this analysis is to ensure that observations within each dataset (i.e., background versus compliance) are representative of single populations and follow consistent temporal trends. The techniques described below are consistent with current practice and statistics guidance (e.g., USEPA 2006; 2007a). However, the existing data have a high percentage of nondetects, which limits the types of statistical evaluations that can be performed. These limitations are discussed were appropriate, in the following sections.

4.3.1.1 Data Processing

Prior to conducting a statistical analysis of the background and site data, data processing may be needed. If a sampling event for a well/analyte/day includes replicates, the following steps will be used to generate a single composite result:

1. Where all replicates are nondetect, the maximum reporting limit is used;

2. Where replicates include one detect and multiple nondetects, the detect is used;

3. Where replicates include one nondetect and multiple detects, the Kaplan Meier mean is used; and

4. Where replicates include all detects, the arithmetic mean is used

Data will sometimes be reported with different numbers of significant figures, which is an indication of variability in the precision of an analytical result. For a replicate group, the result from the data processing steps will be presented with the same number of significant figures as the original reported value for cases (1) and (2). For cases (3) and (4), the mean will be reported using significant figures match the replicate value with the fewest significant figures. Once replicates have been processed, the full data set for a given analyte will be utilized to calculate a BSL. The final BSL will be reported using significant figures that match the majority of the samples in the dataset, typically either 2 or 3 significant figures.

4.3.1.2 Probability Plots

Probability plots (p-plots) serve multiple purposes in exploratory data analysis for establishing background conditions. They allow for a visual inspection of the goodness-of-fit (GOF) to normal, lognormal, and gamma distributions, to accompany more formal statistical tests for GOF (see Section 4.3.2.1). Inflection points or changes in slope can indicate that the data represent a mixture of multiple populations, which may reflect multiple background sources, or a combination of background and site-related sources. Finally, p-plots can be used to identify extreme values in the upper tail of a distribution, which may be indicative of suspected outliers. The identification of outliers is the first step in an outlier analysis, which is an important component of the exploratory data analysis of background data (see Section 4.3.2.2). Probability plots formatted as quantile-quantile plots (Q-Q plots) will be generated for this analysis. Q-Q plots show the quantiles of the empirical distribution versus the quantiles of the hypothesized distribution. Because standard UTL calculations and USEPA guidance (2007a) focus on the normal, lognormal, and gamma distributions, GOF evaluations will also focus on these three distributions. However, the data do not have to fit one of these distributions in order to be used in the evaluation. A straight-line fit on a Q-Q plot suggests the data are from a single population with the specified distribution.

4.3.1.3 Box Plots

A box plot shows the interquartile range (i.e., 25th and 75th percentiles), measures of central tendency (e.g., 50th percentile, arithmetic mean), spread of the data, and extreme values. When data from multiple wells are presented side-by-side for the same constituent, this graphic can help to determine if each well is representative of the same hydrostratigraphic unit. Box plots can also help to identify potential outliers based on the product of the interquartile range (IQR = 75th - 25th percentiles) added to the 75th percentile. Commonly, values that exceed the 75th percentile plus 1.5 times IQR are considered moderate outliers, whereas values that exceed 75th percentile plus 3.0 times IQR are extreme outliers. Side-by-side box plots will be generated to compare background and compliance wells. These box plots will include a tabular summary of selected statistics, including sample sizes (detects, nondetects, and total), the minimum, maximum, arithmetic mean, median, and standard deviation of detected results, and a range of percentiles (25th, 50th, 75th).

4.3.1.4 Trend Analysis

In general, trend plots show the concentrations over time within a well or within all background or compliance wells. These plots can reveal patterns in the data, such as periodic fluctuations (e.g., seasonality), or a consistent trend (increasing or decreasing) in the data. These plots are particularly useful for evaluating data from wells in unimpacted areas because reporting limits for nondetects may change over time, thereby masking any real changes in groundwater quality.

Two statistical tests will be used to evaluate trends for wells in background and compliance wells: Mann-Kendall Test and Sen’s Slope Estimator. Each test has the flexibility to accommodate any particular distribution form, and each is relatively insensitive to outliers and nondetects (values less than reporting limits). For the Mann-Kendall Test, a series of pairwise slopes are calculated to determine the change in the concentration divided by the time interval between sequential sampling events. A test statistic “S” is computed based on the difference between the number of pairwise slopes that are strictly positive differences and negative differences. The null hypothesis of no trend (equal numbers of positive and negative differences) is evaluated at a 95% confidence interval, which for Sen’s Slope is based on a calculation of the 95% confidence interval for the median of the pairwise slopes.

Sample size requirements for characterizing background conditions depend on the number of wells and the number of observations per well. USEPA (1989) recommends a full year (n= 4 quarters) of sampling per well for units represented by at least four wells, or n=8 per well for units represented by fewer than four wells. A minimum of four sampling events per well is needed to run the Mann-Kendall and Sen's Slope Tests. If the data contain nondetects, a minimum of four detects is needed and the reporting limits of nondetects are closely evaluated to determine the influence of nondetects on the slopes (e.g., historical data with high reporting limits). For these tests, nondetects are included at one-half the reporting limit and nondetects greater than twice the maximum detected concentration are excluded in order to minimize potential biases in the trend analysis due to differences in reporting limits over time.

The Mann-Kendall and Sen's Slope Tests require an aggregation procedure when there are observations from multiple wells on any given day. Gilbert (1987) provides an elaborate procedure to adjust the variance of the test statistic, *S*, but also suggests a reasonable alternative is to calculate a summary statistic, such as the mean or median. For this analysis, the following data processing steps will be implemented: 1) sort co-occurring observations in ascending order and calculate the relative percent difference (RPD = 100% x (min – X_i) / (0.5 x (min + X_i)) and retain all observations, X_i, for which RPD ≤ 50%; 2) calculate the arithmetic mean of observations retained in Step 1. This procedure reduces the chance of introducing anomalous, high concentrations from a single well in the calculation of the concentration that is intended to be representative of the overall unit on a given day.

Several variations of trend plots will be generated to evaluate temporal variation in background and compliance wells. Trends will be evaluated within individual wells and also for data pooled across background or compliance wells.

The Mann-Kendall test for trend requires that sample locations used in the test do not exhibit seasonal variability. Trend plots will be inspected for potential seasonal cycles (e.g., quarterly intervals). For datasets with suspected seasonality, hypothesis testing will be conducted with Kruskall-Wallis tests to determine if there are statistically significant (α=0.05) differences in means of data grouped by season. If seasonal cycles are present in the data, the Seasonal-Kendall (SK) tests for trend will be used (Hirsch et al., 1982; Gilbert, 1987). The SK test performs the Mann-Kendall trend test for individual seasons of the year and then combines the individual results into one overall test. USGS generally recommends that a minimum of 5 years of data be collected to perform the SK test (Helsel, Mueller, and Slack, 2006). Many approaches to deseasonalizing data exist. The simple method suggested by USEPA (USEPA, 1989, Section 7.2) will be utilized to adjust the concentrations prior to conducting subsequent statistical analysis described below.

4.3.2 Statistical Analysis of Background Data

Two conventional approaches for conducting comparisons of site data to background data include establishing BSLs for point-by-point comparisons (determining if one or more site observations exceeds the BSL), and applying hypothesis tests to determine if the overall distributions are the same. The point-by-point approach is inherently conservative – it is prone to high Type I error rates (identifying concentrations at a site as elevated when, in fact, they are not) because the probability of an exceedance of the BSL is a function of the number of comparisons (sample size of the site data set). For site data sets with n=10 observations, the probability of at least one "false" exceedance of a BSL with 95% coverage of background concentrations may be greater than 40%[1, 2]. By contrast, hypothesis tests are implemented to determine if differences in the central tendency (mean/median) or upper tails of the distributions are statistically significant. Two-sample hypothesis tests are not subject to high error rates, and Type I error rates for multiple sample comparisons (through a one-way analysis of variance [ANOVA]) can be easily corrected (e.g., Bonferroni adjusted $\alpha \approx$ (desired α/n)). Furthermore, applying both evaluations of central tendency and upper tails ensures that the approach is protective.

Statistical guidance on implementing point-by-point comparisons and hypothesis testing is available from 329 IAC 10-21-6 (2004) and USEPA (USEPA 1992, 2006, 2007a). USEPA (2007b) indicates that methods that compare the distributions, and in particular hypothesis tests, are preferred, provided sufficient sample sizes (e.g., 8-10 observations with at least 5 detects) are available in both the site and background datasets. The remainder of this section addresses statistical procedures for both of these techniques and offers recommendations for their implementation.

---

[1] Type I error rate is a function of the sample size (n) of the Site data set. The probability that at least one Site observation is greater than a one-sided 95% UTL of the background distribution (a Type I error rate) is given by $\alpha = \Pr(Y \geq UTL) = 1 - \Pr(Y < UTL) = 1 - 0.95^n$, assuming the UTL is equivalent to the 95th percentile. For n=1, α=0.05, but for n=10, $\alpha = 1 - 0.95^{10} = 0.401$.

[2] USEPA (1992) acknowledges high rates of false positives, but cautions against reducing α to achieve an overall Type I error rate due to the loss of power (increase in Type II error rate – probability of identifying the site as uncontaminated when, in fact, it is). Ideally, additional site data would be collected (USEPA1992, 2007a).

4.3.2.1 Goodness-of-Fit Testing

Goodness-of-fit testing is performed to determine if parametric or nonparametric statistical methods are most appropriate for calculating BSLs or conducting hypothesis testing. Consistent with USEPA guidance (USEPA 2007a, 2007b), data will be evaluated for fits to normal, lognormal, and gamma distributions using methods appropriate for the sample size and degree of censoring. Data will be evaluated for fits to normal and lognormal distributions at α=0.05 significance levels using Shapiro Wilks test for n ≤ 50 and Lilliefors test for n > 50. Anderson Darling and K-S tests will be used to evaluate fits to gamma distributions. Nondetects introduce uncertainty in GOF testing and many methods have been proposed to conduct GOF testing of left-censored data (refer to Helsel, 2005 and USEPA, 2007b for comprehensive overviews). Methods that rely on substitution of a constant (e.g., ½ reporting limit) have been shown to yield unreliable results, even for censoring levels as low as 5% (Helsel, 2005; USEPA, 2007b). Therefore, two alternate methods will be applied in this analysis: 1) GOF on detects only; and 2) GOF on rank-ordered statistics (ROS) (USEPA, 2007a, b). Agreement between the two methods provides supporting evidence for the selection of statistical methods that depend on GOF test results. If the results of the two methods are not the same, visual inspection of the probability plots (Section 4.3.1.2) will be used to determine if the fit is sufficient to apply parametric approaches.

4.3.2.2 Outlier Analysis

Outliers are measurements that are extremely large or small relative to the rest of the data and, therefore, are suspected of misrepresenting the population from which they were collected (USEPA 2006). A primary step in any statistical analysis of groundwater data involves an evaluation of potential outliers. This is particularly important when the objective of the analysis is to establish BSLs or conduct hypothesis testing because summary statistics can be biased high by the presence of one or more outliers. Overestimates of the BSLs or the presence of outliers when conducting hypothesis testing can reduce the power of statistical tests to identify areas where concentrations are elevated above background conditions.

An outlier may represent a true extreme value from a highly variable data set, or it may represent an erroneous measurement. When data are grouped by well location and compared across wells, consistent differences in the distribution of one or more constituents within a given well may indicate that the well is representative of a different population. A qualitative evaluation of quantile-quantile plots and side-by-side box plots will be conducted to identify a subset of "suspected outliers". Statistical tests for outliers will also be conducted to determine if there is sufficient evidence of the likelihood (probability) that one or more extreme values is inconsistent with the remainder of the data at a specified significance level. Depending on characteristics of the data set for each constituent (e.g., sample size, distribution, and degree of censoring), the appropriate statistical test for outliers will be selected from Dixon's test, Rosner's test, Walsh's test, and the IQR test:

- If data excluding suspected outlier(s) are approximately normally distributed (or can be transformed to a normal distribution) and the data set contains a low percentage of nondetects (<15%), Dixon's test is used if the sample size (n) < 25 and Rosner's test is used if n ≥ 25. Prior to conducting either test, Rank Order Statistics (ROS) methods will be utilized to estimate nondetect values for these tests.

- If data excluding suspected outlier(s) are approximately normally distributed (or can be transformed to a normal distribution) and the data set contains greater than 15% nondetects, the IQR test will be used.

- If the data excluding suspected outlier(s) are not approximately normally distributed (or cannot be transformed to a normal distribution), Walsh's test is used if n≥60 and IQR test is used if n<60. Note that Walsh's test will be performed at α=0.10 if n<220.

These tests alone cannot determine whether a statistical outlier should be discarded or corrected within a data set. Removing accurate data with high values and failing to remove outliers that arise from erroneous measurement are opposite kinds of errors that can both lead to a distorted estimate of summary statistics (USEPA, 2006). Therefore, the decision to evaluate BSLs and hypothesis tests with and without statistical outliers will be based on both professional judgment and results of the statistical analysis.

4.3.2.3 Calculation of Background Screening Levels

State and federal guidance indicate BSLs for a groundwater dataset can be based on one of several representative statistics, commonly an upper tolerance limit (UTL) or upper prediction limit (UPL) (329 10-21-6(f)(3) [IAC 2004]; ASTM, 1998; USEPA 1989, 1992, 2006, 2007a). A UTL contains a proportion of the population, whereas a UPL contains one or more future observations. In general, a UTL is the appropriate statistic when the intent is to compare data from unimpacted areas with data from potentially impacted areas (USEPA, 1989 – Section 5). Since this is the goal of the compliance monitoring effort for this site (i.e., comparison of concentrations from upgradient and downgradient wells), a UTL is used in this analysis. UTLs provide an interval within which at least a certain proportion of the population is “contained”, sometimes referred to as “coverage” or percentile (USEPA 2006). This coverage can be achieved “on average” or with a specified probability or level of confidence:

- Average coverage – a tolerance interval is constructed so that it contains *on average* β100% of the population (i.e., the average coverage is β100%).[3, 4]

- Confidence limit on coverage – a tolerance interval with confidence level (1-α)100% is constructed so that it contains *at least* β100% of the population (i.e., the coverage is at least β100%) with probability (1-α)100%.

For this analysis, the proposed statistical methods are based on a one-sided 95 percent confidence interval for the 99th percentile (95/99 UTL). Several methods may be used to calculate a UTL. The appropriate method generally depends on the degree of censoring, whether the data can be fit to a probability distribution (e.g., normal, lognormal, gamma), skewness of the distribution, and whether the desired coverage can be achieved (USEPA 2007a). A hierarchy for selecting the appropriate method for calculating the BSL is given in the table below.

Sample Size	Censoring	Distribution	Skewness	Statistic Used for BSL
n < 8	Detects < 8	NA	NA	Maximum detect
n ≥ 8	Detects < 5	NA	NA	Maximum detect
	Detects ≥ 5 FOD = 100%	N N and LN N and LN and G	NA	Normal 95/99 UTL
		LN	NA	Lognormal 95/99 UTL

[3] Note that there is no explicit confidence level associated with this tolerance interval; for purposes of comparison with tolerance limits with confidence intervals, this type of approach is sometimes described as yielding a tolerance interval with a confidence level of about 50%.

[4] A tolerance interval with average coverage of β100% is equivalent to a prediction interval for k=1 future observations with associated confidence level β100%.

Sample Size	Censoring	Distribution	Skewness	Statistic Used for BSL
		G LN and G	NA	Gamma 95/99 UTL
		not N, LN, or G	NA	Nonparametric 95/99 UTL or Poisson 95/99 UTL[1]
	Detects ≥ 5 FOD < 100%	N or LN	Mild[2]	Kaplan-Meier 95/99 UTL
			Moderate to High[2]	Nonparametric 95/99 UTL or Poisson 95/99 UTL[1]
		not N or LN	NA	Nonparametric 95/99 UTL or Poisson 95/99 UTL[1]

Abbreviations: FOD = frequency of detects (detects/n); G = gamma distribution; LN = lognormal distribution; N = normal distribution; n = sample size; NA = not applicable; ND = nondetect

[1] Rank-ordered statistic; for n ≤299, the nonparametric UTL is equal to the maximum and the average coverage of the maximum is given by n/(n+1) (Conover, 1999). For larger sample sizes, values less than the maximum may achieve 99% coverage with 95% confidence.

[2]Skewness is quantified by the standard deviation of the natural logarithm of the detects (σ_{ln}). Mild skew corresponds to σ_{ln} <1; Moderate to high skew corresponds to $\sigma_{ln} \geq 1$ (USEPA, 2007a).

A minimum of n=8 observations and n=5 detects is needed in the background data set in order to evaluate goodness-of-fit to normal, lognormal, and gamma distributions (USEPA, 2007a). Datasets with all nondetects will not be used to establish a true BSL, although observations will be noted regarding the maximum reporting limit compared to the concentrations (or detection limits) in the compliance well dataset. If the dataset includes at least one detect, either parametric or nonparametric methods will be used, as described below. A UTL that provides 99% coverage with 95% confidence is readily attainable with a sample size of n=16 if a parametric method can be used. Nonparametric methods based on the maximum detect require very large sample sizes (i.e., n ≥299) to achieve 95% confidence of 99% coverage (see Table A-5 of Conover, 1999).

The distribution of the background dataset will be assessed as discussed in Section 4.3.2.1. For full datasets, parametric UTLs will be calculated for normal, lognormal, and gamma distributions. For full datasets that do not follow a discernable distribution, either a nonparametric 95/99 UTL or Poisson 95/99 UTL will be calculated. A nonparametric UTL may be based on a rank-ordered value in the dataset. For sample sizes less than 299, the nonparametric 95/99 UTL is equivalent to the maximum detect (Conover 1999). If the rank-ordered statistic selected to represent the nonparametric 95/99 UTL does not achieve the appropriate coverage (i.e., 99%) for a given sample size on average, then the Poisson UTL will be calculated based on a methods described by Gibbons (1987, 1994) and USEPA (1992). For left-censored data, the Poisson parameter will be determined by Kaplan-Meier (KM) methods, which are recommended by USEPA (2007a) as the most robust nonparametric maximum likelihood estimation technique. Specifically, the sum of the concentrations will be estimated by the product of the KM mean and the total sample size (detects and nondetects).

For censored datasets that follow a normal or lognormal distribution the choice of method will depend on the skewness, as determined by the standard deviation of the log-transformed data (detects only) (σ). Datasets with $\sigma \leq 1.0$ are considered mildly skewed, whereas datasets with $\sigma > 1.0$ are considered moderately to highly skewed (USEPA, 2007b). UTLs for mildly skewed datasets will be approximated using the Kaplan-Meier 95/99 UTL, while UTLs for moderately to highly skewed datasets will be approximated using the nonparametric or Poisson 95/95 UTL (as described above).

With parametric methods applied to background data (with or without nondetects), sometimes a calculated UTL is greater than the maximum detected concentration. This represents a source of uncertainty in the BSL, and usually occurs when the sample size is low and the variance is high. In such cases, the BSL will be based on the UTL, and it will be noted that the UTL exceeds the maximum detected concentration.

Comparisons will be made on a point-by-point basis to determine if one or more site observations exceeds the BSL. For this analysis, the comparison of site data to BSLs will serve as a preliminary screening step. As indicated above, this type of analysis is prone to high Type I error rates. Therefore, constituents for which one or more exceedances are noted in the site dataset will be subsequently evaluated using hypothesis test, as described in the following section.

4.3.2.4 Hypothesis Testing

Hypothesis tests can be used to determine if differences in the distributions of two data sets are statistically significant. Hypothesis testing will be used in this analysis to evaluate the site and background distributions, and these results will complement the BSL approach described above. Background and site data sets can consist of samples collected at different times and locations. The question addressed by hypothesis tests is whether or not the overall variability for the site population is consistent with that of the background population. As with most statistical tests, the probability of falsely concluding that the concentrations in the site data are higher than background can be specified by the Type I error rate (e.g., α=0.05). It should be noted that USEPA (2007a, 2007b) recommends using hypothesis testing only if both datasets contain at least 8-10 observations (including nondetects).

Two types of hypothesis testing can be conducted: a comparison of central tendencies (means or medians), and a comparison of the upper tails of the distributions. The test of central tendency either tests the means (i.e., a t-test) if both data distributions are normal without nondetects, or the medians (i.e., Wilcoxon Rank Sum test or Gehan's test) as described in USEPA (2007a; 2007b). The Wilcoxon Rank Sum test is conducted when the data contain nondetects and a single reporting limit. Gehan's test can be used instead of the Wilcoxon Rank Sum test in cases when the two datasets contain more than one unique reporting limit.

The quantile test is a non-parametric test used to detect a shift in the right tails of the site and background distributions. The test does not require a distributional assumption; however the test cannot be performed when there are nondetects among the largest 'r' values in the datasets (USEPA, 2007a; 2007b). Therefore, nondetects in the upper tails should be removed and the quantile test run a second time with the nondetects removed from the 'r' largest values.

If both the central tendency and upper tails hypothesis tests conclude that the null hypothesis (e.g., Ho = no statistically significant difference between site and background) cannot be rejected then it may be concluded that site is not elevated above background (at α=0.05). If one or both of the statistical tests shows a statistically significant difference between site and background (at α=0.05), then the null hypothesis may be rejected in favor of the alternate hypothesis that some site locations may be elevated as compared to background.

4.4 Decontamination Procedures

The water level indicator will be cleaned before being brought to the Site. The water level probe and tape will be decontaminated after completion of measurements in each monitoring well by a three-step process: (1) spray with a diluted non-phosphate detergent such as Liquinox, (2) spray with deionized water, and (3) wipe off using clean paper towel. The decontaminated water level meter shall not be placed directly" on the ground surface prior to insertion in a monitoring well, or if it is necessary to place it on the ground, it will be placed on a clean surface such as the meter's carrying case, a plastic bucket, or a plastic garbage bag.

Either separate dedicated purging and sampling pumps will be supplied for each well, or one pump will be used to purge and sample all wells. If dedicated pumps are supplied for each well, the pump will remain in the well between sampling events and decontamination will not be required. If a single submersible pump is used to purge and sample all wells, the pump will be thoroughly decontaminated between each well. Decontamination information such as time/date/method for reusable well pumps will be completed in the 'Notes' section of Figure 2. New tubing will be used for each well and all used tubing will be properly discarded. The submersible pump will be decontaminated by submerging the pump in a 5-gallon bucket of diluted non-phosphate detergent, and pumping the detergent solution through the pump. The pump will then be submerged into a bucket of deionized water to rise out the pump. Rinse water will be drained from the pump. The suspension cable and electrical line will be decontaminated as described above for the water level indicator.

4.5 Water Level Indicator Maintenance

The water level indicator will be maintained to perform as the manufacturer warrants. The probe will be kept clean and dry. Batteries will be charged, electrical connections will be tested, and the buzzer and lights will function properly. All maintenance will be performed prior to the monitoring activities. The initial 50 foot portion of the water level indicator (approximately 10 feet more than the deepest groundwater elevation) will be inspected for stretch-in-tape before each monitoring event. It will be measured using a graduated survey tape that measures in 0.01 foot increments. The survey tape will not be used in the field, and its sole purpose will be for comparison to the water level indicator tape. The water level indicator tape will be replaced when stretch exceeds 0.01 feet anywhere along the tape. Tape that cannot be cleaned to a visibly acceptable appearance or that is excessively bent or kinked, will not be used.

4.6 Calibration Methods for Field Equipment

Field indicator parameter sensors (pH, ORP, conductivity and DO) will be calibrated the start of the sampling event using an appropriate calibration fluid. Calibration methods will be completed each subsequent day the sampling event extends. Documentation of calibration activities will be completed on the Instrument Calibration Record attached as Figure 5. The turbidity sensor is required to be calibrated once per year and is completed by the equipment supplier.

5. Monitoring Well Redevelopment and Replacement Criteria

The monitoring wells will be gauged during the sampling events (semi-annually) to determine the degree of siltation in the monitoring wells. Monitoring wells will be redeveloped if greater than one foot of siltation is noted in the well (i.e. the total depth of the well is measured to be less than the total depth indicated on the revised monitoring well construction diagrams by one foot or more). Redevelopment will first consist of pumping the well to reduce silt to within 0.1 feet of the as-built depth. A purge pump such as an Envirotech Purger DC-60 or equivalent will be used. The pump will be properly decontaminated before and after each use. The pump and associated tubing will be lowered into the well and the pump activated. The pump may be raised and lowered in the well during operation in order to help suspend any sediment and allow for its removal. In the event the well runs dry, the pump will be turned off and well allowed to recover. Upon recovery, pumping will resume. If determined appropriate, a hand surge block may also be used to help suspend and remove sediment from the well screen. Redevelopment will be complete when the total depth of the well is within 0.2’ of the as-built construction well depth or the redevelopment water is sediment-free.

Monitoring wells from which samples are collected will be replaced if siltation of greater than 50% (five feet) of the well screen is measured in the first semi-annual monitoring event following redevelopment. Replacement of monitoring wells used only for hydraulic monitoring will be evaluated to determine if replacement is necessary. In addition, wells will be replaced or repaired if they have been damaged to a point to which water level or total depth cannot be measured or from which samples cannot be collected.

References

ASTM International (ASTM). 1998. Standard Guide for Developing Appropriate Statistical Approaches for Ground-Water Detection Monitoring Programs. D 6312-98 (Reapproved 2005).

Conover, W.J. 1999. Practical Nonparametric Statistics. Third Edition. John Wiley & Sons.

Gibbons, R.D. 1987. Statistical Models for the Analysis of Volatile Organic Compounds in Waste Disposal Sites. *Ground Water*, 25: 572-580.

Gibbons, R.D. 1994. Statistical Methods for Groundwater Monitoring. John Wiley & Sons, New York.

Gilbert, R.O. 1987. Statistical Methods for Environmental Pollution Monitoring. John Wiley & Sons, New York.

Guenther, W.C. 1972. Tolerance Intervals for Univariate Distributions. Naval Research Logistics Quarterly. 19:309-333.

Helsel, D.R., Mueller, D.K., and Slack, J.R., 2006. Computer Program for the Kendall Family of Trend Tests: U.S. Geological Survey Scientific Investigations Report 2005-5274. Available online at: http://pubs.usgs.gov/sir/2005/5275/pdf/sir2005-5275.pdf.

Hirsch, R.M., J.R. Slack, and R.A. Smith. 1982. Techniques of trend analysis for monthly water quality data. *Water Resources Research*, 18: 107-121.

IAC. 2004. Statistical evaluation requirements and procedures. 329 IAC 10-21-6.

IDEM. 1997. Guidance for Statistical Evaluation Plan Preparation and Review. Office of Land Quality. WASTE-0003-NPD. February.

USEPA, 1989. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Interim Final Guidance. Office of Solid Waste, Waste Management Division. April.

USEPA, 1992. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Addendum to Interim Final Guidance. Office of Solid Waste, Permits and State Programs Division. July. http://www.epa.gov/swertio1/chartext_edu.htm#stats.

USEPA. 2006. Data Quality Assessment: Statistical Methods for Practitioners. EPA QA/G-9S. Office of Environmental Information. EPA/240/B-06/003. February.

USEPA. 2007a. ProUCL Version 4.0 Technical Guide. Office of Research and Development. EPA/600/R-07/041. April.

USEPA. 2007b. ProUCL Version 4.0 User Guide. Office of Research and Development. EPA/600/R-07/038. April.

ARCADIS

Attachment A

Pace Analytical Laboratories QAPP

Resubmitted August 2006

Attachment H References

Meyer, W., Reussow, J.P., Gilles, D.C., 1975, Availability of Ground Water in Marion County, Indiana. USGS Open-File Report #75-312, Indianapolis.

ARCADIS Geraghty & Miller, Inc., 1991, Hydrogeological, Geophysical, and Geotechnical Investigation of the Area Around Retention Basins #1 and #2 Plant 5, Allison Gas Turbine Division, Indianapolis, Indiana.

EPA/530-SW-89-026, April 1989, Statistical Analysis of Ground Water Monitoring Data at RCRA Facilities, Interim Final Guidance.

EPA/240/B-06/003, February 2006, Addendum to Interim Final Guidance (July 1992), Data Quality Assessment: Statistical Methods for Practitioners, EPA QA/G-9S.

EPA/600/R-07/041, April 2007, ProUCL Version 4.0 Technical Guide.

Ground Water, 25: 572-580; and 1994 [pp. 38-40], Statistical Methods for Groundwater Monitoring. John Wiley & Sons, New York).