RAM GROUP *The Risk Assessment & Management Group of Gannett Fleming, Inc.*

December 10, 2008

Gregory W. Dunn, L.P.G.
Illinois Environmental Protection Agency (IEPA)
1021 North Grand Avenue East
P.O. Box 19276
Springfield, Illinois 62794-9276

RE: Evaluation of Soil Gas Data Collected at Residential Properties near Former MGP Site, Champaign, Illinois

Dear Mr. Dunn:

The Risk Assessment and Management Group of Gannett Fleming, Inc. (RAM Group) is submitting one original and two copies of the above referenced report to the IEPA on behalf of our client Ameren Services. The soil gas sampling fieldwork was performed on October 15, 2008.

Please call any of the following if you have questions or need clarification or additional documentation:

- Kendall Pickett, RAM Group – 713-784-5151
- Atul Salhotra, RAM Group – 713-784-5151
- Brian Martin, Ameren Services – (314) 554-2233

Sincerely,

Atul M. Salhotra, Ph.D.
Principal Professional

Kendall L. Pickett
Senior Geologist

cc: Cary Ware, Illinois Department of Public Health (1 copy)
Brian Martin, Ameren Services (2 copies)
Stuart Cravens, Kelron Environmental (4 copies)

Evaluation of Soil Gas Data Collected at Residential Properties near Former MGP Site Champaign, Illinois

Prepared for:

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December 2008

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ABBREVIATIONS

ATSDR	Agency for Toxic Substances and Disease Registry
CCV	Continuing Calibration Verification
COC	Chain of Custody
EPA	Environmental Protection Agency
GRI	Gas Research Institute
HASP	Health and Safety Plan
IDW	Investigation Derived Waste
IEPA	Illinois Environmental Protection Agency
IRIS	Integrated Risk Information System
LCS	Laboratory Control Sample
MGP	Manufactured Gas Plant
MRL	Minimal Risk Level
NHDES	New Hampshire Department of Environmental Services
OEHHA	Office of Environmental Health Hazard Assessment
OSWER	Office of Solid Waste and Emergency Response
PAH	Polycyclic Aromatic Hydrocarbons
PPE	Personal Protective Equipment
PRG	Preliminary Remediation Goal
PRT	Post Run Tubing
RfC	Reference Concentration
RL	Reporting Limit
RO	Remediation Objective
RPD	Relative Percent Difference
RSL	Regional Screening Level
SRC	Syracuse Research Corporation
TACO	Tiered Approach to Corrective Action Objectives
URF	Unit Risk Factor
WBEOH	Wisconsin Bureau of Environmental and Occupational Health

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ABBREVIATIONS

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COC	Chain of Custody
EPA	Environmental Protection Agency
GRI	Gas Research Institute
HASP	Health and Safety Plan
IDW	Investigation Derived Waste
IEPA	Illinois Environmental Protection Agency
IRIS	Integrated Risk Information System
LCS	Laboratory Control Sample
MGP	Manufactured Gas Plant
MRL	Minimal Risk Level
NHDES	New Hampshire Department of Environmental Services
OEHHA	Office of Environmental Health Hazard Assessment
OSWER	Office of Solid Waste and Emergency Response
PAH	Polycyclic Aromatic Hydrocarbons
PPE	Personal Protective Equipment
PRG	Preliminary Remediation Goal
PRT	Post Run Tubing
RfC	Reference Concentration
RL	Reporting Limit
RO	Remediation Objective
RPD	Relative Percent Difference
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This report presents the results of the soil gas sampling and basement survey event performed on October 15, 2008 at the following three residential properties near the former MGP site in Champaign, Illinois:

- 505 E. Washington Street
- 507 E. Washington Street
- 412 E. Hill Street

The soil gas sampling event consisted of the collection of nine soil gas samples (including one duplicate) and one ambient air sample from eight locations along the perimeter of the three residential properties. The samples were collected in SUMMA canisters using Geoprobe® post-run tubing (PRT) methods. Appropriate QA/QC samples were also collected.

The soil gas samples were compared to the draft Illinois Environmental Protection Agency (IEPA) Tiered Approach to Corrective Action Objectives (TACO) Tier 1 soil gas remediation objectives (ROs) for residential land use. The comparison indicated that the concentrations of none of the chemicals exceeded the Tier 1 ROs, and hence the residual soil and groundwater impacts from the former MGP are not of concern.

The Illinois Licensed Professional Engineer review letter is included in Appendix J.

1.1 SITE LOCATION

The former manufactured gas plant (MGP) site is located at 308 North Fifth Street in Champaign, Illinois. This investigation focused on the collection of soil gas samples to evaluate soil gas inhalation risk at three residential properties located to the north and west of the former MGP site.

The MGP site has been the subject of several previous investigations (PSC 2008). These investigations have resulted in the collection of soil and groundwater data, as well as site stratigraphy and hydrogeology.

Figure 1-1 shows the locations of the three residential properties, former MGP site boundary, railroad easement, and nearby streets. The former MGP site is mostly vacant with the former booster house building remaining and some poly tanks used to store investigation-derived wastewater. The former MGP site is fenced and access is restricted by locked gates.

1.2 SETTING

The residences are located within the city of Champaign, Illinois in Champaign County. The general area consists of mostly residential and some commercial properties.

Two of the subject residential properties are located to the north of the former MGP site and also north of an active railroad right-of-way that borders the former MGP site to the north. These homes are located at 505 East Washington (resident owner occupied and full time day-care facility in basement) and 507 East Washington (currently vacant). Each of the homes have basements that are partially below grade. The third residence is located at 412 East Hill (resident occupied) west of the former MGP site across N. Fifth Street and also has a basement that is partially below grade.

1.3 OBJECTIVE OF THIS REPORT

This report presents the results of the October 15, 2008 soil gas sampling event at the three residential properties. The objective of the sampling was to:

- Obtain nine soil gas samples (including one duplicate) near the three residences and one ambient air sample;
- Perform laboratory analysis of the soil gas and ambient air samples and duplicate for MGP related chemicals;
- Perform basement surveys at the three residences and interview occupants as available;

- Compile and evaluate the field and laboratory analysis data in regards to the potential for MGP chemicals to cause vapor inhalation concerns to the residences; and

- Document the results of the investigation in a formal report.

This investigation was performed in accordance with the RAM Group letter to Mr. Brian Martin dated August 21, 2008 (Appendix A).

1.4 OVERVIEW

The October 15, 2008 soil gas sampling event was performed by the RAM Group of Gannett Fleming, Inc. Geoprobe® services were provided by Soil Essentials, Inc. and laboratory analytical services were provided by Air Toxics, Ltd., both under subcontract to RAM Group.

Soil gas sampling and basement surveys were performed on October 15, 2008 at the following three residential properties in Champaign, Illinois:

- 505 E. Washington Street
- 507 E. Washington Street
- 412 E. Hill Street

The following personnel performed the soil gas sampling and basement surveys:

- Cory Johnson, Soil Essentials driller
- Keith Klemm, Gannett Fleming
- Kendall Pickett, RAM Group
- Stu Cravans, Kelron Environmental (basement survey at 412 E. Hill Street on October 22, 2008)

The following personnel were also present to observe activities:

- Brian Martin, Ameren
- Pete Szama, PSC
- Gregory Dunn, IEPA
- Andy Friereich, IEPA
- Student intern, IEPA
- Gina Jackson, District 1 Representative
- Matthew Miller, Gannett Fleming
- Grant Antonlini and another representative of the Champaign County Healthcare Consumers group

2.1 PRE-INVESTIGATION ACTIVITIES

2.1.1 Utilities Clearance

Soil Essentials, Inc., the drilling company, contacted the state utility locate service in Illinois (JULIE Locate) to coordinate marking of underground utilities at the surface on and near the three residential properties. Upon arrival at the site on October 15, 2008, paint markings and flags were present. RAM Group used these markings and site observations to avoid encountering subsurface utilities during sampling.

2.1.2 Daily Site Health & Safety Meetings

A field safety meeting was held on the morning of October 15, 2008 before any fieldwork was performed to review the site-specific health and safety plan prepared for this project (Appendix B).

2.2 SOIL GAS AND AMBIENT AIR SAMPLING

The weather conditions were overcast in the 60-70's ^{o}F with occasional rain showers throughout the day.

Based on the PSC *Off-Site Investigation Report, Former Manufactured Gas Plant, Champaign, Illinois, State ID 0190100008*, dated August 22, 2008, the soils in the vicinity of the site consist of glacial till of mostly tight silty clays in the upper 10 feet bgs and sandy sediments below 10 feet bgs. The water table has been measured at depths of 7 to 8 feet bgs.

2.2.1 Soil Gas Sampling and Analysis

Nine soil gas samples (including one duplicate) were collected from eight locations using hand and Geoprobe® sampling methods. The work plan called for soil gas samples to be collected from each boring, at approximately 6 ft bgs (approximately one foot below the bottom of the basement slab, estimated at 5 ft bgs and above the water table, estimated at 7-8 ft bgs) adjacent to three private residences. However, tight soils encountered in the soil column did not allow for gas collection at the designated depths, instead sampling was performed at depths where a more permeable soil layer was encountered. Specific depths are shown in Table 2-1. Small diameter steel rods were temporarily installed at each sample location by Soil Essentials. Extreme care was taken to prevent damage to the properties. Ground water was not encountered at any of the sample locations.

Soil gas samples were collected in 1-liter SUMMA canisters (batch certified) using Geoprobe® post-run tubing (PRT) methods. One duplicate soil gas sample was collected from a location at the 507 E. Washington Street property.

The sampling approach involved the use of small diameter steel rods that were advanced vertically by hand or using a Geoprobe® 550B track-mounted rig. Hydrated bentonite was placed around the rods where they entered the ground to plug the borehole annulus (Photograph 1, Appendix C). Teflon® tubing was attached to the PRT adapter and pushed down inside the rods, seated, and threaded into the expendable point holder. Next, a Swagelok® three-way valve and a gas-tight 60-mL disposable syringe were connected to the Teflon® tubing and the steel rods were pulled up approximately 6 to 8 inches to dislodge the rods from the expendable point.

A tracer test was performed using difluoroethane to check for the presence of leaks in the sampling system (i.e., short-circuiting). Household paper towels, wetted with difluoroethane, were wrapped around the steel rods at the ground surface/bentonite seal (to test for short-circuiting at the borehole annulus) and around the Teflon® tubing where the tubing exited the steel rods to test for short-circuiting across the O-ring seal in the PRT adapter.

The initial vacuum of each 1-L Summa canister was measured in the field prior to sampling using a liquid-filled vacuum gauge to confirm the vacuum was at least 27 inches of mercury (in Hg). The initial vacuum was recorded on the chain of custody (COC) and in the field log book. Purge volume calculations were performed and the tubing was purged prior to sample collection using a Swagelok® three-way valve and a gas-tight 60-mL disposable syringe. A 5-micron filter was installed on the canister inlet to prevent solids from entering and to restrict the soil gas flow rate into the canister. The 1-L Summa was then connected to the Swagelok® three-way valve and the sample was collected. Generally, the sampling duration was between 5 and 7 minutes with one exception (VP412EHILL-1 was sampled for 18 minutes) until the final vacuum in the canister was about 5 in Hg. The sample collection time, initial vacuum, and the final vacuum were recorded on the COC and in the field log book. A copy of the pertinent pages from the field logbook is presented in Appendix D.

The samples were shipped by overnight courier in containers sealed with custody seals to the Air Toxics, Ltd. laboratory in Folsom, California. The samples were analyzed for volatile organic compounds, naphthalene, and 1,1-difluoroethane (leak detection chemical) using EPA method TO-15 (modified).

After collection of each sample and withdrawal of the steel rods, the resulting borehole was filled with hydrated bentonite chips to the surface.

The sample locations at the following residential properties are shown on Figure 1-1.

2.2.1.1 505 E. Washington Street

This property was occupied by the residents and the basement was in operation as a day-care center with children and employees.

Two soil gas samples were collected, one on the south side (Sample ID #VP505EWASH-1) and one on the west side (Sample ID #VP505EWASH-2), both within 2.5 ft of the house. The small diameter steel rods were installed by hand using a slide hammer to push the rod to the desired sampling depths.

Sample #VP505EWASH-1 was collected at a depth of 5.5 feet below ground surface (ft bgs), and Sample #VP505EWASH-2 was collected at a depth of 4.5 ft bgs. Table 2-1 presents details of the soil gas samples.

Photographs 2-4 show sampling procedures at the VP505EWASH-2 location (Appendix C).

2.2.1.2 507 E. Washington Street

This property was vacant and we were informed by the client that the interior was in such disrepair that the home would likely have to be demolished. The basement did not appear to be used for habitation.

Three soil gas samples were collected, one on the west side (Sample ID #VP507EWASH-1), one on the south side (Sample ID #VP507EWASH-2), and one on the east side (Sample ID #VP507EWASH-3), all within 3.5 ft of the house. The small diameter steel rods were installed using a Geoprobe® 550B track-mounted rig to push the rod to the desired sampling depths.

The first attempt to collect Sample #VP507EWASH-1 was not successful and several attempts were made to collect soil gas at depths of 6 ft bgs, 5 ft bgs, and 4 ft bgs, but the soils were too tight. This location was about mid-way between the houses at 505 E. Washington Street and 507 E. Washington Street. Near the end of the day, a successful attempt was made to collect Sample #VP507EWASH-1 at a location adjacent to the house.

Sample #VP507EWASH-1 was collected at a depth of 3.5 ft bgs, Sample #VP507EWASH-2 was collected at a depth of 5.0 ft bgs, and Sample #VP507EWASH-3 was collected at a depth of 5.0 ft bgs. A duplicate soil gas sample was collected at 5.0 ft bgs from the #VP507EWASH-2 sample location and was labeled #VP507EWASH-F. Table 2-1 presents details of the soil gas samples.

2.2.1.3 412 E. Hill Street

Three soil gas samples were collected, one on the north side (Sample ID #VP412EHILL-1), one on the east side (Sample ID #VP412EHILL-2), and one on the south side (Sample ID #VP412EHILL-3), all within 3.5 ft of the house. The small diameter steel rods were installed using a Geoprobe® 550B track-mounted rig to push the rods to the desired sampling depths. Plywood sheets were used at this location to protect the lawn from damage by the rig.

Sample #VP412EHILL-1 was collected at a depth of 6.0 ft bgs, Sample #VP412EHILL-2 was collected at a depth of 3.8 ft bgs, and Sample #VP412EHILL-3 was collected at a depth of 4.5 ft bgs. Table 2-1 presents details of the soil gas samples.

Photographs 5-8 show sampling procedures at the VP412EHILL-3 sample location (Appendix C).

2.2.2 Ambient Air Sampling and Analysis

One ambient (outdoor) air sample was collected at the 507 E. Washington Street property in a 6-liter SUMMA canister to characterize the ambient air in the vicinity of the sampling locations during sampling. Figure 1-1 shows the location of this sample.

An ambient air sample was labeled VP507EWASH(AMBIENT) and was collected from just above ground surface near the #VP507EWASH-1 sample location. The sample location was conducted within 30 feet of a residential street (E. Washington Street), which is lightly traveled. The initial vacuum of the 6-L Summa canister was measured in the field prior to sampling using a liquid-filled vacuum gauge to confirm the pressure was at least 25 in Hg. The initial vacuum was recorded on COC and in the field log book. A 5-micron particulate filter was installed on the inlet to prevent solids from entering the canister and to restrict the sample flow rate. The sampling duration was about 18 minutes and the final vacuum in the canister was about 5 in Hg. The sample collection time, initial vacuum, and the final vacuum were recorded on the COC and in the field log book.

The samples were shipped by overnight courier in a container sealed with custody seals to the Air Toxics, Ltd. laboratory in Folsom, California. The samples were analyzed for volatile organic compounds and naphthalene using EPA method TO-15 (modified).

2.3 BASEMENT SURVEYS

The basement surveys consisted of a walk-through of the basement, documentation of observations on a form, and some photographs. Copies of the field forms are presented in Appendix E. Photographs are presented in Appendix C. The surveys of the 505 E. Washington Street and 507 E. Washington Street basements were performed on October 15, 2008 by Kendall Pickett of RAM Group. The survey of the 412 E. Hill Street basement was performed on October 22, 2008 by Stu Cravans of Kelron Environmental, as access was not available on October 15, 2008.

2.3.1 505 E. Washington Street

Much of the following information was provided by the resident and owner of the day-care business and documented on the Indoor Air Building Survey Form in Appendix E. The entry door is accessed from the backyard near the southeast corner of the house. The basement is used as an operating day-care and consists of a washroom, kitchen preparation area, day care area, bathroom, office, and a bedroom for a son of the resident. No crawl spaces were noted. There is reportedly a sump in the washroom that could not be observed due to storage of materials on top. The basement walls and floor slab are concrete with paneling and floor coverings and appear to be in good condition. The basement has not flooded in the past. The house is on central heat (natural gas) and central air conditioning (electric) and includes storm doors and storm windows. Various plumbing pipes enter the basement into the bathroom, washroom, and kitchen areas on the south and east sides of the basement. The layout of the basement is shown on Figure 2-1, which includes the approximate locations of the soil gas sampling locations. The basement extends approximately 3 feet above grade and 4 feet below grade with a footprint of approximately 38 ft (east-west by 28 ft (north-south).

Photograph 9 (Appendix C) shows the presence of oven cleaner and tire shine containers located inside the basement on the window sill. Other chemical products in the basement area include cleaning solvents, oven cleaners, floor wax, furniture/floor polish, air fresheners, glues, and paints. Also, the linoleum flooring is reportedly new.

The day care typically includes 16 children and 2 adults during the day, 10 children and 2 adults at night until midnight, and one adult resident in the bedroom at various times during day and night. The day care operates from about 6 AM to midnight, Monday-Friday. There are adult smokers in the house and basement. Dry cleaned clothes enter the house on a weekly basis. Pest control services are provided by professionals on a monthly basis. The resident noted foul odors outside at the end of June or July 2008, but did not provide specifics.

2.3.2 507 E. Washington Street

This home was not occupied; therefore, no occupants were interviewed. The basement survey was based on observations made during a walk-though of the basement and documented on the Indoor Air Building Survey Form in Appendix E.

The basement does not appear to have been used for habitation. It appears to have been used primarily for storage. The basement consisted of a slanted storm entry door accessed from the backyard, concrete floor slab, masonry brick walls below grade, and cinder block walls above grade. There were no floor, wall, or ceiling coverings. There are ledges that extend into the basement about 1.5 to 2 feet from most walls at a level of about 3 feet above the floor slab. There is one brick column and several temporary support posts holding first floor joists in place. Approximately 3 feet of the basement extended above grade and about 4.5 feet below grade below the building footprint of about 40 ft (east-west) by 28 ft (north-south), except for the crawl spaces.

The basement consists of a large open room that extends to the south, west, and north perimeter of the house footprint and contains a hot water heater (natural gas) and a central heat unit (natural gas) and duct work (system appears new), and an open sump. The sump contained water and trash. A small room is present to the east of the main room and extends to the east perimeter of the house footprint. There are two crawl spaces in the northeast and southeast corners of the basement. There are no floor drains or sinks/toilets. The main room contained discarded clothing, toys, cooking utensils, furniture, a ladder, books, plastic gasoline container, paint cans, files, mattress, 5-gallon plastic water bottles, and miscellaneous debris. Plumbing pipes enter the basement from the south and east walls and the electrical panel is on the south wall. The layout of the basement is shown on Figure 2-2, which includes the approximate locations of the soil gas sampling locations.

The walls have several openings due to deteriorated mortar between bricks, cinder blocks, and around window and door frames, as well as holes in the walls. The concrete floor slab is cracked and deteriorated in some areas thus exposing the underlying soil. The basement did not appear to prevent water infiltration and there was a musty odor.

Photographs 10-16 show various views inside the basement (Appendix C).

2.3.3 412 E. Hill Street

During the soil gas sampling activities on October 15, 2008, the resident would not allow access to the basement to perform a survey. Therefore, a representative of Kelron

Environmental returned on October 22, 2008 to perform the basement survey. Observations made during the survey and information provided by the tenant are documented on a form and diagram (Appendix E).

The owner of the property resides next door to the west. The house is wood frame with ½ basement and ½ crawl space. The first floor footprint is 36 ft (east-west) by 28 ft (north-south). The basement extends one foot above grade and about 5 feet below grade. The floor slab is concrete and walls are masonry brick with outer concrete facing. The floor was dry at the time of the reconnaissance. There is a sump with water that was reportedly sampled on September 15, 2008 and was non-detect for the constituents analyzed. There are no floor drains or sinks/toilets. Stairs enter the first floor near the center of the house. There is one window located at the south end of the east wall. There are three crawl spaces in the northeast corner and along the west wall of the basement with dirt floors. There is a forced air gas furnace and gas water heater located in the center of the basement. Cracks were noted along the floor/wall intersections. There is no basement or enclosed crawl space below the front porch (southeast corner of house). The layout of the basement is shown on Figure 2-3, which includes the approximate locations of the soil gas sampling locations.

2.4 SAMPLE ANALYSIS

Laboratory analysis was performed by Air Toxics Ltd. in Folsom, California. Air Toxics analyzed the soil gas samples using Method TO-15 GC/MS in full scan mode and included naphthalene and the leak detection chemical (1,1-difluoroethane). The ambient air sample was analyzed using the same method, but without the leak detection compound. The laboratory report and chain-of-custody form are included in Appendix F. Table 2-2 presents a summary of the laboratory analysis results.

2.5 DECONTAMINATION PROCEDURES

Personal Protective Equipment (PPE) and decontamination procedures are described in the site-specific health and safety plan (HASP) included in Appendix B. The following comments provide a general description of measures taken to mitigate cross contamination between soil gas sampling locations and from the natural environment.

The primary source of cross contamination from one sampling location to the next is the use of non-dedicated equipment. During this sampling event, 1.25-inch diameter rods with expendable point holder, Swagelok® components, valves, quick connects, adapters, syringes, and Teflon® tubing were used to obtain samples at each location. The Teflon® tubing and syringes were new and dedicated for each sample location and disposed after each use. The 1.25-inch diameter rods with expendable point holder, Swagelok® components, valves, quick connects, and adapters were decontaminated before use at each soil gas sampling point using an Alconox soap wash followed by a water rinse.

Contamination from the natural environment and other outside sources was controlled through the use of the following:

- Dedicated sampling equipment (new dedicated disposable Teflon® tubing and syringes for purging and sampling),
- Use of disposable Nitrile gloves,
- Use of custody seals and chain-of-custody protocols during delivery of samples to the laboratory.

2.6 INVESTIGATION DERIVED WASTE (IDW)

Investigative derived waste consisted of decon water and disposables. The decon water was placed in a poly tank inside the fenced, gated, and locked former MGP site for future disposal by Ameren. Disposables were contained in a plastic garbage bag and disposed in the trash.

2.7 QUALITY ASSURANCE AND CONTROL

2.7.1 Field Methods

Specific controls were implemented during the soil gas sampling activities to ensure sample quality and to avoid false positives or false negatives during data acquisition.

- The samples were collected in SUMMA canisters that were batch certified by Air Toxics, which included two 100% certified 1-liter SUMMA canisters out of the 10 SUMMA canisters used (nine 1-liter and one 6-liter). For batch certification, canisters are typically processed in the same manner and up to 6 canisters are placed in the oven at a time. One of the 6 canisters is 100% certified.

- SUMMA canister pressures were acceptable during this sampling event for the canisters used. According to Air Toxics, Ltd., the canister vacuum in the field should have a vacuum greater than 25-inches of mercury (Hg). Also, canisters should be returned to the lab with some vacuum remaining and the lab receipt vacuum reading should not vary from the final field vacuum reading by more than 7-inches Hg. These criteria were met as shown on Table 2-1.

- Leak detection compound was used during sampling. In five samples the leak detection compound (1,1-difluoroethane) was detected at very low concentrations that ranged from 15 to 27 ug/m^3. These results do not indicate leaks that could affect the data quality. Although, IEPA has not established criteria for the acceptable amount of leak detection compound in a sample, according to Air Toxics, Ltd. (personal communication), California Department of Toxic Substances Control and California Regional Water Quality control Board, Los Angeles Region (California EPA 2003) considers up to 10 ug/L (1.00E+04 ug/m^3) to be acceptable.

- Dedicated sampling equipment (new dedicated disposable Teflon® tubing and syringes for purging and sampling) was used.

- Use of disposable Nitrile gloves.

- Non-dedicated equipment was decontaminated between sampling locations.

- Chain-of-Custody protocols were followed including the use of custody seals.

- A "field duplicate" sample was collected (VP507EWASH-F) in a separate 1-liter SUMMA canister immediately following the collection of the original sample (VP507EWASH-2). The results between the original and "field duplicate" are comparable as can be seen in Table 2-3. Although, these are not strictly duplicate samples, the relative percent difference (RPD) between the concentrations for all chemicals was less than 25% except for benzene and toluene for which the RPD was 36.3% and 37.8%, respectively.

2.7.2 Laboratory Methods

A comparison of the chain-of-custody to the laboratory login confirmation revealed no discrepancies. Sampling dates, times, name of sampler, received date, analyses requested, initial and final canister vacuum were listed on the chain-of-custody form. According to the chain-of-custody, all samples were received at the laboratory on October 18, 2008 within three days of sample collection in good condition with custody seals intact.

Typical holding time for TO-15 analysis is 30 days. All samples were collected on October 15, 2008 and analyzed on October 29, 2008 within the holding time.

The Air Toxics report includes a narrative and various laboratory flags to qualify specific results if necessary. No issues were identified in the narrative. Three results were flagged in the Laboratory Control Sample (LCS):

- Bromomethane was Q-flagged
- MTBE was Q-flagged
- 1,1-Difluoroethane was NS-flagged

Based on discussions with Air Toxics' personnel, bromomethane and MTBE %-recoveries were slightly elevated; therefore, the results reported for these chemicals in each sample may be biased high. This means that the reported results may be higher than the actual sample concentrations. Since neither of these chemicals were detected in the samples submitted and are typically not MGP related, this does not affect the quality of the results.

The NS-flag for 1,1-difluoroethane means the LCS sample was not spiked for this compound, since this compound is not on the standard list of chemicals for the TO-15 method. This chemical was added to the analysis request on the Chain-of-Custody form since it was the leak detection chemical used in the field. This chemical was not detected in the laboratory blank and this chemical was spiked in the Continuing Calibration Verification (CCV) sample and met method retention requirements; therefore, this flag does not indicate that the results have been compromised.

Dilutions of the samples ranged from 2.42 to 2.53. This is within the standard range of dilutions due to the repressurization of the samples after receipt at the laboratory and was not due to high concentrations of any chemicals in the samples. Therefore, these dilutions are part of the standard method procedures and do not indicate an issue with the quality of the sample results.

The results of the lab blank, lab surrogates, and lab duplicate were within the method requirements.

Internal standard responses and retention times were within method limits for all field samples and quality control samples unless qualified or discussed in the lab narrative.

The initial and all continuing calibration verification standards were within method limits for all samples and quality control samples unless qualified or in the narratives.

The laboratory data passed the data usability review. It is our opinion that the data are reliable and can be used in the overall evaluation and management of the site.

3.1 INTRODUCTION

This chapter discusses the evaluation of soil gas samples described in Section 2.0 and presented in Table 2-2. The evaluation is presented in two parts. Section 3.2 evaluates the volatile chemicals potentially related to the operations of the former MGP and Section 3.3 evaluates volatile chemicals not related to the MGP operations. The evaluation is consistent with the Illinois Environmental Protection Agency's (IEPA's) draft 35 Ill. Adm. Code Part 742: Tiered Approach to Corrective Action (TACO).

3.2 EVALUATION OF MGP RELATED CHEMICALS

This section focuses on the MGP related chemicals.

3.2.1 Selection of MGP Related Chemicals

To select chemicals that are potentially associated with former MGP operations, the following references were reviewed:

- Gas Research Institute (GRI), 1996. Management of Manufactured Gas Plant Sites Vol I. (edited by Hayes, T.D., Linz, D.G., Nakles, D.V., and Leuschner, A.P.). Amherst Scientific Publishers, Amherst, MA.

- Hatheway, A., 2002. Geoenvironmental Protocol for Site and Waste Characterization of Former Manufactured Gas Plants: Worldwide Remediation Challenge in Semi-volatile Organic Wastes. Engineer. Geol. 64:317–338.

- New Hampshire Department of Environmental Services (NHDES), 2006. Environmental Fact Sheet, Manufactured Gas Plant Sites.

- Wisconsin Bureau of Environmental and Occupational Health (WBEOH), 2004. Health-based Guidelines for Air Management, Public Participation, and Risk Communication during the Excavation of Former Manufactured Gas Plants.

GRI (1996) classifies the potential chemicals in former MGP wastes as inorganics, metals, volatile aromatics, phenols, and polycyclic aromatic hydrocarbons (PAHs). Table 5-1 of GRI (1996) presenting chemicals at MGP sites is included in Appendix G.

Hatheway (2002) discusses that there is a relationship between various chemical substances generated by the former MGP and various processes of gas manufacturing both in terms of characteristics and quantity of the waste. For instance, light tar oils, which contain monocyclic and duo cyclic PAHs were the typical wastes generated in carbureted water gas process. Specifically, the benzene, toluene, ethylbenzene, and xylenes (BTEX) were the components of gas liquor waste, which was produced by carbureted water gas and oil gas processes.

NHDES (2006) states the chemical composition of former MGP waste depends on the type of coal and the gasification process used. The fact sheet also states that VOCs (benzene and toluene), PAHs (naphthalene), tar acids (phenol and cresol), and creosote are the main chemicals associated with former MGP waste.

WBEOH (2004) presents the chemicals in soil, sediment, and groundwater at former MGP sites located in Wisconsin. Table 1 of WBEOH (2004) presenting MGP chemicals is included in Appendix G.

The above references indicate that BTEX, styrene, and naphthalene are the primary MGP-related volatile chemicals.

Of the 63 chemicals detected in soil gas samples collected at the Champaign site, the following seven chemicals were identified as MGP-related chemicals:

- Benzene
- Toluene
- Ethylbenzene
- m,p-Xylenes
- o-Xylene
- Styrene
- Naphthalene

As per Section 742.200 of the draft TACO rule, all of the above chemicals meet the definition of volatile chemicals.

3.2.2 Comparison of Soil Gas Concentrations for MGP Chemicals with Tier 1 Soil Gas Remediation Objectives for Residential Properties

The Tier 1 soil gas remediation objectives (ROs) for residential properties were obtained from Table G of Appendix B in Section 742 of draft TACO rule. Table 3-1 presents both soil gas ROs and soil gas concentrations for MGP chemicals. The comparison of soil gas concentrations with Tier 1 soil gas ROs indicated none of the MGP chemicals exceeds the Tier 1 soil gas ROs.

3.3 EVALUATION OF NON-MGP RELATED CHEMICALS

Of the 63 chemicals detected, 56 are non-MGP related chemicals and are presented in Table 3-2. As per Section 742.200 of draft TACO rule, all of these chemicals meet the definition of volatile chemicals. Of these chemicals, 30 have TACO Tier 1 soil gas ROs; whereas, 26 chemicals do not have TACO Tier 1 soil gas ROs.

3.3.1 Evaluation of Non-MGP Chemicals with TACO Tier 1 Soil Gas ROs

The Tier 1 soil gas ROs for residential properties for these 30 chemicals were obtained from Table G of Appendix B in Section 742 of draft TACO rule. Table 3-3 presents both soil gas concentrations and Tier 1 soil gas ROs. Comparison of soil gas concentrations with Tier 1 soil gas ROs indicated that none of the soil gas concentrations exceeds the Tier 1 soil gas ROs.

3.3.2 Evaluation of Non-MGP Chemicals without TACO Tier 1 Soil Gas ROs

Consistent with the methodology presented in TACO Section 742.515(f), Tier 1 soil gas ROs were developed for these chemicals. Of the 26 chemicals relevant input parameters were readily available for 17 chemicals. For these chemicals Tier 1 ROs were developed as discussed in Appendix H.

Tier 1 soil gas ROs developed are presented in Table 3-6. The Tier 1 soil gas ROs were compared with soil gas concentrations. The comparison indicated that none of the soil gas concentrations exceeded the respective Tier 1 soil gas ROs.

3.3.3 Evaluation of 9 Other Non-MGP and Non-TACO Chemicals

There are nine non-MGP and non-TACO chemicals for which ROs have not been developed due to non-availability of toxicity and some physical/chemical information. These chemicals may be generated by various natural and anthropogenic sources; however, none is MGP related. Table 3-7 presents concentrations of these chemicals. Also, these chemicals and their possible sources are presented in Appendix I.

3.3 SUMMARY OF DATA EVALUATION

Based on the above evaluation none of the soil gas concentrations exceeds the Tier 1 soil gas ROs.

SECTION 4.0
SUMMARY AND RECOMMENDATIONS

This report presents the results of the soil gas sampling and basement survey event performed on October 15, 2008 at the following three residential properties near the former MGP site in Champaign, Illinois:

- 505 E. Washington Street
- 507 E. Washington Street
- 412 E. Hill Street

The soil gas sampling event consisted of the collection of nine soil gas samples (including one duplicate) and one ambient air sample from eight locations along the perimeter of the three residential properties. The samples were collected in SUMMA canisters using Geoprobe® post-run tubing (PRT) methods. Appropriate QA/QC samples were also collected.

The soil gas samples were compared to the draft Illinois Environmental Protection Agency (IEPA) Tiered Approach to Corrective Action Objectives (TACO) Tier 1 soil gas remediation objectives (ROs) for residential land use. The comparison indicated that the concentrations of none of the chemicals exceeded the Tier 1 ROs, and hence the residual soil and groundwater impacts from the former MGP are not of concern.

Based on the above results, no further action is recommended relative to potential indoor air inhalation risks to the residents.

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Hatheway, A., 2002. Geoenvironmental Protocol for Site and Waste Characterization of Former Manufactured Gas Plants: Worldwide Remediation Challenge in Semi-volatile Organic Wastes. Engineer. Geol. 64:317–338.

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New Hampshire Department of Environmental Services (NHDES), 2006. Environmental Fact Sheet, Manufactured Gas Plant Sites.

PSC Industrial Outsourcing, LP, 2008. Off-Site Investigation Report, Former Manufactured Gas Plant, Champaign, Illinois, State ID 0190100008, August 22.

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USEPA, 2004. User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings.

USEPA, June 2008. Regional Screening Levels for Chemical Contaminants at Superfund Sites, Chemical Specific Parameters.

USEPA, July 2008. Regional Screening Levels for Chemical Contaminants at Superfund Sites.

Wisconsin Bureau of Environmental and Occupational Health (WBEOH), 2004. Health-based Guidelines for Air Management, Public Participation, and Risk Communication during the Excavation of Former Manufactured Gas Plants.

TABLES

Table 2-1
Soil Gas Sample Details
Former MGP Site, Champaign, Illinois

Sample	Depth	Canister Pressure/Vacuum			Concentration of Leak Detection Compound*	Analytical Method	Date Collected	Date Analyzed
		Initial[1]	Final[2]	Lab receipt[3]				
	[ft]	[Hg]			[ug/m^3]			
412 E. Hill Street								
VP412EHILL-1	6	-28.9	-5.0	-6	15	Modified TO-15 (Full Scan)	10/15/2008	10/31/2008
VP412EHILL-2	3.8	-27.7	-5.0	-6	<14			
VP412EHILL-3	4.5	-28.0	-5.0	-6	27			
505 E. Washington Street								
VP505EWASH-1	5.5	-27.4	-5.0	-6	<14	Modified TO-15 (Full Scan)	10/15/2008	10/31/2008
VP505EWASH-2	4.5	-27.1	-5.0	-6	<14			
507 E. Washington Street								
VP507EWASH-1	3.5	-27.5	-5.0	-6	19	Modified TO-15 (Full Scan)	10/15/2008	10/31/2008
VP507EWASH-1(lab duplicate)			-5.0	6	16			
VP507EWASH-2	5	-27.4	-5.0	-5.5	27			
VP507EWASH-3	5	-28.4	-5.0	-5	<13			
VP507EWASH-F	5	-28.9	-5.0	-5	20			
VP507EWASH(AMBIENT)	Ground Surface	-28	-5.0	-6	N/A			

Notes:
N/A: Not applicable
Hg: Inches of mercury
ug/m^3: micrograms per meter cube
*: Leak detection compound was 1,1-Difluoroethane
<: Reporting limit
1: Field measurement prior to filling canister
2: Field measurement after filling canister
3: Lab measurement upon receipt of canister

Table 2-2
Comprehensive Soil Gas Concentrations (ug/m^3)
412 E Hill Street, Champaign, Illinois

Chemical	CAS	412 E Hill Street			505 E Washington Street		507 E Washington Street					
							VP507EWASH-1					
		VP412EHILL-1	VP412EHILL-2	VP412EHILL-3	VP505EWASH-1	VP505EWASH-2	Original	Lab Duplicate	VP507EWASH-2	VP507EWASH-F (field duplicate of -2)	VP507EWASH-3	Ambient Air
Freon 12	75-71-8	<6.2	<6.2	<6.2	<6.2	<6.2	<6.2	<6.2	**9**	**8.8**	<6.0	<6.2
Freon 114	76-14-2	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.6	<8.4	<8.4	<8.8
Chloromethane	74-87-3	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Vinyl Chloride	75-01-4	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.1	<3.1	<3.2
1,3-Butadiene	106-99-0	**9.2**	**2.9**	**25**	**4.4**	**9.4**	<2.8	<2.8	**9.7**	**5**	**4**	<2.8
Bromomethane	74-83-9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.8	<4.7	<4.7	<4.9
Chloroethane	75-00-3	<3.3	<3.3	<3.3	<3.3	<3.3	<3.3	<3.3	<3.2	<3.2	<3.2	<3.3
Freon 11	75-69-4	<7.1	<7.1	<7.1	<7.1	<7.1	<7.1	<7.1	<6.9	<6.8	<6.8	<7.1
Ethanol	64-17-5	**50**	**17**	**280**	**14**	**20**	**13**	**12**	**18**	**19**	**29**	**11**
Freon 113	76-13-1	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7	<9.5	<9.3	<9.3	<9.7
1,1-Dichloroethene	75-35-4	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<4.9	<4.8	<4.8	<5.1
Acetone	67-64-1	**230**	**110**	**580**	**120**	**160**	**120**	**120**	**180**	**180**	**230**	**16**
2-Propanol	67-63-0	**14**	**50**	**100**	<12	**46**	**37**	**38**	**13**	<12	**16**	**23**
Carbon Disulfide	75-15-0	<3.9	<3.9	<3.9	**7.6**	<3.9	<3.9	<3.9	**4.3**	<3.8	<3.8	<3.9
3-Chloropropene	107-05-1	<16	<16	<16	<16	<16	<16	<16	<15	<15	<15	<16
Methylene Chloride	75-09-2	<4.4	<4.4	<4.4	<4.4	<4.4	<4.4	<4.4	<4.3	<4.2	<4.2	<4.4
Methyl tert-butyl ether	1634-04-4	<4.6	<4.6	<4.6	<4.6	<4.6	<4.6	<4.6	<4.4	<4.4	<4.4	<4.6
trans-1,2-Dichloroethene	156-60-5	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<4.9	<4.8	<4.8	<5.0
Hexane	110-54-3	**9.5**	**7.3**	**20**	**17**	**14**	**8**	**8.5**	**14**	**11**	**14**	<4.4
1,1-Dichloroethane	75-34-3	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.0	<4.9	<4.9	<5.1
2-Butanone (MEK)	78-93-3	**47**	**18**	**130**	**26**	**43**	**21**	**18**	**40**	**34**	**56**	<3.7
cis-1,2-Dichloroethene	156-59-2	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<4.9	<4.8	<4.8	<5.0
Tetrahydrofuran	109-99-9	>3.7	<3.7	<3.7	<3.7	<3.7	<3.7	<3.7	<3.6	<3.6	<3.6	<3.7
Chloroform	67-66-3	<6.2	<6.2	<6.2	<6.2	<6.2	<6.2	<6.2	<6.0	<5.9	<5.9	<6.2
1,1,1-Trichloroethane	71-55-6	<6.9	<6.9	<6.9	<6.9	<6.9	<6.9	<6.9	<6.7	<6.6	<6.6	<6.9
Cyclohexane	110-82-7	<4.4	<4.4	**5.9**	**8.9**	**4.8**	<4.4	<4.4	**5.3**	**4.2**	**6.1**	<4.4
Carbon Tetrachloride	56-23-5	<8.0	<8.0	<8.0	<8.0	<8.0	<8.0	<8.0	<7.8	<7.6	<7.6	<8.0
2,2,4-Trimethylpentane	540-84-1	**8.1**	**7.2**	**13**	**14**	**10**	**6.9**	**7.7**	**11**	**8.9**	**15**	<5.9
Benzene	71-43-2	**8.5**	**5.9**	**14**	**13**	**10**	**8**	**7.4**	**14**	**9.7**	**10**	<4.0
1,2-Dichloroethane	107-06-2	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.0	<4.9	<4.9	<5.1
Heptane	142-82-5	**10**	**7.6**	**21**	**19**	**17**	**12**	**13**	**20**	**13**	**19**	<5.2
Trichloroethene	79-01-6	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	**7.3**	<6.5	<6.5	<6.8
1,2-Dichloropropane	78-87-5	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	<5.7	<5.6	<5.6	<5.8
1,4-Dioxane	123-91-1	<18	<18	<18	<18	<18	<18	<18	<18	<17	<17	<18
Bromodichloromethane	75-27-4	<8.5	<8.5	<8.5	<8.5	<8.5	<8.5	<8.5	<8.3	<8.1	<8.1	<8.5

Table 2-2
Comprehensive Soil Gas Concentrations (ug/m^3)
412 E Hill Street, Champaign, Illinois

Chemical	CAS	412 E Hill Street			505 E Washington Street		507 E Washington Street					
		VP412EHILL-1	VP412EHILL-2	VP412EHILL-3	VP505EWASH-1	VP505EWASH-2	VP507EWASH-1		VP507EWASH-2	VP507EWASH-F (field duplicate of -2)	VP507EWASH-3	Ambient Air
							Original	Lab Duplicate				
cis-1,3-Dichloropropene	10061-01-5	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7	<5.6	<5.5	<5.5	<5.7
4-Methyl-2-pentanone	108-10-1	<5.2	<5.2	**6.5**	<5.2	<5.2	<5.2	<5.2	<5.0	<5.0	**5.4**	<5.2
Toluene	108-88-3	**120**	**86**	**190**	**210**	**200**	**150**	**140**	**220**	**150**	**170**	<4.8
trans-1,3-Dichloropropene	10061-02-6	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7	<5.6	<5.5	<5.5	<5.7
1,1,2-Trichloroethane	79-00-5	<6.9	<6.9	<6.9	<6.9	<6.9	<6.9	<6.9	<6.7	<6.6	<6.6	<6.9
Tetrachloroethene	127-18-4	<8.6	<8.6	<8.6	<8.6	<8.6	<8.6	<8.6	<8.4	<8.2	<8.2	<8.6
2-Hexanone	591-78-6	<21	<21	<21	<21	<21	<21	<21	<20	<20	<20	<21
Dibromochloromethane	124-48-1	<11	<11	<11	<11	<11	<11	<11	<10	<10	<10	<11
1,2-Dibromoethane (EDB)	106-93-4	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7	<9.5	<9.3	<9.3	<9.7
Chlorobenzene	108-90-7	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	<5.7	<5.6	<5.6	<5.8
Ethyl Benzene	100-41-4	**40**	**28**	**52**	**50**	**50**	**44**	**42**	**61**	**51**	**57**	<5.5
m,p-Xylene	108-38-3/ 106-42-3	**160**	**120**	**210**	**190**	**200**	**180**	**180**	**240**	**210**	**230**	<5.5
o-Xylene	95-47-6	**77**	**54**	**94**	**84**	**89**	**83**	**81**	**110**	**98**	**110**	<5.5
Styrene	100-42-5	<5.4	<5.4	<5.4	<5.4	<5.4	<5.4	<5.4	<5.3	<5.2	<5.2	<5.4
Bromoform	75-25-2	<13	<13	<13	<13	<13	<13	<13	<13	<12	<12	<13
Cumene	98-82-8	<6.2	<6.2	**7.2**	**6.6**	<6.2	<6.2	<6.2	**8.3**	**7**	**7.9**	<6.2
1,1,2,2-Tetrachloroethane	79-34-5	<8.7	<8.7	<8.7	<8.7	<8.7	<8.7	<8.7	<8.5	<8.3	<8.3	<8.7
Propylbenzene	103-65-1	**25**	**20**	**30**	**24**	**26**	**27**	**26**	**34**	**34**	**34**	<6.2
4-Ethyltoluene	622-96-8	**100**	**83**	**130**	**97**	**100**	**120**	**110**	**150**	**150**	**140**	<6.2
1,3,5-Trimethylbenzene	108-67-8	**56**	**42**	**45**	**34**	**52**	**45**	**41**	**55**	**59**	**76**	<6.2
1,2,4-Trimethylbenzene	95-63-6	**160**	**120**	**160**	**120**	**140**	**160**	**150**	**190**	**210**	**210**	<6.2
1,3-Dichlorobenzene	541-73-1	<7.6	<7.6	<7.6	<7.6	<7.6	<7.6	<7.6	<7.4	<7.3	<7.3	<7.6
1,4-Dichlorobenzene	106-46-7	<7.6	<7.6	<7.6	<7.6	<7.6	<7.6	<7.6	<7.4	<7.3	<7.3	<7.6
alpha-Chlorotoluene	100-44-7	<6.5	<6.5	<6.5	<6.5	<6.5	<6.5	<6.5	<6.4	<6.3	<6.3	<6.5
1,2-Dichlorobenzene	95-50-1	<7.6	<7.6	<7.6	<7.6	<7.6	<7.6	<7.6	<7.4	<7.3	<7.3	<7.6
1,2,4-Trichlorobenzene	120-82-1	<38	<38	<38	<38	<38	<38	<38	<37	<36	<36	<38
Hexachlorobutadiene	87-68-3	<54	<54	<54	<54	<54	<54	<54	<53	<52	<52	<54
Naphthalene	91-20-3	<26	<26	<26	<26	<26	<26	<26	<26	<25	<25	<26

Notes:

<: Reporting limit shown

Values with bold font are detected values.

*: RO for 1,3-dichloropropylene (cis + trans)

**: RO for p-xylene

Table 2-3
Comparison of Original Sample Results to Field Duplicate (ug/m^3)
Former MGP Site, Champaign, Illinois

CAS Number	Chemical	VP507EWASH						RPD (%)
		Original (-2)	Original (RL)	5 X Original RL	Duplicate (-F)	Duplicate (RL)	5 X Duplicate RL	
71-55-6	1,1,1-Trichloroethane	<6.7			<6.6			
79-34-5	1,1,2,2-Tetrachloroethane	<8.5			<8.3			
79-00-5	1,1,2-Trichloroethane	<6.7			<6.6			
75-34-3	1,1-Dichloroethane	<5			<4.9			
75-35-4	1,1-Dichloroethene	<4.9			<4.8			
75-37-6	1,1-Difluoroethane	27	<13	65	20	<13	65	
120-82-1	1,2,4-Trichlorobenzene	<37			<36			
95-63-6	1,2,4-Trimethylbenzene	190	<6.1	30.5	210	<5.9	29.5	10.00
106-93-4	1,2-Dibromoethane (EDB)	<9.5			<9.3			
95-50-1	1,2-Dichlorobenzene	<7.4			<7.3			
107-06-2	1,2-Dichloroethane	<5			<4.9			
78-87-5	1,2-Dichloropropane	<5.7			<5.6			
108-67-8	1,3,5-Trimethylbenzene	55	<6.1	30.5	59	<5.9	29.5	7.02
106-99-0	1,3-Butadiene	9.7	<2.7	13.5	5	<2.7	13.5	
541-73-1	1,3-Dichlorobenzene	<7.4			<7.3			
106-46-7	1,4-Dichlorobenzene	<7.4			<7.3			
123-91-1	1,4-Dioxane	<18			<17			
540-84-1	2,2,4-Trimethylpentane	11	<5.8	29	8.9	<5.6	28	
78-93-3	2-Butanone (Methyl Ethyl Ketone)	40	<3.6	18	34	<3.6	18	16.22
591-78-6	2-Hexanone	<20			<20			
67-63-0	2-Propanol	13			<12			
107-05-1	3-Chloropropene	<15			<15			
622-96-8	4-Ethyltoluene	150	<6.1	30.5	150	<5.9	29.5	0.00
108-10-1	4-Methyl-2-pentanone	<5			<5			
67-64-1	Acetone	180	<12	60	180	<11	55	0.00
100-44-7	alpha-Chlorotoluene	<6.4			<6.3			1.57
71-43-2	Benzene	14	<3.9	19.5	9.7	<3.9	19.5	36.29
75-27-4	Bromodichloromethane	<8.3			<8.1			
75-25-2	Bromoform	<13			<12			
74-83-9	Bromomethane	<4.8			<4.7			
75-15-0	Carbon Disulfide	4.3			<3.8			
56-23-5	Carbon Tetrachloride	<7.8			<7.6			
108-90-7	Chlorobenzene	<5.7			<5.6			
75-00-3	Chloroethane	<3.2			<3.2			
67-66-3	Chloroform	<6			<5.9			
74-87-3	Chloromethane	<10			<10			
156-59-2	cis-1,2-Dichloroethene	<4.9			<4.8			
10061-01-5	cis-1,3-Dichloropropene	<5.6			<5.5			
98-82-8	Cumene	8.3	<6.1	30.5	7	<5.98	29.9	
110-82-7	Cyclohexane	5.3	<4.2	21	4.2	<4.2	21	
124-48-1	Dibromochloromethane	<10			<10			

Table 2-3
Comparison of Original Sample Results to Field Duplicate (ug/m^3)
Former MGP Site, Champaign, Illinois

CAS Number	Chemical	VP507EWASH						RPD (%)
		Original (-2)	Original (RL)	5 X Original RL	Duplicate (-F)	Duplicate (RL)	5 X Duplicate RL	
64-17-5	Ethanol	18	<9.3	46.5	19	<9.1	45.5	
100-41-4	Ethyl Benzene	61	<5.4	27	51	<5.2	26	17.86
75-69-4	Freon 11	<6.9			<6.8			
76-13-1	Freon 113	<9.5			<9.3			
76-14-2	Freon 114	<8.6			<8.4			
75-71-8	Freon 12	9	<6.1	30.5	8.8	<6	30	
142-82-5	Heptane	20	<5.1	25.5	13	<5	25	
87-68-3	Hexachlorobutadiene	<53			<52			
110-54-3	Hexane	14	<4.4	22	11	<4.3	21.5	
108-38-3/106-42-3	m,p-Xylene	240	<5.4	27	210	<5.2	26	13.33
1634-04-4	Methyl tert-butyl ether	<4.4			<4.4			
75-09-2	Methylene Chloride	<4.3			<4.2			
91-20-3	Naphthalene	<26			<25			
95-47-6	o-Xylene	110	<5.4	27	98	<5.2	26	11.54
103-65-1	Propylbenzene	34	<6.1	30.5	34	<5.9	29.5	0.00
100-42-5	Styrene	<5.3			<5.2			
127-18-4	Tetrachloroethene	<8.4			<8.2			
109-99-9	Tetrahydrofuran	<3.6			<3.6			
108-88-3	Toluene	220	<4.6	23	150	<4.6	23	37.84
156-60-5	trans-1,2-Dichloroethene	<4.9			<4.8			
10061-02-6	trans-1,3-Dichloropropene	<5.6			<5.5			
79-01-6	Trichloroethene	7.3			<6.5			
75-01-4	Vinyl Chloride	<3.2			<3.1			

Notes:

<: Reporting limit SAD: Sample absolute difference RPD: Relative percent difference RL: Reporting limit

Table 3-1
Soil Gas Concentrations for MGP Chemicals (ug/m^3)
Former MGP Site, Champaign, Illinois

Chemical	CAS	Residential Tier 1 Soil Gas RO (ug/m^3)	412 E Hill Street			505 E Washington Street		507 E Washington Street					
								VP507EWASH-1					
			VP412EHILL-1	VP412EHILL-2	VP412EHILL-3	VP505EWASH-1	VP505EWASH-2	Original	Lab Duplicate	VP507EWASH-2	VP507EWASH-3	VP507EWASH-F	Ambient Air
Benzene	71-43-2	41000	**8.5**	**5.9**	**14**	**13**	**10**	**8**	**7.4**	**14**	**10**	**9.7**	<4.0
Toluene	108-88-3	140000000	**120**	**86**	**190**	**210**	**200**	**150**	**140**	**220**	**170**	**150**	<4.8
Ethyl Benzene	100-41-4	59000000	**40**	**28**	**52**	**50**	**50**	**44**	**42**	**61**	**57**	**51**	<5.5
m,p-Xylene	108-38-3/ 106-42-3	16000000*	**160**	**120**	**210**	**190**	**200**	**180**	**180**	**240**	**230**	**210**	<5.5
o-Xylene	95-47-6	17000000	**77**	**54**	**94**	**84**	**89**	**83**	**81**	**110**	**110**	**98**	<5.5
Styrene	100-42-5	34000000	<5.4	<5.4	<5.4	<5.4	<5.4	<5.4	<5.4	<5.3	<5.2	<5.2	<5.4
Naphthalene	91-20-3	610000	<26	<26	<26	<26	<26	<26	<26	<26	<25	<25	<26

Notes:
<: Reporting limit shown
Values with bold font are detected values.
*: RO for p-xylene

Table 3-2
Soil Gas Concentrations for Non-MGP Chemicals (ug/m^3)
Former MGP Site, Champaign, Illinois

Chemical	CAS	412 E Hill Street			505 E Washington Street		507 E Washington Street					
							VP507EWASH-1					
		VP412EHILL-1	VP412EHILL-2	VP412EHILL-3	VP505EWASH-1	VP505EWASH-2	Original	Lab Duplicate	VP507EWASH-2	VP507EWASH-3	VP507EWASH-F	Ambient Air
Freon 12	75-71-8	<6.2	<6.2	<6.2	<6.2	<6.2	<6.2	<6.2	**9**	<6.0	**8.8**	<6.2
Freon 114	76-14-2	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.6	<8.4	<8.4	<8.8
Chloromethane	74-87-3	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Vinyl Chloride	75-01-4	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.1	<3.1	<3.2
1,3-Butadiene	106-99-0	**9.2**	**2.9**	**25**	**4.4**	**9.4**	<2.8	<2.8	**9.7**	**4**	**5**	<2.8
Bromomethane	74-83-9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.8	<4.7	<4.7	<4.9
Chloroethane	75-00-3	<3.3	<3.3	<3.3	<3.3	<3.3	<3.3	<3.3	<3.2	<3.2	<3.2	<3.3
Freon 11	75-69-4	<7.1	<7.1	<7.1	<7.1	<7.1	<7.1	<7.1	<6.9	<6.8	<6.8	<7.1
Ethanol	64-17-5	**50**	**17**	**280**	**14**	**20**	**13**	**12**	**18**	**29**	**19**	**11**
Freon 113	76-13-1	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7	<9.5	<9.3	<9.3	<9.7
1,1-Dichloroethene	75-35-4	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<4.9	<4.8	<4.8	<5.1
Acetone	67-64-1	**230**	**110**	**580**	**120**	**160**	**120**	**120**	**180**	**230**	**180**	**16**
2-Propanol	67-63-0	**14**	**50**	**100**	<12	**46**	**37**	**38**	**13**	**16**	<12	**23**
Carbon Disulfide	75-15-0	<3.9	<3.9	<3.9	**7.6**	<3.9	<3.9	<3.9	**4.3**	<3.8	<3.8	<3.9
3-Chloropropene	107-05-1	<16	<16	<16	<16	<16	<16	<16	<15	<15	<15	<16
Methylene Chloride	75-09-2	<4.4	<4.4	<4.4	<4.4	<4.4	<4.4	<4.4	<4.3	<4.2	<4.2	<4.4
Methyl tert-butyl ether	1634-04-4	<4.6	<4.6	<4.6	<4.6	<4.6	<4.6	<4.6	<4.4	<4.4	<4.4	<4.6
trans-1,2-Dichloroethene	156-60-5	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<4.9	<4.8	<4.8	<5.0
Hexane	110-54-3	**9.5**	**7.3**	**20**	**17**	**14**	**8**	**8.5**	**14**	**14**	**11**	<4.4
1,1-Dichloroethane	75-34-3	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.0	<4.9	<4.9	<5.1
2-Butanone (MEK)	78-93-3	**47**	**18**	**130**	**26**	**43**	**21**	**18**	**40**	**56**	**34**	<3.7
cis-1,2-Dichloroethene	156-59-2	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<4.9	<4.8	<4.8	<5.0
Tetrahydrofuran	109-99-9	>3.7	<3.7	<3.7	<3.7	<3.7	<3.7	<3.7	<3.6	<3.6	<3.6	<3.7
Chloroform	67-66-3	<6.2	<6.2	<6.2	<6.2	<6.2	<6.2	<6.2	<6.0	<5.9	<5.9	<6.2
1,1,1-Trichloroethane	71-55-6	<6.9	<6.9	<6.9	<6.9	<6.9	<6.9	<6.9	<6.7	<6.6	<6.6	<6.9
Cyclohexane	110-82-7	<4.4	<4.4	**5.9**	**8.9**	**4.8**	<4.4	<4.4	**5.3**	**6.1**	**4.2**	<4.4
Carbon Tetrachloride	56-23-5	<8.0	<8.0	<8.0	<8.0	<8.0	<8.0	<8.0	<7.8	<7.6	<7.6	<8.0
2,2,4-Trimethylpentane	540-84-1	**8.1**	**7.2**	**13**	**14**	**10**	**6.9**	**7.7**	**11**	**15**	**8.9**	<5.9
1,2-Dichloroethane	107-06-2	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.0	<4.9	<4.9	<5.1
Heptane	142-82-5	**10**	**7.6**	**21**	**19**	**17**	**12**	**13**	**20**	**19**	**13**	<5.2
Trichloroethene	79-01-6	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	**7.3**	<6.5	<6.5	<6.8
1,2-Dichloropropane	78-87-5	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	<5.7	<5.6	<5.6	<5.8
1,4-Dioxane	123-91-1	<18	<18	<18	<18	<18	<18	<18	<18	<17	<17	<18
Bromodichloromethane	75-27-4	<8.5	<8.5	<8.5	<8.5	<8.5	<8.5	<8.5	<8.3	<8.1	<8.1	<8.5
cis-1,3-Dichloropropene	10061-01-5	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7	<5.6	<5.5	<5.5	<5.7

Table 3-2
Soil Gas Concentrations for Non-MGP Chemicals (ug/m^3)
Former MGP Site, Champaign, Illinois

Chemical	CAS	412 E Hill Street			505 E Washington Street		507 E Washington Street					
							VP507EWASH-1					
		VP412EHILL-1	VP412EHILL-2	VP412EHILL-3	VP505EWASH-1	VP505EWASH-2	Original	Lab Duplicate	VP507EWASH-2	VP507EWASH-3	VP507EWASH-F	Ambient Air
4-Methyl-2-pentanone	108-10-1	<5.2	<5.2	**6.5**	<5.2	<5.2	<5.2	<5.2	<5.0	**5.4**	<5.0	<5.2
trans-1,3-Dichloropropene	10061-02-6	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7	<5.6	<5.5	<5.5	<5.7
1,1,2-Trichloroethane	79-00-5	<6.9	<6.9	<6.9	<6.9	<6.9	<6.9	<6.9	<6.7	<6.6	<6.6	<6.9
Tetrachloroethene	127-18-4	<8.6	<8.6	<8.6	<8.6	<8.6	<8.6	<8.6	<8.4	<8.2	<8.2	<8.6
2-Hexanone	591-78-6	<21	<21	<21	<21	<21	<21	<21	<20	<20	<20	<21
Dibromochloromethane	124-48-1	<11	<11	<11	<11	<11	<11	<11	<10	<10	<10	<11
1,2-Dibromoethane (EDB)	106-93-4	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7	<9.5	<9.3	<9.3	<9.7
Chlorobenzene	108-90-7	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	<5.7	<5.6	<5.6	<5.8
Bromoform	75-25-2	<13	<13	<13	<13	<13	<13	<13	<13	<12	<12	<13
Cumene	98-82-8	<6.2	<6.2	**7.2**	**6.6**	<6.2	<6.2	<6.2	**8.3**	**7.9**	**7**	<6.2
1,1,2,2-Tetrachloroethane	79-34-5	<8.7	<8.7	<8.7	<8.7	<8.7	<8.7	<8.7	<8.5	<8.3	<8.3	<8.7
Propylbenzene	103-65-1	**25**	**20**	**30**	**24**	**26**	**27**	**26**	**34**	**34**	**34**	<6.2
4-Ethyltoluene	622-96-8	**100**	**83**	**130**	**97**	**100**	**120**	**110**	**150**	**140**	**150**	<6.2
1,3,5-Trimethylbenzene	108-67-8	**56**	**42**	**45**	**34**	**52**	**45**	**41**	**55**	**76**	**59**	<6.2
1,2,4-Trimethylbenzene	95-63-6	**160**	**120**	**160**	**120**	**140**	**160**	**150**	**190**	**210**	**210**	<6.2
1,3-Dichlorobenzene	541-73-1	<7.6	<7.6	<7.6	<7.6	<7.6	<7.6	<7.6	<7.4	<7.3	<7.3	<7.6
1,4-Dichlorobenzene	106-46-7	<7.6	<7.6	<7.6	<7.6	<7.6	<7.6	<7.6	<7.4	<7.3	<7.3	<7.6
alpha-Chlorotoluene	100-44-7	<6.5	<6.5	<6.5	<6.5	<6.5	<6.5	<6.5	<6.4	<6.3	<6.3	<6.5
1,2-Dichlorobenzene	95-50-1	<7.6	<7.6	<7.6	<7.6	<7.6	<7.6	<7.6	<7.4	<7.3	<7.3	<7.6
1,2,4-Trichlorobenzene	120-82-1	<38	<38	<38	<38	<38	<38	<38	<37	<36	<36	<38
Hexachlorobutadiene	87-68-3	<54	<54	<54	<54	<54	<54	<54	<53	<52	<52	<54

Notes:

<: Reporting limit shown

Values with bold font are detected values.

*: RO for 1,3-dichloropropylene (cis + trans)

**: RO for p-xylene

Table 3-3
Soil Gas Concentrations for Non-MGP Chemicals with TACO Tier 1 Remediation Objectives (ug/m^3)
Former MGP Site, Champaign, Illinois

Chemical	CAS	Residential Tier 1 Soil Gas RO (ug/m^3)	412 E Hill Street			505 E Washington Street		507 E Washington Street					
								VP507EWASH-1					
			VP412EHILL-1	VP412EHILL-2	VP412EHILL-3	VP505EWASH-1	VP505EWASH-2	Original	Lab Duplicate	VP507EWASH-2	VP507EWASH-3	VP507EWASH-F	Ambient Air
Freon 12	75-71-8	32000000	<6.2	<6.2	<6.2	<6.2	<6.2	<6.2	<6.2	**9**	<6.0	**8.8**	<6.2
Vinyl Chloride	75-01-4	30000	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.1	<3.1	<3.2
Bromomethane	74-83-9	830000	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.8	<4.7	<4.7	<4.9
Freon 11	75-69-4	97000000	<7.1	<7.1	<7.1	<7.1	<7.1	<7.1	<7.1	<6.9	<6.8	<6.8	<7.1
1,1-Dichloroethene	75-35-4	240000	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<4.9	<4.8	<4.8	<5.1
Carbon Disulfide	75-15-0	81000000	<3.9	<3.9	<3.9	**7.6**	<3.9	<3.9	<3.9	**4.3**	<3.8	<3.8	<3.9
Methylene Chloride	75-09-2	590000	<4.4	<4.4	<4.4	<4.4	<4.4	<4.4	<4.4	<4.3	<4.2	<4.2	<4.4
Methyl tert-butyl ether	1634-04-4	350000000	<4.6	<4.6	<4.6	<4.6	<4.6	<4.6	<4.6	<4.4	<4.4	<4.4	<4.6
trans-1,2-Dichloroethene	156-60-5	10000000	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<4.9	<4.8	<4.8	<5.0
1,1-Dichloroethane	75-34-3	81000000	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.0	<4.9	<4.9	<5.1
2-Butanone (MEK)	78-93-3	440000000	**47**	**18**	**130**	**26**	**43**	**21**	**18**	**40**	**56**	**34**	<3.7
cis-1,2-Dichloroethene	156-59-2	27000000	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<4.9	<4.8	<4.8	<5.0
Chloroform	67-66-3	12000	<6.2	<6.2	<6.2	<6.2	<6.2	<6.2	<6.2	<6.0	<5.9	<5.9	<6.2
1,1,1-Trichloroethane	71-55-6	770000000	<6.9	<6.9	<6.9	<6.9	<6.9	<6.9	<6.9	<6.7	<6.6	<6.6	<6.9
Carbon Tetrachloride	56-23-5	24000	<8.0	<8.0	<8.0	<8.0	<8.0	<8.0	<8.0	<7.8	<7.6	<7.6	<8.0
1,2-Dichloroethane	107-06-2	10000	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.0	<4.9	<4.9	<5.1
Trichloroethene	79-01-6	180000	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	**7.3**	<6.5	<6.5	<6.8
1,2-Dichloropropane	78-87-5	7200	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	**<5.7**	<5.6	<5.6	<5.8
1,4-Dioxane	123-91-1	15000	<18	<18	<18	<18	<18	<18	<18	<18	<17	<17	<18
Bromodichloromethane	75-27-4	450000000	<8.5	<8.5	<8.5	<8.5	<8.5	<8.5	<8.5	<8.3	<8.1	<8.1	<8.5
cis-1,3-Dichloropropene	10061-01-5	110000*	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7	<5.6	<5.5	<5.5	<5.7
trans-1,3-Dichloropropene	10061-02-6	110000*	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7	<5.6	<5.5	<5.5	<5.7
Tetrachloroethene	127-18-4	66000	<8.6	<8.6	<8.6	<8.6	<8.6	<8.6	<8.6	<8.4	<8.2	<8.2	<8.6
1,2-Dibromoethane (EDB)	106-93-4	1600	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7	<9.5	<9.3	<9.3	<9.7
Chlorobenzene	108-90-7	8300000	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	<5.7	<5.6	<5.6	<5.8
Bromoform	75-25-2	1800000	<13	<13	<13	<13	<13	<13	<13	<13	<12	<12	<13
Cumene	98-82-8	30000000	<6.2	<6.2	**7.2**	**6.6**	<6.2	<6.2	<6.2	**8.3**	**7.9**	**7**	<6.2
1,4-Dichlorobenzene	106-46-7	317000	<7.6	<7.6	<7.6	<7.6	<7.6	<7.6	<7.6	<7.4	<7.3	<7.3	<7.6
1,2-Dichlorobenzene	95-50-1	11000000	<7.6	<7.6	<7.6	<7.6	<7.6	<7.6	<7.6	<7.4	<7.3	<7.3	<7.6
1,2,4-Trichlorobenzene	120-82-1	1600000	<38	<38	<38	<38	<38	<38	<38	<37	<36	<36	<38

Notes:
<: Reporting limit shown
Values with bold font are detected values.
*: RO for 1,3-dichloropropylene (cis + trans)

Table 3-4
Toxicological Information Used to Calculate Tier 1 ROs for Non-MGP Soil Gas Chemicals without TACO ROs
Former MGP Site, Champaign, Illinois

Chemical	CAS No.	URF [(ug/m3) $^{-1}$]		RfC [mg/m^3]	
		Value	Source	Value	Source
Chloromethane	74-87-3	1.80E-06	R	9.00E-02	I
1,3-Butadiene	106-99-0	3.00E-05	I	2.00E-03	I
Chloroethane	75-00-3	NA		1.00E+01	I
Freon 113	76-13-1	NA		3.00E+01	R
Acetone	67-64-1	NA		1.30E+01	A
2-Propanol	67-63-0	NA		3.20E-03	C(1hr)
3-Chloropropene	107-05-1	NA		1.00E-03	I
Hexane	110-54-3	NA		7.00E-01	I
Cyclohexane	110-82-7	NA		6.00E+00	I
4-Methyl-2-pentanone	108-10-1	NA		3.00E+00	I
1,1,2-Trichloroethane	79-00-5	1.60E-05	I	NA	
Dibromochloromethane	124-48-1	2.70E-05	C	NA	
1,1,2,2-Tetrachloroethane	79-34-5	5.80E-05	I	NA	
1,3,5-Trimethylbenzene	108-67-8	NA		6.00E-03	R
1,2,4-Trimethylbenzene	95-63-6	NA		7.00E-03	R
alpha-Chlorotoluene	100-44-7	4.90E-05	C	1.00E-03	R
Hexachlorobutadiene	87-68-3	2.20E-05	I	NA	

Notes:

I = USEPA, Integrated Risk Information System (IRIS). Accessed via Internet.

C = California EPA, Office of Environmental Health Hazard Assessment, Toxicity Criteria Database, accessed via Internet.

A = Agency for Toxic Substances and Disease Registry (ATSDR), December 2006. Minimal Risk Levels (MRLs).

R = USEPA, July 2008. Regional Screening Levels for Chemical Contaminants at Superfund Sites.

NA: Not available

Table 3-5
Physical Chemical Properties Used to Calculate Tier 1 ROs for Non-MGP Soil Gas Chemicals without Tier 1 ROs
Former MGP Site, Champaign, Illinois

Chemical	CAS No.	Vapor Pressure (P) atm	Molecular Weight (MW) [g/mole]	Solubility in Water (S) [mg/L]	Dimensionless Henry's Law Constant (H') at 25 °C [-]	Organic Carbon Partition Coefficient (K_{oc}) [L/kg]	Diffusivity in Air (D_i) [cm^2/s]	Diffusivity in Water (D_w) [cm^2/s]	Normal Boiling Temperature T_B °K	Critical Temperature T_c °K	Enthalpy of Vaporization at the Normal Boiling Point cal/mole
Chloromethane	74-87-3	5.66E+00	5.05E+01	5.33E+03	3.62E-01	6.30E+00	1.26E-01	6.50E-06	2.50E+02	4.17E+02	5.12E+03
1,3-Butadiene	106-99-0	2.77E+00	5.41E+01	7.35E+02	3.02E+00	4.47E+01	2.49E-01	1.08E-05	2.70E+02	4.25E+02	5.37E+03
Chloroethane	75-00-3	1.33E+00	6.45E+01	5.68E+03	3.62E-01	1.62E+01	2.71E-01	1.15E-05	2.86E+02	4.60E+02	5.88E+03
Freon 113	76-13-1	*4.36E-01*	*1.87E+02*	*1.70E+02*	*1.96E+01*	*3.72E+02*	***3.80E-02***	***8.60E-06***	*3.22E+02*	4.87E+02	6.46E+03
Acetone	67-64-1	3.03E-01	5.80E+01	1.00E+06	1.60E-03	7.80E-01	1.24E-01	1.14E-05	3.29E+02	5.08E+02	6.96E+03
2-Propanol	67-63-0	*5.98E-02*	*6.01E+01*	*1.97E+04*	*3.21E-04*	*2.50E+01*	*9.59E-02*	*1.03E-05*	*3.56E+02*	NA	NA
3-Chloropropene	107-05-1	*4.84E-01*	*7.65E+01*	*3.37E+03*	*4.50E-01*	*5.00E+01*	***9.40E-02***	***1.10E-05***	*3.19E+02*	NA	NA
Hexane	110-54-3	1.99E-01	8.62E+01	1.24E+01	7.38E+01	1.58E+03	2.00E-01	7.77E-06	3.43E+02	5.08E+02	6.90E+03
Cyclohexane	110-82-7	1.28E-01	8.42E+01	5.50E+01	6.15E+00	6.31E+02	8.39E-02	9.10E-06	3.55E+02	NA	NA
4-Methyl-2-pentanone	108-10-1	2.63E-02	1.00E+02	1.90E+04	5.70E-03	1.00E+01	7.50E-02	7.80E-06	3.94E+02	5.71E+02	8.24E+03
1,1,2-Trichloroethane	79-00-5	3.03E-02	1.30E+02	4.40E+03	3.73E-02	5.01E+01	7.80E-02	8.80E-06	**3.88E+02**	6.02E+02	8.32E+03
Dibromochloromethane	124-48-1	6.45E-03	2.08E+02	2.60E+03	3.20E-02	6.92E+01	3.66E-02	1.05E-05	4.07E+02	6.78E+02	5.90E+03
1,1,2,2-Tetrachloroethane	79-34-5	6.05E-03	1.70E+02	3.00E+03	1.39E-02	1.00E+02	7.10E-02	7.90E-06	4.24E+02	6.61E+02	9.00E+03
1,3,5-Trimethylbenzene	108-67-8	3.26E-03	1.20E+02	4.82E+01	3.60E-01	6.17E+02	6.02E-02	8.67E-06	4.39E+02	6.37E+02	9.32E+03
1,2,4-Trimethylbenzene	95-63-6	2.76E-03	1.20E+02	5.70E+01	2.53E-01	1.17E+03	6.06E-02	7.92E-06	4.44E+02	6.49E+02	9.37E+03
alpha-Chlorotoluene	100-44-7	*1.72E-03*	*1.27E+02*	*5.25E+02*	*1.69E-02*	*1.39E+02*	***6.30E-02***	***8.80E-06***	*4.54E+02*	6.85E+02	8.77E+03
Hexachlorobutadiene	87-68-3	2.89E-04	2.60E+02	3.20E+00	3.32E-01	5.00E+04	5.61E-02	6.16E-06	4.94E+02	7.38E+02	1.02E+04

Notes:
Normal: IEPA; Bold: PhysProp; Normal with Underline: USEPA, 2004; NA: Not available
Italic: Chemfate; Italic Bold: Regional Screening Levels; Italic with Underline: TCEQ, June 2007

Table 3-6

Tier 1 ROs Developed for Non-MGP Soil Gas Chemicals without TACO Tier 1 ROs (ug/m^3)

Former MGP Site, Champaign, Illinois

Chemical	CAS	Residential Tier 1 Soil Gas RO (ug/m^3)	412 E Hill Street			505 E Washington Street		507 E Washington Street					
								VP507EWASH-1					
			VP412EHILL-1	VP412EHILL-2	VP412EHILL-3	VP505EWASH-1	VP505EWASH-2	Original	Lab Duplicate	VP507EWASH-2	VP507EWASH-3	VP507EWASH-F	Ambient Air
Chloromethane	74-87-3	124000	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,3-Butadiene	106-99-0	3770	**9.2**	**2.9**	**25**	**4.4**	**9.4**	<2.8	<2.8	**9.7**	**4**	**5**	<2.8
Chloroethane	75-00-3	446000000	<3.3	<3.3	<3.3	<3.3	<3.3	<3.3	<3.3	<3.2	<3.2	<3.2	<3.3
Freon 113	76-13-1	9530000000	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7	<9.5	<9.3	<9.3	<9.7
Acetone	67-64-1	1250000000	**230**	**110**	**580**	**120**	**160**	**120**	**120**	**180**	**230**	**180**	**16**
2-Propanol	67-63-0	387000	**14**	**50**	**100**	<12	**46**	**37**	**38**	**13**	**16**	<12	**23**
3-Chloropropene	107-05-1	128000	<16	<16	<16	<16	<16	<16	<16	<15	<15	<15	<16
Hexane	110-54-3	42300000	**9.5**	**7.3**	**20**	**17**	**14**	**8**	**8.5**	**14**	**14**	**11**	<4.4
Cyclohexane	110-82-7	457000000	<4.4	<4.4	**5.9**	**8.9**	**4.8**	<4.4	<4.4	**5.3**	**6.1**	**4.2**	<4.4
4-Methyl-2-pentanone	108-10-1	481000000	<5.2	<5.2	**6.5**	<5.2	<5.2	<5.2	<5.2	<5.0	**5.4**	<5.0	<5.2
1,1,2-Trichloroethane	79-00-5	22600	<6.9	<6.9	<6.9	<6.9	<6.9	<6.9	<6.9	<6.7	<6.6	<6.6	<6.9
Dibromochloromethane	124-48-1	28500	<11	<11	<11	<11	<11	<11	<11	<10	<10	<10	<11
1,1,2,2-Tetrachloroethane	79-34-5	6830	<8.7	<8.7	<8.7	<8.7	<8.7	<8.7	<8.7	<8.5	<8.3	<8.3	<8.7
1,3,5-Trimethylbenzene	108-67-8	1200000	**56**	**42**	**45**	**34**	**52**	**45**	**41**	**55**	**76**	**59**	<6.2
1,2,4-Trimethylbenzene	95-63-6	1390000	**160**	**120**	**160**	**120**	**140**	**160**	**150**	**190**	**210**	**210**	<6.2
alpha-Chlorotoluene	100-44-7	9110	<6.5	<6.5	<6.5	<6.5	<6.5	<6.5	<6.5	<6.4	<6.3	<6.3	<6.5
Hexachlorobutadiene	87-68-3	22800	<54	<54	<54	<54	<54	<54	<54	<53	<52	<52	<54

Notes:

<: Reporting limit shown

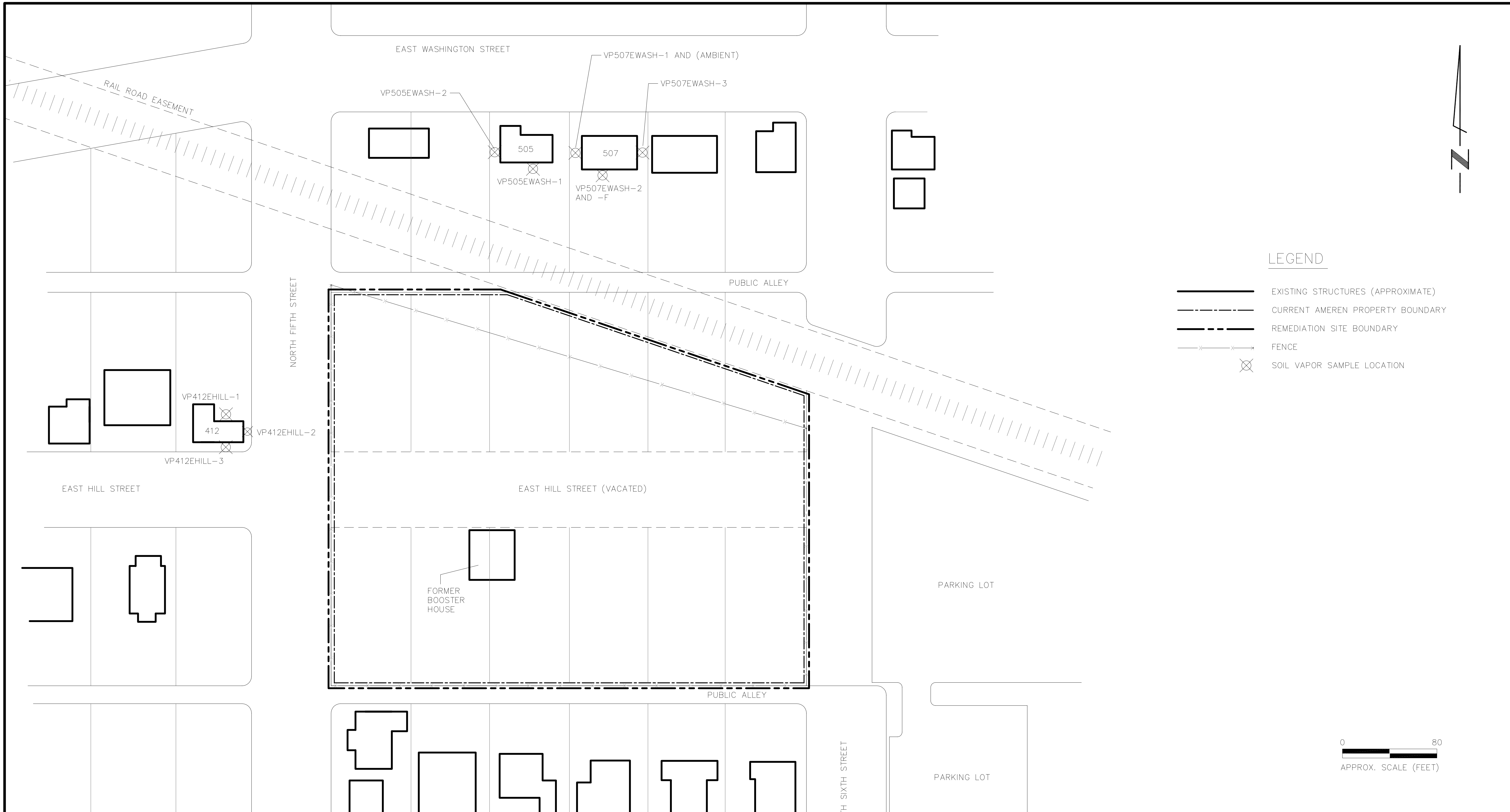
Values with bold font are detected values.

Table 3-7
Soil Vapor Concentrations for Non-MGP Chemicals without TACO Tier 1 Remediation Objectives (ug/m^3)
Former MGP Site, Champaign, Illinois

Chemical	CAS	Residential Tier 1 Soil Gas RO (ug/m^3)	412 E Hill Street			505 E Washington Street		507 E Washington Street					
			VP412EHILL-1	VP412EHILL-2	VP412EHILL-3	VP505EWASH-1	VP505EWASH-2	VP507EWASH-1		VP507EWASH-2	VP507EWASH-3	VP507EWASH-F	Ambient Air
								Original	Lab Duplicate				
Freon 114	76-14-2	NC	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.6	<8.4	<8.4	<8.8
Ethanol	64-17-5	NC	**50**	**17**	**280**	**14**	**20**	**13**	**12**	**18**	**29**	**19**	**11**
Tetrahydrofuran	109-99-9	NC	>3.7	<3.7	<3.7	<3.7	<3.7	<3.7	<3.7	<3.6	<3.6	<3.6	<3.7
2,2,4-Trimethylpentane	540-84-1	NC	**8.1**	**7.2**	**13**	**14**	**10**	**6.9**	**7.7**	**11**	**15**	**8.9**	<5.9
Heptane	142-82-5	NC	**10**	**7.6**	**21**	**19**	**17**	**12**	**13**	**20**	**19**	**13**	<5.2
2-Hexanone	591-78-6	NC	<21	<21	<21	<21	<21	<21	<21	<20	<20	<20	<21
Propylbenzene	103-65-1	NC	**25**	**20**	**30**	**24**	**26**	**27**	**26**	**34**	**34**	**34**	<6.2
4-Ethyltoluene	622-96-8	NC	**100**	**83**	**130**	**97**	**100**	**120**	**110**	**150**	**140**	**150**	<6.2
1,3-Dichlorobenzene	541-73-1	NC	<7.6	<7.6	<7.6	<7.6	<7.6	<7.6	<7.6	<7.4	<7.3	<7.3	<7.6

Notes:
<: Reporting limit shown
Values with bold font are detected values.
NC: Not calculated due to lack of toxicity or physical chemical information

FIGURES



RAM Group of Gannett Fleming, Inc.
5433 Westheimer, Suite 725, Houston, TX 77056

Figure 1-1
Soil Gas Sampling Locations

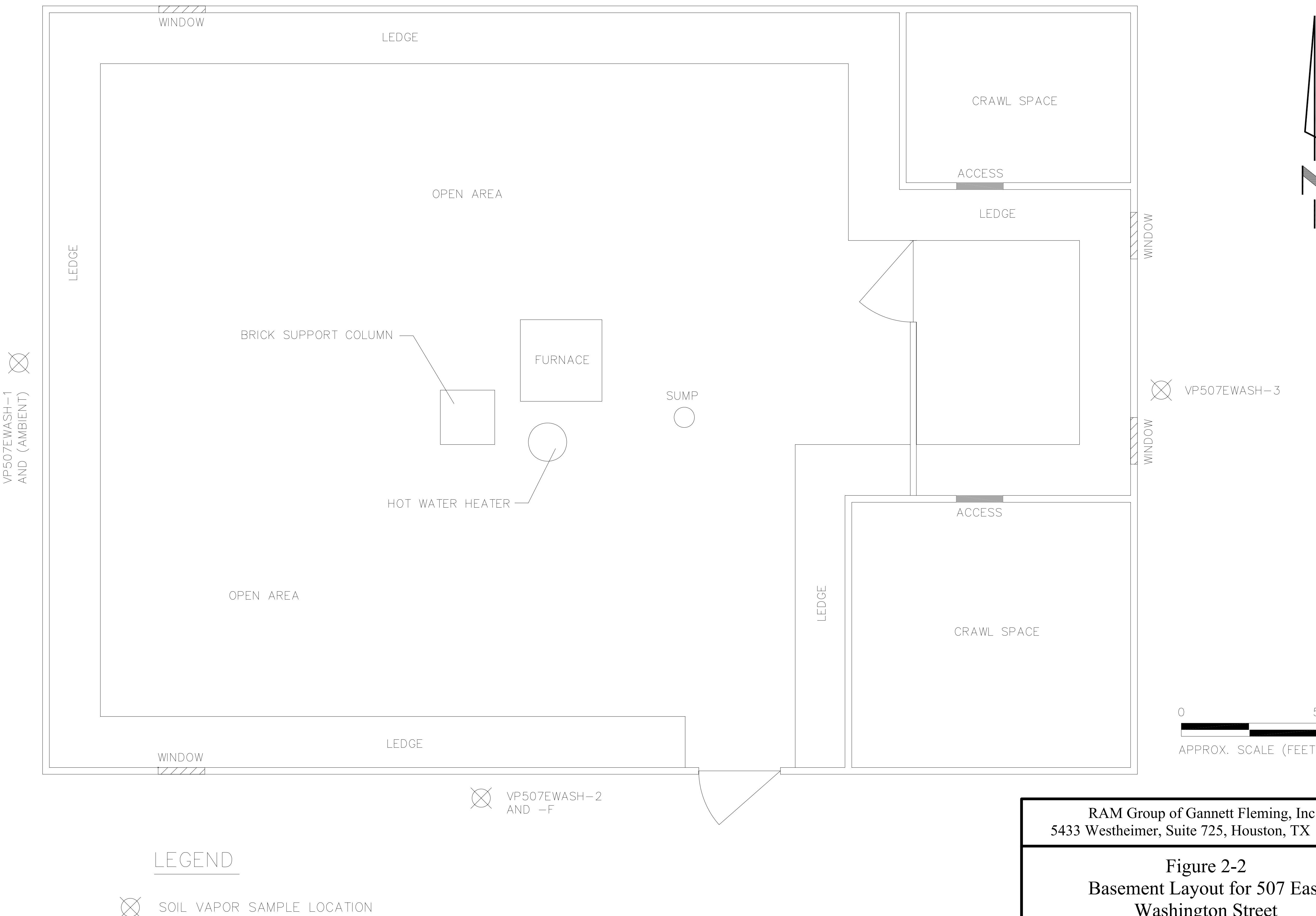
Ameren
Champaign, Illinois

PROJ. NO: 005067 | D/B: TLD | DATE: 12/08

RAM Group of Gannett Fleming, Inc.
5433 Westheimer, Suite 725, Houston, TX 77056

Figure 2-1
Basement Layout for 505 East
Washington Street
Ameren Site
Champaign, Illinois

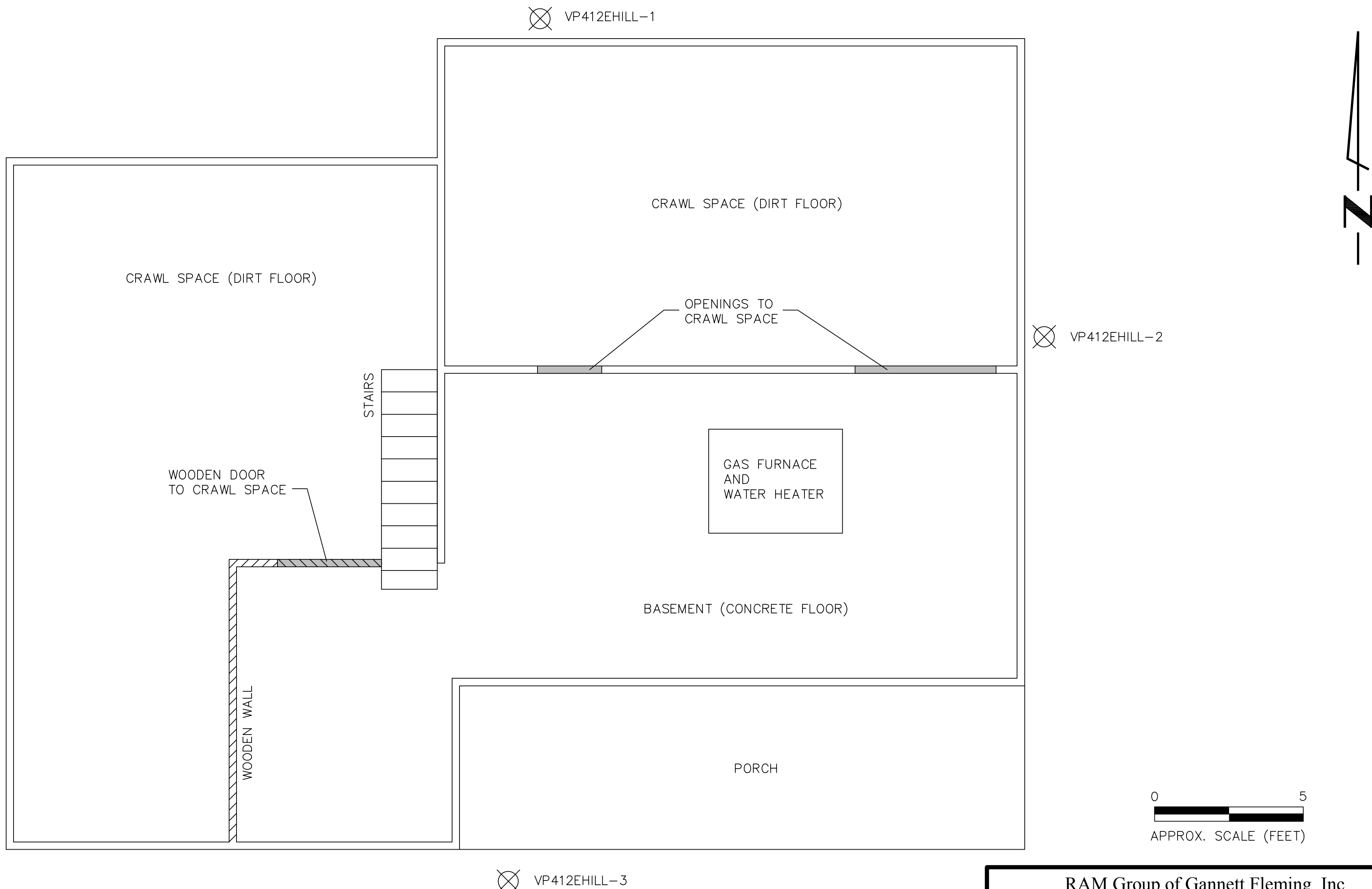
PROJ. NO: 005067	D/B: TLD	DATE: 12/08



RAM Group of Gannett Fleming, Inc.
5433 Westheimer, Suite 725, Houston, TX 77056

Figure 2-2
Basement Layout for 507 East Washington Street
Ameren Site
Champaign, Illinois

PROJ. NO: 005067	D/B: TLD	DATE: 12/08



LEGEND

⊗ SOIL VAPOR SAMPLE LOCATION

RAM Group of Gannett Fleming, Inc.
5433 Westheimer, Suite 725, Houston, TX 77056

Figure 2-3

Ameren Site
Basement Layout for 412 East Hill Street
Champaign, Illinois

PROJ. NO: 005067	D/B: TLD	DATE: 12/08

Appendix A
Scope of Work

August 21, 2008 ***Transmitted by E mail***

Mr. Brian Martin
Ameren Services
One Ameren Plaza
1901 Chouteau Avenue, MC 602
St. Louis, MO 63166-6149

Re: Soil Vapor Sampling
Former Manufactured Gas Plant Site, Champaign, Illinois

Dear Brian:

Thank you very much for the opportunity to collect the data necessary to evaluate potential soil vapor migration and vapor inhalation risk at this site. With our merger with Gannett Fleming (GF), we are excited at the opportunity to continue to provide an expanded set of high quality services to you.

The following tasks will be conducted:

An OSHA-compliant health and safety plan (HASP) will be prepared prior to mobilization. The state one-call service will be notified at least 48 hours before the fieldwork to mark the locations of sub-surface utilities along the public rights-of-way in the vicinity of the three residential properties to be sampled. These markings as well as visual observations at each residence will be used in an effort to avoid encountering sub-surface utilities during the fieldwork.

Coordination with residents and owners will be conducted to explain and coordinate the work prior to mobilization to the field. We understand the three residential homes are located at 412 East Hill (resident owner occupied) located west of the former MGP site, 505 East Washington (resident owner occupied and full time day care in basement) located north of the MGP site, and 507 East Washington (resident renter occupied) located north of the MGP site. Each of the homes have basements that are partially below grade extending to a depth of approximately five feet below ground surface (bgs).

We understand that the soils in the vicinity of the site consist of glacial till consisting of mostly tight silty clays in the upper 10 feet bgs and sandy sediments below 10 feet bgs. The water table has been measured at depths of 7 to 8 feet bgs.

Keith Klemm or Devin Yeatman will perform the fieldwork according to the following schedule:

Day 1: Travel to the site and perform site reconnaissance, mark utility and sampling locations, inspect all Summa canisters and other field equipment, and purchase any field supplies necessary.

Day 2: Install eight temporary vapor sampling borings to a target depth of approximately six feet below ground surface (approximately one foot below the bottom of the basement slab, estimated at 5 ft bgs and above the water table, estimated at 7-8 ft bgs) adjacent to three private residences. We will verify groundwater depths prior to beginning the field works at nearby accessible shallow monitoring wells. The vapor borings will be installed using a geoprobe track-mounted rig. Extreme care will be taken to prevent damage to private property. Soil vapor samples will be collected from the borings using post-run tubing (PRT) methods. One co-located duplicate soil vapor sample will be collected from a location between the two residences located on East Washington Street along with one ambient (outdoor) air sample.

Day 3: Continuation of work performed on Day 2. The samples will be shipped and the field technician will travel back to the office to complete any remaining paperwork.

Day 20: Receipt of all data from laboratory (standard turnaround) in electronic format.

Day 45: Submission of draft report for your review and comments. Single report including data collection, risk evaluation, and recommendations.

Day 60: Finalization of the report.

[cost portion of letter deleted for proprietary reasons]

We look forward to working with you on this project and will call you soon to discuss this.

Sincerely,

Kendall L. Pickett
Senior Geologist

Appendix B
Site Health & Safety Plan

FORMER AMEREN MANUFACTURED GAS PLANT SITE
HEALTH AND SAFETY PLAN
GANNETT FLEMING, INC.

SITE NAME	Ameren - Champaign	**PROJECT #**	50067
ADDRESS	308 N. 5th Street	**PROJECT CONTACT**	Kendall Pickett (Houston Office)
CITY, STATE	Champaign, Illinois	**PM PHONE**	(713) 784-5151
VERSION NO.	1	**CLIENT CONTACT**	Brian Martin
DATE	October 6, 2008	**CLIENT PHONE**	(314) 554-2233
PREPARED BY	Erin Beares	**SIGNATURE**	Erin Beares
APPROVED BY	Chris Ralston	**SIGNATURE**	[illegible]
REVIEWED BY	Rob Scrafford	**SIGNATURE**	[illegible]

1 SITE BACKGROUND AND DESCRIPTION

The former Champaign and Urbana Gas Light Company and subsequently AmerenIP, operated a manufactured gas plant on this site from approximately 1869 to the 1930's. The plant was then on standby status from the 1930's through the 1950's and was used to meet peak demands. The site was vacant and unused from 1960 until 1979 when the property was sold to American Legion Post 559 as a meeting house. The property was then repurchased by AmerenIP in 1991 and has since remained vacant.

The site consists of a vacant flat area secured by a chain-link fence. There are residential properties to the north, south and west and commercial properties to the east.

1.1 SITE TYPE

	Active		Agricultural		Recreational
X	Inactive	X	Commercial		Natural Area
X	Secure	X	Residential		Unknown
	Unsecured	X	Industrial		Other
	Landfill		Military		

1.2 SURROUNDING POPULATION

X	Industrial	X	Residential
	Urban		Rural

1.3 SITE TOPOGRAPHY

This site consists of flat topography.

1.4 ANTICIPATED WEATHER CONDITIONS

The predicted weather is fall temperatures and a possibility of rain showers.

2 DESCRIPTION OF ON-SITE ACTIVITIES

	Soil sampling		Well gauging
	Lagoon/pond sampling		Well sampling
	Drum sampling		Tank sampling

CHANGES AND/OR DEVIATIONS FROM THIS PLAN REQUIRE A SAFETY PLAN AMENDMENT

X	Oversight of drill crew		Asbestos sampling
	Site walk		On-site meeting
	Tank removal oversight		Air monitoring
	Groundwater sampling		Product removal from specified wells
X	Geoprobe® Soil Borings		Monitoring Well Installation
	Sump gauging	X	Soil Vapor Sampling

2.1 SPECIFIC WORK TASKS

1. Installation of eight soil borings using Geoprobe.
2. Sample soil vapor using Geoprobe post-run tubing.

2.2 SUBCONTRACTOR TASKS

Geoprobe drilling will be performed by a subcontractor, yet to be determined.

3 ON-SITE ORGANIZATION AND COORDINATION

The following personnel are designated to carry out the stated job functions on-site.

GF Project Manager/Contact:	Kendall Pickett
GF Safety Manager:	Sid Curran
Site Safety and Health Supervisor (SSHS):	Keith Klemm
Field Team Leader (FTL):	Keith Klemm
Field Team Members:	Keith Klemm, Kendall Pickett
Contractor Personnel:	TBD
Regulators/Client:	Ameren Services

All personnel arriving or departing from the site should log in and out with the SSHS. All activities on-site must be approved by the Gannett Fleming, Inc. Project Manager. The SSHS will maintain a site log.

3.1 TRAINING AND MEDICAL SURVEILLANCE

All onsite personnel must meet the requirements of OSHA 29CFR 1910.120 (f) prior to entry into the exclusion zone. Documentation of each employee's health monitoring records is the responsibility of their employer. Employees must be able to produce copies of their training records, if asked to do so.

4 ON-SITE CONTROL

N/A

5 HAZARD ASSESSMENT

5.1 Hazard evaluation

X	Slip/trip/fall	X	Chemical		Heat stress
	Open trenches (small for piping)		Radiation	X	Overhead utilities
	Confined spaces		Flammable atmospheres		Cold stress
	Work around vacuum tank and hoses		Asbestos	X	Machinery

CHANGES AND/OR DEVIATIONS FROM THIS PLAN REQUIRE A SAFETY PLAN AMENDMENT

	Floor openings		Ladders	X	Buried utilities
X	Vehicle traffic		Gas cylinders		Poisonous plants
	Entry into excavation		Insects		

**Note this list is not inclusive of all hazards, which may be encountered.

5.2 On-site hazards

The substance(s) in Table 1 (attached) are known or suspected to be on-site. The primary hazards of each are identified.

6 PERSONAL PROTECTIVE EQUIPMENT AND SAFETY PROCEDURES

6.1 Personal Protective Equipment

The following designated items will be the minimum protection required while in the exclusion zone. Specific activities may require modification to this list.

ANTICIPATED LEVEL OF PROTECTION: B___ C___ D_X

JUSTIFICATION:_Level D protection is anticipated based on the open atmosphere. Upgrades would be based on air monitoring results or field observations.

LEVEL B WILL INCLUDE: (Check all that apply)
COVERALL: Saranex___ Polytyvek___ Tyvek
GLOVES: Latex___ Nitrile___ Silver Shields___ Butyl___ Other
BOOTS: Steel Toe___ Latex Booties___ Robars___ Other
SUPPLIED AIR: SCBA__ Airlines
SPLASH APRON: Acid___ Other/Type:___/
OTHER EQUIPMENT: Hardhat___ Flash Light___ Radio___ Life Jacket___ Car Phone
Earplugs

ACTIVITIES TO BE PERFORMED IN LEVEL B: (Please List)
Not anticipated.

LEVEL C WILL INCLUDE: (Check all that apply)
COVERALL: Saranex___ Polytyvek___ Tyvek
GLOVES: Latex___ Nitrile___ Silver Shields___ Butyl___ Other
BOOTS: Steel Toe___ Latex Booties___ Robars___ Other
FULL FACE RESPIRATOR: Positive Pressure___ Negative Pressure
CARTRIDGES: GMC-P100___ Other/Type___/_________________ Escape Pack:
OTHER EQUIPMENT: Hardhat___ Flash Light___ Radio___ Life Jacket___ Car Phone
Earplugs

ACTIVITIES TO BE PERFORMED IN LEVEL C: (Please List)
Not anticipated.

LEVEL D WILL INCLUDE: (Check all that apply)
COVERALL: Tyvek___ Cotton___ Other
GLOVES: Latex___ Nitrile_X_ Cotton___ Other _(leather/work)
BOOTS: Steel Toe_X_ Latex Booties___ Robars___ Other_____
OTHER EQUIPMENT: Hardhat_X (if an overhead hazard is present) Safety Glasses_X
Flash Light___ Radio___ Cell Phone_X_ Earplugs _X_ Safety Vest _X

CHANGES AND/OR DEVIATIONS FROM THIS PLAN REQUIRE A SAFETY PLAN AMENDMENT

ACTIVITIES TO BE PERFORMED IN LEVEL D: (Please List)

1. Soil vapor sampling
2. Installation of soil borings

AIR MONITORING: (Check all that apply)
___ FID _X_ PID ___CGI___ DRAGER PUMP (LIST TUBES)__________RADIATION METER____
LOW-VOLUME PUMP___ HI-VOLUME PUMP___OTHERS (LIST)____________________________

6.2 Safety Procedures

- Eating, drinking, chewing gum or tobacco, smoking, or any practice which increases the potential of hand-to-mouth transfer of dangerous material is **PROHIBITED**.
- Any facial hair that interferes with a satisfactory fit of respiratory protective devices to the face is **PROHIBITED**.
- All joins between the protective suit and gloves, boots, respirator and zipper must be taped with duct tape when working near the machinery.
- An eye station will be located in the staging area.

7 COMMUNICATION PROCEDURES

Hand signals will be agreed upon during the tailgate safety meeting prior to commencement of activities each day. Cell phones will be available for emergency use. Personnel should remain within sight of the Field Team Leader.

Thee short blasts of the vehicle horn is the emergency signal to indicate that all personnel should leave the area and convene at the location designated by the Field Team Leader.

The following standard hand signals will be used in case of failure of radio communications.

Hand gripping throat	→	Out of air; can't breathe
Grip partner's wrist or both hands around waist	→	Leave area immediately
Hands on top of head	→	Need assistance
Thumbs up	→	OK; I am alright; I understand
Thumbs down	→	No; negative

Telephone communication to the Command Post should be established as soon as practicable.

8 DECONTAMINATION PROCEDURES

8.1 Personnel Decontamination

All boots and other potentially contaminated garments that have, or may have, contacted contaminated materials will be cleaned with detergent/water solution and rinsed with water in wash tubs. The wash water, rinse water, and residues will be collected and properly stored until sampling results are received and final disposition of the waste can be determined. Disposable PPE will be properly bagged and disposed of. All contaminated boots, clothing, and equipment that cannot be decontaminated will be disposed of with the disposable garments.

8.2 Sampling Equipment Decontamination
Sampling equipment will be decontaminated in the field using buckets, brushes, alconox, water and isopropyl alcohol.

8.3 Heavy Equipment Decontamination
Geoprobe rods will be decontaminated between sampling locations using buckets, brushes, alconox, and water.

8.4 Emergency Decontamination
Emergency decontamination will be conducted in the same manner as described above, when possible.

8.5 Decontamination Equipment
The following decontamination equipment is required:

X	Buckets	X	Decontamination pad
X	Brushes		Water hoses
X	Tubs		Disposal drums
	Steam cleaner	X	Cleaning solution
	Other	X	Water

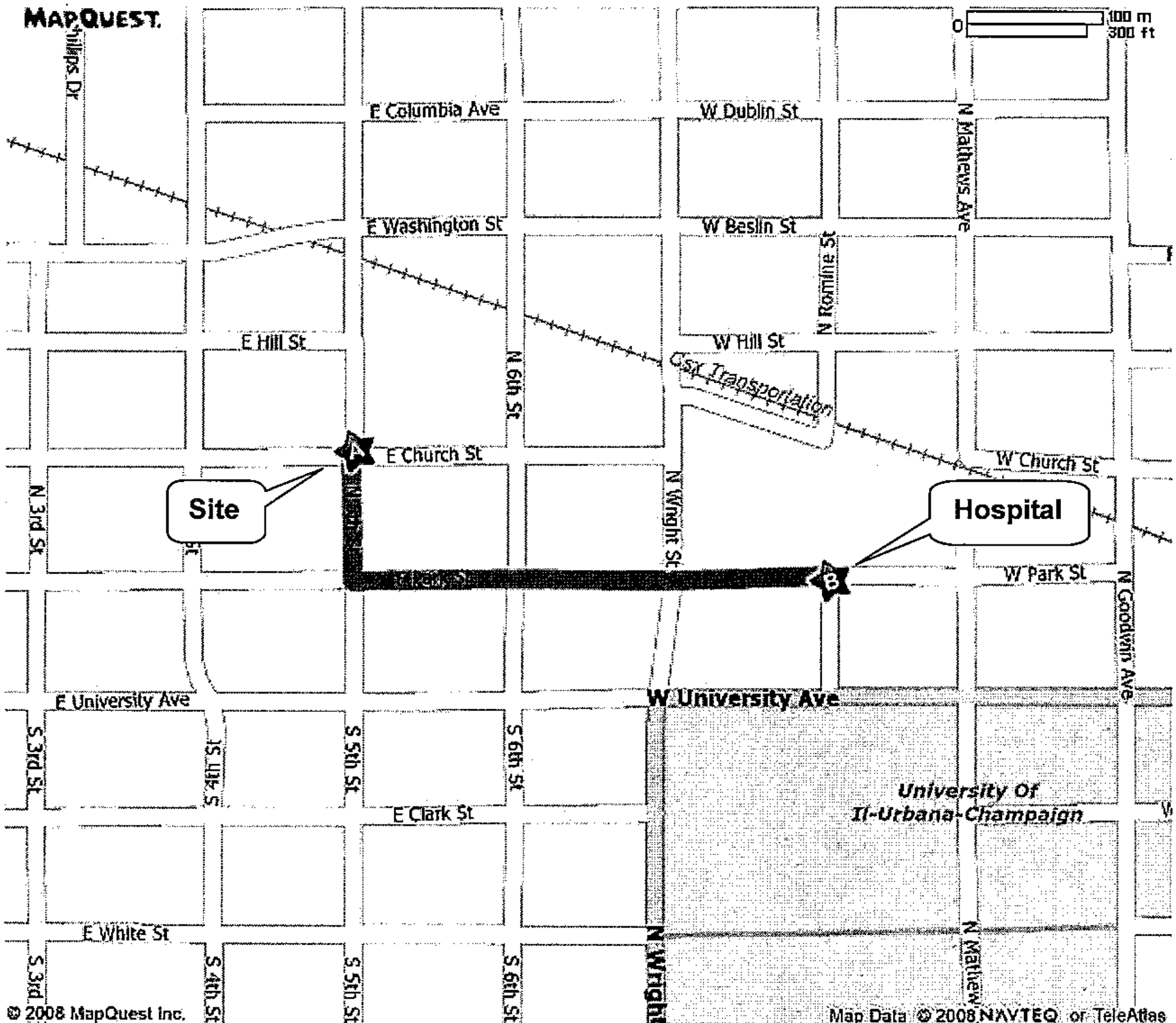
9 SITE SAFETY AND HEALTH PROCEDURES

9.1 Environmental Monitoring
See Table 2 (attached) for the specified intervals and action levels for the PID to be used on-site.

The following activities will be performed:
- Recharge each instrument at the end of each day.
- Record all reading in the site logbook.
- If an instrument fails to work, it must be repaired or replaced before work requiring its use can continue.
- Instrument readings above the action level require evacuation, reevaluation, and consultation with the Gannett Fleming, Inc. Health and Safety Manager for PPE upgrade.
- Dusty conditions may warrant upgrade in PPE. Consult with the Gannett Fleming, Inc. Health and Safety Manager if dusty conditions exist.

9.2 Emergency Medical Care

HOSPITAL: Provena Covenant Medical Center
1400 W. Park Street
Urbana, IL 61801



Source: MapQuest

DIRECTIONS TO HOSPITAL:

1. Start at 308 N 5th St going toward E Church St
2. Turn left on E Park St – go 0.3 miles
3. Arrive at 1400 W Park St on left

APPROXIMATE DISTANCE: 0.34 Miles

APPROXIMATE TRAVEL TIME: 1 Minute

CHANGES AND/OR DEVIATIONS FROM THIS PLAN REQUIRE A SAFETY PLAN AMENDMENT

FIRE DEPARTMENT: 911

POLICE DEPARTMENT: 911

AMBULANCE 911

FIRST AID KIT AVAILABLE AT Field vehicle

EYE WASH STATION AVAILABLE AT Field vehicle

GANNETT FLEMING TELEPHONE NO. (410) 585-1460 Baltimore Office
Sid Curran, Health and Safety Manager
(717) 763-7211 Harrisburg Office (Headquarters)
Thomas Gingrich, Regional Health & Safety Officer

9.3 Fire and Rescue Equipment

Fire extinguishers are located inside the wash building located immediately adjacent to the site. In addition, the Field Team Lead should have a fire extinguisher in the car.

First aid equipment is available on-site as follows:
First aid kit: In field vehicle and in wash building
Emergency eye wash: In field vehicle
Emergency shower: N/A

I have read and I understand the safety guidelines presented in this plan. I further understand that each contractor performing work on this site is solely responsible for the health and safety of their workers.

NAME (signature)	NAME (print)
[signature]	Keith Klemm
[signature]	Kendall Pickett

CHANGES AND/OR DEVIATIONS FROM THIS PLAN REQUIRE A SAFETY PLAN AMENDMENT

Table 1. Chemicals of Concern

Contaminant	Chemical / Physical Properties	Incompat -ibilities	Threshold Limit Value/ Permissible Exposure Limit	Immediately Dangerous to Life & Health	Route	Exposure Symptoms	First Aid
Benzene	MW: 78.1 BP: 176°F Fl.P: 12°F Sol: 0.07% VP: 75 mmHg	Strong Oxidizers, many fluorides & perchlorates nitric acid	0.1 ppm	500 ppm	Inhalation Ingestion Contact Skin absorption	Irritated eyes, skin, nose Dizziness, nausea Lassitude, Dermatitis, bone marrow depression	Eye: Immediately wash eyes with water Skin: Wash with soap and water immediately Inhalation: Move to fresh air, medical attention ASAP Swallow: Immediate medical attention
Ethyl benzene	MW: 106.2 BP: 62°F Fl.P: 55°F Sol: 0.01% VP: 7 mmHg	Strong Oxidizers	100 ppm	800 ppm	Inhalation, Ingestion, Contact	Irritated eyes, skin; Headache, dermatitis, narcosis	Eye: Immediately wash eyes with water Skin: Flush with water promptly Inhalation: Move to fresh air, medical attention ASAP Swallow: Immediate medical attention
Xylene	MW: 106.2 BP: 292°F Fl.P: 90°F Sol: 0.02% VP: 7 mmHG	Strong oxidizers, strong acids	100 ppm	900 ppm	Inhalation, Absorption, Ingestion, Contact	Irritated eyes, skin, nose throat; dizziness, excitement, drowsiness, nausea, vomiting, abdominal pain	Eye: Immediately wash eyes with water Skin: Wash skin with soap and water immediately Inhalation: Move to fresh air, medical attention immediately Swallow: Medical attention immediately
Toluene	MW: 92.1 BP: 232°F Fl.P: 40°F Sol: 0.07% VP: 21 mmHG	Strong Oxidizers	100 ppm	500 ppm	Inhalation, Absorption, Ingestion, Contact	Irritated eyes, skin, nose, coughing, dizziness, headache, Lassitude, dilated pupils, liver and kidney damage	Eye: Immediately wash eyes with water Skin: Flush with water immediately Inhalation: Move to fresh air, medical attention ASAP Swallow: Medical attention immediately

*Numerous PAH's have also been identified to exist at this site, including Benzo(a)pyrene in concentrations ranging from 10 mg/kg to 7700 mg/kg. Proper PPE, including gloves and safety glasses will be worn at all times during the short periods when exposure to these compounds is possible.

CHANGES AND/OR DEVIATIONS FROM THIS PLAN REQUIRE A SAFETY PLAN AMENDMENT

Table 2

AIR MONITORING ACTION LEVELS

Monitoring Equipment	Ambient Reading	Action
FID/PID*	Background	Level D
	1 - 5 units/ppm	Level C
	5-500 units/ppm	Level B
	>500 units/ppm	Exit area, consult health and safety coordinator. Note: Action levels based on sustained reading in breathing zone.

*Action levels provided as guidelines. Compound specific action levels may be lower or higher based on the TLV for the compound. Where unknown concentrations of organic vapors may be present caution is advised. Level B may be required until ambient concentrations are determined.

EFFECTS OF HEAT EXPOSURE

Adverse weather conditions are important considerations in planning and conducting site operations. Hot or cold weather can cause physical discomfort, loss of efficiency, and personal injury. Of particular importance is heat stress resulting from protective clothing decreasing natural ventilation of the body. Heat stress can occur even when temperatures are considered moderate. One or more of the following recommendations will help reduce heat stress:

- Provide plenty of liquids. Drink plenty of water or commercial drink mixes along with more heavily salted foods (unless on a low salt diet) to replace body fluids (water and electrolytes) lost due to sweating. To prevent dehydration, response personnel should be encouraged to drink generous amounts of water even if not thirsty. Heat-related problems can happen before the sensation of thirst occurs.
- Provide cooling devices to aid natural body ventilation. These devices, however, add weight, and their use should be balanced against worker fatigue. Long cotton underwear or similar type garments act as a wick to help absorb moisture and protect the skin from direct contact with heat-absorbing chemical protective clothing. It should be the minimum undergarment worn.
- Install mobile showers and/or hose-down facilities to reduce body temperature and cool protective clothing.
- Ensure that adequate shelter is available to protect personnel against heat, cold, rain, snow, and that a shaded resting area is provided on sunny days. On hot days, air conditioned rest areas should be provided.
- In hot weather, rotate teams of workers wearing protective clothing or performing extremely arduous tasks. In extremely hot weather, conduct non-emergency response operations in the early morning or evening.
- Response personnel should be encouraged to maintain their physical fitness. Physically fit personnel are less prone to stress-related problems.
- Liquids which act as diuretics (such as alcohol and coffee) should be avoided or their intake minimized before anticipated operation. These can contribute to dehydration and subsequent heat-related problems.

<u>HEAT STRESS MONITORING</u>
For monitoring the body's recuperative ability to handle excess heat, one or more of the following techniques should be used as a screening technique. Monitoring of personnel wearing protective clothing should commence when the ambient temperature is 70°F or above. Frequency of monitoring should increase as the ambient temperature increases or if slow recovery rates are indicated. When temperatures exceed 80°F, workers must be monitored for heat stress after every work period.

- Heart rate (HR) should be measured by counting the radial pulse for 30 seconds as early as possible in the resting period. The HR at the beginning of the rest period should not exceed 110 beats per minute. If the HR is higher, the next work period should be shortened by 10 minutes (or 33 percent), while the length of the rest period stays the same. If the pulse rate is 100 beats per minute at the beginning of the next rest period, the following work cycle should be shortened by 33 percent.
- Body temperature should be measured orally with a clinical thermometer as early as possible in the resting period. Oral temperature (OT) at the beginning of the rest period should not exceed 99°F. If it does, the next work period should be shortened by 10 minutes (or 33 percent), while the length of the rest period stays the same. However, if the OT

exceeds 99.7°F at the beginning of the next period, the following work cycle should be further shortened by 33 percent. OT should be measured again at the end of the rest period to make sure that it has dropped below 99°F.

- Body water loss (BWL) due to sweating should be measured by weighing the worker in the morning and in the evening. The clothing worn should be similar at both weighing; preferably the worker should be nude. The scale should be accurate to plus or minus □ pounds. BWL should not exceed 1.5 percent of the total body weight. If it does, workers should be instructed to increase their daily intake of fluids to replace the water lost through perspiration. Ideally, body fluids should be maintained at a constant level during the work day. This requires replacement of salt lost in sweat as well.

Good hygienic standards must be maintained by frequent change of clothing and daily showering. Clothing should be permitted to dry during rest periods. Persons who notice skin problems should immediately consult medical personnel.

EFFECT OF HEAT STRESS

If the body's physiological processes fail to maintain a normal body temperature because of excessive heat, a number of physical reactions can occur ranging from mild (such as fatigue, irritability, anxiety, and decreased concentration, dexterity, or movement) to fatal. Standard reference books should be consulted for specific first aid treatment. Medical help must be obtained for the more serious conditions.

Heat-related problems are:

- Heat Rash: caused by continuous exposure to heat and humid air and aggravated by chafing clothes. Decreases ability to tolerate heat as well as being a nuisance.
- Heat Cramps: caused by profuse perspiration with inadequate fluid intake and chemical replacement (especially salts). Signs: muscle spasm and pain in the extremities and abdomen.
- Heat Exhaustion: caused by increased stress on various organs to meet increased demands to cool the body. Signs: shallow breathing; pale, cool, moist skin; profuse sweating; dizziness and lassitude.
- Heat Stroke: the most severe form of heat stress. Can be fatal. Medical help must be obtained immediately. Body must be cooled immediately to prevent severe injury and/or death. Signs: red, hot, dry skin; no perspiration; nausea; dizziness and confusion; strong, rapid pulse; coma.

USEPA STANDARD OPERATING SAFETY GUIDES, Office of Emergency and Remedial Response, Emergency Response Division, July 1988.

USEPA STANDARD OPERATING SAFETY GUIDES, Office of Emergency and Remedial Response, Emergency Response Division, July 1988.

Appendix C
Photographs

PHOTO 1: View of packing bentonite putty seal around probe.

PHOTO 2: View to North along west side of 505 E. Washington at location of VP505EWASH-2. Probe in ground, tubing inside probe.

PHOTO 3: Purging VP505EWASH-2.

PHOTO 4: Obtain soil vapor sample in 1-Liter Summa Canister at VP505EWASH-2.

PHOTO 5: View to NW from N. Fifth St. MGP entrance gate looking at 412 E. Hill and Soil Essentials truck & trailer and Geoprobe rig at VP412EHill-3 location.

PHOTO 6: View to north at VP412EHill-3 location. Note plywood under Geoprobe rig.

PHOTO 7: Attaching 1-Liter SUMMA canister at VP412EHill-3 location. Note white paper towels with leak detection compound wrapped around equipment.

PHOTO 8: Another view of leak detector paper towels around rod on top of bentonite putty seal at VP412EHill-3 location.

PHOTO 9: View of oven cleaner & tire shine chemical containers on window ceil of south basement wall at 505 E. Washington.

PHOTO 10: Inside basement of 507 E. Washington looking east along north wall. Note new central heating unit and water heater, both fueled by natural gas.

PHOTO 11: Inside basement of 507 E. Washington looking North from entrance on south side of house. Note gasoline container, paint cans, and floor sump.

PHOTO 12: Inside basement of 507 E. Washington looking at water in swamp. Note broken concrete floor slab and exposed soil.

PHOTO 13: View of small basement room looking SE at corner of room. Left wall is outside east wall and right wall is interior wall with crawl space beyond.

PHOTO 14: View from small basement room into crawl space below northeast corner of house.

PHOTO 15: View of window along south wall of basement. There are several gaps between window frame and bricks & cinder blocks in this area and throughout basement.

PHOTO 16: View of entrance to basement from south exterior of house.

Wednesday, 10/15/08

Rainy, expecting thunderstorms

0630 - K. Klemm (GF) and K. Pickett (RAM) onsite to prep for soil vapor sampling.

0637 - C. Johnson (Soil Essentials) onsite. Will begin at 505 E. Washington St.

0910 - Spoke to Ameren. Given permission to begin work. Residents know that we will be present.

0715 MW in front of 507 E. Washington EW @ 28+'

0720 Setup on VP505 E.Wash-1 at 6' BGS #36555 Canister #
IV = 27.4 lift up 6-8"

0805 Setup on VP505 E.Wash-2 at 6' BGS lift up 6-8" - too tight did not sample lift up another 10-12" & reattach on point

0855 End of VP505 E.Wash-2 sampling

0900 Performed basement survey at 507 E. Washington

0915 Set up on VP507 E.Wash-1 between homes at 505 & 507 E.Wash.
0940 - too tight - no flow purge lift up 6" (cont on p13)

Soil Vapor Sampling Details

Sample ID/ Location	Canister #	Init Vac.	Final Vac.	Purge Vol (mL)	Sample Start	Sample Stop
VP505 E.Wash-1 (6')	36555	27.4	5.0	125	0755	080202
VP505 E.Wash-2 (6')	36553	27.1	—	125	1st attempt	
(5.5') (4.5') "	"	"	5.0	150	2nd attempt 084745	085356
VP507 E.Wash-1 (6')	34167	27.4		170	1st attempt	
(5') "	"	"		170	2nd attempt	
(4') "	"	"		570	3rd attempt	
VP507 E.Wash-2 (6')	"	"		170	1st attempt	
(5') "	"	"	5.0	380	104430	105146
VP507 E.Wash-?	2085	28.9	5.0	—	105800	110345
VP507 E.Wash-3 (6')	36522	28.4	~~5.0~~	300	1st attempt	
(5.5) "	"	"		7	2nd attempt	
(5') "	"	"		700	3rd attempt	
"	"	28.4	5.0	115511	114800	
VP412 E. Hill-1 (7')	34081	28.9		310	1st attempt	
(6.5') "	"			610	2nd attempt	
"	"	18	5.0	131055	132920	
"				900	3rd attempt	
VP412 E. Hill-2	2219	27.7	—	1200	—	—
"	"	"	—	1500	—	—
"	"	"	5.0	1800	143602	1441:..
VP412 E. Hill-3 (4.5')	36494	28.0	5.0	3400	152700	1531:4.
VP507 E.Wash-1 (3.5')	(33727)	27.5	5.0	960	1636:10	1642:2.
VP507 E.Wash Ambient		28.0	5.0	—	1658:20	1715:3.

Vapor Probe Locations

VP505E.Wash-1 (backyard) — 27" south from S. wall of basement; 57" west of W. wall of basement entrance

20'2" east of SWC of outside basement corner

29" east of E. edge of A/C slab

Note - Photo of oven cleaner & tire shine cans on window seal of basement

VP505 E.Wash-2 (west side) — 12' 4" N of SWC of outside basement corner; 19" west of west wall of basement

VP507E Wash-2 (backyard)

KK

10/15/08 (continued)

0945 tight during purge - lifted up another 6-8" (at 5' bgs)

1015 setup with Geoprobe rig on VP507E.Wash-2 in backyard at 6' bgs
tight on 1st attempt
pulled up to 5' bgs

1055 Setting up to take duplicate at VP507EWash-2 (-F), no add'l purge

1110 Moving to next location

1115 Driving probe to 6' bgs at VP507EWash-3 (east side of house)

1120 too tight pulled up to 5.5' bgs

1135 too tight pulled up to 5' bgs

1240 Setting up on VP412EHill-1 (backyard) at 7' BGS - too tight pulled up 6-8", too tight pulled up another 6-8"

1350 - Set up at VP412EHill-2, Drove point down to 5.5 ft bgs, but could not purge at sample depth of 5.0 (to bottom of rod). Pulled up 6", then ~~1350~~ 8", then 6" (bottom of rod at approx. 3'-10" bgs.

KK

10/15/08 (continued)

1432 - Able to complete VP 412EHILL-2 with bottom of rod at ~~[illegible]~~ 3' 10"

1505 Set up to sample VP 412EHILL-3 in front yard at 4.5' bgs
1535 completed sampling

1605 Set up to sample VP 507EWash-1 @ 6' bgs on west side of house (moved closer to house from previous location between 505 & 507 E. Washington) pulled up ≈ 8". Tight pulled up another 6". Tight pulled up to 4' bgs. Tight pulled up to 3.5' bgs.

1655 Set up for Ambient sample in 6-L Summa. Placed sample cannister near VP 507EWash-1.

1736 - Site cleanup complete Gate to former Ameren Facility locked. Depart from site.

KK

Thursday, 10/16/08

45°F, Sunny

0740 - Depart from Champaigne to Alton, IL

1052 - K. Klemm (GF) onsite at Alton site for soil vapor well sampling.

1100 - VW-1 is submerged in puddle. Will attempt to remove standing water, allow to dry, and return later to sample.

1223 - Water encountered while purging VW-1. Will attempt to purge out as much water as possible, but will not be able to sample today.

1227 - Removed approx 60mL water from VW-1 tubing, but droplets remain trapped inside.

1611 - Sampling completed. Difluoroethane was used as tracer during all sample collection

16~~[illegible]~~ - Site cleanup completed. Depart from site.

KK

10/15/08
[initials]

Champaign Location
<u>412 E. Hill</u>

VP 412 E Hill-1 34" north of northernmost wall
10' 2" east of patio slab
10' west of NEC of house

VP412 E Hill-2
40" east of east wall of house
7'10" south of NEC of house

VP 412 E Hill-3
40" South of cinder block supporting porch
between SEC of porch & entrance ramp
onto porch
8' 3" ~~east~~ west of SEC of porch

VP 507 E. Wash-2
38" south of south wall
16'9" ~~west~~ east of SWC of house

VP 507 E Wash-3
42" east of eastermost wall
14' South of NEC of house
14' North of SEC of house

VP 507 E WASH-1
29" west of west wall
12'6" South of NWC of house
15' 10" North of SWC of house

Field Forms and Check lists
for
Manufactured Gas Plant Sites

Developed for:

Ameren Services
One Ameren Plaza
1901 Chouteau Avenue
P.O. Box 66149, MC 602
St. Louis, MO 63166-6149

Developed by:

Risk Assessment & Management (RAM) Group, Inc.
5433 Westheimer, Suite 725, Houston, TX 77056
Ph: (713) 784-5151
Fax: (713) 784-6105
www.ramgp.com

MGP Site Name:	Ameren- Champaigne, IL
Ameren:	
Date:	10/15/08
Prepared By:	
Completed On:	

MGP Site:		
Table of Contents		
Form	**Description**	**Check box if**
Field Forms and Checklists		
Form 1	Building Characteristics to be Determined Before Finalization of Work Plan	☐
Form 2	Location of Soil, Soil Vapor, and Geotechnical Data to be Collected	☐
Form 3	Summary of Data Collected	☐
Form 4.1	Preparation of Subsurface Soil/Sub-slab Vapor Sampling	☐
Form 4.2	Vapor Sampling Analysis and Equipment Checklist	☐
Form 5	Vapor Sampling Field Documentation Checklist	☐
Form 6	Soil Vapor Sampling Documentation During Sampling	☐
Form 7	Geotechnical Parameters	☐

Building Characteristics to be Determined Before Finalization of Work Plan

Form 1

Building Identification					
Ownership					
Age of Building					
Number of Floors (Yes/No)					
Number of Elevators (Yes/No)					
First Floor Footprint Dimensions (L x W in ft)					
Crawl Space Dimensions (L x W x H in ft)					
Basement Footprint Dimensions (L x W in ft)					
Basement Height (ft)					
Basement Height Above Ground Surface (ft)					
First Floor Height (ft)					
Basement Floor Type					
Thickness of Basement Walls (ft)					
Thickness of Slab (ft)					
Condition of Slab					
Vapor Barrier (Yes/No)					
Post-Tension Slab (Yes/No)					
Sump Characteristics					
HVAC Characteristics					
Information on Doors/Windows					
Locations of floor drains, sinks, toilets on lowest floor of building					
As-Built Drawings or Plans Reviewed (Yes/No)					
Exposure Characteristics:					
Building Activities-General					
First Floor Activities					
Basement Activities					
Number of Workers					
Work-week number of days					
Work-day number of hours					

Note: Add additional sheets for relevant comments/information; Locate all buildings on a site map.

MGP Site:

Location of Soil, Soil Vapor, and Geotechnical Data to be Collected

Form 2

Boring Name	P/T	GW Table Range __ to __ (ft bgs) Depths (ft bgs) 3-5	7-9	10-12	TO-15: Full-suite ~~BTEX~~ with Naphthalene and Difluoroethane	Styrene	Acenaphthene	Anthracene	Fluorene	Naphthalene	Other Chemicals**	Soil Samples	Bio-Indicators***	Geotechnical Samples
					Yes/No									
SB-1*	P	3-5	7-9	10-12	Yes	Yes	No	No	No	No	Yes	Yes	Yes	Yes
VP507EWASH-1	T	≈3.5ft			X									
VP505EWASH-1	T	≈5.5ft			X									
VP507EWASH-2	T	5ft			X									
VP507EWASH-F	T	5ft			X									
VP412EHILL-2	T	3ft-10in			X									
VP505EWASH-2	T	≈4.5ft			X									
VP507EWASH-3	T	5ft			X									
VP412EHILL-3	T	4.5ft			X									
VP412EHILL-1	T	≈6ft			X									
V:														
Total Number of Samples					0	0	0	0	0	0	0	0	0	0

Notes: P-Permanent sampling probes; *Completed for illustration only; **Provide details in comments section;
T-Temporary sampling probes; ***Bio-indicators (O_2, CO_2, N_2, CH_4 etc.) for evaluation of biodegradation. Provide details in comments; For Geotechnical methods see Form 7.
For PAHs-Use methods in Section 3.4.6.2 in SOP; For VOCs and Naphthalene-Use methods in Section 3.4.6.1 in SOP. □

Comments:

One ambient sample also collected (VP507EWASHCAMBIENT) in area immediately adjacent to VP507EWASH1.

VP507EWASH-F was collected in same location as VP507EWASH-2.

MGP Site:

Summary of Data Collected — **Form 3**

Number	Activity	Planned	Lab (F, M, B)	Actual	Lab (F, M, B)
1	Method of Drilling	Geoprobe PRT	NA	Geoprobe PRT	NA
2	Number of Permanent Probes		NA		NA
3	Number of Temporary Probes		NA		NA
4	Number of Soil Vapor Samples	8 + 1 Duplicate	F	8 + 1 Duplicate	F
5	Number of Soil Samples				
6	Number of Geo-technical Samples				
7	Number of Bio-indicator Samples				
8	Number of Sub-slab vapor Samples				

Notes: F - Fixed Laboratory; M - Mobile Laboratory; B - Both Fixed and Mobile Laboratories; NA - Not Applicable.

MGP Site:

Preparation of Subsurface Soil/Sub-slab Vapor Sampling **Form 4.1**

Pre-Sampling Activities:	Yes	No	N/A
Access from Property Owners/Tenants	☑	☐	☐
State One-call Contacted	☑	☐	☐
Subsurface Utilities Marked	☑	☐	☐
Site Drawings/Plans/As-builts Reviewed	☐	☐	☑
Proposed Sample Locations Accessible	☑	☐	☐
Proposed Sample Locations Approved by	☑	☐	☐
• Site Owner	☑	☐	☐
• Tenant	☑	☐	☐
• Client	☑	☐	☐
• Regulatory Agency	☑	☐	☐
• Other			

Site visitors included Ameren, Illinois EPA, PSC, activist groups,

Other Ameren or Site-Specific Requirements:

MGP Site:

Vapor Sampling Analysis and Equipment Checklist

Form 4.2

Vapor Laboratory Analysis:	Yes	No	N/A
Mobile Lab	☐	☐	☑
Permanent Lab	☑	☐	☐
RLs ≤ Regulatory Target Levels	☒	☐	☐
Vapor Sampling Equipment:			
Tedlar Bags	☐	☑	☑
Syringes	☑	☐	☐
Tubes and Cartridges	☐	☐	☑
Summa Canisters	☑	☐	☐
Flow Controller	☐	☐	☑
Tubing Type			
• Nylon	☐	☐	☑
• Teflon	☑	☐	☐
• Other			

Leak Test Methods:			
Containment	☐	☐	☑
Helium (Recommended)	☐	☐	☑
2-propanol	☐	☐	☑
Lab Grade of Tracer Gas	☑	☐	☐

Other

Difluoroethane used as leak detector compound

Air Pumps

N/A

Connectors

All fittings were 1/4" Swagelok (stainless steel)

Note: RL - Laboratory Reporting Limits.

MGP Site:

Vapor Sampling Field Documentation Checklist

Form 5

Field Personnel:	Keith Klemm (Gannett Fleming), Kendall Pickett (RAM Group), Cory Johnson (Soil Essentials)
Weather Conditions: Raining, Humidity, Cloudiness, etc.	Cloudy in morning, changing to rain showers by noon. Showers throughout entire afternoon.
Temperature	Ranged 60°F - 70°F
Barometric Pressure	Not measured
Wind Speed and Direction	Not measured
Surface Soil Conditions: Wet, Dry, Moist, Standing Water, Frozen/Snow covered	Moist to wet
Chain of Custody Forms Completed:	1 COC for Air Toxics, LTD
Shipment Method and Tracking Numbers:	FedEx overnight

Do not collect soil vapor samples during or within 3 days of a significant rain event.

p. 1 of 3

MCL Site:

Soil Vapor Sampling Documentation During Sampling

Form 6

Sample ID & Interval	VP507EWASH-1	VP507EWASH-2	VP507EWASH-3	VP507EWASH-F
Sample Dates/Times	10/15/08 1642	10/15/08 1051	10/15/08 1155	10/15/08 1103
Equilibration Time				
Purging:				
Volume Purged	520 mL	380 mL	700 mL	N/A - Duplicate for 507 EWASH-2
Flow Rate	~~<200 mL/min~~ <60 mL/min	<60 mL/min	<60 mL/min	<60 mL/min for 507 EWASH-2
Time Interval	≈ 70 sec	≈ 45 sec	≈ 80 sec	N/A
Canister	N/A			→
Pump	N/A			→
Other				
Leak Testing:				
Surface Seal	Hydrated bentonite			→
Bucket Containment	N/A			→
Tracer Chemical	Difluoroethane			→
Tracer gas labgrade (Yes/No)	No			→
Onsite Measurement	No			→
Lab Measurement	Yes (Air Toxics, LTD)			→
Pre-sample test	N/A			→
Post-sample test	N/A			→
Field Adjustment Performed ?*	N/A			→
Sample Collection:**				→
Sample Volume	1-Liter			→
Beginning Vacuum	27.5	27.4	28.4	28.9
Ending Vacuum	5.0 in. Hg			→
Flow Rate	<200 mL/min			→
Sample Container	Summa Canister batch [illegible]			→

Notes:

* Includes inspection of probe and other system components.

** Refer to Sections 3.4.6.1 and 3.4.6.2 of SOP for details. ** For sub-slab sampling refer to Section 4 of SOP.

MGP Site:

Soil Vapor Sampling Documentation During Sampling

Form 6

Sample ID & Interval	VP412 EHILL-1	VP412 EHILL-2	VP412EHILL-3	VP 505ENASH-1
Sample Dates/Times	10/15/08 1329	10/15/08 1441	10/15/08 1531	10/15/08 0802
Equilibration Time				
Purging:				
Volume Purged	900 ML	1800 ML	340 ML	125 ML
Flow Rate	<60 ML/MIN	<60 ML/MIN	<60 ML/MIN	<60 ML/MIN
Time Interval	≈ 100 sec	≈ 200 sec	≈ 50 sec	≈ 20 sec
Canister	~~34081~~ NA	~~2219~~ NA	~~36494~~ NA	~~36555~~ NA
Pump	NA	NA	NA	NA
Other				
Leak Testing:				
Surface Seal	Hydrated bentonite	→	→	→
Bucket Containment	NA	NA	NA	NA
Tracer Chemical	Difluoroethane	→	→	→
Tracer gas labgrade (Yes/No)	No	No	No	No
Onsite Measurement	No	No	No	No
Lab Measurement	Yes (AirToxics Ltd)	→	→	→
Pre-sample test	NA	NA	NA	NA
Post-sample test	NA	NA	NA	NA
Field Adjustment Performed ?*	NA	NA	NA	NA
Sample Collection:**				
Sample Volume	1 Liter	1 Liter	1 Liter	1 Liter
Beginning Vacuum	28.9	27.7	28.0	27.4
Ending Vacuum	5.0	5.0	5.0	5.0
Flow Rate	< 200 ML/MIN	→	→	→
Sample Container	SUMMA Canister (batch certified)	→	→	→

Notes:
* Includes inspection of probe and other system components.
** Refer to Sections 3.4.6.1 and 3.4.6.2 of SOP for details. ** For sub-slab sampling refer to Section 4 of SOP.

MGP Site:

Soil Vapor Sampling Documentation During Sampling

Form 6

Sample ID & Interval	VP505 EWASH-2	VP505 EWASH (AMBIENT)		
Sample Dates/Times	10/15/08 0853	10/15/08 1715		
Equilibration Time				
Purging:				
Volume Purged	170 mL	NA		
Flow Rate	< 60 mL/MIN	NA		
Time Interval	≈ 25 sec	NA		
Canister	~~36553~~ NA	NA		
Pump	NA	NA		
Other				
Leak Testing:				
Surface Seal	Hydrated bentonite	NA		
Bucket Containment	NA	NA		
Tracer Chemical	Difluoroethane	→		
Tracer gas labgrade (Yes/No)	No	No		
Onsite Measurement	No	No		
Lab Measurement	Yes (AirToxics Ltd)	→		
Pre-sample test	NA	NA		
Post-sample test	NA	NA		
Field Adjustment Performed ?*	NA	NA		
Sample Collection:**				
Sample Volume	1 Liter	6 Liter		
Beginning Vacuum	27.1	28.0		
Ending Vacuum	5.0	5.0		
Flow Rate	< 200 mL/MIN	≈ 350 mL/min		
Sample Container	SUMMA Canister (batch	certified) →		

Notes:
* Includes inspection of probe and other system components.
** Refer to Sections 3.4.6.1 and 3.4.6.2 of SOP for details. ** For sub-slab sampling refer to Section 4 of SOP.

Appendix E
Basement Survey Forms

INDOOR AIR BUILDING SURVEY FORM PAGE 1 OF 4

Building Address: 505 E. Washington

Property Contact: Pearl Buchanan Samuels Owner /(Renter)/ other: ______

Contact's Phone: home ( ) ______ work (217) 351-9847 cell ( ) ______

Building occupants: Children under age 13 ~~8~~ 16 day 10 night Children age 13-18 0 Adults 2 – till midnight naps in basement

How long in this residence? 17-18 yrs

History of wet basement or flooding? 1250 SF

No

General Description of Building Construction and Materials:

How many occupied stories does the building have? 1+ Basement 4BR 2 Baths

Does someone sleep in the basement? Y

Has the building been weatherized with any of the following? (Circle all that apply)
(Insulation) attic (Storm Windows) Energy-Efficient Windows Other (specify) ______

Approximately how much of the basement is below grade level? ≈ 4' below grade

Total wall area: 30x7x2 + 22x7x2 = 728 SF.

Total wall area in contact with soil: 7' Ceiling in basement

30x4x2 + 22x4x2 = 416 SF

Basement Floor Description:

1 Bedroom Bath Laundry Day-care
1 ofc Pantry Kitchen

Basement Walls Description:

Paneled wall & water board on concrete

Moisture, water, or wet floors or walls observed or sensed:

No

Is a basement sump present? (Y)/N) Laundry Room Sufficient water for sampling? (Y/N) ? Covered, could not access

Sump Construction: ______

Does the basement have any observable characteristics that might permit soil vapor entry? (i.e. cracks in concrete, crack at wall/floor, pipe penetrations):

Floor in good condition
Plumbing pipes in laundry room, bath room & kitchen in basement

5 Rooms in basement
12 paces E-W (≈38')
9 paces N-S (≈28')

Building address: 505 E. Washington
Date: 10/15/08

Heating and Ventilation System(s) Present Central Air - Energy Efficient

What type of heating system(s) are used in this building? (Circle all that apply)

(Hot Air Circulation) | Heat Pump | Stream Radiation | Wood Stove
Hot Air Radiation | Unvented Kerosene heater | Electric Baseboard | Other (specify) ____

What type(s) of fuel(s) are used in this building? (Circle all that apply)

(Natural Gas) | (Electric) | Coal | Other (specify) ____
Fuel Oil | Wood | Solar

What type of mechanical ventilation systems are present in the building? (Circle all that apply)

(Central Air Conditioning) | Mechanical Fans | Bathroom Ventilation Fan
Individual Air Conditioning Units | (Kitchen Range Hood) | Air-to-Air Heat Exchanger
Open windows | Other (specify) ____

Do any occupants of the building smoke? (Yes) / No How often? Daily

Has anyone smoked within the building within the last 48 hours? (Yes) / No

Do the occupants of the building have their clothes dry-cleaned? (Yes) / No

When were dry-cleaned clothes last brought into the building? Last week

Have the occupants ever noticed any unusual odors in the building? (Yes) / No

Describe (with location): End of June/July - outside foul smells

Any known spills of a chemical immediately outside or inside the building? Yes / (No)

Describe (with location): ____

Has the building been treated with any insecticides/pesticides? If so, what chemicals are used and how often are they applied? Once per month

Do any of the occupants apply pesticides/herbicides in the yard or garden? If so, what chemicals are used and how often are they applied? No

Any use of chemicals not listed above? Yes / No

Building address: 505 E. Washington
Date: 10/15/08

INDOOR AIR BUILDING SURVEY FORM PAGE 3 OF 4

Indoor Contaminant Sources

Identify all potential indoor sources found on the first floor and basement levels, the location of the sources, and whether the item was removed from the building at least 48 hours prior to indoor air sampling event.

Potential Sources	Location(s)	Removed Prior to Sampling? (Yes / No / NA)
Gasoline storage cans	Outside shed	Y
Gas-powered equipment	" Lawn mower	Y
Kerosene storage cans	" Torches	Y
Paints / thinners / strippers		N
Cleaning solvents	Laundry room & upstairs	Y
Oven cleaners	" "	Y
Carpet / upholstery cleaners		N
Moth balls		N
Polishes / waxes	Wax Laundry Rm	Y
Insecticides		N
Furniture / floor polish	Laundry Rm	Y
Nail polish / polish remover	Upstairs Bedrm	Y
Hairspray	" Bath	Y
Cologne / perfume	" Bedrm	Y
Air fresheners	Laundry & upstairs	Y
Hobbies - glues, paints, etc.	Basement ofc	Y
Fireplace		N NA
Wood stove or kerosene burner		N NA
New furniture / upholstery	New table - upstairs	Y NA
New carpeting / flooring	Linoleum tile in basement	Y NA
Recent painting in building?		N NA
Medical Equipment		N NA

INDOOR AIR BUILDING SURVEY FORM PAGE 4 OF 4

Indoor Contaminant Sources – Did not perform survey with meter

Identify all potential indoor sources as detected by the ppbRAE located on the first floor and basement levels, the location of the sources. Provide a brief description of source and the two PID responses obtained from the initial and follow-up screenings.

Location Number	Location	Brief Description	ppbRAE Response (initial screening)	ppbRAE Response (follow-up screening)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
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25				
26				
27				
28				
29				
30				
31				
32				
33				

MGP Site:

Building Characteristics to be Determined Before Finalization of Work Plan

Form 1

Building Identification					
Ownership	Nina Sibley				
Age of Building					
Number of Floors (Yes/No)	1 + basement				
Number of Elevators (Yes/No)	No				
First Floor Footprint Dimensions (L x W in ft)					
Crawl Space Dimensions (L x W x H in ft)	No				
Basement Footprint Dimensions (L x W in ft)					
Basement Height (ft)	7'				
Basement Height Above Ground Surface (ft)	4-5'				
First Floor Height (ft)	8'				
Basement Floor Type	Linoleum Tile				
Thickness of Basement Walls (ft)					
Thickness of Slab (ft)					
Condition of Slab					
Vapor Barrier (Yes/No)	No				
Post-Tension Slab (Yes/No)	No				
Sump Characteristics					
HVAC Characteristics					
Information on Doors/Windows	Storm windows & doors				
Locations of floor drains, sinks, toilets on lowest floor of building					
As-Built Drawings or Plans Reviewed (Yes/No)					
Exposure Characteristics:					
Building Activities-General	Residence & Day Care				
First Floor Activities	Residence				
Basement Activities	Day Care & Residence				
Number of Workers	2				
Work-week number of days	M-F				
Work-day number of hours	4 & 9				

Note: Add additional sheets for relevant comments/information; Locate all buildings on a site map.

Building Address: 507 E. Washington

Property Contact: NA Owner / Renter / other: Vacant

Contact's Phone: home ( ) work ( ) cell ( )

Building occupants: Children under age 13 0 Children age 13-18 0 Adults 0

How long in this residence? NA

History of wet basement or flooding?

?

General Description of Building Construction and Materials:

Basement: Brick walls, concrete slab, wood frame 1st floor with vinyl siding and composition roof. 1 Story + basement (Brick below grade, cinder block above grade) 8"-thick cinder block

How many occupied stories does the building have? 0

Does someone sleep in the basement? 0

Has the building been weatherized with any of the following? (Circle all that apply)

Insulation Storm Windows Energy-Efficient Windows Other (specify)

Approximately how much of the basement is below grade level? 4' Footprint of house: 40' x 28'

Total wall area: 8' ceiling 13 paces x 9 paces (EW, NS)

Total wall area in contact with soil: Less 6' x 16' offset in NEC of basement

Basement Floor Description:

Concrete slab, cracked, broken, exposed soil areas, poor condition. One sump with debris & standing water about 6-8" below floor of

Basement Walls Description:

Brick, Deteriorated, holes, gaps around window frames & outside doorframe, No door, storm door with open frame, poor condition

Moisture, water, or wet floors or walls observed or sensed:

No

Is a basement sump present? (Y/N) Y Sufficient water for sampling? (Y/N) Y

Sump Construction:

Does the basement have any observable characteristics that might permit soil vapor entry? (i.e. cracks in concrete, crack at wall/floor, pipe penetrations):

Cracked floors, cracked walls, holes in walls, gaps between bricks & mortar, exposed soil through floor

Central heat-gas in basement

Hot water heater-gas in basement

Basement (footprint of house less 6' x 16' offset (NEC of basement)

Building address: 507 E. Washington
Date: 10/15/08

INDOOR AIR BUILDING SURVEY FORM PAGE 2 OF 4

Heating and Ventilation System(s) Present

What type of heating system(s) are used in this building? (Circle all that apply)

(Hot Air Circulation) — New
Heat Pump
Stream Radiation
Wood Stove
Hot Air Radiation
Unvented Kerosene heater
Electric Baseboard
Other (specify) ____________

What type(s) of fuel(s) are used in this building? (Circle all that apply)

(Natural Gas)
(Electric)
Coal
Other (specify) ____________
Fuel Oil
Wood
Solar

What type of mechanical ventilation systems are present in the building? (Circle all that apply)

(Central Air Conditioning)
Mechanical Fans
Bathroom Ventilation Fan
Individual Air Conditioning Units
Kitchen Range Hood
Air-to-Air Heat Exchanger
Open windows
Other (specify) ____________

Do any occupants of the building smoke? *Yes / No* How often? NA

Has anyone smoked within the building within the last 48 hours? *Yes / No* NA

Do the occupants of the building have their clothes dry-cleaned? *Yes / No* NA

When were dry-cleaned clothes last brought into the building? NA

Have the occupants ever noticed any unusual odors in the building? *Yes / No* NA

Describe (with location): ____________

Any known spills of a chemical immediately outside or inside the building? (Yes) / No

Describe (with location): Foul odors in backyard due to moldy belongings on lawn exposed to weather, Musty odors in basement

Has the building been treated with any insecticides/pesticides? If so, what chemicals are used and how often are they applied? ?

Do any of the occupants apply pesticides/herbicides in the yard or garden? If so, what chemicals are used and how often are they applied? ?

Any use of chemicals not listed above? (Yes) / No

Noted gasoline plastic containers and paint cans in basement

Building address: 507 E. Washington
Date: 10/15/08

INDOOR AIR BUILDING SURVEY FORM PAGE 3 OF 4

Indoor Contaminant Sources

Identify all potential indoor sources found on the first floor and basement levels, the location of the sources, and whether the item was removed from the building at least 48 hours prior to indoor air sampling event.

Potential Sources	Location(s)	Removed Prior to Sampling? (Yes / No / NA)
Gasoline storage cans	basement	Y
Gas-powered equipment		
Kerosene storage cans		
Paints / thinners / strippers	basement	Y
Cleaning solvents		
Oven cleaners		
Carpet / upholstery cleaners		
Moth balls		
Polishes / waxes		
Insecticides		
Furniture / floor polish		
Nail polish / polish remover		
Hairspray		
Cologne / perfume		
Air fresheners		
Hobbies - glues, paints, etc.		
Fireplace		NA
Wood stove or kerosene burner		NA
New furniture / upholstery		NA
New carpeting / flooring		NA
Recent painting in building?		NA
Medical Equipment		NA

INDOOR AIR BUILDING SURVEY FORM PAGE 4 OF 4

Indoor Contaminant Sources – Did not perform survey with meter

Identify all potential indoor sources as detected by the ppbRAE located on the first floor and basement levels, the location of the sources. Provide a brief description of source and the two PID responses obtained from the initial and follow-up screenings.

Location Number	Location	Brief Description	ppbRAE Response (initial screening)	ppbRAE Response (follow-up screening)
1	Basement	Gasoline & Paint Cans		
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
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28				
29				
30				
31				
32				
33				

MGP Site:

Building Characteristics to be Determined Before Finalization of Work Plan					Form 1
Building Identification					
Ownership	?				
Age of Building	?				
Number of Floors (Yes/No)	1 + basement				
Number of Elevators (Yes/No)	No				
First Floor Footprint Dimensions (L x W in ft)					
Crawl Space Dimensions (L x W x H in ft)					
Basement Footprint Dimensions (L x W in ft)					
Basement Height (ft)	8'				
Basement Height Above Ground Surface (ft)	4.5'				
First Floor Height (ft)	8'				
Basement Floor Type	concrete slab				
Thickness of Basement Walls (ft)					
Thickness of Slab (ft)					
Condition of Slab	Poor, cracked, exposed soil				
Vapor Barrier (Yes/No)	No				
Post-Tension Slab (Yes/No)	No				
Sump Characteristics					
HVAC Characteristics	gas unit in basement, duct work to 1st Floor				
Information on Doors/Windows	Standard				
Locations of floor drains, sinks, toilets on lowest floor of building	Sump in basement, No drains, sinks, toilets in basement				
As-Built Drawings or Plans Reviewed (Yes/No)	No				
Exposure Characteristics:					
Building Activities-General	Vacant				
First Floor Activities	None				
Basement Activities	None				
Number of Workers	None				
Work-week number of days	None				
Work-day number of hours	None				

Note: Add additional sheets for relevant comments/information; Locate all buildings on a site map.

10/15/08
[initials]

Basement at 507 E. Washington Survey

- Sump with auto
- Brick walls
- Concrete slab floor with cracks & exposed soil,
- two separate rooms
- not used for living quarters or human activity
- musty odors
- gas hot water heater
- gas furnace
- floor about 4.5' below grade
- cracks around windows along brick
- one window boarded
- holes in walls to outside
- Storm door entrance from back yard
- No entrance from surface
- 14 paces - side to side entire basement
- 1.5-2.0 foot ledge about 3' above floor all around
- utility entrances in basement walls
- new furnace
- paint cans
- gasoline can

large room
- 7 paces on floor front to back
- 9 paces on floor side to side

Small room - 3 x 3 paces on floor

Building Address	412 East Hill Street Champaign, IL 61820	**Ownership**	Willie Claiborne 410 East Hill Street Champaign, IL 61820

Rental Tenant ((Y) N) Alvia Dyson **Number/Type Residents** 2 Adults / 1 child 3.

Construction Wood frame 1 story house with 1/2 basement and 1/2 crawlspace

Age of Building ________ years

Number of Floors/Description 1 story, 1/2 basement, 1/2 crawlspace

First Floor Footprint Length 36' Width 28' Height ____

Second Floor (if applicable) Length ____ Width ____ Height ____

BASEMENT

Location Length 20 / 7 Width 11' = 220 ft2 / 4.5' = 66 ft2 — 286 ft2

Finished Yes No

Basement Height Total Floor to Ceiling 6' Below ground 5' Above ground 1'

Floor Type Concrete Thickness 3.5"

Wall Type Brick w/ outer facing Thickness ~3.5"

Condition of Floor Cracks Wet Damp (Dry)

Additonal Description ____

Vapor Barrier Yes (No) **Description** ____

Sump (Yes) No

Dimensions 14 x 14", 12" deep from top of slab

Additional Description ~4" water. Sump Pump. Sampled 9/15/08 - non-detect

Floor Drains Yes (No) **Location** ____

Sinks/Toilets Yes (No) **Location** ____

Additional Description ____

Basement Door Location Stairs (28" wide) at west-central (center of house)

Basement Windows (Yes) No **Number** 1

	Location	*Dimension*	*Aboveground*	*Belowground*
Location Window 1	S. end of E. wall	16 x 30"	Flush	NO
Location Window 2				
Location Window 3				

CRAWL SPACE

Location Length 20' / 15' / 8 Width 11' NE = 220 ft2 / 14' NW = 210 ft2 / 9.5' SW = 76 ft2

Access Point multiple

Floor Type DIRT **Floor Thickness** ____

Additional Description Crawl space ht. ranges from 2 to 5 feet; Avg ≅ 2.5 - 3'

Vapor Barrier Yes (No) **Description** ____

Heating System in Basement (Yes) No

Type of System Forced Air / Gas Furnace

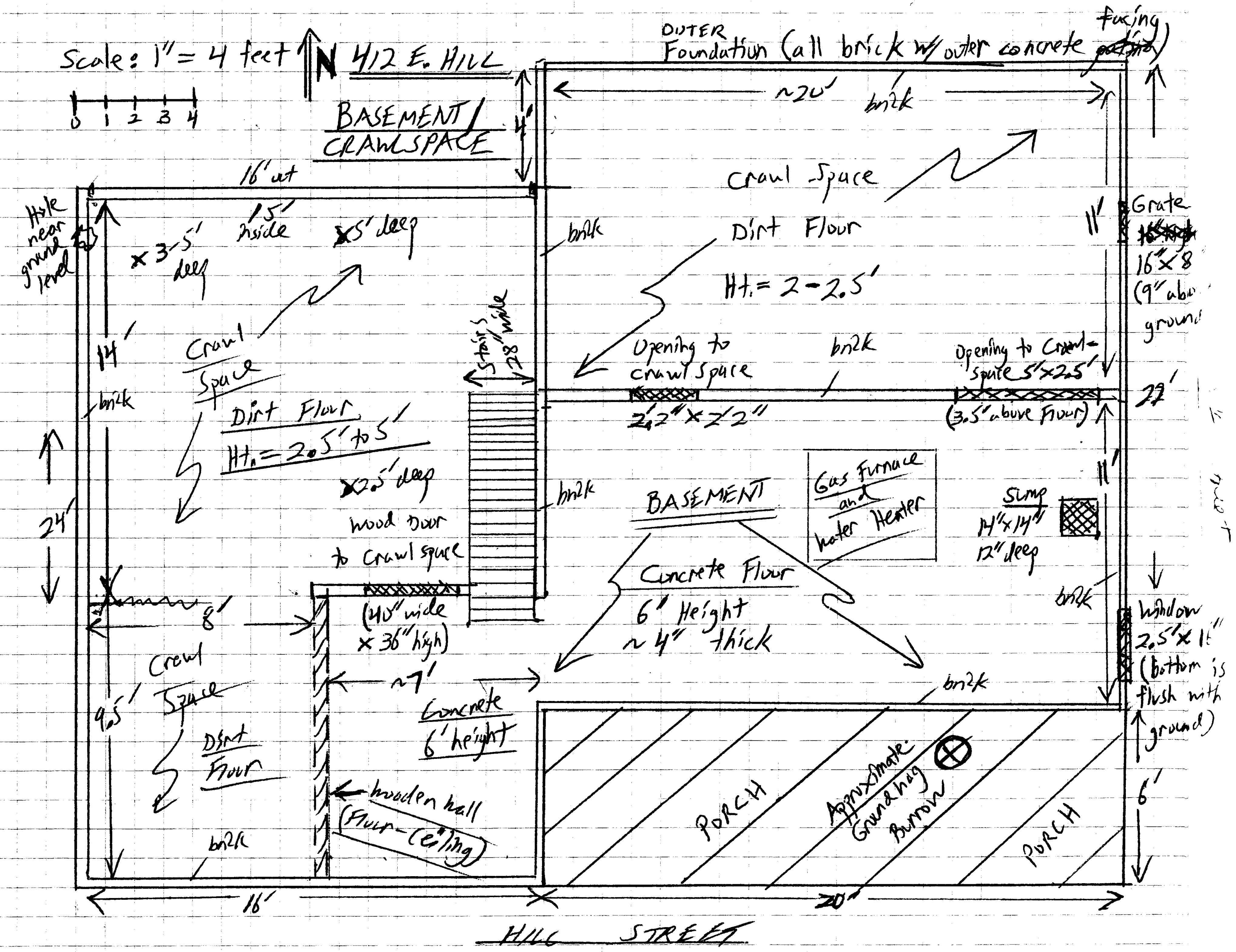
Location of System center of basement

Observable Entry Points for Soil Vapor Entry

Cracks in Floor	Yes	(No)	
Cracks in Wall	Yes	(No)	Brick w/ old mortar
Floor/Wall Intersection Cracks	(Yes)	No	
Pipe Penetrations	Yes	(No)	

Surveyed by: Stu Cravens / Kelron Env. Date: 10/22/08

Signature: [signature] Time In/Out 5:05 / 5:55 pm


Scale: 1" = 4 feet
0 1 2 3 4
N
412 E. HILL
BASEMENT / CRAWLSPACE
OUTER Foundation (all brick w/ outer concrete facing)
~20'
brick
Crawl Space
Dirt Floor
Ht. = 2-2.5'
11'
Grate 16"x8 (9" above ground)
4'
16' out
15' inside
Hole near ground level
x 3-5' deep
x 5' deep
14'
Crawl Space
Dirt Floor
Ht. = 2.5' to 5'
x 2.5' deep
wood Door to Crawl space
Stairs 28" wide
Opening to crawl space
2'2" x 2'2"
Opening to Crawl-space 5'x2.5'
(3.5' above Floor)
22'
Gas Furnace and water Heater
BASEMENT
Sump 14"x14" 12" deep
Concrete Floor
6' Height
~4" thick
window 2.5'x1.5' (bottom is flush with ground)
24'
8'
(40" wide x 36" high)
~7'
Concrete 6' height
9.5'
Crawl Space
Dirt Floor
wooden wall (Floor-ceiling)
PORCH
Approximate Groundhog Burrow
PORCH
6'
16'
20'
HILL STREET

Appendix F
Laboratory Analytical Report and Chain of Custody Form

AN ENVIRONMENTAL ANALYTICAL LABRATORY

10/31/2008

Mr. Kendall Pickett
Gannett Fleming
5433 Westheimer Road
Suite 725
Houston TX 77056-5312

Project Name: Ameren - Champaign
Project #: 050067

Dear Mr. Kendall Pickett

The following report includes the data for the above referenced project for sample(s) received on 10/18/2008 at Air Toxics Ltd.

The data and associated QC analyzed by Modified TO-15 are compliant with the project requirements or laboratory criteria with the exception of the deviations noted in the attached case narrative.

Thank you for choosing Air Toxics Ltd. for you air analysis needs. Air Toxics Ltd. is committed to providing accurate data of the highest quality. Please feel free to contact the Project Manager: Bryanna Langley at 916-985-1000 if you have any questions regarding the data in this report.

Regards,

Bryanna Langley
Project Manager

180 BLUE RAVINE ROAD, SUITE B FOLSOM, CA - 95630
(916) 985-1000 .FAX (916) 985-1020
Hours 8:00 A.M to 6:00 P.M. Pacific

AN ENVIRONMENTAL ANALYTICAL LABORATORY

WORK ORDER #: 0810427

Work Order Summary

CLIENT:	Mr. Kendall Pickett Gannett Fleming 5433 Westheimer Road Suite 725 Houston, TX 77056-5312	**BILL TO:**	Accounts Payable Gannett Fleming 4701 Mt. Hope Dr. Suite A Baltimore, MD 21215-1883
PHONE:	(713) 784-5151	**P.O. #**	050067.C
FAX:	(713) 784-6105	**PROJECT #**	050067 Ameren - Champaign
DATE RECEIVED:	10/18/2008	**CONTACT:**	Bryanna Langley
DATE COMPLETED:	10/31/2008		

FRACTION #	NAME	TEST	RECEIPT VAC./PRES.	FINAL PRESSURE
01A	VP507EWASH-1	Modified TO-15	6.0 "Hg	15 psi
01AA	VP507EWASH-1 Lab Duplicate	Modified TO-15	6.0 "Hg	15 psi
02A	VP505EWASH-1	Modified TO-15	6.0 "Hg	15 psi
03A	VP507EWASH-2	Modified TO-15	5.5 "Hg	15 psi
04A	VP507EWASH-F	Modified TO-15	5.0 "Hg	15 psi
05A	VP412EHILL-2	Modified TO-15	6.0 "Hg	15 psi
06A	VP505EWASH-2	Modified TO-15	6.0 "Hg	15 psi
07A	VP507EWASH-3	Modified TO-15	5.0 "Hg	15 psi
08A	VP412EHILL-3	Modified TO-15	6.0 "Hg	15 psi
09A	VP412EHILL-1	Modified TO-15	6.0 "Hg	15 psi
10A	VP507EWASH(AMBIENT)	Modified TO-15	6.0 "Hg	15 psi
11A	Lab Blank	Modified TO-15	NA	NA
12A	CCV	Modified TO-15	NA	NA
13A	LCS	Modified TO-15	NA	NA

CERTIFIED BY: Linda L. Freeman DATE: 10/31/08

Laboratory Director

Certfication numbers: CA NELAP - 02110CA, LA NELAP/LELAP- AI 30763, NJ NELAP - CA004
NY NELAP - 11291, UT NELAP - 9166389892, AZ Licensure AZ0719
Name of Accrediting Agency: NELAP/Florida Department of Health, Scope of Application: Clean Air Act,
Accreditation number: E87680, Effective date: 07/01/08, Expiration date: 06/30/09
Air Toxics Ltd. certifies that the test results contained in this report meet all requirements of the NELAC standards

180 BLUE RAVINE ROAD, SUITE B FOLSOM, CA - 95630
(916) 985-1000 . (800) 985-5955 . FAX (916) 985-1020

Air Toxics LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

LABORATORY NARRATIVE
Modified TO-15
Gannett Fleming
Workorder# 0810427

Seven 1 Liter Summa Canister, Two 1 Liter Summa Canister (100% Certified), and one 6 Liter Summa Canister samples were received on October 18, 2008. The laboratory performed analysis via modified EPA Method TO-15 using GC/MS in the full scan mode. The method involves concentrating up to 0.2 liters of air. The concentrated aliquot is then flash vaporized and swept through a water management system to remove water vapor. Following dehumidification, the sample passes directly into the GC/MS for analysis.

This workorder was independently validated prior to submittal using 'USEPA National Functional Guidelines' as generally applied to the analysis of volatile organic compounds in air. A rules-based, logic driven, independent validation engine was employed to assess completeness, evaluate pass/fail of relevant project quality control requirements and verification of all quantified amounts.

Method modifications taken to run these samples are summarized in the table below. Specific project requirements may over-ride the ATL modifications.

Requirement	*TO-15*	*ATL Modifications*
Daily CCV	</= 30% Difference	</= 30% Difference; Compounds exceeding this criterion and associated data are flagged and narrated.
Sample collection media	Summa canister	ATL recommends use of summa canisters to insure data defensibility, but will report results from Tedlar bags at client request
Method Detection Limit	Follow 40CFR Pt.136 App. B	The MDL met all relevant requirements in Method TO-15 (statistical MDL less than the LOQ). The concentration of the spiked replicate may have exceeded 10X the calculated MDL in some cases

Receiving Notes

There were no receiving discrepancies.

Analytical Notes

The reported CCV for each daily batch may be derived from more than one analytical file due to the client's request for non-standard compounds.

Non-standard compounds may have different acceptance criteria than the standard TO-14A/TO-15 compound list as per contract or verbal agreement.

Definition of Data Qualifying Flags

Eight qualifiers may have been used on the data analysis sheets and indicates as follows:

B - Compound present in laboratory blank greater than reporting limit (background subtraction no performed).

J - Estimated value.

E - Exceeds instrument calibration range.

S - Saturated peak.

Q - Exceeds quality control limits.

U - Compound analyzed for but not detected above the reporting limit.

UJ- Non-detected compound associated with low bias in the CCV

N - The identification is based on presumptive evidence.

File extensions may have been used on the data analysis sheets and indicates as follows:

a-File was requantified

b-File was quantified by a second column and detector

r1-File was requantified for the purpose of reissue

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Summary of Detected Compounds
MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

Client Sample ID: VP507EWASH-1

Lab ID#: 0810427-01A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
Ethanol	5.1	6.7	9.5	13
Acetone	5.1	50	12	120
2-Propanol	5.1	15	12	37
Hexane	1.3	2.3	4.4	8.0
2-Butanone (Methyl Ethyl Ketone)	1.3	7.0	3.7	21
2,2,4-Trimethylpentane	1.3	1.5	5.9	6.9
Benzene	1.3	2.5	4.0	8.0
Heptane	1.3	3.0	5.2	12
Toluene	1.3	40	4.8	150
Ethyl Benzene	1.3	10	5.5	44
m,p-Xylene	1.3	41	5.5	180
o-Xylene	1.3	19	5.5	83
Propylbenzene	1.3	5.6	6.2	27
4-Ethyltoluene	1.3	25	6.2	120
1,3,5-Trimethylbenzene	1.3	9.2	6.2	45
1,2,4-Trimethylbenzene	1.3	33	6.2	160
1,1-Difluoroethane	5.1	7.0	14	19

Client Sample ID: VP507EWASH-1 Lab Duplicate

Lab ID#: 0810427-01AA

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
Ethanol	5.1	6.4	9.5	12
Acetone	5.1	51	12	120
2-Propanol	5.1	16	12	38
Hexane	1.3	2.4	4.4	8.5
2-Butanone (Methyl Ethyl Ketone)	1.3	6.2	3.7	18
2,2,4-Trimethylpentane	1.3	1.6	5.9	7.7
Benzene	1.3	2.3	4.0	7.4
Heptane	1.3	3.1	5.2	13
Toluene	1.3	38	4.8	140
Ethyl Benzene	1.3	9.8	5.5	42
m,p-Xylene	1.3	41	5.5	180
o-Xylene	1.3	19	5.5	81
Propylbenzene	1.3	5.3	6.2	26
4-Ethyltoluene	1.3	23	6.2	110
1,3,5-Trimethylbenzene	1.3	8.4	6.2	41

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Summary of Detected Compounds
MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

Client Sample ID: VP507EWASH-1 Lab Duplicate

Lab ID#: 0810427-01AA

1,2,4-Trimethylbenzene	1.3	30	6.2	150
1,1-Difluoroethane	5.1	6.0	14	16

Client Sample ID: VP505EWASH-1

Lab ID#: 0810427-02A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
1,3-Butadiene	1.3	2.0	2.8	4.4
Ethanol	5.1	7.7	9.5	14
Acetone	5.1	51	12	120
Carbon Disulfide	1.3	2.4	3.9	7.6
Hexane	1.3	4.7	4.4	17
2-Butanone (Methyl Ethyl Ketone)	1.3	9.0	3.7	26
Cyclohexane	1.3	2.6	4.4	8.9
2,2,4-Trimethylpentane	1.3	3.1	5.9	14
Benzene	1.3	4.2	4.0	13
Heptane	1.3	4.6	5.2	19
Toluene	1.3	55	4.8	210
Ethyl Benzene	1.3	11	5.5	50
m,p-Xylene	1.3	43	5.5	190
o-Xylene	1.3	19	5.5	84
Cumene	1.3	1.3	6.2	6.6
Propylbenzene	1.3	4.8	6.2	24
4-Ethyltoluene	1.3	20	6.2	97
1,3,5-Trimethylbenzene	1.3	7.0	6.2	34
1,2,4-Trimethylbenzene	1.3	25	6.2	120

Client Sample ID: VP507EWASH-2

Lab ID#: 0810427-03A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
Freon 12	1.2	1.8	6.1	9.0
1,3-Butadiene	1.2	4.4	2.7	9.7
Ethanol	4.9	9.5	9.3	18
Acetone	4.9	78	12	180
2-Propanol	4.9	5.4	12	13
Carbon Disulfide	1.2	1.4	3.8	4.3
Hexane	1.2	4.0	4.4	14

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Summary of Detected Compounds
MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

Client Sample ID: VP507EWASH-2

Lab ID#: 0810427-03A

2-Butanone (Methyl Ethyl Ketone)	1.2	14	3.6	40
Cyclohexane	1.2	1.5	4.2	5.3
2,2,4-Trimethylpentane	1.2	2.4	5.8	11
Benzene	1.2	4.5	3.9	14
Heptane	1.2	4.8	5.1	20
Trichloroethene	1.2	1.4	6.6	7.3
Toluene	1.2	57	4.6	220
Ethyl Benzene	1.2	14	5.4	61
m,p-Xylene	1.2	56	5.4	240
o-Xylene	1.2	26	5.4	110
Cumene	1.2	1.7	6.1	8.3
Propylbenzene	1.2	6.9	6.1	34
4-Ethyltoluene	1.2	30	6.1	150
1,3,5-Trimethylbenzene	1.2	11	6.1	55
1,2,4-Trimethylbenzene	1.2	38	6.1	190
1,1-Difluoroethane	4.9	9.9	13	27

Client Sample ID: VP507EWASH-F

Lab ID#: 0810427-04A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
Freon 12	1.2	1.8	6.0	8.8
1,3-Butadiene	1.2	2.3	2.7	5.0
Ethanol	4.8	10	9.1	19
Acetone	4.8	76	11	180
Hexane	1.2	3.0	4.3	11
2-Butanone (Methyl Ethyl Ketone)	1.2	11	3.6	34
Cyclohexane	1.2	1.2	4.2	4.2
2,2,4-Trimethylpentane	1.2	1.9	5.6	8.9
Benzene	1.2	3.0	3.9	9.7
Heptane	1.2	3.2	5.0	13
Toluene	1.2	40	4.6	150
Ethyl Benzene	1.2	12	5.2	51
m,p-Xylene	1.2	49	5.2	210
o-Xylene	1.2	22	5.2	98
Cumene	1.2	1.4	5.9	7.0
Propylbenzene	1.2	7.0	5.9	34
4-Ethyltoluene	1.2	31	5.9	150
1,3,5-Trimethylbenzene	1.2	12	5.9	59

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Summary of Detected Compounds
MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

Client Sample ID: VP507EWASH-F

Lab ID#: 0810427-04A

1,2,4-Trimethylbenzene	1.2	43	5.9	210
1,1-Difluoroethane	4.8	7.3	13	20

Client Sample ID: VP412EHILL-2

Lab ID#: 0810427-05A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
1,3-Butadiene	1.3	1.3	2.8	2.9
Ethanol	5.1	9.2	9.5	17
Acetone	5.1	45	12	110
2-Propanol	5.1	20	12	50
Hexane	1.3	2.1	4.4	7.3
2-Butanone (Methyl Ethyl Ketone)	1.3	6.2	3.7	18
2,2,4-Trimethylpentane	1.3	1.5	5.9	7.2
Benzene	1.3	1.8	4.0	5.9
Heptane	1.3	1.8	5.2	7.6
Toluene	1.3	23	4.8	86
Ethyl Benzene	1.3	6.6	5.5	28
m,p-Xylene	1.3	28	5.5	120
o-Xylene	1.3	12	5.5	54
Propylbenzene	1.3	4.0	6.2	20
4-Ethyltoluene	1.3	17	6.2	83
1,3,5-Trimethylbenzene	1.3	8.5	6.2	42
1,2,4-Trimethylbenzene	1.3	25	6.2	120

Client Sample ID: VP505EWASH-2

Lab ID#: 0810427-06A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
1,3-Butadiene	1.3	4.2	2.8	9.4
Ethanol	5.1	10	9.5	20
Acetone	5.1	69	12	160
2-Propanol	5.1	19	12	46
Hexane	1.3	3.8	4.4	14
2-Butanone (Methyl Ethyl Ketone)	1.3	14	3.7	43
Cyclohexane	1.3	1.4	4.4	4.8
2,2,4-Trimethylpentane	1.3	2.1	5.9	10
Benzene	1.3	3.3	4.0	10

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Summary of Detected Compounds
MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

Client Sample ID: VP505EWASH-2

Lab ID#: 0810427-06A

Heptane	1.3	4.2	5.2	17
Toluene	1.3	53	4.8	200
Ethyl Benzene	1.3	11	5.5	50
m,p-Xylene	1.3	46	5.5	200
o-Xylene	1.3	20	5.5	89
Propylbenzene	1.3	5.2	6.2	26
4-Ethyltoluene	1.3	21	6.2	100
1,3,5-Trimethylbenzene	1.3	10	6.2	52
1,2,4-Trimethylbenzene	1.3	28	6.2	140

Client Sample ID: VP507EWASH-3

Lab ID#: 0810427-07A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
1,3-Butadiene	1.2	1.8	2.7	4.0
Ethanol	4.8	16	9.1	29
Acetone	4.8	96	11	230
2-Propanol	4.8	6.6	12	16
Hexane	1.2	4.0	4.3	14
2-Butanone (Methyl Ethyl Ketone)	1.2	19	3.6	56
Cyclohexane	1.2	1.8	4.2	6.1
2,2,4-Trimethylpentane	1.2	3.2	5.6	15
Benzene	1.2	3.2	3.9	10
Heptane	1.2	4.7	5.0	19
4-Methyl-2-pentanone	1.2	1.3	5.0	5.4
Toluene	1.2	46	4.6	170
Ethyl Benzene	1.2	13	5.2	57
m,p-Xylene	1.2	52	5.2	230
o-Xylene	1.2	25	5.2	110
Cumene	1.2	1.6	5.9	7.9
Propylbenzene	1.2	7.0	5.9	34
4-Ethyltoluene	1.2	28	5.9	140
1,3,5-Trimethylbenzene	1.2	16	5.9	76
1,2,4-Trimethylbenzene	1.2	42	5.9	210

Client Sample ID: VP412EHILL-3

Lab ID#: 0810427-08A

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Summary of Detected Compounds
MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

Client Sample ID: VP412EHILL-3

Lab ID#: 0810427-08A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
1,3-Butadiene	1.3	11	2.8	25
Ethanol	5.1	150	9.5	280
Acetone	5.1	240	12	580
2-Propanol	5.1	41	12	100
Hexane	1.3	5.8	4.4	20
2-Butanone (Methyl Ethyl Ketone)	1.3	45	3.7	130
Cyclohexane	1.3	1.7	4.4	5.9
2,2,4-Trimethylpentane	1.3	2.8	5.9	13
Benzene	1.3	4.2	4.0	14
Heptane	1.3	5.2	5.2	21
4-Methyl-2-pentanone	1.3	1.6	5.2	6.5
Toluene	1.3	52	4.8	190
Ethyl Benzene	1.3	12	5.5	52
m,p-Xylene	1.3	48	5.5	210
o-Xylene	1.3	22	5.5	94
Cumene	1.3	1.5	6.2	7.2
Propylbenzene	1.3	6.1	6.2	30
4-Ethyltoluene	1.3	26	6.2	130
1,3,5-Trimethylbenzene	1.3	9.1	6.2	45
1,2,4-Trimethylbenzene	1.3	33	6.2	160
1,1-Difluoroethane	5.1	10	14	27

Client Sample ID: VP412EHILL-1

Lab ID#: 0810427-09A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
1,3-Butadiene	1.3	4.1	2.8	9.2
Ethanol	5.1	26	9.5	50
Acetone	5.1	96	12	230
2-Propanol	5.1	5.8	12	14
Hexane	1.3	2.7	4.4	9.5
2-Butanone (Methyl Ethyl Ketone)	1.3	16	3.7	47
2,2,4-Trimethylpentane	1.3	1.7	5.9	8.1
Benzene	1.3	2.6	4.0	8.5
Heptane	1.3	2.5	5.2	10
Toluene	1.3	32	4.8	120
Ethyl Benzene	1.3	9.1	5.5	40

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Summary of Detected Compounds
MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

Client Sample ID: VP412EHILL-1

Lab ID#: 0810427-09A

m,p-Xylene	1.3	38	5.5	160
o-Xylene	1.3	18	5.5	77
Propylbenzene	1.3	5.1	6.2	25
4-Ethyltoluene	1.3	22	6.2	100
1,3,5-Trimethylbenzene	1.3	11	6.2	56
1,2,4-Trimethylbenzene	1.3	32	6.2	160
1,1-Difluoroethane	5.1	5.4	14	15

Client Sample ID: VP507EWASH(AMBIENT)

Lab ID#: 0810427-10A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
Acetone	5.1	6.6	12	16
2-Propanol	5.1	9.3	12	23
Ethanol	5.1	6.0	9.5	11

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: VP507EWASH-1

Lab ID#: 0810427-01A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**5102908**	**Date of Collection: 10/15/08**
Dil. Factor:	**2.53**	**Date of Analysis: 10/29/08 02:20 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
Freon 12	1.3	Not Detected	6.2	Not Detected
Freon 114	1.3	Not Detected	8.8	Not Detected
Chloromethane	5.1	Not Detected	10	Not Detected
Vinyl Chloride	1.3	Not Detected	3.2	Not Detected
1,3-Butadiene	1.3	Not Detected	2.8	Not Detected
Bromomethane	1.3	Not Detected	4.9	Not Detected
Chloroethane	1.3	Not Detected	3.3	Not Detected
Freon 11	1.3	Not Detected	7.1	Not Detected
Ethanol	5.1	6.7	9.5	13
Freon 113	1.3	Not Detected	9.7	Not Detected
1,1-Dichloroethene	1.3	Not Detected	5.0	Not Detected
Acetone	5.1	50	12	120
2-Propanol	5.1	15	12	37
Carbon Disulfide	1.3	Not Detected	3.9	Not Detected
3-Chloropropene	5.1	Not Detected	16	Not Detected
Methylene Chloride	1.3	Not Detected	4.4	Not Detected
Methyl tert-butyl ether	1.3	Not Detected	4.6	Not Detected
trans-1,2-Dichloroethene	1.3	Not Detected	5.0	Not Detected
Hexane	1.3	2.3	4.4	8.0
1,1-Dichloroethane	1.3	Not Detected	5.1	Not Detected
2-Butanone (Methyl Ethyl Ketone)	1.3	7.0	3.7	21
cis-1,2-Dichloroethene	1.3	Not Detected	5.0	Not Detected
Tetrahydrofuran	1.3	Not Detected	3.7	Not Detected
Chloroform	1.3	Not Detected	6.2	Not Detected
1,1,1-Trichloroethane	1.3	Not Detected	6.9	Not Detected
Cyclohexane	1.3	Not Detected	4.4	Not Detected
Carbon Tetrachloride	1.3	Not Detected	8.0	Not Detected
2,2,4-Trimethylpentane	1.3	1.5	5.9	6.9
Benzene	1.3	2.5	4.0	8.0
1,2-Dichloroethane	1.3	Not Detected	5.1	Not Detected
Heptane	1.3	3.0	5.2	12
Trichloroethene	1.3	Not Detected	6.8	Not Detected
1,2-Dichloropropane	1.3	Not Detected	5.8	Not Detected
1,4-Dioxane	5.1	Not Detected	18	Not Detected
Bromodichloromethane	1.3	Not Detected	8.5	Not Detected
cis-1,3-Dichloropropene	1.3	Not Detected	5.7	Not Detected
4-Methyl-2-pentanone	1.3	Not Detected	5.2	Not Detected
Toluene	1.3	40	4.8	150
trans-1,3-Dichloropropene	1.3	Not Detected	5.7	Not Detected

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: VP507EWASH-1

Lab ID#: 0810427-01A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**5102908**	**Date of Collection:**	**10/15/08**
Dil. Factor:	**2.53**	**Date of Analysis:**	**10/29/08 02:20 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
1,1,2-Trichloroethane	1.3	Not Detected	6.9	Not Detected
Tetrachloroethene	1.3	Not Detected	8.6	Not Detected
2-Hexanone	5.1	Not Detected	21	Not Detected
Dibromochloromethane	1.3	Not Detected	11	Not Detected
1,2-Dibromoethane (EDB)	1.3	Not Detected	9.7	Not Detected
Chlorobenzene	1.3	Not Detected	5.8	Not Detected
Ethyl Benzene	1.3	10	5.5	44
m,p-Xylene	1.3	41	5.5	180
o-Xylene	1.3	19	5.5	83
Styrene	1.3	Not Detected	5.4	Not Detected
Bromoform	1.3	Not Detected	13	Not Detected
Cumene	1.3	Not Detected	6.2	Not Detected
1,1,2,2-Tetrachloroethane	1.3	Not Detected	8.7	Not Detected
Propylbenzene	1.3	5.6	6.2	27
4-Ethyltoluene	1.3	25	6.2	120
1,3,5-Trimethylbenzene	1.3	9.2	6.2	45
1,2,4-Trimethylbenzene	1.3	33	6.2	160
1,3-Dichlorobenzene	1.3	Not Detected	7.6	Not Detected
1,4-Dichlorobenzene	1.3	Not Detected	7.6	Not Detected
alpha-Chlorotoluene	1.3	Not Detected	6.5	Not Detected
1,2-Dichlorobenzene	1.3	Not Detected	7.6	Not Detected
1,2,4-Trichlorobenzene	5.1	Not Detected	38	Not Detected
Hexachlorobutadiene	5.1	Not Detected	54	Not Detected
Naphthalene	5.1	Not Detected	26	Not Detected
1,1-Difluoroethane	5.1	7.0	14	19

Container Type: 1 Liter Summa Canister

Surrogates	%Recovery	Method Limits
Toluene-d8	100	70-130
1,2-Dichloroethane-d4	121	70-130
4-Bromofluorobenzene	117	70-130

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: VP507EWASH-1 Lab Duplicate

Lab ID#: 0810427-01AA

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**5102909**	**Date of Collection: 10/15/08**
Dil. Factor:	**2.53**	**Date of Analysis: 10/29/08 03:01 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
Freon 12	1.3	Not Detected	6.2	Not Detected
Freon 114	1.3	Not Detected	8.8	Not Detected
Chloromethane	5.1	Not Detected	10	Not Detected
Vinyl Chloride	1.3	Not Detected	3.2	Not Detected
1,3-Butadiene	1.3	Not Detected	2.8	Not Detected
Bromomethane	1.3	Not Detected	4.9	Not Detected
Chloroethane	1.3	Not Detected	3.3	Not Detected
Freon 11	1.3	Not Detected	7.1	Not Detected
Ethanol	5.1	6.4	9.5	12
Freon 113	1.3	Not Detected	9.7	Not Detected
1,1-Dichloroethene	1.3	Not Detected	5.0	Not Detected
Acetone	5.1	51	12	120
2-Propanol	5.1	16	12	38
Carbon Disulfide	1.3	Not Detected	3.9	Not Detected
3-Chloropropene	5.1	Not Detected	16	Not Detected
Methylene Chloride	1.3	Not Detected	4.4	Not Detected
Methyl tert-butyl ether	1.3	Not Detected	4.6	Not Detected
trans-1,2-Dichloroethene	1.3	Not Detected	5.0	Not Detected
Hexane	1.3	2.4	4.4	8.5
1,1-Dichloroethane	1.3	Not Detected	5.1	Not Detected
2-Butanone (Methyl Ethyl Ketone)	1.3	6.2	3.7	18
cis-1,2-Dichloroethene	1.3	Not Detected	5.0	Not Detected
Tetrahydrofuran	1.3	Not Detected	3.7	Not Detected
Chloroform	1.3	Not Detected	6.2	Not Detected
1,1,1-Trichloroethane	1.3	Not Detected	6.9	Not Detected
Cyclohexane	1.3	Not Detected	4.4	Not Detected
Carbon Tetrachloride	1.3	Not Detected	8.0	Not Detected
2,2,4-Trimethylpentane	1.3	1.6	5.9	7.7
Benzene	1.3	2.3	4.0	7.4
1,2-Dichloroethane	1.3	Not Detected	5.1	Not Detected
Heptane	1.3	3.1	5.2	13
Trichloroethene	1.3	Not Detected	6.8	Not Detected
1,2-Dichloropropane	1.3	Not Detected	5.8	Not Detected
1,4-Dioxane	5.1	Not Detected	18	Not Detected
Bromodichloromethane	1.3	Not Detected	8.5	Not Detected
cis-1,3-Dichloropropene	1.3	Not Detected	5.7	Not Detected
4-Methyl-2-pentanone	1.3	Not Detected	5.2	Not Detected
Toluene	1.3	38	4.8	140
trans-1,3-Dichloropropene	1.3	Not Detected	5.7	Not Detected

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: VP507EWASH-1 Lab Duplicate

Lab ID#: 0810427-01AA

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**5102909**	**Date of Collection: 10/15/08**
Dil. Factor:	**2.53**	**Date of Analysis: 10/29/08 03:01 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
1,1,2-Trichloroethane	1.3	Not Detected	6.9	Not Detected
Tetrachloroethene	1.3	Not Detected	8.6	Not Detected
2-Hexanone	5.1	Not Detected	21	Not Detected
Dibromochloromethane	1.3	Not Detected	11	Not Detected
1,2-Dibromoethane (EDB)	1.3	Not Detected	9.7	Not Detected
Chlorobenzene	1.3	Not Detected	5.8	Not Detected
Ethyl Benzene	1.3	9.8	5.5	42
m,p-Xylene	1.3	41	5.5	180
o-Xylene	1.3	19	5.5	81
Styrene	1.3	Not Detected	5.4	Not Detected
Bromoform	1.3	Not Detected	13	Not Detected
Cumene	1.3	Not Detected	6.2	Not Detected
1,1,2,2-Tetrachloroethane	1.3	Not Detected	8.7	Not Detected
Propylbenzene	1.3	5.3	6.2	26
4-Ethyltoluene	1.3	23	6.2	110
1,3,5-Trimethylbenzene	1.3	8.4	6.2	41
1,2,4-Trimethylbenzene	1.3	30	6.2	150
1,3-Dichlorobenzene	1.3	Not Detected	7.6	Not Detected
1,4-Dichlorobenzene	1.3	Not Detected	7.6	Not Detected
alpha-Chlorotoluene	1.3	Not Detected	6.5	Not Detected
1,2-Dichlorobenzene	1.3	Not Detected	7.6	Not Detected
1,2,4-Trichlorobenzene	5.1	Not Detected	38	Not Detected
Hexachlorobutadiene	5.1	Not Detected	54	Not Detected
Naphthalene	5.1	Not Detected	26	Not Detected
1,1-Difluoroethane	5.1	6.0	14	16

Container Type: 1 Liter Summa Canister

Surrogates	%Recovery	Method Limits
Toluene-d8	100	70-130
1,2-Dichloroethane-d4	120	70-130
4-Bromofluorobenzene	109	70-130

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: VP505EWASH-1

Lab ID#: 0810427-02A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**5102910**	**Date of Collection: 10/15/08**
Dil. Factor:	**2.53**	**Date of Analysis: 10/29/08 03:42 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
Freon 12	1.3	Not Detected	6.2	Not Detected
Freon 114	1.3	Not Detected	8.8	Not Detected
Chloromethane	5.1	Not Detected	10	Not Detected
Vinyl Chloride	1.3	Not Detected	3.2	Not Detected
1,3-Butadiene	1.3	2.0	2.8	4.4
Bromomethane	1.3	Not Detected	4.9	Not Detected
Chloroethane	1.3	Not Detected	3.3	Not Detected
Freon 11	1.3	Not Detected	7.1	Not Detected
Ethanol	5.1	7.7	9.5	14
Freon 113	1.3	Not Detected	9.7	Not Detected
1,1-Dichloroethene	1.3	Not Detected	5.0	Not Detected
Acetone	5.1	51	12	120
2-Propanol	5.1	Not Detected	12	Not Detected
Carbon Disulfide	1.3	2.4	3.9	7.6
3-Chloropropene	5.1	Not Detected	16	Not Detected
Methylene Chloride	1.3	Not Detected	4.4	Not Detected
Methyl tert-butyl ether	1.3	Not Detected	4.6	Not Detected
trans-1,2-Dichloroethene	1.3	Not Detected	5.0	Not Detected
Hexane	1.3	4.7	4.4	17
1,1-Dichloroethane	1.3	Not Detected	5.1	Not Detected
2-Butanone (Methyl Ethyl Ketone)	1.3	9.0	3.7	26
cis-1,2-Dichloroethene	1.3	Not Detected	5.0	Not Detected
Tetrahydrofuran	1.3	Not Detected	3.7	Not Detected
Chloroform	1.3	Not Detected	6.2	Not Detected
1,1,1-Trichloroethane	1.3	Not Detected	6.9	Not Detected
Cyclohexane	1.3	2.6	4.4	8.9
Carbon Tetrachloride	1.3	Not Detected	8.0	Not Detected
2,2,4-Trimethylpentane	1.3	3.1	5.9	14
Benzene	1.3	4.2	4.0	13
1,2-Dichloroethane	1.3	Not Detected	5.1	Not Detected
Heptane	1.3	4.6	5.2	19
Trichloroethene	1.3	Not Detected	6.8	Not Detected
1,2-Dichloropropane	1.3	Not Detected	5.8	Not Detected
1,4-Dioxane	5.1	Not Detected	18	Not Detected
Bromodichloromethane	1.3	Not Detected	8.5	Not Detected
cis-1,3-Dichloropropene	1.3	Not Detected	5.7	Not Detected
4-Methyl-2-pentanone	1.3	Not Detected	5.2	Not Detected
Toluene	1.3	55	4.8	210
trans-1,3-Dichloropropene	1.3	Not Detected	5.7	Not Detected

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: VP505EWASH-1

Lab ID#: 0810427-02A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**5102910**	**Date of Collection: 10/15/08**
Dil. Factor:	**2.53**	**Date of Analysis: 10/29/08 03:42 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
1,1,2-Trichloroethane	1.3	Not Detected	6.9	Not Detected
Tetrachloroethene	1.3	Not Detected	8.6	Not Detected
2-Hexanone	5.1	Not Detected	21	Not Detected
Dibromochloromethane	1.3	Not Detected	11	Not Detected
1,2-Dibromoethane (EDB)	1.3	Not Detected	9.7	Not Detected
Chlorobenzene	1.3	Not Detected	5.8	Not Detected
Ethyl Benzene	1.3	11	5.5	50
m,p-Xylene	1.3	43	5.5	190
o-Xylene	1.3	19	5.5	84
Styrene	1.3	Not Detected	5.4	Not Detected
Bromoform	1.3	Not Detected	13	Not Detected
Cumene	1.3	1.3	6.2	6.6
1,1,2,2-Tetrachloroethane	1.3	Not Detected	8.7	Not Detected
Propylbenzene	1.3	4.8	6.2	24
4-Ethyltoluene	1.3	20	6.2	97
1,3,5-Trimethylbenzene	1.3	7.0	6.2	34
1,2,4-Trimethylbenzene	1.3	25	6.2	120
1,3-Dichlorobenzene	1.3	Not Detected	7.6	Not Detected
1,4-Dichlorobenzene	1.3	Not Detected	7.6	Not Detected
alpha-Chlorotoluene	1.3	Not Detected	6.5	Not Detected
1,2-Dichlorobenzene	1.3	Not Detected	7.6	Not Detected
1,2,4-Trichlorobenzene	5.1	Not Detected	38	Not Detected
Hexachlorobutadiene	5.1	Not Detected	54	Not Detected
Naphthalene	5.1	Not Detected	26	Not Detected
1,1-Difluoroethane	5.1	Not Detected	14	Not Detected

Container Type: 1 Liter Summa Canister

Surrogates	%Recovery	Method Limits
Toluene-d8	99	70-130
1,2-Dichloroethane-d4	124	70-130
4-Bromofluorobenzene	110	70-130

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: VP507EWASH-2

Lab ID#: 0810427-03A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**5102911**	**Date of Collection: 10/15/08**
Dil. Factor:	**2.47**	**Date of Analysis: 10/29/08 04:24 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
Freon 12	1.2	1.8	6.1	9.0
Freon 114	1.2	Not Detected	8.6	Not Detected
Chloromethane	4.9	Not Detected	10	Not Detected
Vinyl Chloride	1.2	Not Detected	3.2	Not Detected
1,3-Butadiene	1.2	4.4	2.7	9.7
Bromomethane	1.2	Not Detected	4.8	Not Detected
Chloroethane	1.2	Not Detected	3.2	Not Detected
Freon 11	1.2	Not Detected	6.9	Not Detected
Ethanol	4.9	9.5	9.3	18
Freon 113	1.2	Not Detected	9.5	Not Detected
1,1-Dichloroethene	1.2	Not Detected	4.9	Not Detected
Acetone	4.9	78	12	180
2-Propanol	4.9	5.4	12	13
Carbon Disulfide	1.2	1.4	3.8	4.3
3-Chloropropene	4.9	Not Detected	15	Not Detected
Methylene Chloride	1.2	Not Detected	4.3	Not Detected
Methyl tert-butyl ether	1.2	Not Detected	4.4	Not Detected
trans-1,2-Dichloroethene	1.2	Not Detected	4.9	Not Detected
Hexane	1.2	4.0	4.4	14
1,1-Dichloroethane	1.2	Not Detected	5.0	Not Detected
2-Butanone (Methyl Ethyl Ketone)	1.2	14	3.6	40
cis-1,2-Dichloroethene	1.2	Not Detected	4.9	Not Detected
Tetrahydrofuran	1.2	Not Detected	3.6	Not Detected
Chloroform	1.2	Not Detected	6.0	Not Detected
1,1,1-Trichloroethane	1.2	Not Detected	6.7	Not Detected
Cyclohexane	1.2	1.5	4.2	5.3
Carbon Tetrachloride	1.2	Not Detected	7.8	Not Detected
2,2,4-Trimethylpentane	1.2	2.4	5.8	11
Benzene	1.2	4.5	3.9	14
1,2-Dichloroethane	1.2	Not Detected	5.0	Not Detected
Heptane	1.2	4.8	5.1	20
Trichloroethene	1.2	1.4	6.6	7.3
1,2-Dichloropropane	1.2	Not Detected	5.7	Not Detected
1,4-Dioxane	4.9	Not Detected	18	Not Detected
Bromodichloromethane	1.2	Not Detected	8.3	Not Detected
cis-1,3-Dichloropropene	1.2	Not Detected	5.6	Not Detected
4-Methyl-2-pentanone	1.2	Not Detected	5.0	Not Detected
Toluene	1.2	57	4.6	220
trans-1,3-Dichloropropene	1.2	Not Detected	5.6	Not Detected

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: VP507EWASH-2

Lab ID#: 0810427-03A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**5102911**	**Date of Collection: 10/15/08**
Dil. Factor:	**2.47**	**Date of Analysis: 10/29/08 04:24 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
1,1,2-Trichloroethane	1.2	Not Detected	6.7	Not Detected
Tetrachloroethene	1.2	Not Detected	8.4	Not Detected
2-Hexanone	4.9	Not Detected	20	Not Detected
Dibromochloromethane	1.2	Not Detected	10	Not Detected
1,2-Dibromoethane (EDB)	1.2	Not Detected	9.5	Not Detected
Chlorobenzene	1.2	Not Detected	5.7	Not Detected
Ethyl Benzene	1.2	14	5.4	61
m,p-Xylene	1.2	56	5.4	240
o-Xylene	1.2	26	5.4	110
Styrene	1.2	Not Detected	5.3	Not Detected
Bromoform	1.2	Not Detected	13	Not Detected
Cumene	1.2	1.7	6.1	8.3
1,1,2,2-Tetrachloroethane	1.2	Not Detected	8.5	Not Detected
Propylbenzene	1.2	6.9	6.1	34
4-Ethyltoluene	1.2	30	6.1	150
1,3,5-Trimethylbenzene	1.2	11	6.1	55
1,2,4-Trimethylbenzene	1.2	38	6.1	190
1,3-Dichlorobenzene	1.2	Not Detected	7.4	Not Detected
1,4-Dichlorobenzene	1.2	Not Detected	7.4	Not Detected
alpha-Chlorotoluene	1.2	Not Detected	6.4	Not Detected
1,2-Dichlorobenzene	1.2	Not Detected	7.4	Not Detected
1,2,4-Trichlorobenzene	4.9	Not Detected	37	Not Detected
Hexachlorobutadiene	4.9	Not Detected	53	Not Detected
Naphthalene	4.9	Not Detected	26	Not Detected
1,1-Difluoroethane	4.9	9.9	13	27

Container Type: 1 Liter Summa Canister (100% Certified)

Surrogates	%Recovery	Method Limits
Toluene-d8	101	70-130
1,2-Dichloroethane-d4	116	70-130
4-Bromofluorobenzene	106	70-130

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: VP507EWASH-F

Lab ID#: 0810427-04A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**5102912**	**Date of Collection: 10/15/08**
Dil. Factor:	**2.42**	**Date of Analysis: 10/29/08 05:05 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
Freon 12	1.2	1.8	6.0	8.8
Freon 114	1.2	Not Detected	8.4	Not Detected
Chloromethane	4.8	Not Detected	10	Not Detected
Vinyl Chloride	1.2	Not Detected	3.1	Not Detected
1,3-Butadiene	1.2	2.3	2.7	5.0
Bromomethane	1.2	Not Detected	4.7	Not Detected
Chloroethane	1.2	Not Detected	3.2	Not Detected
Freon 11	1.2	Not Detected	6.8	Not Detected
Ethanol	4.8	10	9.1	19
Freon 113	1.2	Not Detected	9.3	Not Detected
1,1-Dichloroethene	1.2	Not Detected	4.8	Not Detected
Acetone	4.8	76	11	180
2-Propanol	4.8	Not Detected	12	Not Detected
Carbon Disulfide	1.2	Not Detected	3.8	Not Detected
3-Chloropropene	4.8	Not Detected	15	Not Detected
Methylene Chloride	1.2	Not Detected	4.2	Not Detected
Methyl tert-butyl ether	1.2	Not Detected	4.4	Not Detected
trans-1,2-Dichloroethene	1.2	Not Detected	4.8	Not Detected
Hexane	1.2	3.0	4.3	11
1,1-Dichloroethane	1.2	Not Detected	4.9	Not Detected
2-Butanone (Methyl Ethyl Ketone)	1.2	11	3.6	34
cis-1,2-Dichloroethene	1.2	Not Detected	4.8	Not Detected
Tetrahydrofuran	1.2	Not Detected	3.6	Not Detected
Chloroform	1.2	Not Detected	5.9	Not Detected
1,1,1-Trichloroethane	1.2	Not Detected	6.6	Not Detected
Cyclohexane	1.2	1.2	4.2	4.2
Carbon Tetrachloride	1.2	Not Detected	7.6	Not Detected
2,2,4-Trimethylpentane	1.2	1.9	5.6	8.9
Benzene	1.2	3.0	3.9	9.7
1,2-Dichloroethane	1.2	Not Detected	4.9	Not Detected
Heptane	1.2	3.2	5.0	13
Trichloroethene	1.2	Not Detected	6.5	Not Detected
1,2-Dichloropropane	1.2	Not Detected	5.6	Not Detected
1,4-Dioxane	4.8	Not Detected	17	Not Detected
Bromodichloromethane	1.2	Not Detected	8.1	Not Detected
cis-1,3-Dichloropropene	1.2	Not Detected	5.5	Not Detected
4-Methyl-2-pentanone	1.2	Not Detected	5.0	Not Detected
Toluene	1.2	40	4.6	150
trans-1,3-Dichloropropene	1.2	Not Detected	5.5	Not Detected

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: VP507EWASH-F

Lab ID#: 0810427-04A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**5102912**	**Date of Collection:**	**10/15/08**
Dil. Factor:	**2.42**	**Date of Analysis:**	**10/29/08 05:05 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
1,1,2-Trichloroethane	1.2	Not Detected	6.6	Not Detected
Tetrachloroethene	1.2	Not Detected	8.2	Not Detected
2-Hexanone	4.8	Not Detected	20	Not Detected
Dibromochloromethane	1.2	Not Detected	10	Not Detected
1,2-Dibromoethane (EDB)	1.2	Not Detected	9.3	Not Detected
Chlorobenzene	1.2	Not Detected	5.6	Not Detected
Ethyl Benzene	1.2	12	5.2	51
m,p-Xylene	1.2	49	5.2	210
o-Xylene	1.2	22	5.2	98
Styrene	1.2	Not Detected	5.2	Not Detected
Bromoform	1.2	Not Detected	12	Not Detected
Cumene	1.2	1.4	5.9	7.0
1,1,2,2-Tetrachloroethane	1.2	Not Detected	8.3	Not Detected
Propylbenzene	1.2	7.0	5.9	34
4-Ethyltoluene	1.2	31	5.9	150
1,3,5-Trimethylbenzene	1.2	12	5.9	59
1,2,4-Trimethylbenzene	1.2	43	5.9	210
1,3-Dichlorobenzene	1.2	Not Detected	7.3	Not Detected
1,4-Dichlorobenzene	1.2	Not Detected	7.3	Not Detected
alpha-Chlorotoluene	1.2	Not Detected	6.3	Not Detected
1,2-Dichlorobenzene	1.2	Not Detected	7.3	Not Detected
1,2,4-Trichlorobenzene	4.8	Not Detected	36	Not Detected
Hexachlorobutadiene	4.8	Not Detected	52	Not Detected
Naphthalene	4.8	Not Detected	25	Not Detected
1,1-Difluoroethane	4.8	7.3	13	20

Container Type: 1 Liter Summa Canister

Surrogates	%Recovery	Method Limits
Toluene-d8	98	70-130
1,2-Dichloroethane-d4	118	70-130
4-Bromofluorobenzene	111	70-130

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: VP412EHILL-2

Lab ID#: 0810427-05A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**5102913**	**Date of Collection: 10/15/08**
Dil. Factor:	**2.53**	**Date of Analysis: 10/29/08 05:46 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
Freon 12	1.3	Not Detected	6.2	Not Detected
Freon 114	1.3	Not Detected	8.8	Not Detected
Chloromethane	5.1	Not Detected	10	Not Detected
Vinyl Chloride	1.3	Not Detected	3.2	Not Detected
1,3-Butadiene	1.3	1.3	2.8	2.9
Bromomethane	1.3	Not Detected	4.9	Not Detected
Chloroethane	1.3	Not Detected	3.3	Not Detected
Freon 11	1.3	Not Detected	7.1	Not Detected
Ethanol	5.1	9.2	9.5	17
Freon 113	1.3	Not Detected	9.7	Not Detected
1,1-Dichloroethene	1.3	Not Detected	5.0	Not Detected
Acetone	5.1	45	12	110
2-Propanol	5.1	20	12	50
Carbon Disulfide	1.3	Not Detected	3.9	Not Detected
3-Chloropropene	5.1	Not Detected	16	Not Detected
Methylene Chloride	1.3	Not Detected	4.4	Not Detected
Methyl tert-butyl ether	1.3	Not Detected	4.6	Not Detected
trans-1,2-Dichloroethene	1.3	Not Detected	5.0	Not Detected
Hexane	1.3	2.1	4.4	7.3
1,1-Dichloroethane	1.3	Not Detected	5.1	Not Detected
2-Butanone (Methyl Ethyl Ketone)	1.3	6.2	3.7	18
cis-1,2-Dichloroethene	1.3	Not Detected	5.0	Not Detected
Tetrahydrofuran	1.3	Not Detected	3.7	Not Detected
Chloroform	1.3	Not Detected	6.2	Not Detected
1,1,1-Trichloroethane	1.3	Not Detected	6.9	Not Detected
Cyclohexane	1.3	Not Detected	4.4	Not Detected
Carbon Tetrachloride	1.3	Not Detected	8.0	Not Detected
2,2,4-Trimethylpentane	1.3	1.5	5.9	7.2
Benzene	1.3	1.8	4.0	5.9
1,2-Dichloroethane	1.3	Not Detected	5.1	Not Detected
Heptane	1.3	1.8	5.2	7.6
Trichloroethene	1.3	Not Detected	6.8	Not Detected
1,2-Dichloropropane	1.3	Not Detected	5.8	Not Detected
1,4-Dioxane	5.1	Not Detected	18	Not Detected
Bromodichloromethane	1.3	Not Detected	8.5	Not Detected
cis-1,3-Dichloropropene	1.3	Not Detected	5.7	Not Detected
4-Methyl-2-pentanone	1.3	Not Detected	5.2	Not Detected
Toluene	1.3	23	4.8	86
trans-1,3-Dichloropropene	1.3	Not Detected	5.7	Not Detected

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: VP412EHILL-2

Lab ID#: 0810427-05A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**5102913**	**Date of Collection: 10/15/08**
Dil. Factor:	**2.53**	**Date of Analysis: 10/29/08 05:46 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
1,1,2-Trichloroethane	1.3	Not Detected	6.9	Not Detected
Tetrachloroethene	1.3	Not Detected	8.6	Not Detected
2-Hexanone	5.1	Not Detected	21	Not Detected
Dibromochloromethane	1.3	Not Detected	11	Not Detected
1,2-Dibromoethane (EDB)	1.3	Not Detected	9.7	Not Detected
Chlorobenzene	1.3	Not Detected	5.8	Not Detected
Ethyl Benzene	1.3	6.6	5.5	28
m,p-Xylene	1.3	28	5.5	120
o-Xylene	1.3	12	5.5	54
Styrene	1.3	Not Detected	5.4	Not Detected
Bromoform	1.3	Not Detected	13	Not Detected
Cumene	1.3	Not Detected	6.2	Not Detected
1,1,2,2-Tetrachloroethane	1.3	Not Detected	8.7	Not Detected
Propylbenzene	1.3	4.0	6.2	20
4-Ethyltoluene	1.3	17	6.2	83
1,3,5-Trimethylbenzene	1.3	8.5	6.2	42
1,2,4-Trimethylbenzene	1.3	25	6.2	120
1,3-Dichlorobenzene	1.3	Not Detected	7.6	Not Detected
1,4-Dichlorobenzene	1.3	Not Detected	7.6	Not Detected
alpha-Chlorotoluene	1.3	Not Detected	6.5	Not Detected
1,2-Dichlorobenzene	1.3	Not Detected	7.6	Not Detected
1,2,4-Trichlorobenzene	5.1	Not Detected	38	Not Detected
Hexachlorobutadiene	5.1	Not Detected	54	Not Detected
Naphthalene	5.1	Not Detected	26	Not Detected
1,1-Difluoroethane	5.1	Not Detected	14	Not Detected

Container Type: 1 Liter Summa Canister

Surrogates	%Recovery	Method Limits
Toluene-d8	99	70-130
1,2-Dichloroethane-d4	120	70-130
4-Bromofluorobenzene	107	70-130

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: VP505EWASH-2

Lab ID#: 0810427-06A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**5102914**	**Date of Collection: 10/15/08**
Dil. Factor:	**2.53**	**Date of Analysis: 10/29/08 06:27 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
Freon 12	1.3	Not Detected	6.2	Not Detected
Freon 114	1.3	Not Detected	8.8	Not Detected
Chloromethane	5.1	Not Detected	10	Not Detected
Vinyl Chloride	1.3	Not Detected	3.2	Not Detected
1,3-Butadiene	1.3	4.2	2.8	9.4
Bromomethane	1.3	Not Detected	4.9	Not Detected
Chloroethane	1.3	Not Detected	3.3	Not Detected
Freon 11	1.3	Not Detected	7.1	Not Detected
Ethanol	5.1	10	9.5	20
Freon 113	1.3	Not Detected	9.7	Not Detected
1,1-Dichloroethene	1.3	Not Detected	5.0	Not Detected
Acetone	5.1	69	12	160
2-Propanol	5.1	19	12	46
Carbon Disulfide	1.3	Not Detected	3.9	Not Detected
3-Chloropropene	5.1	Not Detected	16	Not Detected
Methylene Chloride	1.3	Not Detected	4.4	Not Detected
Methyl tert-butyl ether	1.3	Not Detected	4.6	Not Detected
trans-1,2-Dichloroethene	1.3	Not Detected	5.0	Not Detected
Hexane	1.3	3.8	4.4	14
1,1-Dichloroethane	1.3	Not Detected	5.1	Not Detected
2-Butanone (Methyl Ethyl Ketone)	1.3	14	3.7	43
cis-1,2-Dichloroethene	1.3	Not Detected	5.0	Not Detected
Tetrahydrofuran	1.3	Not Detected	3.7	Not Detected
Chloroform	1.3	Not Detected	6.2	Not Detected
1,1,1-Trichloroethane	1.3	Not Detected	6.9	Not Detected
Cyclohexane	1.3	1.4	4.4	4.8
Carbon Tetrachloride	1.3	Not Detected	8.0	Not Detected
2,2,4-Trimethylpentane	1.3	2.1	5.9	10
Benzene	1.3	3.3	4.0	10
1,2-Dichloroethane	1.3	Not Detected	5.1	Not Detected
Heptane	1.3	4.2	5.2	17
Trichloroethene	1.3	Not Detected	6.8	Not Detected
1,2-Dichloropropane	1.3	Not Detected	5.8	Not Detected
1,4-Dioxane	5.1	Not Detected	18	Not Detected
Bromodichloromethane	1.3	Not Detected	8.5	Not Detected
cis-1,3-Dichloropropene	1.3	Not Detected	5.7	Not Detected
4-Methyl-2-pentanone	1.3	Not Detected	5.2	Not Detected
Toluene	1.3	53	4.8	200
trans-1,3-Dichloropropene	1.3	Not Detected	5.7	Not Detected

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: VP505EWASH-2

Lab ID#: 0810427-06A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**5102914**	**Date of Collection:**	**10/15/08**
Dil. Factor:	**2.53**	**Date of Analysis:**	**10/29/08 06:27 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
1,1,2-Trichloroethane	1.3	Not Detected	6.9	Not Detected
Tetrachloroethene	1.3	Not Detected	8.6	Not Detected
2-Hexanone	5.1	Not Detected	21	Not Detected
Dibromochloromethane	1.3	Not Detected	11	Not Detected
1,2-Dibromoethane (EDB)	1.3	Not Detected	9.7	Not Detected
Chlorobenzene	1.3	Not Detected	5.8	Not Detected
Ethyl Benzene	1.3	11	5.5	50
m,p-Xylene	1.3	46	5.5	200
o-Xylene	1.3	20	5.5	89
Styrene	1.3	Not Detected	5.4	Not Detected
Bromoform	1.3	Not Detected	13	Not Detected
Cumene	1.3	Not Detected	6.2	Not Detected
1,1,2,2-Tetrachloroethane	1.3	Not Detected	8.7	Not Detected
Propylbenzene	1.3	5.2	6.2	26
4-Ethyltoluene	1.3	21	6.2	100
1,3,5-Trimethylbenzene	1.3	10	6.2	52
1,2,4-Trimethylbenzene	1.3	28	6.2	140
1,3-Dichlorobenzene	1.3	Not Detected	7.6	Not Detected
1,4-Dichlorobenzene	1.3	Not Detected	7.6	Not Detected
alpha-Chlorotoluene	1.3	Not Detected	6.5	Not Detected
1,2-Dichlorobenzene	1.3	Not Detected	7.6	Not Detected
1,2,4-Trichlorobenzene	5.1	Not Detected	38	Not Detected
Hexachlorobutadiene	5.1	Not Detected	54	Not Detected
Naphthalene	5.1	Not Detected	26	Not Detected
1,1-Difluoroethane	5.1	Not Detected	14	Not Detected

Container Type: 1 Liter Summa Canister (100% Certified)

Surrogates	%Recovery	Method Limits
Toluene-d8	98	70-130
1,2-Dichloroethane-d4	115	70-130
4-Bromofluorobenzene	107	70-130

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: VP507EWASH-3

Lab ID#: 0810427-07A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**5102915**	**Date of Collection: 10/15/08**
Dil. Factor:	**2.42**	**Date of Analysis: 10/29/08 07:08 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
Freon 12	1.2	Not Detected	6.0	Not Detected
Freon 114	1.2	Not Detected	8.4	Not Detected
Chloromethane	4.8	Not Detected	10	Not Detected
Vinyl Chloride	1.2	Not Detected	3.1	Not Detected
1,3-Butadiene	1.2	1.8	2.7	4.0
Bromomethane	1.2	Not Detected	4.7	Not Detected
Chloroethane	1.2	Not Detected	3.2	Not Detected
Freon 11	1.2	Not Detected	6.8	Not Detected
Ethanol	4.8	16	9.1	29
Freon 113	1.2	Not Detected	9.3	Not Detected
1,1-Dichloroethene	1.2	Not Detected	4.8	Not Detected
Acetone	4.8	96	11	230
2-Propanol	4.8	6.6	12	16
Carbon Disulfide	1.2	Not Detected	3.8	Not Detected
3-Chloropropene	4.8	Not Detected	15	Not Detected
Methylene Chloride	1.2	Not Detected	4.2	Not Detected
Methyl tert-butyl ether	1.2	Not Detected	4.4	Not Detected
trans-1,2-Dichloroethene	1.2	Not Detected	4.8	Not Detected
Hexane	1.2	4.0	4.3	14
1,1-Dichloroethane	1.2	Not Detected	4.9	Not Detected
2-Butanone (Methyl Ethyl Ketone)	1.2	19	3.6	56
cis-1,2-Dichloroethene	1.2	Not Detected	4.8	Not Detected
Tetrahydrofuran	1.2	Not Detected	3.6	Not Detected
Chloroform	1.2	Not Detected	5.9	Not Detected
1,1,1-Trichloroethane	1.2	Not Detected	6.6	Not Detected
Cyclohexane	1.2	1.8	4.2	6.1
Carbon Tetrachloride	1.2	Not Detected	7.6	Not Detected
2,2,4-Trimethylpentane	1.2	3.2	5.6	15
Benzene	1.2	3.2	3.9	10
1,2-Dichloroethane	1.2	Not Detected	4.9	Not Detected
Heptane	1.2	4.7	5.0	19
Trichloroethene	1.2	Not Detected	6.5	Not Detected
1,2-Dichloropropane	1.2	Not Detected	5.6	Not Detected
1,4-Dioxane	4.8	Not Detected	17	Not Detected
Bromodichloromethane	1.2	Not Detected	8.1	Not Detected
cis-1,3-Dichloropropene	1.2	Not Detected	5.5	Not Detected
4-Methyl-2-pentanone	1.2	1.3	5.0	5.4
Toluene	1.2	46	4.6	170
trans-1,3-Dichloropropene	1.2	Not Detected	5.5	Not Detected

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: VP507EWASH-3

Lab ID#: 0810427-07A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**5102915**	**Date of Collection: 10/15/08**
Dil. Factor:	**2.42**	**Date of Analysis: 10/29/08 07:08 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
1,1,2-Trichloroethane	1.2	Not Detected	6.6	Not Detected
Tetrachloroethene	1.2	Not Detected	8.2	Not Detected
2-Hexanone	4.8	Not Detected	20	Not Detected
Dibromochloromethane	1.2	Not Detected	10	Not Detected
1,2-Dibromoethane (EDB)	1.2	Not Detected	9.3	Not Detected
Chlorobenzene	1.2	Not Detected	5.6	Not Detected
Ethyl Benzene	1.2	13	5.2	57
m,p-Xylene	1.2	52	5.2	230
o-Xylene	1.2	25	5.2	110
Styrene	1.2	Not Detected	5.2	Not Detected
Bromoform	1.2	Not Detected	12	Not Detected
Cumene	1.2	1.6	5.9	7.9
1,1,2,2-Tetrachloroethane	1.2	Not Detected	8.3	Not Detected
Propylbenzene	1.2	7.0	5.9	34
4-Ethyltoluene	1.2	28	5.9	140
1,3,5-Trimethylbenzene	1.2	16	5.9	76
1,2,4-Trimethylbenzene	1.2	42	5.9	210
1,3-Dichlorobenzene	1.2	Not Detected	7.3	Not Detected
1,4-Dichlorobenzene	1.2	Not Detected	7.3	Not Detected
alpha-Chlorotoluene	1.2	Not Detected	6.3	Not Detected
1,2-Dichlorobenzene	1.2	Not Detected	7.3	Not Detected
1,2,4-Trichlorobenzene	4.8	Not Detected	36	Not Detected
Hexachlorobutadiene	4.8	Not Detected	52	Not Detected
Naphthalene	4.8	Not Detected	25	Not Detected
1,1-Difluoroethane	4.8	Not Detected	13	Not Detected

Container Type: 1 Liter Summa Canister

Surrogates	%Recovery	Method Limits
Toluene-d8	99	70-130
1,2-Dichloroethane-d4	112	70-130
4-Bromofluorobenzene	105	70-130

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: VP412EHILL-3

Lab ID#: 0810427-08A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**5102917**	**Date of Collection: 10/15/08**
Dil. Factor:	**2.53**	**Date of Analysis: 10/29/08 10:23 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
Freon 12	1.3	Not Detected	6.2	Not Detected
Freon 114	1.3	Not Detected	8.8	Not Detected
Chloromethane	5.1	Not Detected	10	Not Detected
Vinyl Chloride	1.3	Not Detected	3.2	Not Detected
1,3-Butadiene	1.3	11	2.8	25
Bromomethane	1.3	Not Detected	4.9	Not Detected
Chloroethane	1.3	Not Detected	3.3	Not Detected
Freon 11	1.3	Not Detected	7.1	Not Detected
Ethanol	5.1	150	9.5	280
Freon 113	1.3	Not Detected	9.7	Not Detected
1,1-Dichloroethene	1.3	Not Detected	5.0	Not Detected
Acetone	5.1	240	12	580
2-Propanol	5.1	41	12	100
Carbon Disulfide	1.3	Not Detected	3.9	Not Detected
3-Chloropropene	5.1	Not Detected	16	Not Detected
Methylene Chloride	1.3	Not Detected	4.4	Not Detected
Methyl tert-butyl ether	1.3	Not Detected	4.6	Not Detected
trans-1,2-Dichloroethene	1.3	Not Detected	5.0	Not Detected
Hexane	1.3	5.8	4.4	20
1,1-Dichloroethane	1.3	Not Detected	5.1	Not Detected
2-Butanone (Methyl Ethyl Ketone)	1.3	45	3.7	130
cis-1,2-Dichloroethene	1.3	Not Detected	5.0	Not Detected
Tetrahydrofuran	1.3	Not Detected	3.7	Not Detected
Chloroform	1.3	Not Detected	6.2	Not Detected
1,1,1-Trichloroethane	1.3	Not Detected	6.9	Not Detected
Cyclohexane	1.3	1.7	4.4	5.9
Carbon Tetrachloride	1.3	Not Detected	8.0	Not Detected
2,2,4-Trimethylpentane	1.3	2.8	5.9	13
Benzene	1.3	4.2	4.0	14
1,2-Dichloroethane	1.3	Not Detected	5.1	Not Detected
Heptane	1.3	5.2	5.2	21
Trichloroethene	1.3	Not Detected	6.8	Not Detected
1,2-Dichloropropane	1.3	Not Detected	5.8	Not Detected
1,4-Dioxane	5.1	Not Detected	18	Not Detected
Bromodichloromethane	1.3	Not Detected	8.5	Not Detected
cis-1,3-Dichloropropene	1.3	Not Detected	5.7	Not Detected
4-Methyl-2-pentanone	1.3	1.6	5.2	6.5
Toluene	1.3	52	4.8	190
trans-1,3-Dichloropropene	1.3	Not Detected	5.7	Not Detected

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: VP412EHILL-3

Lab ID#: 0810427-08A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**5102917**	**Date of Collection: 10/15/08**
Dil. Factor:	**2.53**	**Date of Analysis: 10/29/08 10:23 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
1,1,2-Trichloroethane	1.3	Not Detected	6.9	Not Detected
Tetrachloroethene	1.3	Not Detected	8.6	Not Detected
2-Hexanone	5.1	Not Detected	21	Not Detected
Dibromochloromethane	1.3	Not Detected	11	Not Detected
1,2-Dibromoethane (EDB)	1.3	Not Detected	9.7	Not Detected
Chlorobenzene	1.3	Not Detected	5.8	Not Detected
Ethyl Benzene	1.3	12	5.5	52
m,p-Xylene	1.3	48	5.5	210
o-Xylene	1.3	22	5.5	94
Styrene	1.3	Not Detected	5.4	Not Detected
Bromoform	1.3	Not Detected	13	Not Detected
Cumene	1.3	1.5	6.2	7.2
1,1,2,2-Tetrachloroethane	1.3	Not Detected	8.7	Not Detected
Propylbenzene	1.3	6.1	6.2	30
4-Ethyltoluene	1.3	26	6.2	130
1,3,5-Trimethylbenzene	1.3	9.1	6.2	45
1,2,4-Trimethylbenzene	1.3	33	6.2	160
1,3-Dichlorobenzene	1.3	Not Detected	7.6	Not Detected
1,4-Dichlorobenzene	1.3	Not Detected	7.6	Not Detected
alpha-Chlorotoluene	1.3	Not Detected	6.5	Not Detected
1,2-Dichlorobenzene	1.3	Not Detected	7.6	Not Detected
1,2,4-Trichlorobenzene	5.1	Not Detected	38	Not Detected
Hexachlorobutadiene	5.1	Not Detected	54	Not Detected
Naphthalene	5.1	Not Detected	26	Not Detected
1,1-Difluoroethane	5.1	10	14	27

Container Type: 1 Liter Summa Canister

Surrogates	%Recovery	Method Limits
Toluene-d8	100	70-130
1,2-Dichloroethane-d4	115	70-130
4-Bromofluorobenzene	109	70-130

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: VP412EHILL-1

Lab ID#: 0810427-09A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**5102918**	**Date of Collection: 10/15/08**
Dil. Factor:	**2.53**	**Date of Analysis: 10/29/08 11:05 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
Freon 12	1.3	Not Detected	6.2	Not Detected
Freon 114	1.3	Not Detected	8.8	Not Detected
Chloromethane	5.1	Not Detected	10	Not Detected
Vinyl Chloride	1.3	Not Detected	3.2	Not Detected
1,3-Butadiene	1.3	4.1	2.8	9.2
Bromomethane	1.3	Not Detected	4.9	Not Detected
Chloroethane	1.3	Not Detected	3.3	Not Detected
Freon 11	1.3	Not Detected	7.1	Not Detected
Ethanol	5.1	26	9.5	50
Freon 113	1.3	Not Detected	9.7	Not Detected
1,1-Dichloroethene	1.3	Not Detected	5.0	Not Detected
Acetone	5.1	96	12	230
2-Propanol	5.1	5.8	12	14
Carbon Disulfide	1.3	Not Detected	3.9	Not Detected
3-Chloropropene	5.1	Not Detected	16	Not Detected
Methylene Chloride	1.3	Not Detected	4.4	Not Detected
Methyl tert-butyl ether	1.3	Not Detected	4.6	Not Detected
trans-1,2-Dichloroethene	1.3	Not Detected	5.0	Not Detected
Hexane	1.3	2.7	4.4	9.5
1,1-Dichloroethane	1.3	Not Detected	5.1	Not Detected
2-Butanone (Methyl Ethyl Ketone)	1.3	16	3.7	47
cis-1,2-Dichloroethene	1.3	Not Detected	5.0	Not Detected
Tetrahydrofuran	1.3	Not Detected	3.7	Not Detected
Chloroform	1.3	Not Detected	6.2	Not Detected
1,1,1-Trichloroethane	1.3	Not Detected	6.9	Not Detected
Cyclohexane	1.3	Not Detected	4.4	Not Detected
Carbon Tetrachloride	1.3	Not Detected	8.0	Not Detected
2,2,4-Trimethylpentane	1.3	1.7	5.9	8.1
Benzene	1.3	2.6	4.0	8.5
1,2-Dichloroethane	1.3	Not Detected	5.1	Not Detected
Heptane	1.3	2.5	5.2	10
Trichloroethene	1.3	Not Detected	6.8	Not Detected
1,2-Dichloropropane	1.3	Not Detected	5.8	Not Detected
1,4-Dioxane	5.1	Not Detected	18	Not Detected
Bromodichloromethane	1.3	Not Detected	8.5	Not Detected
cis-1,3-Dichloropropene	1.3	Not Detected	5.7	Not Detected
4-Methyl-2-pentanone	1.3	Not Detected	5.2	Not Detected
Toluene	1.3	32	4.8	120
trans-1,3-Dichloropropene	1.3	Not Detected	5.7	Not Detected

Air Toxics LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: VP412EHILL-1

Lab ID#: 0810427-09A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**5102918**	**Date of Collection: 10/15/08**
Dil. Factor:	**2.53**	**Date of Analysis: 10/29/08 11:05 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
1,1,2-Trichloroethane	1.3	Not Detected	6.9	Not Detected
Tetrachloroethene	1.3	Not Detected	8.6	Not Detected
2-Hexanone	5.1	Not Detected	21	Not Detected
Dibromochloromethane	1.3	Not Detected	11	Not Detected
1,2-Dibromoethane (EDB)	1.3	Not Detected	9.7	Not Detected
Chlorobenzene	1.3	Not Detected	5.8	Not Detected
Ethyl Benzene	1.3	9.1	5.5	40
m,p-Xylene	1.3	38	5.5	160
o-Xylene	1.3	18	5.5	77
Styrene	1.3	Not Detected	5.4	Not Detected
Bromoform	1.3	Not Detected	13	Not Detected
Cumene	1.3	Not Detected	6.2	Not Detected
1,1,2,2-Tetrachloroethane	1.3	Not Detected	8.7	Not Detected
Propylbenzene	1.3	5.1	6.2	25
4-Ethyltoluene	1.3	22	6.2	100
1,3,5-Trimethylbenzene	1.3	11	6.2	56
1,2,4-Trimethylbenzene	1.3	32	6.2	160
1,3-Dichlorobenzene	1.3	Not Detected	7.6	Not Detected
1,4-Dichlorobenzene	1.3	Not Detected	7.6	Not Detected
alpha-Chlorotoluene	1.3	Not Detected	6.5	Not Detected
1,2-Dichlorobenzene	1.3	Not Detected	7.6	Not Detected
1,2,4-Trichlorobenzene	5.1	Not Detected	38	Not Detected
Hexachlorobutadiene	5.1	Not Detected	54	Not Detected
Naphthalene	5.1	Not Detected	26	Not Detected
1,1-Difluoroethane	5.1	5.4	14	15

Container Type: 1 Liter Summa Canister

Surrogates	%Recovery	Method Limits
Toluene-d8	100	70-130
1,2-Dichloroethane-d4	117	70-130
4-Bromofluorobenzene	108	70-130

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AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: VP507EWASH(AMBIENT)

Lab ID#: 0810427-10A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**5102919**	**Date of Collection: 10/15/08**
Dil. Factor:	**2.53**	**Date of Analysis: 10/29/08 11:58 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
Freon 12	1.3	Not Detected	6.2	Not Detected
Freon 114	1.3	Not Detected	8.8	Not Detected
Vinyl Chloride	1.3	Not Detected	3.2	Not Detected
Bromomethane	1.3	Not Detected	4.9	Not Detected
Chloroethane	1.3	Not Detected	3.3	Not Detected
Freon 11	1.3	Not Detected	7.1	Not Detected
1,1-Dichloroethene	1.3	Not Detected	5.0	Not Detected
Freon 113	1.3	Not Detected	9.7	Not Detected
Methylene Chloride	1.3	Not Detected	4.4	Not Detected
1,1-Dichloroethane	1.3	Not Detected	5.1	Not Detected
cis-1,2-Dichloroethene	1.3	Not Detected	5.0	Not Detected
Chloroform	1.3	Not Detected	6.2	Not Detected
1,1,1-Trichloroethane	1.3	Not Detected	6.9	Not Detected
Carbon Tetrachloride	1.3	Not Detected	8.0	Not Detected
Benzene	1.3	Not Detected	4.0	Not Detected
1,2-Dichloroethane	1.3	Not Detected	5.1	Not Detected
Trichloroethene	1.3	Not Detected	6.8	Not Detected
1,2-Dichloropropane	1.3	Not Detected	5.8	Not Detected
cis-1,3-Dichloropropene	1.3	Not Detected	5.7	Not Detected
Toluene	1.3	Not Detected	4.8	Not Detected
trans-1,3-Dichloropropene	1.3	Not Detected	5.7	Not Detected
1,1,2-Trichloroethane	1.3	Not Detected	6.9	Not Detected
Tetrachloroethene	1.3	Not Detected	8.6	Not Detected
1,2-Dibromoethane (EDB)	1.3	Not Detected	9.7	Not Detected
Chlorobenzene	1.3	Not Detected	5.8	Not Detected
Ethyl Benzene	1.3	Not Detected	5.5	Not Detected
m,p-Xylene	1.3	Not Detected	5.5	Not Detected
o-Xylene	1.3	Not Detected	5.5	Not Detected
Styrene	1.3	Not Detected	5.4	Not Detected
1,1,2,2-Tetrachloroethane	1.3	Not Detected	8.7	Not Detected
1,3,5-Trimethylbenzene	1.3	Not Detected	6.2	Not Detected
1,2,4-Trimethylbenzene	1.3	Not Detected	6.2	Not Detected
1,3-Dichlorobenzene	1.3	Not Detected	7.6	Not Detected
1,4-Dichlorobenzene	1.3	Not Detected	7.6	Not Detected
alpha-Chlorotoluene	1.3	Not Detected	6.5	Not Detected
1,2-Dichlorobenzene	1.3	Not Detected	7.6	Not Detected
1,3-Butadiene	1.3	Not Detected	2.8	Not Detected
Hexane	1.3	Not Detected	4.4	Not Detected
Cyclohexane	1.3	Not Detected	4.4	Not Detected

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: VP507EWASH(AMBIENT)

Lab ID#: 0810427-10A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**5102919**	**Date of Collection: 10/15/08**
Dil. Factor:	**2.53**	**Date of Analysis: 10/29/08 11:58 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
Heptane	1.3	Not Detected	5.2	Not Detected
Bromodichloromethane	1.3	Not Detected	8.5	Not Detected
Dibromochloromethane	1.3	Not Detected	11	Not Detected
Cumene	1.3	Not Detected	6.2	Not Detected
Propylbenzene	1.3	Not Detected	6.2	Not Detected
Chloromethane	5.1	Not Detected	10	Not Detected
1,2,4-Trichlorobenzene	5.1	Not Detected	38	Not Detected
Hexachlorobutadiene	5.1	Not Detected	54	Not Detected
Acetone	5.1	6.6	12	16
Carbon Disulfide	1.3	Not Detected	3.9	Not Detected
2-Propanol	5.1	9.3	12	23
trans-1,2-Dichloroethene	1.3	Not Detected	5.0	Not Detected
2-Butanone (Methyl Ethyl Ketone)	1.3	Not Detected	3.7	Not Detected
Tetrahydrofuran	1.3	Not Detected	3.7	Not Detected
1,4-Dioxane	5.1	Not Detected	18	Not Detected
4-Methyl-2-pentanone	1.3	Not Detected	5.2	Not Detected
2-Hexanone	5.1	Not Detected	21	Not Detected
Bromoform	1.3	Not Detected	13	Not Detected
4-Ethyltoluene	1.3	Not Detected	6.2	Not Detected
Ethanol	5.1	6.0	9.5	11
Methyl tert-butyl ether	1.3	Not Detected	4.6	Not Detected
3-Chloropropene	5.1	Not Detected	16	Not Detected
2,2,4-Trimethylpentane	1.3	Not Detected	5.9	Not Detected
Naphthalene	5.1	Not Detected	26	Not Detected

Container Type: 6 Liter Summa Canister

Surrogates	%Recovery	Method Limits
Toluene-d8	95	70-130
1,2-Dichloroethane-d4	117	70-130
4-Bromofluorobenzene	112	70-130

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: Lab Blank

Lab ID#: 0810427-11A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**5102905**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 10/29/08 11:26 AM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
Freon 12	0.50	Not Detected	2.5	Not Detected
Freon 114	0.50	Not Detected	3.5	Not Detected
Chloromethane	2.0	Not Detected	4.1	Not Detected
Vinyl Chloride	0.50	Not Detected	1.3	Not Detected
1,3-Butadiene	0.50	Not Detected	1.1	Not Detected
Bromomethane	0.50	Not Detected	1.9	Not Detected
Chloroethane	0.50	Not Detected	1.3	Not Detected
Freon 11	0.50	Not Detected	2.8	Not Detected
Ethanol	2.0	Not Detected	3.8	Not Detected
Freon 113	0.50	Not Detected	3.8	Not Detected
1,1-Dichloroethene	0.50	Not Detected	2.0	Not Detected
Acetone	2.0	Not Detected	4.8	Not Detected
2-Propanol	2.0	Not Detected	4.9	Not Detected
Carbon Disulfide	0.50	Not Detected	1.6	Not Detected
3-Chloropropene	2.0	Not Detected	6.3	Not Detected
Methylene Chloride	0.50	Not Detected	1.7	Not Detected
Methyl tert-butyl ether	0.50	Not Detected	1.8	Not Detected
trans-1,2-Dichloroethene	0.50	Not Detected	2.0	Not Detected
Hexane	0.50	Not Detected	1.8	Not Detected
1,1-Dichloroethane	0.50	Not Detected	2.0	Not Detected
2-Butanone (Methyl Ethyl Ketone)	0.50	Not Detected	1.5	Not Detected
cis-1,2-Dichloroethene	0.50	Not Detected	2.0	Not Detected
Tetrahydrofuran	0.50	Not Detected	1.5	Not Detected
Chloroform	0.50	Not Detected	2.4	Not Detected
1,1,1-Trichloroethane	0.50	Not Detected	2.7	Not Detected
Cyclohexane	0.50	Not Detected	1.7	Not Detected
Carbon Tetrachloride	0.50	Not Detected	3.1	Not Detected
2,2,4-Trimethylpentane	0.50	Not Detected	2.3	Not Detected
Benzene	0.50	Not Detected	1.6	Not Detected
1,2-Dichloroethane	0.50	Not Detected	2.0	Not Detected
Heptane	0.50	Not Detected	2.0	Not Detected
Trichloroethene	0.50	Not Detected	2.7	Not Detected
1,2-Dichloropropane	0.50	Not Detected	2.3	Not Detected
1,4-Dioxane	2.0	Not Detected	7.2	Not Detected
Bromodichloromethane	0.50	Not Detected	3.4	Not Detected
cis-1,3-Dichloropropene	0.50	Not Detected	2.3	Not Detected
4-Methyl-2-pentanone	0.50	Not Detected	2.0	Not Detected
Toluene	0.50	Not Detected	1.9	Not Detected
trans-1,3-Dichloropropene	0.50	Not Detected	2.3	Not Detected

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: Lab Blank

Lab ID#: 0810427-11A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**5102905**	**Date of Collection: NA**	
Dil. Factor:	**1.00**	**Date of Analysis: 10/29/08 11:26 AM**	

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (uG/m3)	Amount (uG/m3)
1,1,2-Trichloroethane	0.50	Not Detected	2.7	Not Detected
Tetrachloroethene	0.50	Not Detected	3.4	Not Detected
2-Hexanone	2.0	Not Detected	8.2	Not Detected
Dibromochloromethane	0.50	Not Detected	4.2	Not Detected
1,2-Dibromoethane (EDB)	0.50	Not Detected	3.8	Not Detected
Chlorobenzene	0.50	Not Detected	2.3	Not Detected
Ethyl Benzene	0.50	Not Detected	2.2	Not Detected
m,p-Xylene	0.50	Not Detected	2.2	Not Detected
o-Xylene	0.50	Not Detected	2.2	Not Detected
Styrene	0.50	Not Detected	2.1	Not Detected
Bromoform	0.50	Not Detected	5.2	Not Detected
Cumene	0.50	Not Detected	2.4	Not Detected
1,1,2,2-Tetrachloroethane	0.50	Not Detected	3.4	Not Detected
Propylbenzene	0.50	Not Detected	2.4	Not Detected
4-Ethyltoluene	0.50	Not Detected	2.4	Not Detected
1,3,5-Trimethylbenzene	0.50	Not Detected	2.4	Not Detected
1,2,4-Trimethylbenzene	0.50	Not Detected	2.4	Not Detected
1,3-Dichlorobenzene	0.50	Not Detected	3.0	Not Detected
1,4-Dichlorobenzene	0.50	Not Detected	3.0	Not Detected
alpha-Chlorotoluene	0.50	Not Detected	2.6	Not Detected
1,2-Dichlorobenzene	0.50	Not Detected	3.0	Not Detected
1,2,4-Trichlorobenzene	2.0	Not Detected	15	Not Detected
Hexachlorobutadiene	2.0	Not Detected	21	Not Detected
Naphthalene	2.0	Not Detected	10	Not Detected
1,1-Difluoroethane	2.0	Not Detected	5.4	Not Detected

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
Toluene-d8	95	70-130
1,2-Dichloroethane-d4	113	70-130
4-Bromofluorobenzene	113	70-130

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: CCV

Lab ID#: 0810427-12A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**5102902**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 10/29/08 09:04 AM**

Compound	%Recovery
Freon 12	114
Freon 114	107
Chloromethane	97
Vinyl Chloride	94
1,3-Butadiene	97
Bromomethane	114
Chloroethane	79
Freon 11	111
Ethanol	89
Freon 113	99
1,1-Dichloroethene	102
Acetone	86
2-Propanol	91
Carbon Disulfide	91
3-Chloropropene	86
Methylene Chloride	96
Methyl tert-butyl ether	127
trans-1,2-Dichloroethene	89
Hexane	84
1,1-Dichloroethane	91
2-Butanone (Methyl Ethyl Ketone)	88
cis-1,2-Dichloroethene	92
Tetrahydrofuran	87
Chloroform	90
1,1,1-Trichloroethane	103
Cyclohexane	86
Carbon Tetrachloride	107
2,2,4-Trimethylpentane	82
Benzene	84
1,2-Dichloroethane	113
Heptane	89
Trichloroethene	100
1,2-Dichloropropane	89
1,4-Dioxane	91
Bromodichloromethane	109
cis-1,3-Dichloropropene	96
4-Methyl-2-pentanone	92
Toluene	89
trans-1,3-Dichloropropene	98

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: CCV

Lab ID#: 0810427-12A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**5102902**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 10/29/08 09:04 AM**

Compound	%Recovery
1,1,2-Trichloroethane	90
Tetrachloroethene	94
2-Hexanone	81
Dibromochloromethane	104
1,2-Dibromoethane (EDB)	91
Chlorobenzene	91
Ethyl Benzene	91
m,p-Xylene	92
o-Xylene	93
Styrene	90
Bromoform	111
Cumene	93
1,1,2,2-Tetrachloroethane	91
Propylbenzene	100
4-Ethyltoluene	85
1,3,5-Trimethylbenzene	125
1,2,4-Trimethylbenzene	95
1,3-Dichlorobenzene	101
1,4-Dichlorobenzene	100
alpha-Chlorotoluene	103
1,2-Dichlorobenzene	99
1,2,4-Trichlorobenzene	105
Hexachlorobutadiene	108
Naphthalene	98
1,1-Difluoroethane	114

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
Toluene-d8	101	70-130
1,2-Dichloroethane-d4	114	70-130
4-Bromofluorobenzene	111	70-130

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: LCS

Lab ID#: 0810427-13A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**5102903**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 10/29/08 09:39 AM**

Compound	%Recovery
Freon 12	119
Freon 114	111
Chloromethane	104
Vinyl Chloride	102
1,3-Butadiene	100
Bromomethane	131 Q
Chloroethane	93
Freon 11	116
Ethanol	106
Freon 113	122
1,1-Dichloroethene	122
Acetone	95
2-Propanol	103
Carbon Disulfide	102
3-Chloropropene	95
Methylene Chloride	113
Methyl tert-butyl ether	147 Q
trans-1,2-Dichloroethene	97
Hexane	98
1,1-Dichloroethane	104
2-Butanone (Methyl Ethyl Ketone)	96
cis-1,2-Dichloroethene	102
Tetrahydrofuran	95
Chloroform	100
1,1,1-Trichloroethane	114
Cyclohexane	96
Carbon Tetrachloride	117
2,2,4-Trimethylpentane	93
Benzene	93
1,2-Dichloroethane	122
Heptane	99
Trichloroethene	106
1,2-Dichloropropane	98
1,4-Dioxane	97
Bromodichloromethane	119
cis-1,3-Dichloropropene	106
4-Methyl-2-pentanone	104
Toluene	103
trans-1,3-Dichloropropene	107

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: LCS

Lab ID#: 0810427-13A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**5102903**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 10/29/08 09:39 AM**

Compound	%Recovery
1,1,2-Trichloroethane	98
Tetrachloroethene	102
2-Hexanone	88
Dibromochloromethane	114
1,2-Dibromoethane (EDB)	96
Chlorobenzene	98
Ethyl Benzene	98
m,p-Xylene	98
o-Xylene	99
Styrene	98
Bromoform	117
Cumene	102
1,1,2,2-Tetrachloroethane	97
Propylbenzene	108
4-Ethyltoluene	115
1,3,5-Trimethylbenzene	99
1,2,4-Trimethylbenzene	99
1,3-Dichlorobenzene	105
1,4-Dichlorobenzene	104
alpha-Chlorotoluene	111
1,2-Dichlorobenzene	102
1,2,4-Trichlorobenzene	106
Hexachlorobutadiene	108
Naphthalene	104
1,1-Difluoroethane	Not Spiked

Q = Exceeds Quality Control limits.

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
Toluene-d8	102	70-130
1,2-Dichloroethane-d4	111	70-130
4-Bromofluorobenzene	110	70-130

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CHAIN-OF-CUSTODY RECORD

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Page 1 of 1

Project Manager Robert Scafford
Collected by: (Print and Sign) Keith Klemm [signature]
Company Gannett Fleming Email rscafford@gfnet.com
Address 4201 Mount Hope Dr. Suite A City Baltimore State MD Zip 21215
Phone 410-585-1460 Fax 410-585-1420

Project Info:
P.O. # 050067.C
Project # 050067
Project Name Ameren - Champaigne

Turn Around Time: [X] Normal ☐ Rush specify

Lab Use Only Pressurized by: Date: Pressurization Gas: N_2 He

Lab I.D.	Field Sample I.D. (Location)	Can #	Date of Collection	Time of Collection	Analyses Requested	Canister Pressure/Vacuum Initial	Final	Receipt	Final (psi)
01A	VP507EWASH-1	33727	10/15/08	1642	TO-15: Full Scan with	27.5	5.0		
02A	VP505EWASH-1	36555	↓	0902	Naphthalene and	27.4	5.0		
03A	VP507EWASH-2	34167		1051	Difluoroethane	27.4	5.0		
04A	VP507EWASH-F	2085		1103	↓	28.9	5.0		
05A	VP412EHILL-2	2219		1441		27.7	5.0		
06A	VP505EWASH-2	36553		0853		27.1	5.0		
07A	VP507EWASH-3	36522		1155		28.4	5.0		
08A	VP412EHILL-3	36494		1531		28.0	5.0		
09A	VP412EHILL-1	34081		1329		28.9	5.0		
10A	VP507EWASH (AMBIENT)	33669	↓	1715	TO-15: Full Scan with Naphthalene	28.0	5.0		

Relinquished by: (signature) [signature] Date/Time 10/15/08/2300 Received by: (signature) [signature] Date/Time 10/18/08 915
Relinquished by: (signature) Date/Time Received by: (signature) Date/Time
Relinquished by: (signature) Date/Time Received by: (signature) Date/Time

Notes:

Lab Use Only	Shipper Name	Air Bill #	Temp (°C)	Condition	Custody Seals Intact?	Work Order #
	FedEx		NA	Good	(Yes) No None	0810427

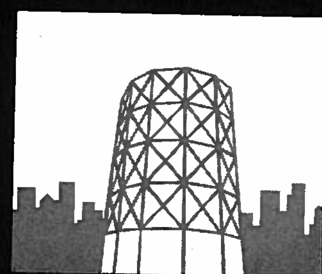
Form 1293 rev.11

Appendix G
References for Selection of MGP Related Chemicals

GRI®

VOLUME 1

Management of Manufactured Gas Plant Sites



Two-Volume Practical Reference Guide from Gas Research Institute

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Table 5-1 Wastes and Chemicals of Interest at MGP Sites

WASTES		
Free tars, oils, and lampblack	Organic-contaminated soils - Heavily contaminated - Lightly contaminated	
Organic-contaminated vessel, surface, and groundwaters	Purifier wastes	Mixed wastes and fill

CHEMICALS: INORGANICS	METALS	VOLATILE AROMATICS	PHENOLICS	POLYNUCLEAR AROMATIC HYDROCARBONS
Ammonia	Aluminum	Benzene	Phenol	Acenaphthene
Cyanide	Antimony	Ethyl Benzene	2-Methylphenol	Acenaphthylene
Nitrate	Arsenic	Toluene	4-Methylphenol	Anthracene
Sulfate	Barium	Total Xylenes	2,4-Dimethylphenol	Benzo(a)anthracene
Sulfide	Cadmium			Benzo(a)pyrene
Thiocyanates	Chromium			Benzo(b)fluoranthene
	Copper			Benzo(g,h,i)perylene
	Iron			Benzo(k)fluoranthene
	Lead			Chrysene
	Manganese			Dibenzo(a,h)anthracene
	Mercury			Dibenzofuran
	Nickel			Fluoranthene
	Selenium			Fluorene
	Silver			Indeno(1,2,3. cd)pyrene
	Vanadium			Naphthalene
	Zinc			Phenanthrene
				Pyrene
				2-Methyl Naphthalene

5.1 WASTES

The five wastes listec based upon the survey o of the process residuals as man and nature have

The wastes reveal th oils and lampblack and based upon the relativel and the regulatory signi hydrocarbons. Potential which tend to be widel should be noted again t site wastes with miscella demolition. Mixed was combination of hazardc

5.2 CHEMICALS

The methodology f The chemicals of regula in the EPA CLP or ir compared to the chem residuals (Chapter 2). T of regulatory concern t to be there based upon smaller set of chemicals of interest for MGP si

The chemical scree limitations of both the identified in the site v scope of the study frc available at the time t understand the impac investigations should c scans of both aqueous classes and chemicals p

The results of the the six primary chemic extent that exceptions rationale for and impa

5.2.1 Inorganic Chen

Six inorganic com nitrogen (cyanide, am sulfates) compounds.

ELSEVIER

Engineering Geology 64 (2002) 317–338

ENGINEERING GEOLOGY

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Geoenvironmental protocol for site and waste characterization of former manufactured gas plants; worldwide remediation challenge in semi-volatile organic wastes☆

Allen W. Hatheway*

Consultant in Mitigation and Forensics Rolla, Missouri and Big Arm, Montana, USA

Abstract

The most common and difficult of all hazardous waste sites are those that historically produced artificial (manufactured) gas; for gas-making was international in scope and at the very core of the industrial revolution. With former manufactured gas plants (FMGPs), virtually no geologic region in the industrialized or urbanized world or its trade centers and ports escaped the gas industry. These plants applied pyrolysis of organic matter (roasting to drive off volatiles in the form of useful gases) to illuminate the world and to fuel all manner of progress. Gas was and is the universal fuel. Its prominence stemmed from the omnipresence of organic matter and the universal process for the extraction of its volatile contents to manufacture useful gas. Furthermore, for most of the century and a half-long history of manufactured gas, natural gas was unavailable to slow or daunt the production of man-made gas and the universal creation of its toxic tar residues and other harmful waste residuals. Today we face the presence of toxic organic gas manufacturing residuals as a unique threat to both the health and welfare of contemporary society, as well as being a long-term threat to the environment that is dominantly geologic in character. Most of these tar residuals are highly resistant to natural degradation or attenuation in the environment and their lives, therefore, they are measured in geologic time. Given its environmental persistence, potential problems associated with tar may exist centuries to thousands of years. Engineering geologists and geological engineers are, by training and experience, particularly well equipped to plan, manage and conduct site and waste characterization efforts for FMGPs and related coal-tar sites. © 2002 Elsevier Science B.V. All rights reserved.

Keywords: Site and waste characterization; Former manufactured gas plants; Semi-volatile organic wastes

1. Introduction

Derelict industrial waste sites are among the greatest environmental problems worldwide. “Uncontrolled hazardous waste sites” (UHWS) have been noticed as a major societal threat for about the last quarter century.

With these sites we face a vast spectrum of compounds comprising the waste and an infinite variety of complex geological materials/waste settings. The variable relationships between geologic conditions and the fate of hazardous waste is the most difficult of all site characterization challenges for those working in the applied earth sciences.

The very presence, design layout, management and operation of each gas works was wholly influenced by geologic site features and accessibility to natural and man-made resources. Likewise, historically, the

☆ An Inaugural Paper in Principles of Engineering Geology; The George A. Kiersch Series, Engineering Geology, Amsterdam.

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management options for toxic waste by-products (i.e. sell, use, discard) were often governed by the location of the gas works or their geologic setting, including proximity to surface water bodies, wetlands, and unoccupied land. Economics also played a large role in the operations of the gas plant, from the selection of feedstock to the management of by-products and wastes.

Most of the broad advances made in dealing with toxic and persistent groundwater contaminants have been concentrated on and successful in dealing with halogenated (chlorinated), specialty chemical compounds created since 1928 to serve as solvents, pesticides and heat-dissipation oils. These solvents are volatile organic compounds (VOCs) and their nature and geologic affinities and associations are very different from the predominant semi-volatile organic compounds (SVOCs) associated with the processes of manufacturing gas, as well as the halogenated pesticides and heat-dissipation compounds.

This paper deals with the associations between geologic conditions and the nature and ultimate face of the tar residuals and oils generated by the manufacture of gas and coke, and by the processing of the tar and oil by-products of the industry. Tar residuals and gas oil are composed of complex mixtures of hundreds of aliphatic and aromatic organic hydrocarbons. The constituents of tar and oil that are of specific interest for investigation and remediation at former manufactured gas plant (FMGP) sites are the polycyclic aromatic hydrocarbons (PAHs). Many of these compounds are of particular concern because they are suspected human carcinogens. Sixteen of the PAHs found in tar are on the U.S. Environmental Protection Agency (USEPA) list of priority pollutants. Also of grave concern are the known and emerging carcinogenicity of the PAHs and the toxic threats of associated cyanides, heavy metals, and sulfur compounds.

2. Historic background of manufactured gas

Prior to 1792, inhabited portions of the earth were lit at night by various types of tallow candles and oil lamps. The streets of most cities were unlit and on moonless nights thieves abounded so that no citizen was safe. Likewise, commerce was restricted to daylight hours and nighttime deliberations of government were carried on under the feeble light of whale oil and candle. Factories worked on single 12-h shifts when possible.

The complacency of this world was shattered by a discovery by Scotsman William Murdoch (now known as Murdock) in 1792. Murdock was a brilliant self-educated mechanical engineer who was employed as an erection engineer by Boulton & Watt of Birmingham, England. While on assignment in Cornwall, to install a steam (pumping) engine at a local mine, Murdock fashioned the world's first gas manufacturing and house lighting system, in his spare time, at his home at Redruth. The rest truly is history.

Murdock returned soon to Birmingham and, by 1798, had built institutional gas plants for double-shift lighting factories in England's industrial "Black Country" northwest of Birmingham and raised the specter of gas lighting. By the turn of the 19th century, awareness of artificial gas and gas lighting had awakened in Moravia (now Czech Republic), Belgium and France. This knowledge came to be focused by the German Moravian Friedrich Albrecht Winzler, at London, around the year 1804.

Murdock went on to pursue other important works in practical engineering and Winzler, anglicized as Winsor, created the world-pioneering Chartered Gas Light and Coke of London (1812), sometimes known as the London and Westminster Gas Light and Coke Company. The world took note and the British Empire, upon whose flag the "sun never set," cheerfully began to light its nighttime world. The first experimentation with gas lighting in the United States was in 1796 at Philadelphia (the Italian fireworks manufacturers, the Brothers Ambroise) and around 1810 at Newport, RI, by David Melville. America's first commercial gas lighting occurred in Baltimore in 1816.

A complete treatment of the historic technical aspects of the subject is contained in *Remediation of Former Manufactured Gas Plants and Other Coal-Tar Sites* (Hatheway, in press (a)).

3. The chemical–geologic connection of manufactured gas

Gas manufacturing and gas lighting were of the highest order of technologies at the turn of the 19th

Table 1
De facto geologic siting conditions for manufactured gas plants

Geologic/related anthropogenic factors	Application	Rationale
Proximity to central business district	Optimal gas distribution at minimal cost	Saves in cost and effort toward placing gas mains for distribution of plant gas to the city.
Size of site	Half hectare minimum; generally much larger	Based on premise that city would grow and that more and more gas could be sold, hence the need to expand the plant; a few to tens of ha. of space most desirable.
Sited on transportation route	Rail, river or canal ideally accessible to the plant site by spur or slip. Vehicle transport rarely available during the era of manufactured gas.	Incoming feedstock such as coal, coke, and oils, as well as replacement supplies and parts for the making machines. Export of such salable residuals as must go off-site, such as coke, tar, light oils, ammonia, sulfur and cyanides.
Plant elevation lower than distribution zone	Illuminating and fuel gas is lighter than air	Designed to rise from the plant throughout the gas distribution area.
Entrance "Fluids" at the highest elevated portion of the works	Fluids able to move through plant from process start to finish	Facilitates movement of process water and fluids by gravity, without requiring pump energy.
Source of process water	On-site well or adjacent water body (lake, river, stream)	High demand for water; to generate steam and to clarify gas; water used to gather and manage tar residuals and to produce tar for possible use or sale.
Stable foundation for works structure	Retort benches and other gas-manufacturing machines, as well as clarification, purification, and storage structures have heavy foundation loads	Entire function of gas manufacturing, treatment and storage is sensitive to stress fracturing as well as gas and fluid leakage from foundation settlement on poor or over-stressed foundation earth materials.
Located on inferior site of rail tracks	Gas works were considered nuisances by the public	Resulted in devaluation of surrounding properties.
Site drainage	From gate to lower end of the site.	Most operators took effort to see that the working surface of the gas yard was trafficable in all weather.
Off-site drainage	Effluents could not be stored on the plant site	Required consideration of some form of off-site removal of liquids from the plant site.
Above frequent flood levels	Gas machines highly susceptible to thermal and silting damage from floodwaters	Gas was considered essential once the supply was initiated and coal-gas retorts could not be shut down without thermal damage.
Plant "Upsets"; explosions and other emergency situations	Floods, explosions, hurricanes, unseated gas holders, frozen valves	May have resulted in direct discharges of process residuals and wastes to the ground, to include surface waters. Also flood erosion and transport of residuals and wastes. Search for contemporary newspaper accounts of impact on FMGP.
Waste disposal area(s)	Plant generated significant amounts of solid and liquid waste that could not be accommodated on the plant site	Typically solids assigned to plant dump, mostly as broken bricks and ceramic retort fragments, along with purification wastes. Dumps typically had high voids ratios and were a tempting disposal for toxic liquids and sludges.
	Large and sometimes deep tar ponds have been encountered at Duquoin, IL, Larium and Pontiac, MI, and Carondelet Coke Works, St. Louis, MO; the latter measured in hectare of area and meters of depth	Contemporary swamps, sloughs and lowlands were favorite dumpsite candidates. Adjacent low land was often selected for use as typically unlined tar ponds and tar lagoons, as a waste disposal option when tar quality fell below sales or during bad-market conditions.

century. Science and trade journals eagerly carried news of its developments and applications. Likewise, technical books began to appear, in English as early as 1815 (Accum, 1815). All that was needed to create gas and to have gas lighting was feedstock (coal), an iron monger (i.e. blacksmith) and some ready financing.

At its beginning and for several decades thereafter, manufactured gas could be generated anywhere, given the two essential ingredients, but it required a local means of storage. This was solved immediately by invention of the *gasometer*—or *gas holder*. The technical impracticalities of its transmission prevented its distribution beyond a few miles of each gas works. Reliable, high-pressure metal pipelines were to be a thing of the future, a problem not wholly solved until 1928.

Initially, the gas engineer was faced with physical decisions related to the actual siting and layout of the gas works. Once the financing was raised (about £6,000 or US$30,000), the rest of the equation was based on geologic and anthropogenic factors (Table 1), the latter not directly recognized at the time.

4. Generic process of gas-making

It is imperative that the remedial site manager tasked with investigation and remediation of an FMGP have knowledge of the general gas manufacturing processes and the specific processes, equipment, and operational practices of the plant being investigated.

Basically, an organic feedstock (e.g. coal or oil) was pyrolytically roasted (in the absence of oxygen) to release volatile constituents in the form of raw gas. For manufacture of coal gas roasting was a batch process of a few hours' duration. For production of gas from oil (i.e. water gas, carburetted water gas, oil-enriched water gas, and the various types of oil gas), roasting was a continuous process conducted in sequential cycles of a few minutes each.

Once created, the gas always contained tar and other microscopic impurities inimical to the purpose of the gas, which was for illumination, heating, or used as an industrial fuel. Removal of these impurities was performed in two sequential efforts. The first effort, which occurred immediately after the gas was

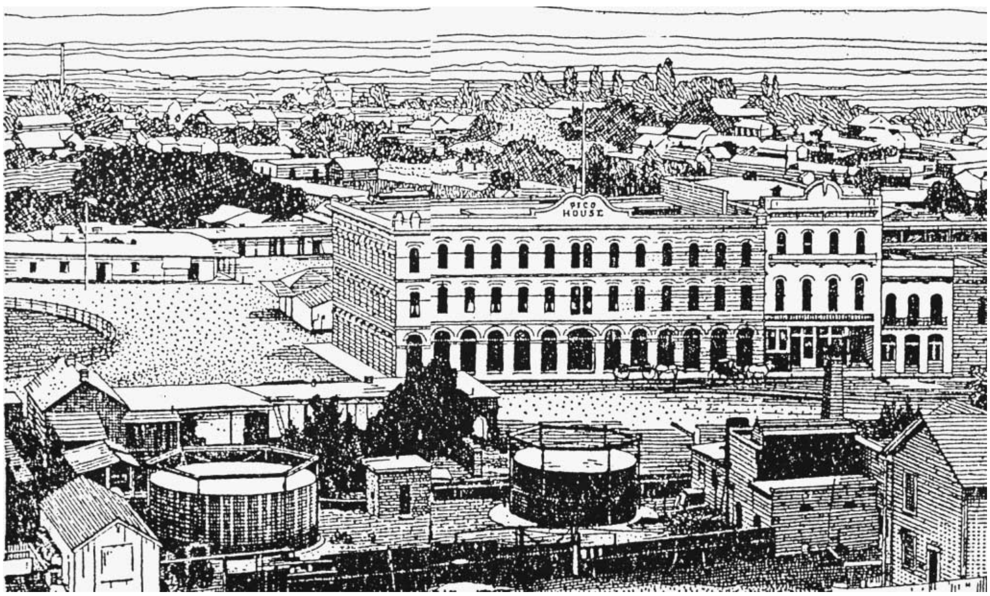

Fig. 1. Los Angeles Gas Company works off Aliso Street at today's historic Olvera Street Plaza. This was a coal-gas plant employing feedstock sent from Australia and from Britain as return cargoes for California grains. The works fronted Governor Pio Pico's hotel and it sported gas lights. Note the two gas holders already present at the 3-year-old plant. In the center is the lime house, storing purification media (from Newcomen Society of America, 1966).

generated and released from the retort (coal gas) or the generator (water gas, carburetted water gas [CWG], oil-enriched water gas and oil gas), never had a simplistic name and was conducted in devices named condensers, washers and scrubbers and in combinations of those devices. For this overall process, I use the generic term of *clarification*. The subsequent and finishing process of treatment always was termed *purification*.

Most of the gas treatment was involved in clarification. Purification, however, was essentially the same process for all forms of manufactured gas. Purifiers came in a wide variety of shapes, mainly right-circular cylinders and square-sided paralellapipeds. Known generically as ''boxes,'' these devices produced ''box wastes'' that demanded strict attention toward their management as solid wastes. In the past 2 years, a rash of discoveries of derelict box wastes has brought their fate and today's threats, mainly from forms of cyanide, to the forefront of our national remediation attention.

4.1. Generic layout for a manufactured gas plant

After examining the layout evidence for hundreds of former plants, I have concluded that there never was a consensus physical arrangement employed by the manufactured gas industry. Gas works were designed

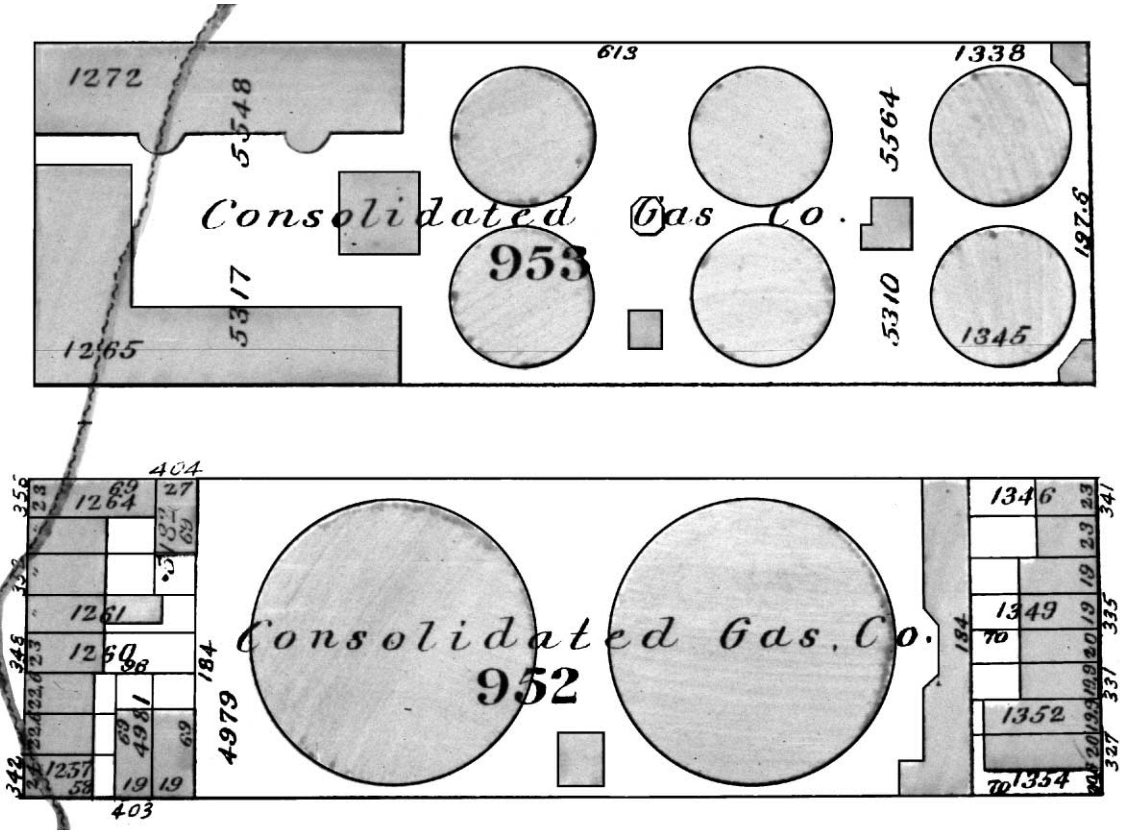

Fig. 2. Large urban gas works, that of the Consolidated Gas of New York City, 1884, when it was formed to consolidate six of the many competing manufactured gas companies. This portion of the plant covers most of two city blocks, with a rail spur in the alleyway. The remainder of the gas works occupied nearly three more city blocks. Each of the blocks is nearly 200 ft wide at the sidewalk. The drawing is a portion of G.M. Hopkins' Ward Maps of the City, published in many water-colored plates. Of course, no external trace of the gasworks exists today but the subsurface predictably will be saturated with tars, to include probable invasion of the utility systems, including drinking water. The bold, irregular line represents a topographic break in slope (from the author's collection of manufactured gas memorabilia).

Table 2
Typical components of FMGPs as potential waste sources

Component	MGP use	Waste source location and potential
Transportation spur	Delivery point of feedstocks; exit point of salable residuals	Human labor was a significant cost to gas making. Feedstocks were brought as close as possible to the retorts and generator houses.
Coal yard	Storage area which kept coal dry for optimal use in firing boilers or as retort feedstock	Kept as close as feasible to the retorts and generators. Many plants chose to place coal in sheds so as to optimize gasification in the presence of minimal water content.
Coke yard	By-product coke from coal-gas plants	Used symbiotically as feedstock for various water gas plants, especially as co-located.
Retort house	Coal-gas retorts housed internally in *benches*; groups of benches as *stacks*	The central building of the gas-making process; generally located at the corner of the plant with highest elevation and near the gate, from which the processed gas left the plant through the station meter.
Generator house	Location of *generator sets* for carburetted water gas process	Generation capacity such that vastly smaller space required for commensurate production over coal-gas process.
Condenser house	Building or addition immediately adjacent to retort house or generator house	After 1920, tended to be out-of-doors. Same configuration used for all gas generating processes; usually a wet process.
Scrubber	Tall (5–10 m) right-circular cylinders with slanted trays holding wood fiber/chips	Usually employed a water shower to remove tar and other process residuals from the gas.
Washer	Gas immersed in agitated water bath to cool gas and drop tar particles	With carburetted water gas and enhanced oil-gas, placed first in the clarification sequence as a seal against back-flow of gas.
Combined washer–scrubber	When employed, generally post-1895	Enhanced the recovery of tar from gas.
Sumps of clarification devices	Condensers, scrubbers and washers, and their combinations had bottom sumps to trap and yield tar and tar sludges	Tar generally removed manually for recovery, reuse or dumping. Spills and leaks assumed in a generic sense. Tar sludges contained refractory geologic impurities such as quartz and feldspar.
Exhauster	Steam-driven gas evacuator to reduce gas pressure and promote flow through system	Position of exhauster chosen by the plant gas engineer to achieve optimal flow of gas through the tar-removal clarification process; most plants had a backup exhauster.
Purifiers (Purifier Boxes)	Gas was passed through "boxes" containing layers of lime, wood chips and/or strips of iron as various forms of sorbants, often in conjunction with each other Generally employed minimally as a pair of "boxes" in series, with at least a spare pair in series	Trapped some tar, but designed to trap sulfur, cyanide, arsenic and other heavy metals all of which originated in or from the organic gas feedstock materials.
Relief holder	(1) With coal gas, the oldest of the gas holders, serving as a raw-gas exposure to tar-dropping seal water before clarification/purification (2) With carburetted or oil-enhanced water gas a necessary presence to buffer gas-pressure variations on blow-run cycles	Relief holders of the first variety can be expected to be of the subsurface variety and left virtually full of unrecovered tar as commonly abandoned. Second variety holder tanks tend to be less commonly abandoned with large volumes of water-gas tar, unless dumped at time of plant decommissioning.
Gas holders (Gasometers)	As many as needed Generally predicated on the largest being equivalent to 1 day's *make* Of prime concern are the subsurface tanks most common to pre-1900 varieties	Of several basic design variations. Those pre-1900 have a subsurface water-seal tank likely to have leaked considerable amounts of PAHs to the subsurface through various fractures related to brick, masonry and/or

Table 2 (*continued*)

Component	MGP use	Waste source location and potential
		concrete or composite construction materials. Valve pits commonly exhibit hot-spot concentrations of PAH contamination.
Tar wells and tar cisterns	Subsurface tanks, right-circular cylinders and rectangular or square-sided; brick, masonry or concrete or composite Less commonly known as "ammonia wells"	Commonly designed with a self-functioning gas-liquor (process water) discharge system to carry off lightest-fraction of gas liquor while retaining the gravity-separated tar fraction; all subject to through-fracture flow leakage to the surrounding earth during the operational period.
Tar separator	Both as above-ground devices housed in structures and as subsurface rectangular-form concrete or wood "tanks," the latter often made of wood planks subject to between-plank leakage	Above-ground devices were machines built to physically separate tar particles from liquor; below-ground devices contained flow baffles functioning to slow in–out flow of gas liquor carrying suspended tar, the latter dropped to the sump of the tar separator.
Boiler house	Necessary to power the exhauster and a variety of small steam engines and fluid pumps	Generally consumed coal or by-product coke; could be rigged for burning tar, under close supervision of temperatures. Ash not expected to be toxic unless exposed.
Oil storage tanks (above ground and underground)	Illuminating or enriching oil for non-coal-gas production	Generally petroleum oils susceptible to biodegradation if leaked or spilled; generally no incentive or reason to dump.
Plant plumbing	Below-ground piping, often in trenches or pipe chases	Virtually all process piping was subject to corrosion and release of PAHs, or release through joints and seams.
Yard drips (Drip Pots)	Light-oil (drip oil) collection sumps placed along gas-flow pipes in the gas yard	Used to collect naphthalene and other light oils; these were of value and were recycled, usually as carburettion oils for water gas, or as industrial solvents.
Furnaces	The fire box located below gas benches and all boilers	Source of operational heat; residue was only ash, cinder, clinker or slag; not expected to be hazardous by nature of its formation.
Station meter	Plant production measuring device housed in a structure at the gas-outlet from the plant	Generally co-located with the plant office and in the up-gradient end of the site, near the plant gate. Not a source of contamination.
Governor	Gas flow control device adjusting distributed gas to main distribution pressure	Should not be a source of contamination.
Rail-spur spills	Operational-era spills of tars and other fluid residuals (light oils and ammonia) being transferred off-site as by-products	Naturally most prominent at larger plants and those plants engaged in by-product recovery operations.
Purification box media spreading ground	Wood-chip and some forms of iron oxide media could be *revivified* on this pad and returned for re-use short of ultimate "spent" condition	Action implies shaking and mass-expansion via pitch forks. Sulfur and Prussian blue (cyanide) could be raked up and sold as by-products in many instances.
Spent wood-chip box waste burning ground	A corner or side area of the gas yard where dry chips could be torched and destroyed by fire	Required dry climate or dry season; ashes carried to a plant dump.
Plant dump	Primary disposal site on the gas yard; broken, fractured, slagged retort bricks; generator lining bricks, all manner of scurf or other carbon-slag wastes, ash, clinker, slag, off-specification tar, tar sludge, lampblack, box wastes, bottles, purifier shelf slats, broken windows, corroded pipe, scrap iron, wagon and vehicle parts, and broken gas-plant equipment	Expect a toxic character in general. Plant dump likely will be found in or at the furthest down-slope corner or extension of the gas yard, along the adjacent creek, stream, or river, or filling any original topographic declivity of the ground at the site. In almost all cases, the plant dump was filled early and supplemented with multiple dumps around the periphery of the gas plant, to within a several-block wagon haul distance.

initially by veteran gas men, who later included master plumbers, and after about 1870 in North America and Europe, by graduate gas engineers, mostly of the mechanical discipline, but including a significant percentage of civil engineers (about 40%). The overall governing condition was the topography of the site, mainly site surface gradient and the presence of an adjacent stream or body of surface water. The designer made the components fit the site and the flow of activity was from higher to lower elevation. Fig. 1 is the small original gas works at Los Angeles, CA. A

Fig. 4. Solid waste typical of the gas works dump. This riverside location displays a variety of maker-marked fire and refractory brick into which typically liquid-waste PAHs were channeled or dumped, either out of convenience to the operators or during times and conditions under which the economics of by-product recovery were considered infeasible (photograph by the author, Lansing, MI, 2001).

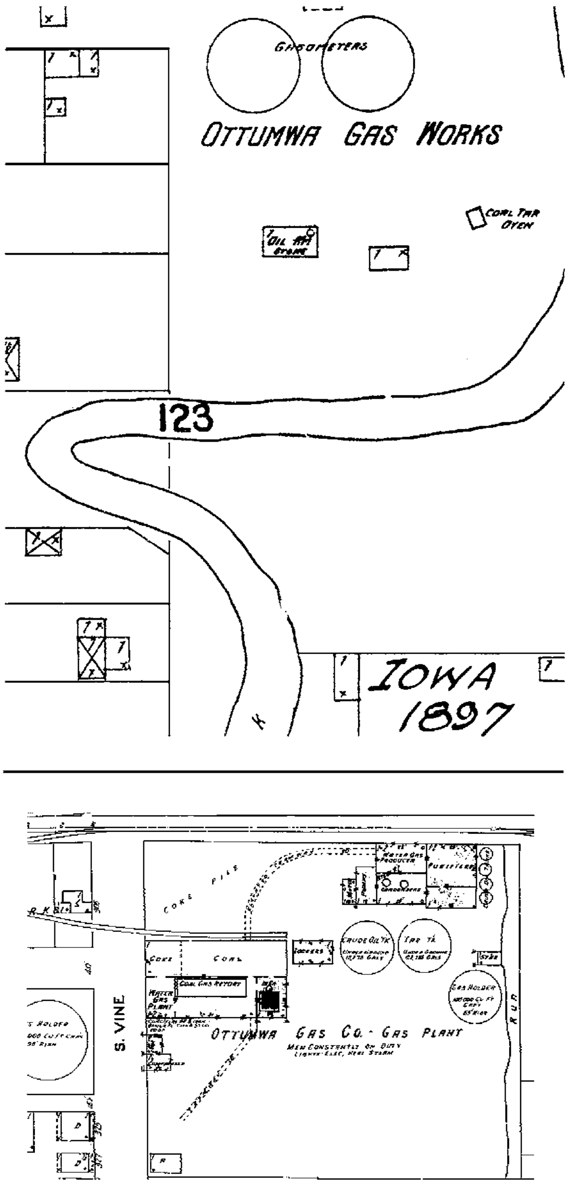

Fig. 3. Medium-sized works displayed by two editions of the Sanborn Fire Insurance Maps of Ottumwa, IA. The plant was independent as shown in the first view and as shown in the second view, was controlled by the United Light and Power, of Chicago (after the Library of Congress Collection). Upper view shows a portion of the plant in 1897, with a prominent "run" (creek) plies the gas yard flowing from the right toward the bottom of the view on its way to join the nearby river. At this time, the plant appears to have been burning at least some of its tar residuals, while other wastes likely made use of the large unoccupied gas yard rear (bottom) for disposal of ammoniacal liquors to the run and disposal of box wastes and other solid debris to the ground. Lower view, drawn in 1930, shows no trace of the now-infilled run, surely the plant dump. Owner Ottumwa Gas Company is modern in its array of symbiotic gas manufacturing processes. Coal gas yet is prominent, for Iowa coal was everywhere abundant and the agricultural rail grid was the finest in America. Coke from the coal-gas retorts likely was fed to the carburetted water gas generators and carburetting oil tanks are prominent. Water gas (blue gas) producers, the third gas manufacturing process, were present to make fuel gas for lively sales for heating and cooking and such gas likely was stored in the 100,000 cf. gas holder by the run. Illuminating gas was stored as a mix of CWG and coal gas in the newer gas holder across South Vine Street. The two older gas holders (gasometers) had been converted to carburetting oil storage and for accumulation of tar for minimum loads to be shipped via tank cars arriving on the nearby railroad siding (both maps are after coverage held in the Library of Congress).

truly large urban FMGP, the 1884 Consolidated Gas Company of New York City is shown as Fig. 2 and portrays the heroic dimensions of the gas yard and its individual buildings such as were common to large cities. Today, greater New York City is the site of at least 130 FMGPs.

To develop an accurate and effective site characterization plan for an FMGP site, an investigator must first understand how the individual *components* of the gas works (Table 2) contributed to the gas-making, treatment, storage and distribution process. The physical layout of the various plant components on a site and the likely subsurface piping connections between them will dictate where wastes were generated, leaked, or spilled. Conversely, bodies of wastes not having these associations were likely dumped around the fringes of the gas yard, in adjacent gullies or topographically low areas (Figs. 3, 4 and 5 and Hatheway, 2000). Without an appreciation of the functions of the various process components, and a knowledge of their locations, field investigators with the best of intentions can develop site and waste characterizations that are flawed. Worse-yet, such flaws may prompt injudicious choices and decisions related to public health and environmental protection. To be blunt, a flawed, inaccurate, or possibly incom-

Fig. 5. Some outstanding gas works residuals. (5L) Motor spirit (a.k.a. Benzol) was the forerunner of our gasoline and benzine was a distilled derivitive of the benzol. Today, these two light nonaqueous-phase liquids (LAPLs) are commonly found as groundwater contaminants, though more often not as free phase (from the Author's collection). (5L) The motor spirit can is British and holds one imperial gallon (both are from the author's collection). (5LL) Freshly excavated box-waste wood chips from the gas works dump at Sacramento FMGP no. 2, California (photographed by the author, 1999). (5RR) Typical appearance of the gas works dump at creek or riverside. This is at Manistee, MI (photographed by the author, 2001).

petent site and waste characterization of an FMGP destroys the accuracy and purpose of risk assessment of any sort. This is especially the case when carcinogenicity is considered.

4.2. Identifying the process flow path

Through the use of standard references sources, such as *Brown's Directory of North American Gas Plants* (Brown's Directory of North American Gas Companies; From 1889), *Sanborn* (Sanborn Fire Insurance Maps) or other fire insurance maps, and the many technical and association journals, it is possible to identify a chronological history of operations of the subject FMGP. I generally employ a working enlargement of the plant layout as found in the literature. To this drawing is applied a series of dashed arrows to denote the likely locations of leaks, spills, or discharges of toxic gas-making residuals to the ground (including discharge to surface drainage and bodies of surface water). Fig. 5 shows two prominent Light, Non-aqueous-Phase Liquid (LNAPL) "light oils" that frequently are encountered as solubilized into ground water passing below the surface of FMGPs.

This is a desktop assessment made before visiting the field. For this exercise, it is always prudent to attempt to secure both historic and recent aerial photographs of the site, particularly stereoscopic coverage. The use of image interpretation, of course, is a standard technique in engineering geology. A search for archival topographic and planar map coverage may well yield additional information concerning original topography. Of special consideration are high and low elevations and topographic lows that will have influenced, if not governed, the layout and the fate of site wastes, whether solid, liquid, toxic or non-toxic.

4.3. A word about sampling gas-house wastes

Characterization of FMGP sites in the United States is rather hindered by the fact that the Resource Conservation and Recover Act (RCRA, 1976, as amended) regulations (Code of Federal Regulations [CFR], Part 260–299) lists only 16 PAHs. In reality, there are some 500 to 3000 separate PAH compounds that can be expected to have been produced and wasted on and around a given FMGP. It is important also to recognize that "tar" and PAHs originate from non-petroleum organic material and it is "asphalt" that is the SVOC product relating to petroleum refining. A distinction is made, however, with the residuals formed from the various processes of oil–gas generation, all of which also are termed "tars" and which contain PAHs. Incomplete combustion of wood, whether used in manufacturing resin-gas or from wood fires, wood furnaces, or forest fires, also produce PAHs.

Since 1995, the popular Voluntary Cleanup Program (VCP), developed by the State of California as the *Expedited Remedial Action Program Act of 1994* have been selected by Responsible Parties (RPs) as a more favorable basis for conduct of their FMGP site cleanups. USEPA embraced this concept nationally and has allowed the States considerable freedom in the conduct of these actions. As with all hazardous waste cleanups, the VCP program generally offers the greatest degree of freedom to the Responsible Party (RP) in proposing key chemical parameters and other sampling and analysis details for site and waste characterization work plans. VCP also is the seat of the ensuing *Brownfields* program of USEPA.

With this in mind, an early site sampling effort designed to test the interpretations generated under the recommended provisions presented later in the paper is recommended. It may be in the best interests of those requesting the investigation or those funding the characterization, to generate an accurate assessment of which detectable PAHs are present in the largest concentrations, thereby possibly indicating those species that may also represent the greatest environmental threats. If strict adherence to the RCRA Appendix VIII list (40CFR261, Appx. VIII) is mandatory, a few supplemental compounds may be proposed for purposes more directly associated with the remediation philosophy of the funding organization.

The hazardous waste list that applies to Comprehensive Environmental Response, Liability and Compensation Act (CERCLA) or SUPERFUND LAW activities (40CFR302.4) does not specify individual compounds, rather, "characteristic" wastes as well as "listed" wastes.

Furthermore, in selecting plant waste bodies for sampling, high priority should be given to selecting samples representative of detected waste sources ("hot spots") as well as of the host stratigraphic unit (the latter for waste that has invaded the interstices or discontinuities of earth material units). Hambley (personal communication, Jul, 2001) notes that species-detection by means of a chromatograph, from tar samples, generally requires verification by mass spectrography, and that strict proof is a function of the resolution of the test column, and the length given over to the analysis. PAHs are not well separated by the gas chromatographic/mass spectrophotometric (GC/MS) method (SW 846 Method 8270) and High Performance Liquid Chromatography (HPLC; USEPA analytic protocol SW 846, method 8310) separates only a limited number of compounds—the 16 PAHs usually specified plus 2 isomers of methyl naphthalene. Also, several compounds can elute at a given time in a GC and identification by MS signatures is not always straightforward. Finally, long-chain hydrocarbons and multi-ring aromatics tend to travel through the chromatograph in a mass without separation. Caution is the word here and additional sampling and analysis generally will be required.

The benzene, toluene, ethylbenzene and xylene (BTEX) VOC compounds all were generated at FMGPs and are often given attention because of their capacity to dissolve away from their source volumes and to form separate, definable groundwater contamination plumes.

As a means of considering relative threats from various source areas or source volumes, it is sometimes appropriate to consider these three artificial groupings of PAH:

1. Total PAH detected and analyzed (TPAH);
2. Total carcinogenic PAH (TCPAH), and;
3. Total non-carcinogenic PAH (TNPAH).

Heavy metals, especially the carcinogen arsenic, were captured and detained at the purifier boxes and generally pose a major concern when present as dumped box wastes.

Parties to the FMGP and related remediation should feel free to suggest or require (as the case may be) screening or detection of elements or compounds in addition to those that may be required State or Federal regulatory consent orders. Such a selection may be helpful in support of the interpretation of operational or environmental conditions to support the remediation concept preferred either by the responsible party or the regulatory agency.

5. Identifying and predicting generic gas plant wastes

The relationships between various toxic wastes produced by FMGPs, and the various processes of gas manufacture are well known, both in characteristics and in relative quantities per thousand cubic feet of gas produced.

5.1. Predicting FMGP waste types

Knowledge of the character of the expected wastes is essential for planning, performance and interpretation of FMGP site and waste characterization efforts. Much of the character of the wastes to be expected at individual gas works sites can be predicted with the assistance of some of the history of that works (Table 3). In particular, Figs. 6 and 7 show drawings typical of the information traditionally held in utility company archives. Application of the following five-step sequence of logic is useful for guiding initial investigation planning efforts:

1. What residuals are to be expected on the basis of the gas manufacturing and treatment processes employed at the plant, by time period?
2. What was the overall flow path of gas and liquors, including precipitation points and likely locations of leaks, spills and other discharge, along with locations of typically leaky gas holder pit tanks, tar wells and tar cisterns, and dedicated plant sewerage?
3. Where were the wastes, as separated from useful residuals likely discharged?
4. How did the geologic setting likely affect the fate and transport of each of the potential gas works wastes and their likely points of discharge?
5. How were the wasted residuals likely removed from the site and to where?

The waste-type analysis forms the basis for the site and waste characterization effort. Some workers representing Potential Responsible Parties (PRPs) indulge in the speculation of “risk assessment” as regards the most likely scenario of exposure of gas-house wastes to human, animal and food-chain receptors, though the

Table 3
Predicting FMGP waste types as the basis for site and waste characterization

Residual	Conditions as a waste	Guidelines to quantities per 10,000 cf. gas produced
Coke	Always a candidate for fuel, for sale in the community or for use at the plant	About 60%, by weight of the original quantity of feedstock coal; approximately 2000 lb of coal per 10,000 cf. of coal gas produced yields of about 1200 lb coke.
Tar	Salable under local and regional market conditions when produced or treated to have less than 4.0% water content	When marketable and containing less than 4.0% water, sold at the plant and via rail tank cars to the many tar distillers, in the range of US$0.05 to US$0.02 per gallon. Required an effort to capture and separate from liquors and its own unsalable sludge. Calculate at 10 to 14 gal per 10,000 cf. gas, depending on the feed stock and operating conditions.
Tar-water emulsion	Commonly formed in CWG process, especially after 1910 and whenever soft coal was substituted for coke and when heavy or crude oil was used in carburettion in lieu of light petroleum oils or light tar oils	Generally unsalable whenever untreated to reduce the water content of tar water emulsions, which ran from in excess of 4% market limit to as much as 92%, as noted in the literature. Calculate at 4 to 6 gal per 10,000 cf. gas.
Liquor	Always a contaminant; was the process water used to extract tar from the tar fog of produced gas. *Ammoniacal Liquor* with coal gas and *Gas Liquor* with CWG	Highly dependent on plant design and mode of operation; generally in the range of high hundreds to tens of thousands of gallons per day. Difficult to relate to quantities of liquor per 10,000 cf. gas produced.
Tar sludge	Made up of the refractory geologic debris minerals and lithologic fragments from the parent coal or residues from parent oil feedstock	Tens to hundreds of gallons per day, depending on local design and operating conditions. Difficult to relate to quantities of liquor per 10,000 cf. gas produced. Sludge was unsalable, unusable, and nearly always dumped.
Lampblack	Uncommon to coal-gas Sometimes found in CWG Common to oil gas	Major amounts produced by Pacific Coast Oil Gas process; as produced, nearly pure, powered carbon; easily sorbs toxic PAHs in post-operational deposits or in gas works dump environments.
Ammonia	Released mainly from coal-gas production, stemming from feedstock coals	Typically wasted in both (post-1875) and smaller coal-gas plants; required special equipment to capture; after 1870 some large-city collection as cleaning agent; after 1920 sometimes a market as ammonium sulfate fertilizer.
Naphthalene	Captured at plant and distribution-system sumps, as pumped from yard and street trips on a weekly basis	Had to be captured and pumped or would cause blockages of transmission and distribution pipes and clogging of gas lights and stove jet ports.
Naphtha	Chemical term for crystallized naphthalene	AKA "moth balls" in commerce.
Light tar oils	Monocyclic and duocyclic PAHs	Historically, these were sold as commercial solvents and fuels or used as carburetting oils at CWG plants.
Medium tar oils	Another term for medium tars of the general 3 to 4-benzene-ring tars	Miscible and co-soluble with the tar mass; separable through distillation; seldom done on plant site.
Heavy tar oils	5,6,7-benzene-ring tars, includes anthracene and the "green oils" (tars)	Miscible and co-soluble with the tar mass; separable through distillation; seldom done on plant site.
Tar pitch	Heavy ends of any residual tar of manufactured gas Common to all processes	Not encountered on site in absence of a still; the end reside from distillation; favored for use as waterproofing and roofing material
Cyanide/Prussian blue	Cyanides formed from C and N released from coal Captured mainly at purification boxes and found as several compounds depending on plant conditions	Most formed in coal gas production; minor amounts to be expected with CWG and lesser amounts with oil gas. Can be released to environment in modern times under locally acidic conditions, mainly in the presence of box-waste sulfur; comes out as water-soluble or as poisonous gas.

Table 3 (*continued*)

Residual	Conditions as a waste	Guidelines to quantities per 10,000 cf. gas produced
Sulphur	Captured in purification boxes	Could be gathered and sold under favorable market conditions, mainly to generate vitriol (sulfuric acid) in urban centers; generally not the case elsewhere.
Ash	Inert refractory mineral residue of coal as a gas-making feedstock or as a plant furnace or boiler fuel	Not expected to contain contaminants above remedial action levels. Should be sampled and tested, however.
Clinker	Partially fused ash	Not expected to contain contaminants above remedial action levels.
Slag	Mineral-fused ash	Forms from retort and boiler furnaces. Not expected to contain contaminants above remedial action levels.
Scurf	Hard carbon deposits formed on interior surfaces of retorts and generators	Removed by manual chipping via iron rods. Not expected to contain contaminants above remedial action levels.
Spent lime (“Blue Billy”)	Spent lime cleared from one-time use in purifying boxes; most common before 1875; crushed limestone as well as pulverized sea shells	Generally a toxic waste containing cyanide and heavy metals, possibly sulfides. May be associated, as dumped, with other spent purification media.
Spent wood chips, excelsior[a] or coarse sawdust	Sorbant wood waste brought to the plant for purification medium; Generally from 1870 to end of manufactured gas era	Consider potentially toxic unless shown otherwise. May be associated with other spend purification media. May not display Prussian blue color until exposed to air.
Spent iron Spirals, Spent iron strips, Spent iron oxide, Spent bog iron (ore)	Sulfur-capturing media brought to the plant for purification; generally post-1875 to the end of manufactured gas	Considered toxic unless shown otherwise. Be concerned with sulfur-related pH conditions that can lead to release cyanide to the environment.[b] May be associated with other spent purification media.
Retort and bench fragments	Retorts replaced at 24-month or lesser frequency	Approximately 1 ton per bench per year. Forms a void matrix for dump-sequestering of PAH toxic waste.
Replaced CWG generator shell lining brick	Average brick liner replacement each 6 months	Approximately 3 tons of brick removed and replaced per generator set per year. Forms a void matrix for dump sequestering of PAH toxic waste.

[a] Spiral-form wood shavings.
[b] “Sulfuric” spelling is consistent with historic usage.

latter two computations generally are neglected. It is recognized, of course, that there are differences in the degrees of potential exposure involving the food chain, between urban and rural areas, with the exception of urban residents who rely on fish and other aquatic life to supplement their diet. Likewise, USEPA has largely abandoned its own regional prosecution of FMGP cleanups in favor of limited special funding to those of the State regulatory agencies that have elected to pursue this highly worthwhile area of environmental remediation.

This paper therefore is presented especially as suggested guidance for the States and Provinces in their deliberations related to defining full disclosure FMGP characterization. Without deliberation as to the likely presence and location of gas-house toxic waste “sources” (a.k.a. “hot spots”), the entire exercise of risk assessment takes on the nature of a ridiculous “drill,” conducted with the reality of a charade that bears little or no bearing to actual site conditions.

5.2. Generic forms of manufactured gas plant wastes

Gas-house wastes are herein classified as a series of groups (Table 4) that are useful for site and waste characterization. In this classification presented physiochemically, it is theoretically possible for PAHs to contain more than six rings; however, no such

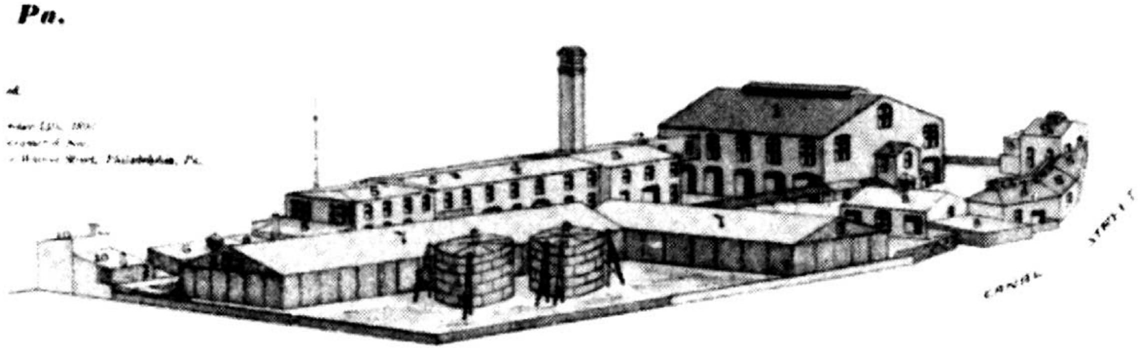

Fig. 6. Ernest Hexamer's Fire Insurance perspective sketch of the Northern Liberties Gas Works off Canal Street, in Philadelphia, 1875. Hexamer was an innovator with this well-appreciated visual feature in his atlases. The 2.5-story generator house proclaims that this works had already adopted T.S.C. Lowe's carburetted water gas sets, as produced at the Lowe factory at nearby Norristown, PA. The plant boiler supplies steam for pumps, gas holder external heating, and drives exhausters and feedstock elevators. The long farside building was the site of clarification and purification of the gas, and such was stored on the gas yard in two gas holders with subsurface pits ("tanks"). Coal and coke was stored in the sheds on the near side of the plant and the works was surrounded by a low fence. Pipe-fitting and maintenance shops and a stable occupy the uphill Canal Street corner of the works, while pipe-fitting shops fill the far downhill corner (from the author's collection).

compounds have been reliably reported as of this writing.

Though many readers will have significant experience with volatile organic compounds (VOCs) such as halogenated (chlorinated) solvents, gas-house tars are non-chlorinated and are classed as semi-volatile organic compounds (SVOCs). This distinction is important, for much of the knowledge of modern remedial-mitigation technology does not apply to site and waste characterization of FMGPs. USEPA recog-

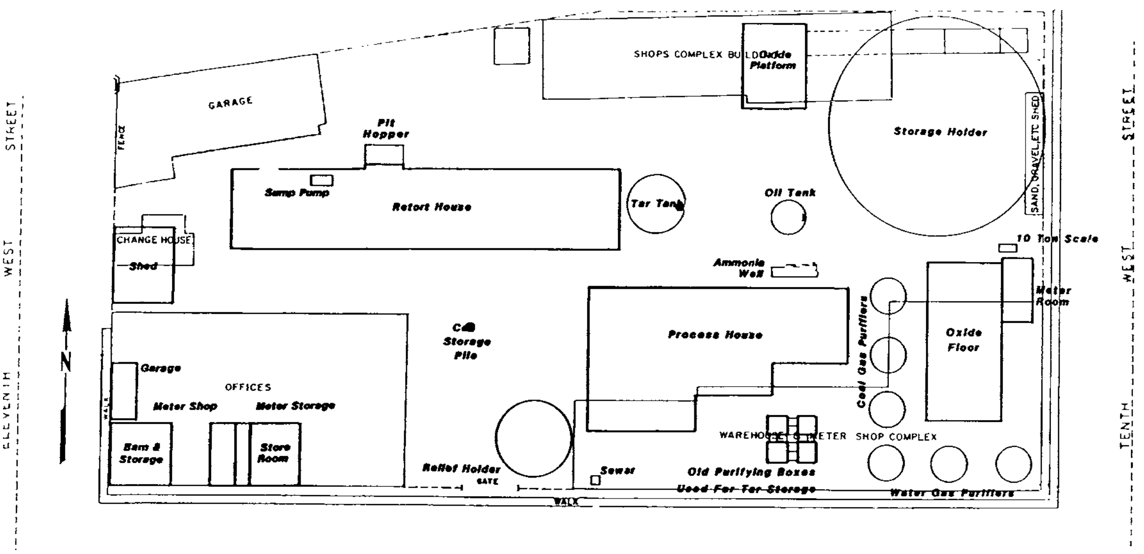

Fig. 7. Salt Lake City's first gas works was established in 1872 at the direction of Mormon Church President Brigham Young. Here is a composite plant layout drawing of the Salt Lake City plant of the Utah Gas and Coke, established in 1907 as an opposition company. This 1924 configuration is as taken from design plans by its holding company owner, American Public Utilities, a subsidiary of the engineers, Kelsey Brewer & Company, of Grand Rapids, MI, also operators of gas and electric properties. Utility company archives were famous for the breadth and detail of their holdings. The FMGP is bordered on the right by 10th West Street and on the left by 11th West Street (after drawing in files of Utah Department of Environmental Quality).

Table 4
Generic forms of manufactured gas plant wastes

Waste form	Nature	Character as a waste source
Solid waste	Plant operation, maintenance, expansion, and demolition debris Found both on-site and in near off-site environs Every site had at least one gas-yard dump Most plants were ringed with multiple off-site dumps	Typically inert and dominated by service-damaged ceramic retort fragments, fractured fire brick, scrap iron and pipe, along with scurf, ash, clinker and slag, some from gas machines, some from plant boilers. Ash and clinker is subject to sorption of PAH if such later comes into contact. Often this inert mass contains dumped toxic tarry wastes in its void interstices.
"Box waste"	Potentially toxic solid waste such as cyanide and heavy metals Found both on-site and in near off-site environs	Media were introduced at about the times shown; Lime (1805), wood chips, excelsior and sawdust (1870), and iron oxide (1875), as borings, scraps, strips, bog iron ore and various forms of particulate oxide. Often used contemporaneously, as layers.
"Gas liquor" (Generic Term) A.k.a. "Ammoniacal Liquor" (Coal-Gas Process) A.k.a. "Gas Liquor" CWG and Oil-Gas Processes)	Combined aqueous condensate of gas manufacture plus process waters applied for gas cooling and precipitation of tar Includes coke quench waters at the retort house and at by-product coke ovens Subject to final, long-term precipitation of PAHs to sediment of the receiving area Tend to be found throughout the site and its subsurface, as ubiquitous waste fluids and as groundwater contaminants	Known as "ammoniacal" if from coal gas, other wise and generally known as "gas liquor." This was the plant process water effluent and may have been treated to recover tar, especially where such documentary evidence exists. The treated residue always was discharged in some fashion, either through leaking subsurface vessels or from design-overflow discharge, or directly into plant surface drainage channels or dedicated sewers. It is important to recognize that some gas liquor is BTEX, as "light oils", are LNAPLs, and the remainder are "medium" to "heavy tar oils" and therefore are DNAPLs.
Tar	Created as a result of all gas-manufacturing from organic feedstock Had to be removed from the raw gas, at the plant, to serve the consumer Was totally lost to the environment at charcoal plants and "beehive" coke ovens	Recover and reuse or sale based entirely on philosophy of plant management as well as on current market conditions for sale. Generally unsalable when water content exceeded 4%; CWG tars typically had a high-water-content emulsion form after 1910. Usually present at FMGPs as bodies of contaminated soil, in abandoned subsurface vessels such as gas holder tanks and tar wells, and as subsurface pockets or "hot spots."
Lampblack	Relatively largest quantities to be found at oil-gas plants	Typically non-toxic but capable of sorbing PAHs later, to significant degrees.
PAH in site ground water	Released continually, from each source area, solubilized into passing groundwater Released from the source in relation to their solubility in the passing ground water	Typically most active during active operation of the gas works. Will persist indefinitely afterward, unless physically removed, as the source areas are essentially non-degradable in nature and have lives measured in geologic time. "Light oils" do not reflect the totality of groundwater contamination.

nizes 16 PAHs as defined toxic compounds (Appendix VIII, 40CFR261), though it is well known that gas feedstocks can produce from 500 to 3000 separate PAH compounds at a single instance of pyrolysis.

We used to have considerable reservation toward penetration of sources for the purpose of sampling for laboratory analysis. Site exploration equipment and skills are now established well enough that all FMGP

Table 5
Predictable general geologic influences on gas plant wastes

Geologic condition	General effect	Implication
Vadose zone	Transmits SVOCs to depth	Depth controlled by magnitude and duration of the discharge or leakage.
Groundwater surface	Terminates free downward component of fluid gas waste flow during active addition by source-creating mechanism, unless the waste is DNAPL	Major force in lateral movement, mainly along flow gradient, with some side-spreading.
Hydraulically conductive vadose-zone bottom stratum	Base of toxic source volume sits on or in the waste mass	Common occurrence in disused sand pits in which original borrow pit was terminated at depth of entry of ground water, and that case repeats itself to flush or leach the waste volume to local ground water.
Alternating sequences of vadose-zone soil stratigraphy	Direct relationship on how much lateral flow transport distance will occur for the less-viscous tar fractions	Vertical trace of horizontal migration will have the irregular appearance of a geophysical borehole density signature (i.e. furthest outward in the most conductive strata).
Geomorphic channel-and-fill	Become selective pathways for lighter tar fractions and, especially gas liquors (as PAH-contaminated wastewaters)	Acts as an overwhelming conduit for contaminant migration as long as supply and relative viscosity overcome gravitational effects, along with channel-bottom permeability to the gas liquor or its suspended tar or dissolved PAHs.
Lateral distance to topographic declivity	Will significantly alter flow path of contaminated ground water	Always be on the lookout for gully-side breakouts.
Solubility in ground water	Most soluble tar fractions will strip off the outer rind of each tarry source volumes and contaminate passing ground water	The situation has the potential to yield and transport contamination for thousands of years or more. Often detected by iridescence of floating water-surface sheens or from fish and other aquatic-life kills, particularly fresh-water clams.
pH of vadose-zone host soil	Under acidic conditions can lead to release of box-waste cyanides and heavy metals	Arsenic, a known carcinogen, is the most common of the box-waste heavy metals.
Active cone of depression	Cone of depression touches host earth material holding the contaminant source volume	Active withdrawal from adjacent ground water supply may induce activated flow movement of FMGP toxics.
Pockets, lenses or channels of higher porosity and/or conductivity	Stratigraphic bodies present as anomalies in an otherwise more dense and less porous/less conductive host medium	Become operational-era sumps as natural "hot spots" of accumulated PAHs as leaked spilled or otherwise discharged to the ground.
Top-of-rock	Very important to anticipate and/or recognize this situation as a potential DNAPL trap, especially if at the base of a soil sequence	Traps most of the tar oils, yet lighter or free-phase DNAPLs will likely have penetrated the more open rock discontinuities. May, in some cases, cause PAH migration counter to the recognized saturated-zone groundwater flow gradient.
Psuedo-geologic pathways for PAH transport	Formal (municipal) and informal (plant) sewers	Most gas plant operators chose to keep the gas yard dry for optimization of plant operation.
	Gas yard drainage features such as tiles	Most gas yards were laid out to drain from the entrance to the adjacent stream or lowland.
	Often leakage occurred along the exterior of the sewer/pipe	Some of these drains leaked wastes before ultimate discharge.
Fluvial sediments	Generally present in thalwegs and channel inverts of natural drainage and as accumulated in lowland areas formerly known as "swamps," adjacent to the FMGP	Usually has an appreciable content of clay-particle and clay mineral content that was instrumental in local capture of the PAH and other impurities discharged with the plant liquors.

Table 5 (*continued*)

Geologic condition	General effect	Implication
Glacial geologic features	Lodgment (basal) till restricts contaminant transport	Light oils could and did penetrate glacial lodgment till joints however.
	Periglacial and proglacial drainage features	May constitute high-velocity operational-era contaminant-transport pathways.
	Buried channels	May constitute high-velocity operational-era contaminant-transport pathways.
	Geomorphic "holidays" ("windows") in glacial-lacustrine clay horizons	Known to destroy natural restraints to PAH migration downward in the soil sequence.

subsurface structures deserve careful, incremental sampling to their ultimate depths. In most cases, hot spots will require some sort of direct treatment and the imperative of maintaining their integrity during field exploration should not be cited as a deterrent to sampling. Nevertheless, invasive sampling should be planned and conducted so as to only minimally disturb contaminated ground.

5.3. Special nature of "tar"

"Tar," as a technical form, refers strictly to the viscous residue from pyrolytic (in the absence of oxygen) combustion of organic matter. Strictly speaking, use of the term "tar" thus implies an origin from coal. Its counterpart term "asphalt" strictly connotes a petroleum origin. During the manufactured gas era, the tars were also referred to as "oils," and they came in combined degrees of specific gravity, from light through medium to heavy oils. The final high-gravity, high-viscosity residue was known as "pitch," which readers older than age 50 will recall having seen tar as a waterproofing roofing material melted on-site in roaster trailers and applied with hot mops.

Tar oils consist of chains of benzene rings. Those that contain three to six benzene rings are known as polycyclic aromatic hydrocarbons (PAHs) or less commonly as polyaromatic hydrocarbons or, equivalently, polynuclear aromatic hydrocarbons (PNAs). The tar "light oils" properly are one-ring (monocyclic) and two-ring (duo-cyclic) PAHs, but these are light, non-aqueous-phase liquids (LNAPLs). PAHs of three or more benzene rings are dense, non-aqueous-phase liquids (DNAPLs). Theoretically, it is possible for PAHs to form in chains of more than six benzene rings, but such has not yet been reliably reported in the literature.

5.4. Typical hot-spot waste locations

In the absence of gas company historic design and layout drawings, the historic Sanborn Maps (Goad Maps in Canada) are the most reliable, generally available indicators of potential FMGP site waste locations. Design and layout drawings, along with equipment inventories and interior and exterior photographs were routinely produced for and by the gas utilities during the era of manufactured gas. Regrettably little of this well-known trove of company archives has been declared as surviving in the traditionally meticulous and comprehensive utility archives. State archives sometimes yield such contributions from the public service commissions. Almost impossible to locate is other such evidence in the hands of collectors, as historic "paper."

As revised aperiodically, it is important to ensure that the Sanborn Map coverage of subsequent editions spans the entire operational period of the plant. In many instances there were process and equipment modifications and replacements, along with other additions that can greatly impact the locations of present-day hot spots.

The author prefers to identify, in prediction, likely locations of hot spots of plant toxic by a series of circled "x" marks with numbers to identify the suspected nature of the wastes and their waste-source form.

Information regarding plant decommissioning and demolition also must be considered. Those FMGPs that were formally decommissioned, most likely in the 1946–1965 time frame, were subject to dumping of on-hand tars left in place at termination of plant activities. Those sites at which derelict tar wastes were brought to the ground surface and spread across the site can greatly alter the resultant contamination. Decommissioning by utilities was typically carried out under formal bid and work-order documents specifying final site conditions.

I strive to overcome not only subtleties but some outstanding misconceptions that have been applied to FMGP remediation since Federal emphasis was placed on remediating such sites in 1985 by USEPA.

6. Geologic controls

The nature of the location of wastes at an FMGP relate mainly to historic gas works technology. For most FMGP sites, the historic record is cloudy due to the fact that archival records relating to most plants are claimed by RPs to have been destroyed. A diligent search of the relevant gas literature (e.g. American Gas-Light Journal) will provide most of the missing events affecting plant operational history.

It becomes paramount, therefore, that the actual search, discovery and verification of gas works wastes be a geologically intensive field activity, following a competent attempt to predict such wastes. Most gas plant remediation professionals have witnessed clean-up overruns of "unexpected" caches of contaminated soil or hot spots of tar pockets that easily reach the magnitude of several thousand cubic meters. The "surprise" was, of course, generally rooted in an unwillingness of the RP to categorically predict the potential for such wastes and to place explorations in the potential area for such waste. Regulatory officials must also be prepared to make such predictions and argue for, or stipulate, that such ground be investigated to their satisfaction.

Once in the ground, and certainly after termination of plant activity, most gas-house wastes become relatively immobile, either because they are SVOC liquids with typically low solubility in ground water and high viscosity, or that they were solid wastes in the first instance. SVOCs basically come to rest in the vadose zone due to a positional equilibrium between their fluid density and viscosity and the pore or fracture medium of the host earth material, upon which gravitational force has acted as the driving mechanism. The viscous SVOC compounds lack the pressure to overcome interstitial forces and to invade pore or fracture space at that point.

I have discovered some geologic truisms as a result of my own FMGP and other site characterization experience. These are offered in Table 5 as the most likely conditions to be expected in planning for characterizing FMGP sites and can be used to develop the first phase of field explorations and to test the resulting observations. Geologic features of the FMGP site may themselves present the greatest physicochemical control over the fate and transport of plant contaminants that have been leaked, spilled or discharged, and were not the subject of plant dumping during the plant operational period.

6.1. Site and waste characterization planning

Once the historic site layout information has been evaluated and interpreted and the predicted sources and location of wastes have been delimited on the site map, explorations can be allocated to the verification of the expected (pre-exploration) stratigraphy and the discovery of waste sources or other hot spots.

Site exploration costs can be managed in an economically effective way if the general findings of Expedited Site Characterization are followed (Beam et al., 1997); to wit, to produce and evaluate findings on a daily basis while the team is mobilized for field activity, and to apply corrections to the plan on that basis. Corrections are made from evaluation of visual observations and from incoming laboratory determinations. Of course, the exploration team must be on a highly credible level of communication with regulatory officials in order to conduct the work plan within a rapid-response framework. Generally, it is most efficient when the RP arranges with the State or Provincial regulatory agency to pay for the presence of an on-site regulatory oversight official.

6.2. Geological and geophysical exploration techniques

Sensitive FMGP site characterization efforts generally begin with the use of a backhoe. Good photo-interpretation skills, followed by field-mapping observation, are primary and essential, as leads to backhoe exploration. Then, on evaluation of site evidence, it is proper to consider some form of push-probe, capable of sensing the geologic character of the subsurface with minimal disturbance of the ground itself, should waste sources be directly encountered. Direct-push devices are ineffective, however, where gas-house solid wastes have been disposed with retort and generator brick fragments.

Backhoes are particularly useful in locating the outer surface of gas holder tank walls, as well as those of the various forms of tar wells and cisterns (same meaning). For most other applications of site characterization technique (Hatheway, in press (b)), exploration of FMGPs do not differ significantly from the prudent choices available for site exploration and sampling for UHWSs in general.

Where soil-vapor gas analysis collectors are appropriate, the gas-collection port must be pushed to such a depth as to avoid the usual background. By their very nature, however, PAHs are only weakly volatile at

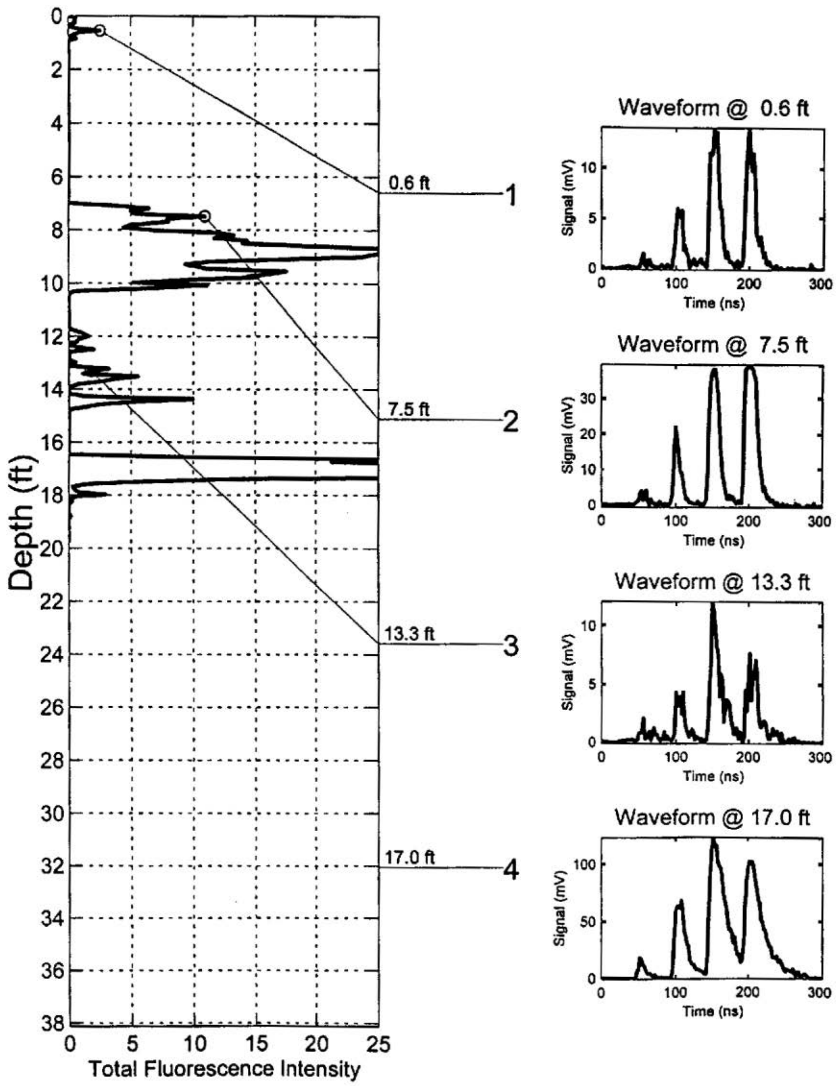

Fig. 8. Composite SCAPS signature from a FMGP site in New York State. The wave form is diagnostic of PAHs with four peaks. The laser-induced fluorescence is tied directly to highly reproducible soil typing by the Unified Soil Classification System (USCS) of the U.S. Army Corps of Engineers (courtesy of Fugro Geosciences, Houston, TX).

ambient temperature. Many probe operators are ultra cautious about incurring damage to their equipment, so that it is prudent to allow extra time for slow advance rates in this ground suspected of having subsurface obstacles.

Of particular use are push devices equipped with fluorescence scanning capability. The original tool in this field is the Site Characterization and Penetration System (SCAPS) developed by the U.S. Army Engineer Waterways Experiment Station, and field-tested in 1990. SCAPS became commercially available in 1994 and is equipped with a fiber-optic laser-induced fluorescence (LIF) device that excites spectral response in soils penetrated outside its sapphire–crystal lens. The collected soil/contamination response is computer-recorded and plotted as a LIF signature opposite the geotechnical push-resistance plot of the stratigraphy being penetrated.

Together, the two vertical plots define the soil types penetrated (in accordance with the Unified Soil Classification System [USCS]) and such contaminant groups as are present, including those groups with compounds and elements typical of gas-house wastes.

Fig. 8 is a segment of an FMGP exploratory boring response signature captured by FUGRO-McClelland consultants, of Houston, TX, who are one of several

Table 6
Criteria for producing a complete and accurate FMGP characterization

Criteria	Scope	Questions to be raised and resolved
Chronological history of the site	Minimally to include screening and abstraction of dates and time periods, gas-manufacturing process, site ownership and configuration (1) *Brown's Directory* (2) Fire Insurance Maps (3) Historic Photographs (4) Local Newspaper Coverage (5) Proceedings of Gas Associations (6) Gas Industry Journals	(1) Fundamental layout of the site, from establishment to termination. (2) Relate gas manufacturing and necessary treatment activity to types of gas-house residuals and wastes. (3) Estimate, quantitatively, the gross amount of site wastes that would likely have been produced for each period (say, decade) of plant history.
Definition of gas-production and treatment paths	Provide layout interpretation of the locations of component steps and transport of gas and residuals on the property	(1) Location and function of all definable components of the gas plant. (2) Pathway of movement of gas and residuals at the site.
Predicted locations of wastes remaining on site today	Examine historic evidence; evaluate such in terms of site as it exists today.	(1) Most likely present location of wastes associated with each component device and structure and each gas production and treatment activity. (2) Portions of the gas yard shown as vacant on Sanborn Maps likely are on-site dumps.
Complete coverage of the plant site area	Apply geologic assessment to all field data to gain an appropriately high-level of confidence that undetected toxic wastes are not left undetected	(1) Ensure that each predicted lead is subject to individual field investigation. (2) Leave no portion of the former gas yard unexplored; To commit such an error is to flaw the entire Remedial Investigation or characterization.
Possible off-site dumps	Commensurate with access to property and the risk assumption policy of the responsible party and the oversight public agency	Presentation of a real question of environmental ethics, especially considering that the adjacent property will likely be owned by interests other than those of the project at hand. May require being addressed by public officials and the regulatory agency.

geoenvironmental firms that market the technique nationally, as their Rapid Optical Screening Tool (ROST)-LIF services.

6.3. Development of the characterization assessment

Characterization should be terminated only when its scope and findings meet established criteria for completeness. Table 6 is offered as a checklist for conduct of FMGP site and waste characterization.

A guiding philosophy for site and waste characterization of FMGPs should always reflect the fact that these toxic compounds are non-degradable with time and are relatively immobile. Whenever they are in contact with ground water, they transfer their toxicity to the environment. Whenever and wherever there are flaws in the characterization of a FMGP (or other coal-tar site) there will come a day when resultant human or environmental damage will be detected after the fact. Our larger cities are rife with derelict MGP sites (130 in Greater New York City and at least 87 in Greater Chicago). Nearly priceless building sites will be heavily cost-impacted by premium foundation treatments when they occur at an FMGP.

7. Conclusions and recommendations

All parties to the characterization of FMGPs and other related sites should bear in mind that incompleteness or flaws in the characterization may leave the public and/or environment at peril.

Some agents working with these sites prefer to apply the concept of Risk-Based Corrective Action (RBCA), in accordance with the provisions of applicable ASTM standards. Based on his own background and experience, the author is strongly opposed to the application of RBCA to any FMGP, because none of the site wastes are environmentally degradable (as opposed to petroleum-based compounds) and seldom are FMGP sites explored with enough thoroughness to preclude that gasworks waste are not left undiscovered. It is unrealistic to expect or factor in any form of future "natural attenuation" for the medium-to-heavy "oil" associations (three-plus benzene-ring molecular structure) of the tars. This objection is based not only on possible reliance on "natural attenuation" but on fate-and-transport assumptions that are not borne out by comprehensive and competent site and waste characterization exploration, logging, evaluation and interpretation.

This paper constitutes a very brief overview of what the author has attempted to encapsulate in his forthcoming technical book *Remediation of Former Manufactured Gas Plants and Other Coal-Tar Sites*. Unlike nearly all other uncontrolled hazardous waste sites, FMGPs represent the most difficult of characterization sites, mainly because of the largely SVOC nature of much of the toxic wastes and the fact that all waste bodies are intimately united with the subsurface geologic conditions at the individual site. The author invites the reader to visit his web site (www.hatheway.net) and to contact him with suggestions, comments and/or questions.

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ENVIRONMENTAL
Fact Sheet

NEW HAMPSHIRE
DEPARTMENT OF
Environmental
Services

29 Hazen Drive, Concord, New Hampshire 03301 • (603) 271-3503 • www.des.nh.gov

ARD-EHP-17 2006

Manufactured Gas Plant Waste

What is a manufactured gas plant?

Until natural gas was introduced, coal was the primary natural resource used for making the gas used to illuminate street lights and mills, as well as for cooking and heating. By the later half of the 19th century, most of the big cities in America had manufactured gas plants (MGPs) that were operated by utility companies. To manufacture the fuel, coal and other ingredients were heated in large brick ovens. As the coal was heated, it produced a gas. The gas was filtered from the ovens and stored in tanks. The gas was then used as fuel throughout a community.

MGP production declined as a network of natural gas pipelines was built across the country in the 1950s. As natural gas became widely available, MGPs closed. It was cheaper to use natural gas. Many MGPs were abandoned and eventually demolished. However, waste and contamination from MGPs still pose an environmental and public health concern.

Why be concerned about wastes from a MGP?

Manufacturing gas from coal generated a lot of waste. Typically, MGP waste in the form of tars, oils, cinders, coke and ash, was buried or used as fill for construction projects. The wastes contain many chemical constituents that are hazardous to human health. The composition of the waste depends on the type of coal and the gasification process used. Chemicals associated with MGP waste include volatile organic compounds (VOCs) like benzene and toluene, polynuclear aromatic hydrocarbons (PAHs) like naphthalene, tar acids like phenol and cresol, creosote, and coal tar pitch.

Can MGP waste be a health hazard?

Waste from the gas manufacturing processes can be found in soil, surface water, and ground water. Depending on the site, the contamination can be minimal or extensive. Most of the contamination is buried under soil and does not pose a direct health risk. However, if coal tar residues come in contact with skin, it can cause redness or a rash. In some people, the coal tar can cause a sunburn effect on skin. Eye irritation is another hazard if coal tar residues get in the eyes.

Can it affect my drinking water?

In cases where the contamination has spread into groundwater, exposure to drinking water contaminants can be a concern. Tests can be performed to determine if water quality is affected by MGP waste.

What are the health hazards from MGP waste?

The Agency for Toxic Substances and Disease Registry (ATSDR), a branch of the US Department of Health and Human Services, provides information on the health hazards from chemical exposures. Toxicology fact sheets for the specific chemical constituents of MGP waste are available at the ATSDR website: http://www.atsdr.cdc.gov/toxfaq.html.

What are the health concerns of cleaning up former MGP sites?

Cleaning up a MGP waste site may temporarily cause discomfort to a neighborhood. The cleanup problems include odors, noise and the presence of heavy machinery. Odors are the most commonly reported nuisance. The odors that may occur can have either a gasoline or mothball-like smell. People with breathing difficulties, such as asthma, may be affected if the odors reach hazardous levels.

The contractors cleaning up MGP waste are trained to manage the site for safety. They monitor and control vapors from reaching levels of health concern to nearby residents. DES actively works with the site clean up team to ensure that odors and other discomforts minimally affect a community.

For more information

For more information regarding the environment and how it relates to your health or any other topics presented here, please call the NH Department of Environmental Services Environmental Health Program at (603) 271-4664, or toll-free in New Hampshire at (800) 498-6868, Ext. 4664. Information is also available at www.des.nh.gov/ard/ehp/.

NH Department of Environmental Services
Environmental Health Program
29 Hazen Drive, PO Box 95
Concord, NH 03302-0095

Health-based Guidelines for Air Management, Public Participation, and Risk Communication During the Excavation of Former Manufactured Gas Plants

Wisconsin Bureau of Environmental and Occupational Health
Department of Health and Family Services
PO Box 2659
Madison, WI 53701-2659
(608) 266-1120
or Internet: dhfs.wisconsin.gov/eh

August 24, 2004

Wisconsin DHFS: Manufactured Gas Plant Air Guidance

damage from sulfur-containing materials, particularly sulfur dioxide (ATSDR MRL=10ppb), are well known (Kleinman 2003) but have not been well addressed as an air issue during MGP remediations. Sulfides (S^{2-} ; metal-sulfur compounds), sulfates (SO_4^{2-} ; compounds of oxygen and sulphur combined with one or more metals), and sulfites, where present, are predictably dispersed with soil and dust particles during MGP excavations. At this time, DHFS recommends that non-volatile sulfur compounds be managed in the context of NAAQS for particles discussed above.

Table 2. Toxicity, odor, volatility, and relative prevalence of major volatile compounds in air at MGP sites.

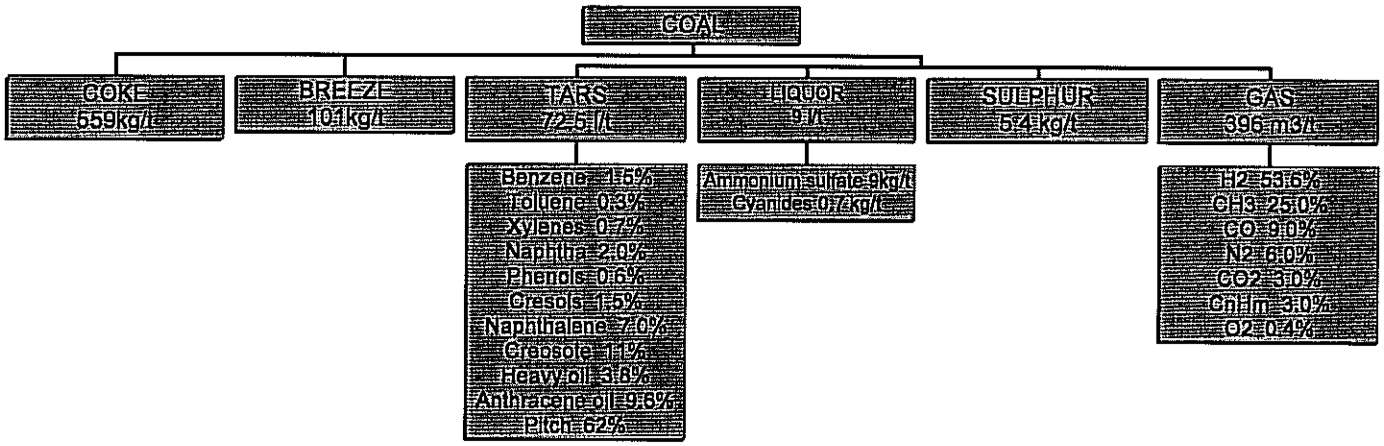
				Prevalence in air at one example MGP site[c]	
	Toxicity RBC ppb[a]	Odor threshold ppb[b]	Vapor pressure mmHg, 68F	Excavation (total volatiles= 4103 μg/m³)	Perimeter (total volatiles = 1117 μg/m³)
Benzene	**10**	**61,000**	**75**	**21.7%**	**7.7%**
Naphthalene	**0.6**	**40**	**0.08**	**46.3%**	**6.3%**
Xylenes	**23**	**20,000**	**7**	**11.5%**	**56.4%**
Toluene	**106**	**1,600**	**21**	**8.3%**	**17%**
Styrene	**235**	**140**	**5**	**Not reported**	**Not reported**
Ethylbenzene	**230**	**100-600**	**7**	**11.9%**	**12.5%**

[a]EPA, *Integrated Risk Information System, 2004.* Reference concentration chronic inhalation.
[b]AIHA 1989
[c]Collins *et al.* 1999

Developing Air Quality Goals and Action Levels

Recommended sentinel compounds. Many different volatile chemicals are present in MGP wastes, but on-site air management decisions are usually based on the monitoring of just a few of these (Collins *et al.* 1999). The choice of representative sentinel compounds in an air management plan should be based both on the risk imparted by a compound's prevalence and toxicity, as well as the analytical ability to detect these compounds. The odor threshold of particular VOCs also factors into their inclusion as a sentinel compound, since tar odors around MGP excavations speaks directly to public risk perception surrounding the remediation work. MGP projects often extrapolate from the fuel spill model, choosing the BTEX group (benzene, toluene, ethylbenzene, xylenes) as representative VOCs. Other candidate sentinel compounds should be considered, based on environmental assessment. For example, groundwater from an MGP test well techniques. Perhaps most important is anticipating dry, windy conditions that disperse stockpiles. In Wisconsin, occasional problems have occurred around MGP sites where winds have dispersed particles and odors from pretreated stockpiles awaiting thermal desorption. In these cases, irritating odors in nearby buildings were resolved using surfactant controls on stockpiles and closing building openings where necessary. With experience, site managers can anticipate and prevent such problems. For example, at a summer MGP excavation in an urban residential location in Wisconsin, site managers found it prudent to cease excavation work during hot or windy afternoons to avoid potential air releases that would generate complaints from the public.

Figure 2. Product yield from coal gasification. (Adapted from Buckley 1983)



PAHs. Polycyclic aromatic hydrocarbons are a diverse group of hydrocarbons that comprise a large proportion of MGP wastes (Figure 2). PAHs are also a focal component of the particles targeted in the NAAQS. The PAHs commonly studied in the environmental literature and included in environmental reports from MGP sites are 2-6 ringed, with molecular weights in the range of 128-300 (Boström *et al.* 2002). The actual breadth of PAH structures present in MGP wastes is probably much greater (Hathaway 2002) if included are little-studied larger molecular weight structures, PAHs with side-chain substituents, and PAHs with sulfur- or nitrogen-containing rings. The tendency of PAHs to disperse ranges from semi-volatile (e.g. naphthalene, vapor pressure 0.08 mm Hg;), to non-volatile structures that are dispersed via surface adsorption to particulate matter. A number of PAHs are toxic following their oxidation to a corresponding reactive structure (ATSDR 1995, Boström *et al.* 2002). Activation to a reactive structure can occur through photooxidation in the case of skin contact, or metabolically in the case of ingestion or inhalation. Benzo(a)pyrene (B(a)P) is one of several PAHs that form

Cyanides. Cyanide wastes at MGP sites exist mostly as stable iron cyanide complexes, such as ferric ferrocyanide, which are associated with oxide box wastes common to coal gas sites. A small percentage (< 5%; Luthy *et al.* 1994) of the total cyanide-containing waste is in the form of less stable metallo-cyanides and cyanide salts. The potential for free cyanides to be released from these materials into groundwater is a topic that has received both scientific and regulatory attention (Ghosh, *et al.* 1999a, 1999b; EPA 2003d). The release of cyanide to air at MGP sites is theoretically possible, but because such releases would occur from very slow dissociation of iron cyanides followed by rapid volatilization and dissipation, this is unlikely to be an exposure issue. DHFS has identified no public health concern from cyanide exposure to the general public at the site perimeter. Still, prudent management of worker safety at MGP sites suggests that cyanide should be monitored in air within the work zone when Prussian Blue soils are encountered.

Table 1. Composition of MGP wastes (From Gas Research Institute 1996). Chemicals in bold have been found to be an environmental or public health concern in soil, sediment, and groundwater at MGP sites in WI.

Inorganics	Metals	VOCs	Phenolics	PAHs
Ammonia	Aluminum	**Benzene**	Phenol	Acenaphthene
Cyanide	Antimony	**Ethyl Benzene**	Methyl phenol	Acenaphthylene
Nitrate	Arsenic	**Toluene**	Dimethyl Phenol	Anthracene
Sulfate	Barium	**Xylenes**		**Benzo(a)anthracene**
Sulfide	Cadmium	**Styrene**		**Benzo(a)pyrene**
Thiocyanates	Chromium			**Benzo(b)fluoranthene**
	Copper			Benzo(g,h,i)perylene
	Iron			Benzo(k)fluoranthene
	Lead			**Chrysene**
	Manganese			**Dibenzo(a,h)anthracene**
	Mercury			Dibenzofuran
	Nickel			**Fluoranthene**
	Selenium			Fluorene
	Silver			**Indeno(1,2,3-cd)pyrene**
	Vanadium			**Naphthalene**
	Zinc			Phenanthrene
				Pyrene
				2-Methylnaphthalene

Sulfur compounds. Sulfur-containing compounds, produced by pyrolysis or combustion of coal, are common in soil and groundwater at MGP sites. This is especially true in oxide box wastes, which may contain 40% sulfur oxides (Luthy *et al.* 1994). Pulmonary

Appendix H
Input Parameters Required to Develop the Tier 1 ROs for Non-MGP Chemicals without TACO Tier 1 ROs

Input Parameters Required to Develop Residential Soil Gas Tier 1 ROs for non-MGP Chemicals without TACO Tier 1 ROs

The soil gas ROs were developed using a combination of default and chemical specific properties.

The development of Tier 1 ROs requires the following parameters:

i. Target risk
ii. Exposure factors
iii. Soil properties
iv. Building parameters
v. Physical/chemical properties
vi. Toxicological information
vii. Models and equations

Default input parameters (i) through (iv) were obtained from Table M, Appendix C of Section 742 in draft TACO rule. Models and equations (vii) were obtained from Table L, Appendix C in Section 742 of draft TACO rule.

Both physical/chemical and toxicological parameters were obtained from various sources and are discussed below:

Toxicological Information

TACO recommends the use of unit risk factor (URF) and reference concentration (RfC) to calculate carcinogenic and non-carcinogenic ROs protective of indoor inhalation. As per Section 742.505(d) (2), the toxicological information was obtained from various sources and hierarchy presented in Office of Solid Waste and Emergency Response (OSWER) Directive 9285.7-53 (USEPA, 2003). The sources and hierarchy are listed below:

i. USEPA, Integrated Risk Information System (IRIS)
ii. California EPA. Office of Environmental Health Hazard Assessment (OEHHA), Toxicity Criteria Database
iii. Agency for Toxic Substances and Disease Registry (ATSDR), December 2006. Minimal Rik Levels (MRLs).
iv. USEPA, July 2008. Regional Screening Levels for Chemical Contaminants at Superfund Sites.

Of the 26 chemicals, toxicity information was available for 17 chemicals from the above four sources mentioned in USEPA (2003) and this information is presented in Table 3-4.

Physical/Chemical Properties

As per Section 742.610(a) in the draft TACO rule after contacting the IEPA, the physical/chemical properties were obtained from the agency recommended sources. The sources and their hierarchy are listed below:

i. Syracuse Research Institute (SRC), June 2008. CHEMFATE Chemical Search
ii. SRC, PHYPROP Database
iii. IEPA recommended values for non-TACO chemicals
iv. USEPA, June 2008. Regional Screening Levels for Chemical Contaminants at Superfund Sites, Chemical Specific Parameters
v. USEPA, 2004. User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings
vi. Texas Commission on Environmental Quality (TCEQ), June 2007. Table for Risk Reduction Program Rule.

For three chemicals namely 2-propanol, 3-chloropropene, and cyclohexane, two physical/chemical properties (critical temperature and enthalpy of vaporization) that require to calculating dimensionless Henry's law constant at system temperature were not available. Therefore, the Tier 1 ROs for these chemical were calculated using a dimensionless Henry's law constant at 25^{o}C.

The physical/chemical properties are presented in Table 3-5. The sources for these properties have also been mentioned in Table 3-5 designating the values with different fonts.

Appendix I
Potential Sources of 9 other non-MGP Chemicals without TACO Tier 1 ROs

Potential Sources of 9 Other Non-MGP Chemicals without Non-TACO Tier 1 ROs

Freon 114:

Freon 114 is the constituent of domestic products like foaming agents and refrigerants. These products may be released to the environment through various waste streams.

Source: Hazardous Substances Data Bank (HSDB)
http://toxnet.nlm.nih.gov/cgi-bin/sis/search/f?./temp/~OVAmKX:1

Ethanol:

Ethanol has been detected in emissions from animal wastes, plants, insects, forest fires, microbes. Therefore, ethanol may be generated by terrestrial activities.

Source: HSDB
http://toxnet.nlm.nih.gov/cgi-bin/sis/search/f?./temp/~7zFfu6:1

Tetrahydrofuran:

This chemical is the constituent of solvents like synthetic resins (e.g., vinyls) and in top-coating solutions. Therefore, this chemical may be released to the environment through various waste streams.

Source: HSDB
http://toxnet.nlm.nih.gov/cgi-bin/sis/search/f?./temp/~vKQhXe:1

2,2,4- Trimethylpentane:

This chemical is the constituent of polyethylene pipes used for distribution of drinking water. Hence it may be released from these from these pipes passing through subsurface near residential areas.

Source: HSDB
http://toxnet.nlm.nih.gov/cgi-bin/sis/search/f?./temp/~HHh0U6:1

n-Heptane:

This chemical is used as a solvent in petroleum based products. Hence may be released to the environment through various waste streams with the use of these products.

Source: HSDB
http://toxnet.nlm.nih.gov/cgi-bin/sis/search/f?./temp/~UhxTsM:1

2-Hexanone:

This chemical is used as a solvent for a wide variety of materials including lacquers, resins, oils, nitrocellulose, acrylates, vinyl, and alkyd coatings. Also, 2-Hexanone has been identified as disinfection by product of ozone treatment in drinking water. Therefore, it may be released to the soil environment through various waste streams.

Source: HSDB
http://toxnet.nlm.nih.gov/cgi-bin/sis/search

n-propylbenzene:

This is the constituent of asphalt and naphtha and it can be used as a solvent. Hence the use of these products may release this chemical into the soil environment. It also can be released to the environment in leachates and vapor emissions from landfills.

Source: HSDB
http://toxnet.nlm.nih.gov/cgi-bin/sis/search/f?./temp/~s4c6tw:1

4-Ethyltoluene:

This chemical is used as an additive in petroleum products and a solvent in a variety of agricultural and domestic products. Hence, it may be released to the soil environment due to the use of these products.

Source: Environment Agency
http://www.environment-agency.gov.uk/business/444255/446867/255244/substances/1024/?lang=_e&theme=&region=&subject=&searchfor=toluene&any_all=&choose_order=&exactphrase=&withoutwords=

1,3-Dichlorobenzene:

This chemical is used as an intermediate in the production of chlorophenols. It can also be used as fumigant and insecticide. Hence it may be released into the soil environment due to the domestic use of these products.

Source: HSDB
http://toxnet.nlm.nih.gov/cgi-bin/sis/search/f?./temp/~NJmNjJ:1

Appendix J
Illinois Licensed Professional Engineer Review Letter

SHIFRIN & ASSOCIATES, inc.
Environmental Engineers

December 10, 2008

Mr. Kendall L. Pickett, P.G., Senior Environmental Geologist
Risk Assessment & Management (RAM) Group, Inc.
5433 Westheimer Suite 725
Houston, Texas 77056

Re: Evaluation of Soil Gas Data Collected at Residential Properties near Former MGP Site Champaign, Illinois

Dear Mr. Pickett:

We have reviewed the draft of the referenced report. The soil gas data collected have been compared with applicable draft Illinois Environmental Protection Agency ("IEPA") Tiered Approach to Corrective Action ("TACO") Tier 1 soil gas remediation objectives for residential land use. It has been concluded that the concentrations of all chemicals in the samples collected were less than the comparable remediation objectives. Based upon these findings, the report concludes that the residual soil and groundwater impacts from the former MGP are not of concern.

Based upon our review, we agree with the above findings.

If you have any questions or require further information, please contact us at your convenience.

Sincerely yours,
SHIFRIN & ASSOCIATES, INC.

Walter G. Shifrin, P.E., President
Illinois Licensed Professional Engineer 062.021317

WALTER G. SHIFRIN 21317 REGISTERED PROFESSIONAL ENGINEER OF ILLINOIS

WGS:mkh

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